INTERVENTIONAL NEURORADIOLOGY

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Official Journal of:
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AAFTN - Asian & Australasian Federation of Interventional & Therapeutic Neuroradiology
SAWITN - South American Working Group in Interventional and Therapeutic Neuroradiology
INSHCM - Interventional Neuroradiology Society of HCM City, Viet Nam

Journal sponsored by:
JSNET - Japanese Society of Neuro Endovascular Therapy
FIO - Italian Federation of Ozone Therapy

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13th Congress of the World Federation of Interventional and Therapeutic Neuroradiology

12th Interdisciplinary Cerebrovascular Symposium, Intracranial Stent Meeting

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Past WFITN Meetings

1991  Zurich – Anton Valavanis
1993  Vancouver – Luc Picard
1995  Kyoto – Waro Taki
1997  New York – Alejandro Berenstein
1999  Algarve – Jorge Campos
2001  Seoul – In Sup Choi
2003  Recife – Ronie Leo Piske
2005  Venice – Marco Leonardi
2007  Beijing – Ling Feng
2009  Montreal – Jean Raymond and Daniel Roy
2011  Capetown – Allan Taylor and David Lefevre
2013  Buenos Aires – Pedro Lylyk and Luis Lemme Plaghos
2015  Gold Coast – Winston Chong, Hal Rice and Laetitia de Villiers
Letter from the President of WFITN

Dear Colleagues
Dear Friends

For the first time since its creation, the WFITN holds its congress in Australia. A distant country for most of us, but a country that has showed will, energy and enthusiasm to welcome us for the most important meeting of our Federation. What a symbol of the wide spread interest in this speciality, and of the importance of a young branch of the neurosciences!

Australia furthermore allows us to celebrate in Gold Coast the 25th anniversary of our Federation, in a city so far away from its original birthplace in Val d’Isère in 1990. Indeed, during a snowy January night after the scientific sessions of the WIN, nine neuro-interventionists met and set up the bases of what has become the World Federation of Interventional and Therapeutic Neuroradiology. Let me here pay a warm tribute to Alex Berenstein, Katsuia Goto, Pierre Lasjaunias (+), Andrew Molyneux, Jacques Moret, Makoto Negoro, Luc Picard, Akira Takahashi and Fernando Vinuela, pioneers of our discipline, without whom we would not stand where we currently are.

I send my most cordial thanks to Winston Chong, President of the 2015 Gold Coast meeting, to Mark Khangure, Honorary President of the meeting, to the local team of the organizing committee led by Hal Rice and Laetitia de Villiers, as to the ANZSNR, for hosting and organizing this congress that, I am sure, will fulfill all our expectations and prove once again the vitality of our discipline.

Two years since the meeting in Buenos Aires have passed, two years during which interventional neuroradiology has evolved, not only through the development of new devices, but also because it has confirmed its important place in the management of ischemic strokes. We have become unavoidable partners of the neuroscientific community, and interventional neuroradiology dialogues currently face to face with all its correspondents. Recognized, necessary, and respected, what are described as endovascular therapies, surgical neuroangiographic procedures, or minimally invasive neurological therapies, are performed worldwide nowadays and one cannot imagine a team interested in neurovascular diseases that would not collaborate with an interventional neuroradiologist: what a path has been trodden since the first attempts of endovascular treatments in non operable patients! These developments and successes have needed to be structured and, during its 25 years of life, through its various congresses, and specific working seminars, the WFITN has endorsed its full responsibility of a mature scientific society in publishing important recommendations about training, relationships with industry, continuing education. These recommendations have had and still have a strong impact in the organization of interventional neuroradiology in all continents, which witnesses the importance of our Society.

The Executive Committee that I have had the honour to chair since 2013 has been the link of a long chain of activities induced by all former Presidents, which allowed the WFITN to continue to live and form itself. The last two years have been very active for the Executive Committee that you have trusted by your votes in Buenos Aires. I want to thank again here all its members, Serge Bracard, Darren Orbach, Luc Picard, Sirintara Pongpech, Jurgen Reul, Michael Soderman, Allan Taylor, Karel Ter Brugge, René Van den Berg, who have supported all the ideas and projects that we have launched, and who all have spent lots of time and dedicated their energy to fill the missions which were assigned to them. I hope that you will consider that some positive impulse has been given to the WFITN thanks to their work and participation.

The four projects that we proposed during this mandate (new website, new constitution, charter of Ethics, teaching courses in Interventional Neuroradiology of the WFITN) have found their accomplishments or are on their way to be finalized. All details will be given to you during the next General Assembly, during which you will elect a new Executive Committee that, I am sure, will continue to work for our Federation with the same spirit of dedication, sense of community, and success as those that have been shown by our mentors and predecessors. During this next General Assembly, you will also have to vote for the President of the 2019 meeting and the city that is proposed to host this conference. The traditional intercontinental rotational rules will continue to allow the WFITN to travel from one continent to another, and to communicate thus with scientific partners all over the world.

But we are not there for the moment. Let us first enjoy the quality of this meeting and be enriched by all the scientific knowledge that will be shared with us.

Welcome to Australia and Gold Coast!
Welcome to the 13th Congress of the WFITN, and long life to our society!

Georges Rodesch, MD PhD
President of the WFITN

Georges Rodesch
Welcome Message

Dear Friends and Colleagues:

Welcome to WFITN 2015 and the Gold Coast, Australia!

The ANZSNR and the organizing committee are indeed honored to host the 13th WFITN meeting, the first time in Australasia.

The ANZSNR is an extremely active society and the organizing committee has been working tirelessly to produce a great scientific meeting; comprehensive, innovative, relevant and up to date.

The recent positive acute stroke trials in Australasia, Europe and America are highlights. A stimulating series of talks and debates have been organized around this topic, which will no doubt generate many discussions.

In addition to the traditional subjects such as aneurysms and AVMs, this meeting will also have a plenary focus on several innovative topics: Non vascular spinal intervention, Interventional oncology and Research. As in the Buenos Aires meeting in 2013, there will be a joint session with ICS which brings together MDs and PhDs, physicians, scientists and researchers working in the field of cerebrovascular diseases to share knowledge and technology to advance Interventional Neuroradiology.

More than anything else, this meeting provides a golden opportunity to rekindle old friendships, make new ones and interact with colleagues from all corners of the globe to share, to learn from and to teach each other in order to improve the lives of our patients and advance Interventional Neuroradiology.

And where better to do this than in one of the world’s most advanced convention center and the ambience of Gold Coast.

The Gold Coast is both exciting and relaxing at the same time. Meet the friendly natives, take in the great weather and the vibrant night life, have a fabulous lunch or dinner by the water, enjoy some water sports or golf or use Gold Coast as the springboard to visit and enjoy the rest of Australia or take a walk or simply just put up your feet and relax, but only after the meeting of course!

We welcome you. We have no doubt that you will have a rewarding time both professionally and socially.

Clinical A/Prof W. K. Winston Chong
President, WFITN 2015 Congress

Hal Rice, Laetitia De villiers, Alan Coulthard, Peter Mitchell, Mark Khangure,
Scientific and Organising Committee, WFITN 2015 Congress
ICS2015 - WELCOME MESSAGE

We welcome you to the international conference for the 12th Interdisciplinary Cerebrovascular Symposium, Intracranial Stent Meeting (ICS) 2015 being held on the Gold Coast, Queensland, Australia.

This conference will bring together PhD and MD experts from their respective fields to meet and present their work. Both undergraduate and post-graduate students will also present their research work. This will hence provide ample opportunities to network and exchange ideas.

ICS2015 will address issues concerning the understanding of cerebrovascular disease and its treatment. There will also be a significant focus on topics including the challenges of implementing flow diverter (FD) technology; new designs and proposals, the development of new material research; including nano technology and endovascular devices, computational fluid dynamic research, and software regulatory studies.

We would like to thank our invited guest speakers, authors and presenters for sharing their expertise and research results.

And of course we are most grateful to our generous sponsors and supporters.

We trust you will enjoy your time at ICS2015 and the beautiful Gold Coast.

Regards

Professor Yi Qian (Itsu Sen) and A/Professor Winston Chong
Conference Chairmen
WFITN Secretariat

There will be a booth from WFITN Secretariat for information about WFITN, membership, new applications, INR Journal, payment of membership fee (etc.) during the congress in Exhibition Hall 1.

Sabine Heckmann
WFITN Secretariat
Postal:
WFITN
c/o Beta Klinik
Joseph-Schumpeter-Allee 15
53227 Bonn

Mobile: 00 49 171 261 666 1
Fax: 0049 228 909075 99
Mail: secretary@wfitn.org, info@wfitn.org
Web: www.wfitn.org
WFITN

WFITN EXECUTIVE COMMITTEE
Georges Rodesch – President
Sirintara Pongpech – Vice President
Michael Söderman – Secretary General
Serge Bracard – Treasurer
Jürgen Reul – Past President
René van den Berg – Member at Large
Darren B. Orbach – Member at Large
Allan Taylor – Member at Large
Luc Picard – Honorary President
Karel TerBrugge – Editor-in-Chief

WFITN 13th Meeting

LOCAL ORGANISING COMMITTEE
Winston Chong – President
Hal Rice – Co Chair
Laetitia de Villiers – Co Chair
Alan Coulthard – ANZSNR President
Mark Khangure – Honorary President
Peter Mitchell – Treasurer

WFITN ADVISORY SCIENTIFIC COMMITTEE
In Sup Choi – USA
Sirintara Pongpech – Thailand
Pedro Lylyk – Argentina
Luis Lemme Plaghos – Argentina
Allan Taylor – South Africa

ABSTRACT REVIEW COMMITTEE
Winston Chong
Hal Rice
Laetitia de Villiers
Alan Coulthard
Mark Khangure
Peter Mitchell

ICS

ICS ORGANISING AND SCIENTIFIC COMMITTEE
Yi Qian – Chair
Winston Chong – Co Chair
Daniel Rufenacht – Committee Member
Makoto Ohta – Committee Member
Mike Iliopoulos – Committee Member
WFITN Faculty List

Alexander, Michael - USA
Benndorf, Goetz - USA
Biondi, Alessandra - France
Bland, Martin - UK
Braccard, Serge - France
Brew S - New Zealand
Brook, Aallan - USA
Brouwer, Patrick - Sweden
Campbell, Bruce - Australia
Cekirge, Saruhan - Turkey
Chapot, Rene - Germany
Chandra, Ranil - Australia
Chaudry, Umair Rashid - USA
Choi, In Sup - USA
Chong, Winston - Australia
Churojana Anchalee - Thailand
Civan, Islak - Turkey
Clouston, John - Australia
Coulthard, Alan - Australia
Cuong, Tran Chi - Vietnam
De Villiers, Laetitia - Australia
De La Fuente, Jose Alberto Garcia - Mexico
Ebinger, Martin - Germany
Fiorella David - USA
Frei, Donald - USA
Gobin, P - USA
Gonzalez, Gilberto - USA
Harrington, Timothy - Australia
Hyogo Toshio - Japan
Ishibashi T - Japan
Ito, Yasushi - Japan
Jiao, Liqun - China
Khangure Mark - Australia
Kim, Bum-Soo - South Korea
Kocer, Naci - Turkey
Kono, Kenichi - Japan
Krings, Timo - Canada
Lemme-Plaghos, Luis - Argentina
Leonardi, Marco - Italy
Ling, Feng - China
Lylyk, Pedro - Argentina
Mahadevan, Jeyaledchumy - Malaysia
Manfre, Luigi - Italy
McCauliffe, Will - Australia
Miao, ZR - China
Mitchell, Peter - Australia
Miyachi, Shigeru - Japan
Mocca, J - USA
Moret, Jacques - France
Morgan, Michael - Australia
Muto, Mario - Italy
Naidich, Thomas - USA
Nahser, Hans - UK
Orbach, Darren - USA
Parker, Geoffrey - Australia
Patel A - USA
Peluso, Jo - Netherlands
Picard, Luc - France
Pongpech, Sirintara - Thailand
Rennie, Adam - UK
Qian, Yi - Australia
Rice, Hal - Australia
Rodesch, Georges - France
Roy, Daniel - Canada
Saatci, Isil - Turkey
Sakai, Nobuyuki - Japan
Scooop, Rebecca - Australia
Siddiqui, Adnan - USA
Singh, TJ - Australia
Slater, LA - Australia
Soderman, Michael - Sweden
Spelle, Laurent - France
Srivatanakul, Kittipong - Japan
Stoodley, Marcus - Australia
Subramaniam, J - Malaysia
Suh, Dae Chul - South Korea
Sultan, Ali Aziz - USA
Szikora, Istvan - Hungary
Taylor, Allan - South Africa
Teng, Michael Mu Huo - Taiwan
TerBrugge, Karel - Canada
Thibault, Lucie - Canada
Turner, R - USA
Umair, R - Pakistan
Van Zwam, Wim - Netherlands
Wendertoth, Jason - Australia
Yan, Bernard - Australia
Yoshimura, Sinichi - Japan
Zhang, Hongqi - China
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SIEMENS PHILIPS
Gold Coast Convention and Exhibition Centre
2684 – 2690 Gold Coast Highway, Broadbeach QLD 4218
Phone: +61 7 5504 4000

CONGRESS LANGUAGE
English will be the official language of the 13th Congress of the World Federation of Interventional and Therapeutic Neuroradiology.

REGISTRATION AND INFORMATION DESK
The registration desk is located in the Main Foyer, Ground Floor, Gold Coast Convention and Exhibition Centre and is open during the following hours.

Sunday 8th November 2015  3:00 pm – 5:00 pm
Monday 9th November 2015  6:30 am – 8:00 pm
Tuesday 10th November 2015  7:00 am – 5:30 pm
Wednesday 11th November 2015  7:00 am – 5:30 pm
Thursday 12th November 2015  7:00 am – 5:30 pm
Friday 13th November 2015  7:00 am – 12:30 pm

CERTIFICATES OF ATTENDANCE
Certificates of attendance will be available at the congress from the registration desk.

WFITN MEMBERSHIP
There will be a booth from WFITN Secretariat for information about WFITN, membership, new applications, INR Journal, payment of membership fee (etc.) during the congress in the exhibition hall.

SPEAKER PREPARATION ROOM
The speaker preparation room is located in Room 4, Gold Coast Convention and Exhibition Centre. An audiovisual technician will be available to assist you with uploading your presentation.

Monday 9th November 2015  6:30 am – 7:00 pm
Tuesday 10th November 2015  7:00 am – 5:30 pm
Wednesday 11th November 2015  7:00 am – 5:30 pm
Thursday 12th November 2015  7:00 am – 5:30 pm
Friday 13th November 2015  7:00 am – 11:40 am

SOCIAL PROGRAM
Congress Welcome Ceremony and Reception
The Congress Welcome Ceremony and Reception will be held in the Exhibition Hall of the Gold Coast Convention and Exhibition Centre on Monday 9th November from 6:30 pm until 8:00 pm.

Gala Dinner WFITN 13th Congress
The Gala Dinner will be held at Jupiter’s Gold Coast on Wednesday 11 November from 7:00 pm until 11:00 pm.
WFITN Symposia
Monday 9 November 2015
13:00 – 13:45
Rooms 5–7

Tuesday 10 November 2015
07:00 – 08:30
Rooms 5–7
13:00 – 13:45
Rooms 5–7

Wednesday 11 November 2015
07:00 – 08:30
Rooms 5–7
13:00 – 13:45
Rooms 5–7

Thursday 12 November 2015
13:00 – 13:45
Rooms 5–7
18:15 – 19:15
Rooms 5–7
Venue Map

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<td>Arena 2</td>
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<td>08:30am to 09:40am</td>
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<td>PLENARY SESSION: Acute Ischaemic Stroke</td>
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<td>09:40am to 10:10am</td>
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<td>Sponsor Symposium: MicroVention</td>
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<td>Arena 2</td>
<td>The Great Debate: Cerebral Vascular Malformations – Where Are We Now</td>
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<td>Room 5-7</td>
<td>Sunrise Symposium: Philips</td>
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<td>07:30am to 08:15am</td>
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<td>Sponsor Symposium: Siemens</td>
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<td>PLENARY SESSION: Innovative and Exciting New Technology Physician Presentations</td>
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<td>Afternoon Tea Break</td>
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<td>03:30pm to 05:30pm</td>
<td>Room 5-9</td>
<td>Concurrent Sessions: Spinal and Neuro-oncology Interventions</td>
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<td></td>
<td>03:30pm to 05:30pm</td>
<td>Room 5-7</td>
<td>Proffered Papers</td>
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<td></td>
<td>03:30pm to 06:30pm</td>
<td>Arena 2</td>
<td>WFITN General Assembly</td>
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<td>04:30pm to 06:30pm</td>
<td>Arena 2</td>
<td>Gala Dinner WFITN 13th Congress</td>
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<tr>
<td>Thursday, 12th November</td>
<td>07:00am to 08:15am</td>
<td>Room 5</td>
<td>Registration</td>
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<td>07:30am to 08:15am</td>
<td>Room 5</td>
<td>LECTURE SERIES: Back to Basics</td>
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<td>08:30am to 10:30am</td>
<td>Arena 2</td>
<td>PLENARY SESSION: Cerebral Aneurysms</td>
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<tr>
<th>Time</th>
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<tr>
<td>10:30am to 11:00am</td>
<td>Arena 2</td>
<td>Morning Tea Break</td>
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<tr>
<td>11:00am to 01:00pm</td>
<td>Arena 2</td>
<td>PLENARY SESSION: Cerebral Aneurysms</td>
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<tr>
<td>01:00pm to 02:00pm</td>
<td>Rooms 5–7</td>
<td>Lunch Break</td>
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<tr>
<td>01:00pm to 01:45pm</td>
<td>Rooms 5–9</td>
<td>Sponsor Symposium: Medtronic</td>
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<tr>
<td>02:00pm to 03:30pm</td>
<td>Arena 2</td>
<td>The Great Debate: Cerebral Aneurysms</td>
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<td>03:30pm to 04:00pm</td>
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<td>Afternoon Tea Break</td>
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<td>04:00pm to 05:30pm</td>
<td>Rooms 5–9</td>
<td>Concurrent Sessions: Cerebral Aneurysms</td>
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<tr>
<td>04:00pm to 06:00pm</td>
<td>Rooms 5–9</td>
<td>Proffered Papers</td>
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<tr>
<td>06:15pm to 07:15pm</td>
<td>Rooms 5–7</td>
<td>Sponsor Symposium: Medtronic</td>
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<tr>
<td>Friday, 13th November</td>
<td>13th WFITN Congress 2015 and ICS Intracranial Stent Meeting 2015</td>
<td>Registration</td>
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<tr>
<td>07:00am to 08:15am</td>
<td>Room 5</td>
<td>LECTURE SERIES: Back to Basics</td>
</tr>
<tr>
<td>07:30am to 08:15am</td>
<td>Arena 2</td>
<td>JOINT WFITN/ICS 2015 PLENARY SESSION: Flow Diversion Therapy</td>
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<td>Arena 2</td>
<td>The Great Debate: Flow Diversion Therapy</td>
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<td>JOINT WFITN/ICS 2015 PLENARY SESSION: Flow Diversion Therapy</td>
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<td>The Great Debate: Flow Diversion Therapy</td>
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<tr>
<td>12:30pm to 12:35pm</td>
<td>Arena 2</td>
<td>Closing Ceremony of WFITN 13th Congress</td>
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<td>Friday, 13th November</td>
<td>Rooms 5–6</td>
<td>ICS Intracranial Stent Meeting 2015 and 13th WFITN Congress 2015</td>
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<tr>
<td>12:30pm to 01:30pm</td>
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<td>Registration</td>
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<tr>
<td>01:30pm to 02:20pm</td>
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<td>Aneurysm Database</td>
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<td>02:20pm to 03:00pm</td>
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<td>MicroVention Special Session: Clinical Application and Technology of FRED</td>
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<tr>
<td>03:00pm to 03:15pm</td>
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<td>Afternoon Tea</td>
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<tr>
<td>03:15pm to 05:35pm</td>
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<td>Cutting Edge Approaches to Vascular Biomedical Research</td>
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<td>05:35pm to 05:45pm</td>
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<td>2016 ICS Presentation</td>
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<tr>
<td>Saturday, 14th November</td>
<td>Crowne Plaza Surfers Paradise – Norfolk Room</td>
<td>ICS Intracranial Stent Meeting 2015</td>
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<tr>
<td>08:30am to 09:15am</td>
<td></td>
<td>Aneurysm Endovascular Therapy and Image Analysis</td>
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<tr>
<td>09:15am to 10:30am</td>
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<td>The Evolution of Computational Haemodynamics as a Clinical Tool in Decision Making</td>
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<td>10:30am to 10:50am</td>
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<td>Morning Tea Break</td>
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<tr>
<td>10:50am to 12:25pm</td>
<td></td>
<td>Cerebrovascular Haemodynamics (Haemodynamic Based Aneurysm Risk Estimation)</td>
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<tr>
<td>12:25pm to 01:45pm</td>
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<td>Lunch Break</td>
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<tr>
<td>01:45pm to 02:50pm</td>
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<td>Cerebral Aneurysm Molecular/Animal Research (Develop a Unifying Concept by Combining the CFD Parameters and Biology/Morphology of the Aneurysms)</td>
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<tr>
<td>02:50pm to 03:10pm</td>
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<td>Afternoon Tea Break</td>
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<tr>
<td>03:10pm to 04:55pm</td>
<td></td>
<td>Virtual Technology Application in Stent Treatment and Development</td>
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<tr>
<td>04:55pm to 05:20pm</td>
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<td>Review for CFD Challenge in Cerebral Aneurysm Risk Diagnosis</td>
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<tr>
<td>05:20pm to 05:40pm</td>
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<td>Panel Discussion</td>
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<td>05:40pm to 05:50pm</td>
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<td>ICS2015 Conference Close</td>
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<tr>
<td>06:30pm to 10:45pm</td>
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<td>ICS2015 Conference Dinner</td>
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Program WFITN, Monday 9 November 2015
Please refer to the program in the congress app and handbook for the latest updates.

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<thead>
<tr>
<th>Time</th>
<th>Room/Area</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>07:00 – 08:10</td>
<td>Registration</td>
<td>Back to Basics Lecture Series</td>
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<tr>
<td>07:30 – 08:10</td>
<td>Room 5</td>
<td>Acute Ischaemic Stroke Imaging. The Evidence, Basics and How to Apply it Clinically</td>
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<tr>
<td></td>
<td></td>
<td>Professor Gilberto Gonzalez, Director of Neuroradiology Division, Massachusetts</td>
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<td>General Hospital, Boston, USA</td>
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<td>08:15 – 08:30</td>
<td>Arena 2</td>
<td>Official Opening of WFITN 13th Congress</td>
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<td></td>
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<td>Dr Georges Rodesch, President, WFITN, Paris, France</td>
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<td>Professor Alan Coulthard, President, ANZSNR, Brisbane, Australia</td>
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<td>Associate Professor Winston Chong, President, WFITN 2015, Melbourne, Australia</td>
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<tr>
<td>08:30 – 09:40</td>
<td>Arena 2</td>
<td>Plenary Session: Acute Ischaemic Stroke</td>
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<tr>
<td>08:30 – 08:50</td>
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<td>Pathophysiology and Current Medical Management of Acute Ischaemic Stroke</td>
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<td>08:50 – 09:10</td>
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<td>It's Happening so FAST</td>
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<td></td>
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<td>Comprehensive Overview of Recent Acute Ischaemic Stroke Trials</td>
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<td>Dr Bruce Campbell, Neurologist and Stroke Research Fellow, The University of</td>
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<td>Melbourne, Melbourne, Australia</td>
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<td>09:10 – 09:40</td>
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<td>Perfusion – Diffusion – Why the Confusion</td>
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<td>Imaging Triage for Acute Ischaemic Stroke Intervention</td>
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<td>Professor Gilberto Gonzalez, Director – Neuroradiology Division, Massachusetts</td>
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<td>General Hospital, Boston, USA</td>
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<td>09:40 – 10:10</td>
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<td>Morning Tea Break</td>
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<tr>
<td>10:10 – 13:00</td>
<td>Arena 2</td>
<td>Plenary Session: Acute Ischaemic Stroke</td>
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<td>10:10 – 11:30</td>
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<td>From the Horse’s Mouth Authors Discuss Their Trial Results</td>
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<td>MR Clean - van Zwam, W (Netherlands)</td>
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<td>Extend IA - Mitchell, P (Australia)</td>
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<td>SWIFT PRIME</td>
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<td>REVASCAT</td>
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<td>Therapy - Mocco, J (USA)</td>
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<td>THRACE - Bracard, S (France)</td>
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<td>Escape - Roy, D (Canada)</td>
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<td>EAST - Miao, ZR (China)</td>
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<tr>
<td>11:30 – 11:45</td>
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<td>Acute Ischaemic Stroke - Endovascular Thrombectomy in the Real World</td>
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<td>Application of New Acute Stroke Trials in Contemporary Clinical Practice</td>
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<td>Dr Timothy Harrington, Interventional Neuroradiologist, North Shore Radiology &amp;</td>
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<td></td>
<td>Nuclear Medicine, Sydney, Australia</td>
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<td>11:45 – 12:15</td>
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<td>Acute Ischaemic Stroke Management in the Asia Pacific Region</td>
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<td>11:45 – 11:55</td>
<td>Korea</td>
<td>Preventative Stroke Therapies</td>
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<td>Intracranial Stenosis Treatment – Intracranial Stenting</td>
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<tr>
<td>12:05 – 12:15</td>
<td>Japan</td>
<td>Preventative Stroke Therapies</td>
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<td>12:15 – 12:35</td>
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<td>Intracranial Stenosis Treatment – Intracranial Stenting</td>
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</table>
07:00 – 08:10  Registration

| 12:25 – 12:35  | Extracranial Stenosis Treatment – Carotid Stenting  
| Professor Yasushi Ito, Department of Neurosurgery, Brain Research Institute, Niigata University, Niigata, Japan  
| 12:35 – 12:50  | Wake Me Up Before You Go  
| NeuroAnaesthesia for Acute Ischaemic Stroke  
| 12:50 – 13:00  | Interim Report on the WEAVE Intracranial Stent Trial: First 50 Consecutive Patients  
| Dr Michael Alexander, Vice-Chairman, Cedars-Sinai Medical Center, Los Angeles, USA  
| 13:00 – 14:00  | Lunch Break  
| 14:00 – 15:00  | The Great Debate: Contemporary Acute Ischaemic Stroke Treatment  
| International Panel of Experts from High Volume Ischaemic Stroke Centres Debate and Discuss Topical Controversies with Live Audience Interaction  
| Acute Imaging – DWI vs. CTP  
| NeuroAnaesthesia – Awake vs. Asleep  
| Device Utilisation – Stent Trier vs. Suction  
| Difficult Ischaemic Stroke Case Presentations  
| Dr Michael Mu Huo Teng, Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan  
| Professor Sirintara Pongpech, Radiologist, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand  
| Acute Stroke Triage Imaging – DWI vs. CTP  
| Dr Bruce Campbell, Neurologist and Stroke Research Fellow, The University of Melbourne, Melbourne, Australia  
| Professor Gilberto Gonzalez, Director – Neuroradiology Division, Massachusetts General Hospital, Boston, USA  
| 15:00 – 15:30  | Afternoon Tea Break  
| 15:30 – 17:30  | Concurrent Sessions: Acute Ischaemic Stroke  
| Room 5  
| 15:30 – 15:50  | Focused: Update of INR Treatment for Intracranial Hypertension  
| Dr Geoffrey Parker, Interventional Neuroradiologist, Royal Prince Alfred Hospital and Macquarie University Hospital, Sydney, Australia  
| Room 5  
| 15:50 – 16:10  | Focused: Minimising the Time from Acute Stroke Onset to Clot Removal  
| Associate Professor Bernard Yan, Neurologist and Endovascular Neurointerventionist, Royal Melbourne Hospital, Melbourne, Australia  
| Room 5  
| 16:10 – 16:25  | Focused: Posterior Fossa Acute Stroke: Endovascular Treatment  
| Professor Naci Kocer, Department of Radiology, Istanbul University, Istanbul, Turkey  
| Room 5  
| 16:25 – 16:55  | Focused: Acute Complications and Long Term Effects of Mechanical Thrombectomy of Acute Ischaemic Stroke  
| Professor Shinichi Yoshimura, Clinical Director of Neurosurgery, Hyogo College of Medicine, Kobe, Japan  
| Room 5  
| a. Who Should be Performing These Procedures  
| b. Suction vs. Stentriever  
| c. General Anaesthetic vs. No General Anaesthetic  
| d. Balloon Catheter Guide vs. No Balloon Guide  
| e. How Distal? M2? M3?  
| Room 6  
| 15:30 – 17:30  | Proffered Papers  
| 001; 002; 003; 004; 005; 006; 007; 008; 009; 010; 011; 012; 013; 014; 015; 016; 017  
| Room 7  
| 15:30 – 17:30  | Proffered Papers  
| 018; 019; 020; 021; 022; 023; 024; 025; 026; 027; 028; 029; 030; 031; 032; 033  

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<td>15:30 – 17:30</td>
<td>Room 8 <strong>Proffered Papers</strong> 034; 035; 036; 037; 038; 039; 040; 041; 042; 043; 044; 045; 046; 047; 048; 049</td>
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<td>15:30 – 17:30</td>
<td>Room 9 <strong>Proffered Papers</strong> 050; 051; 052; 053; 055; 056; 057; 058; 059; 060; 061; 062; 063; 064</td>
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<td>17:30 – 18:30</td>
<td>Arena 2 <strong>Pierre Lasjaunias Lecture</strong></td>
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<td><strong>Technological Advances in Interventional Neuroradiology</strong></td>
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<td><strong>Professor Jacques Moret</strong>, Chairman Department of Interventional Neuroradiology, NEURI Center, Beaujon Hospital, Paris, France</td>
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<tr>
<td>17:30 – 18:00</td>
<td>18:00 – 18:30 <strong>Ethics in Interventional Neuroradiology</strong></td>
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<td><strong>Dr Luc Picard</strong>, Diagnostic And Interventional Neuroradiology, University Hospital, Nancy, France</td>
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<tr>
<td>18:30 – 20:00</td>
<td>Exhibition Hall <strong>WFITN 13th Congress Welcome Ceremony and Reception</strong></td>
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### Program WFITN, Tuesday 10 November 2015

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<tr>
<td>07:00 – 08:15</td>
<td>Registration</td>
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| 07:00 – 08:30 | Sunrise Symposium
Phenox            |
| 07:30 – 08:15 | Back to Basics Lecture Series
Room 5
Spinal Arteriovenous Shunts
Professor Sirintara Pongpech, Radiologist, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand
Spinal Vascular Anatomy
Dr Georges Rodesch, Department of Diagnostic and Therapeutic Neuroradiology, Hospital Foch, Paris, France |
| Arena 2       | 08:30 – 10:00 Plenary Session: Cerebral Vascular Malformations
08:30 – 09:00 Natural History and Current Concepts of Cerebral Arteriovenous Malformations
Professor Michael Morgan, Professor of Cerebrovascular Neurosurgery, Macquarie University, Sydney, Australia
09:00 – 09:20 Clinical Management of Incidental Cerebral Arteriovenous Malformations
New Trials: What More Do They Add
Dr Daniel Roy, Director of Diagnostic Radiology Program, University of Montreal, Montreal, Canada
09:20 – 09:40 Heal with Steel
Symptomatic and Ruptured Cerebral Arteriovenous Malformations – Surgical Management
Professor Michael Morgan, Professor of Cerebrovascular Neurosurgery, Macquarie University, Sydney, Australia
09:40 – 10:00 Go With the Flow
Symptomatic and Ruptured Cerebral Arteriovenous Malformations – Endovascular Management
Dr Jo Peluso, Department of Neurosurgery, St Elisabeth Hospital, Tilburg, Netherlands |
| Arena 2       | 10:00 – 10:30 Morning Tea Break                                       |
| Arena 2       | 10:30 – 13:00 Plenary Session: Cerebral Vascular Malformations
10:30 – 10:50 Get to the Point
Role of Targeted Endovascular Treatment for Intranidal Aneurysms and as Adjunctive Preoperative and Preradiosurgery Treatment
Dr Timo Krings, Krembil Neuroscience Centre, University Health Network, Toronto, Canada
10:50 – 11:10 Reverse This
Transvenous Endovascular Treatment of Cerebral Arteriovenous Malformations
Professor Laurent Spelle, Professor of Interventional Neuroradiology, Brain Vascular Center Beaujon University Hospital, Paris, France
11:10 – 11:30 Update on Radiosurgery Treatment for Cerebral Arteriovenous Malformations and Cerebral Arteriovenous Dural Fistulas
Dr Michael Soderman, Chief Neuroangiography and Stereotaxy, Department of Neuroradiology, Karolinska Hospital, Stockholm, Sweden
11:30 – 11:50 Cerebral Dural Arteriovenous Fistula – Origin, Pathophysiology and Natural History
Professor Shigeru Miyachi, Department of Neurosurgery, Osaka Medical College, Osaka, Japan
11:50 – 12:10 Cerebral Dural Arteriovenous Fistula – Endovascular Treatment and Long Term Results
Professor Dae Chul Suh, Department of Radiology and Research Institute of Radiology, Asan Medical Center, University of Ulsan, College of Medicine, Seoul, Korea
12:10 – 12:30 Latest Endovascular Techniques in Cerebral Dural Arteriovenous Fistula Treatment: Including Transarterial and Transvenous Balloon Assistance
Professor René Chapot, Chief Physician, Clinic for Radiology and Neuroradiology, Alfréd Krupp Hospital, Essen, Germany
12:30 – 12:50 Surgical Management of Cerebral Dural Arteriovenous Fistula
Professor Michael Morgan, Professor of Cerebrovascular Neurosurgery, Macquarie University, Sydney, Australia
12:50 – 13:00 Proffered Paper |

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<tr>
<td>13:00 – 14:00</td>
<td>Lunch Break</td>
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<td>13:00 – 13:45</td>
<td>Sponsor Symposium</td>
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<td>MicroVention</td>
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<td>Arena 2</td>
<td>14:00 – 15:00 The Great Debate: Cerebral Vascular Malformations – Where Are We Now</td>
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<td>International Panel of Experts from High Volume AVM Treatment Centres Debate and Discuss Topical Controversies with Live Audience Interaction</td>
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<td>Timing of Acute Treatment</td>
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<td>Role of Partial and Staged Embolisation</td>
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<td>Combination Therapy:</td>
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<td>Embolisation</td>
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<td>Choosing the Optimal Embolic Agent</td>
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<td>Awake vs. General Anaesthesia</td>
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<td>15:00 – 15:30</td>
<td>Afternoon Tea Break</td>
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<td>15:30 – 17:30</td>
<td>Concurrent Sessions: Cerebral Vascular Malformations</td>
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<tr>
<td>Room 5</td>
<td>15:30 – 15:45 Focused: Paediatric AVM – Vein of Galen Malformation</td>
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<td></td>
<td>Dr Adam Rennie, Consultant Interventional Neuroradiologist, Great Ormond Street Hospital and the National Hospital of Neurology and Neurosurgery, London, United Kingdom</td>
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<tr>
<td>Room 5</td>
<td>15:45 – 16:00 Focused: Paediatric AVM &amp; Aneurysms – Others</td>
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<td></td>
<td>Dr Adam Rennie, Consultant Interventional Neuroradiologist, Great Ormond Street Hospital and the National Hospital of Neurology and Neurosurgery, London, United Kingdom</td>
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<tr>
<td>Room 5</td>
<td>16:00 – 16:15 How I Do It: HHT – Brain and AVM</td>
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<td>Professor Karel TerBrugge, Chief of Neuroradiology, Toronto Western Hospital, Professor, University of Toronto, Toronto, Canada</td>
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<tr>
<td>Room 5</td>
<td>16:15 – 16:30 Focused: Embolisation of High Flow Intracranial AV Fistulas</td>
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<tr>
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<td>Professor Tran Chi Cuong, Neurosurgeon and Neurointerventionalist, University Medical Centre, Ho Chi Minh City, Vietnam</td>
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<td>Room 5</td>
<td>16:30 – 16:45 How I Do It: How I Perform Transvenous Access of the Cavernous Sinus</td>
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<td>Dr Goetz Benndorf, Adjunct Professor in Neuroradiology, University of Southern Denmark, Houston, USA</td>
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<td>Room 5</td>
<td>16:45 – 17:00 How I Do It: How I Perform Transorbital Embolisation of Cavernous Sinus DAVF</td>
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<td>Dr Jason Wenderoth, Interventional Neuroradiologist, Prince of Wales and Sydney Children’s, Prince of Wales Private, Macquarie University and Liverpool Hospitals, Sydney, Australia</td>
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<tr>
<td>Room 5</td>
<td>17:00 – 17:30 M &amp; M Expert Panel: DAVF and AVM</td>
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<td>1. Surgery vs. Endovascular Embolisation for different DAVF Cases</td>
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<td>Superior Sagittal sinus</td>
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<td>Transverse / Sigmoid sinus</td>
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<td>Anterior Cranial Fossa sinus</td>
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<td>Room 6</td>
<td>16:00 – 17:30 Antiplatelet / Anti Coagulation in Endovascular Treatment of Neurovascular Diseases – What’s New?</td>
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<td>Dr Lucie Thibault, WFITN Member – WFITN Consultant and International Lecturer</td>
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<td>Room 7</td>
<td>15:30 – 17:30 Proffered Papers</td>
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<td>07:00 – 08:15</td>
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<td>07:00 – 08:30</td>
<td>Sunrise Symposium</td>
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<tr>
<td>07:30 – 08:15</td>
<td>Neuroanatomy/Embryology for NeuroIntervention</td>
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<tr>
<td>Room 5</td>
<td>Professor Thomas Naidich, Director of Neuroradiology, Mount Sinai Hospital, New York, USA</td>
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<tr>
<td>Arena 2</td>
<td>Plenary Session: Spinal and Neuro-oncology Interventions</td>
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<tr>
<td>08:30 – 10:00</td>
<td>Classification and Natural History of Spinal Vascular Malformations</td>
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<tr>
<td>Philips</td>
<td>Professor Georges Rodesch, Department of Diagnostic and Therapeutic Neuroradiology, Hospital Foch, Paris, France</td>
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<tr>
<td>08:30 – 09:20</td>
<td>Surgical and Endovascular Treatment of Spinal Vascular Malformations: Experience of 1000 Cases</td>
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<td>Arena 2</td>
<td>Ozone-Ozone Therapy for Lumbar Disc Herniation</td>
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<tr>
<td>08:30 – 09:45</td>
<td>Fluoroscopic Guided Endoscopic Treatment of Lumbar Disc Herniation</td>
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<tr>
<td>Dr Patrick Brouwer</td>
<td>Neurointerventionalist, Karolinska Hospital, Stockholm, Sweden</td>
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<td>08:50 – 11:15</td>
<td>Interventional Neuro-Oncology</td>
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<td>Professor Y Pierre Gobin</td>
<td>Professor of Radiology in Neurological Surgery, Weill Cornell Medical College, New York City, USA</td>
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<td>10:00 – 10:30</td>
<td>Morning Tea Break</td>
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<td>Oxygen-Ozone Therapy for Lumbar Disc Herniation</td>
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<tr>
<td>Professor Marco Leonardi</td>
<td>Chair of Neuroradiology, University of Bologna, Bologna, Italy</td>
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<td>11:15 – 12:05</td>
<td>Interventional Neuro-Oncology</td>
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<td>Professor Sirintara Pongpech</td>
<td>Radiologist, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand</td>
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<td>12:05 – 12:35</td>
<td>Transarterial Chemotherapy of Retinoblastoma</td>
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<td>12:35 – 13:00</td>
<td>Special Guest Lecture Professor Thomas Naidich, Director of Neuroradiology, Mount Sinai Hospital, New York, USA</td>
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<td>13:30 – 14:00</td>
<td>Lunch Break</td>
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<td>Sponsor Symposium</td>
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<tr>
<td>14:00 – 15:00</td>
<td>Innovative and Exciting New Technology Physician Presentations</td>
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<td>Room 5</td>
<td>How I Do It: Percutaneous Endoprothesis and Fixation of Spinal Conditions</td>
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<tr>
<td>Dr Mario Muto</td>
<td>Chair of Radiology, Ospedale Carderelli, Naples, Italy</td>
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<td>15:30 – 16:00</td>
<td>How I Do It: Ozone Therapy for Disc Disease</td>
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<tr>
<td>Dr Umair Rashid Chaudhry</td>
<td>Chief Consultant Neuroradiologist, Government Lahore General Hospital, Lahore, Pakistan</td>
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<td>Room 5</td>
<td>Dangerous Extracranial-Intracranial Anatomosis</td>
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<td>Professor In Sup Choi, Department of Radiology, Lahey Hospital and Medical Center, Burlington, USA</td>
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<td>Clinical Angioarchitectural Correlation with Rupture Risk and Treatment</td>
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<td>Arena 2</td>
<td>08:30 – 10:30 Plenary Session: Cerebral Aneurysms</td>
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<td>Is it All in the Wall</td>
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<td>Current Concepts of Cerebral Aneurysms:</td>
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<td>Vessel Wall Disease, Pathophysiology and Growth</td>
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<td>08:50 – 09:15 Natural History of Cerebral Aneurysms and the Current Status of Surgical Management</td>
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<td>Professor Michael Morgan, Professor of Cerebrovascular Neurosurgery, Macquarie University, Sydney, Australia</td>
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<td>09:15 – 09:35 The Fast and the Furious</td>
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<td>Current Status of Endovascular Management of Cerebral Aneurysms</td>
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<td>Professor Jacques Moret, Chairman Department of Interventional Neuroradiology, NEURI center, Beaujon Hospital, Paris, France</td>
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<td>09:35 – 09:55 Don't Underestimate Me – I May Be Small but Could End it All</td>
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<td>Indications for Treatment of Unruptured Small Cerebral Aneurysms</td>
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<td>Dr Aman Patel, Director of Cerebrovascular and Endovascular Neurosurgery and Co-Director of the Neuroendovascular Program, Massachusetts General Hospital, Boston, USA</td>
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<td>09:55 – 10:15 Oh Not You Again</td>
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<td>Risk of Rupture of Residual or Recurrent Cerebral Aneurysms:</td>
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<td>Indications for Surveillance and Retreatment</td>
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<td>Associate Professor Allan Taylor, Head of Neurovascular Unit and Head of Firm Groote Schuur Hospital, Visiting Professor University of the Witwatersrand, Cape Town, South Africa</td>
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<td>10:15 – 10:30</td>
<td>To the End of the Earth</td>
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<td>Follow Up Imaging of Endovascularly Treated Cerebral Aneurysms</td>
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<td>Professor Alan Coulthard, Head, Academic Discipline of Medical Imaging, University of Queensland, Royal Brisbane Hospital, Brisbane, Australia</td>
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<td>Cerebral Vasospasm and Delayed Neurologic Deficit:</td>
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<td>Pathophysiology and Current Concepts</td>
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<td>Dr John Clouston, Director Medical Imaging, Interventional Neuroradiologist, Royal Brisbane and Women's Hospital, Brisbane, Australia</td>
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<td>11:30 – 12:00</td>
<td>Vasospasm and Delayed Neurologic Deficit:</td>
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<td>Clinical and Imaging Indications for Medical Management and Intervention</td>
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<td>Professor Marcus Stoodley, Professor of Neurosurgery, Macquarie University, Sydney, Australia</td>
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<td>12:00 – 12:15</td>
<td>If the Chemistry is Right</td>
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<td>Cerebral Vasospasm and Delayed Neurologic Deficit:</td>
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<td>Endovascular Pharmacological Treatment</td>
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<td>Dr Tj Singh, Interventional Neuroradiologist, Neurological Intervention and Imaging Service, Perth, Australia</td>
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<td>12:15 – 12:30</td>
<td>Cerebral Vasospasm and Delayed Neurologic Deficit:</td>
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<td>Endovascular Mechanical Treatment</td>
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<td>Dr Mohammad Ali Aziz-Sultan, Chief of Vascular/Endovascular Neurosurgery, Brigham and Women's Hospital, Boston, USA</td>
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<td>12:30 – 13:00</td>
<td>Lies and Damned Lies</td>
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<td>Evidence Based Medicine:</td>
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<td>Can We Trust the Published Evidence?</td>
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<td>Professor Martin Bland, Professor of Health Statistics, University of York, York, United Kingdom</td>
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<td>13:00 – 14:00</td>
<td>Lunch Break</td>
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### Arena 2 14:00 – 15:30

The Great Debate: Cerebral Aneurysms

Panel Discussion: Lost in Translation: From Trials to Clinical Practice: Discussions Using Recent Trials as Examples

Chair: Professor Martin Bland, Professor of Health Statistics, University of York, York, United Kingdom

Moderators:
- Professor Alan Coulthard, Head, Academic Discipline of Medical Imaging, University of Queensland, Brisbane, Australia
- Associate Professor Winston Chong, Interventional Neuroradiology, Monash Medical Centre, Melbourne, Australia

Presenters:
- Professor Martin Bland, Professor of Health Statistics, University of York, York, United Kingdom
- Dr Daniel Roy, Director of Diagnostic Radiology Program, University of Montreal, Montreal, Canada

### Room 5 14:00 – 15:00

Workshop: Clinical Papers, Research Methods and Biostatistics

**Professor Martin Bland**, Professor of Health Statistics, University of York, York, United Kingdom

### Room 5 16:45 – 17:30

M & M: Vasospasm and Aneurysms

1. Balloon vs. Drugs – Complications vs. Durability for Vasospasm
2. How to Choose PTS for Intervention for Vasospasm
3. Difficult cases and lessons learned

### Room 6 16:00 – 18:00

Proffered Papers

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### Room 7 16:00 – 18:00

Proffered Papers

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Proffered Papers

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18:15 – 19:15

Sunset Symposium

Medtronic
**Joint Program WFITN and ICS, Friday 13 November 2015**

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<td>07:00 – 08:15</td>
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<td>07:30 – 08:15</td>
<td>Back to Basics Lecture Series</td>
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<td>Room 5</td>
<td><strong>Cerebral Venous Anatomy</strong>&lt;br&gt;<strong>Professor Karel TerBrugge</strong>, Chief of Neuroradiology, Toronto Western Hospital, Professor, University of Toronto, Toronto, Canada&lt;br&gt;<strong>Technical Aspects of Paediatric Neurointerventions</strong>&lt;br&gt;<strong>Dr Darren Orbach</strong>, Division Chief, Interventional &amp; Neurointerventional Radiology, Department of Radiology, Boston Children's Hospital, Boston, USA</td>
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</table>
| Arena 2       | **08:30 – 10:30 JOINT WFITN/ICS 2015 Plenary Session: Flow Diversion Therapy**<br>**08:30 – 08:50**<br>**Know the Flow**<br>Flow Diverting Stents: Indications, Outcomes and Complications in Cerebral Aneurysm Treatment<br>**Professor Rene´ Chapot**, Chief Physician, Clinic for Radiology and Neuroradiology, Alfred Krupp Hospital, Essen, Germany<br>**08:50 – 09:10**<br>**It's On the Inside**<br>Internal Flow Diversion: Indications, Outcomes and Complications in Cerebral Aneurysm Treatment<br>**Professor Pedro Lylyk**, Neurosurgeon, Director and CEO, ENERI (Equipo de Neurocirugía Endovascular y Radiología Intervencionista) and Clinica La Sagrada Familia, Buenos Aires, Argentina<br>**09:10 – 09:30**<br>**Spoilt for Choice – What When and Why**<br>Device Decisions for Endovascular Treatment of Cerebral Aneurysms<br>**Dr István Szikora**, President, National Institute of Neurosciences, Budapest, Hungary<br>**09:30 – 09:50**<br>**Blood On Your Hands**<br>Utilizing Flow Diversion Therapy in Treatment of Ruptured Cerebral Aneurysms<br>**Associate Professor Hal Rice**, Diagnostic and Interventional Radiologist, Qscan Radiology Clinics and Gold Coast University Hospital, Gold Coast, Australia<br>**09:50 – 10:10**<br>**Show the Flow**<br>Computed Flow Dynamics Has Come of Age: Application of CFD in Day to Day Clinical Practice Part I<br>**Professor Yi Qian**, Professor, Macquarie University, Sydney, Australia<br>**10:10 – 10:30**<br>**Show the Flow**<br>Computed Flow Dynamics Has Come of Age: Application of CFD in Day to Day Clinical Practice Part II<br>**Dr Yuichi Murayama**, Manager of Medical Care Division, The Jikei University School of Medicine, Tokyo, Japan<br>**10:30 – 11:00**<br>**Morning Tea Break**<br>**11:00 – 11:40 JOINT WFITN/ICS 2015 Plenary Session: Flow Diversion Therapy**<br>**11:00 – 11:10**<br>Latest Endovascular Technology in Flow Diverting Stents and Intrasaccular Flow Disruption Devices<br>**Dr Ajay Wakhloo**, Director of Neurointerventional Radiology/Endovascular Neurosurgery, Umass Memorial Medical Centre, Worcester, USA<br>**11:10 – 11:30**<br>Cerebral Aneurysm Challenge<br>**Which Aneurysm Has Ruptured?**<br>Can Computed Flow Dynamics Help the Clinician<br>**Dr Kenichi Kono**, Neurosurgeon, Wakayama Rosai Hospital, Wakayama, Japan<br>**11:30 – 12:30**<br>**Great Debate: Flow Diversion Therapy**<br>International Panel of Experts from High Volume Cerebral Aneurysm Treatment Centres Debate and Discuss Topical Controversies with Live Audience Interaction<br>**Flow Diversion in Bifurcation Aneurysms**<br>**Flow Diversion in the Posterior Circulation**<br>**Flow Diversion in Acutely Ruptured Aneurysms**<br>**Presenters**:<br>**Professor Saruhan Cekirge**, Interventional Neuroradiology, KORU and BAYINDIR Hospitals, Ankara, Turkey<br>**12:30 – 12:35**<br>Closing Ceremony of WFITN 13th Congress<br>Closing Address
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<td>1:30 pm</td>
<td>Aneurysm Database</td>
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<td>The Aneurysm Database and AneuX Project</td>
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<td>2:00 pm</td>
<td>Surgical Management of Complicated Cerebral Aneurysm</td>
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<td>2:20 pm</td>
<td>MicroVention Special Session: Clinical Application and Technology of FRED</td>
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<td>3:00 pm</td>
<td>Cutting Edge Approaches to Vascular Biomedical Research</td>
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<td>Another ESM (Engineering Based Medicine)</td>
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<td>Photoluminescent Nanomaterials for Visualisation of Intracellular Molecular Trafficking, Diagnostics and Therapy</td>
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<td>Embedding Quality into Interaction Between Animal Models and Mechanical Evaluation</td>
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<td>4:15 pm</td>
<td>The Use of Computational Fluid Dynamics in the Diagnosis and Prognosis of the Cardiovascular Diseases (CVDs): An Update</td>
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<td>Uncertainty and its Effects on Design of Coronary Stents</td>
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<td>4:55 pm</td>
<td>Progress of Cerebral Aneurysm After Surgical Flow Diversion</td>
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<td>5:15 pm</td>
<td>Cerebral Aneurysm as a Hemodynamic Stress Regulated Inflammatory Disease</td>
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<td>8:30am - 9:15am</td>
<td>Aneurysm Endovascular Therapy and Image Analysis</td>
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<td>8:30am - 9:15am</td>
<td>Therapeutic Effect Observation of Endovascular Recanalization to Treat Symptomatic Subacute or Chronic Vertebrobasilar Artery Occlusion</td>
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<td>8:45am - 9:15am</td>
<td>Parametric Imaging for the Objective Grading of Collateral Flow in Acute MCA Occlusion</td>
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<td>9:15am - 9:45am</td>
<td>Chokesticks Technique for the Recanalization of T Junction Occlusions - Cases Report</td>
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<td>9:45am - 10:15am</td>
<td>Y-Configured, Dual Stent-Assisted Coiling of 12 Basilar Apex Aneurysms</td>
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<td>9:45am - 9:50am</td>
<td>The Evolution of Computational Hemodynamics as a Clinical Tool in Decision Making</td>
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<td>9:45am - 9:50am</td>
<td>Association Between Flow-Rate Waveform-Based Flow Instabilities and Rupture Status Indicators in Cerebral Aneurysm: A CFD Study</td>
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<td>9:45am - 9:50am</td>
<td>High-Resolution Magnetic Resonance Vessel Wall Imaging (MR-VWI)</td>
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<td>9:50am - 10:00am</td>
<td>How can Physicians Benefit from Hemodynamic Simulations? An Individualized Therapy Planning Approach for Intracranial Aneurysm</td>
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<td>10:00am - 10:10am</td>
<td>Numerical Simulations of Post-Surgical Flow and Thrombosis in Basilar Artery Aneurysms</td>
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<td>10:10am - 10:20am</td>
<td>Estimation of Recanalization for Cerebral Aneurysm after Coil Embolization by Computational Fluid Dynamics Analysis</td>
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<td>Hemodynamic Differences of the Same Location Aneurysms According to the Rupture Status</td>
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<td>10:20am - 10:30am</td>
<td>Stagnation and Complex Flow in Ruptured Cerebral Aneurysm: A Possible Association with Hemostatic Pattern</td>
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<td>10:30am - 10:35am</td>
<td>Morning Tea</td>
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<tr>
<td>10:35am - 12:20pm</td>
<td>Cerebrovascular Haemodynamics (Haemodynamic Based Aneurysm Risk Estimation)</td>
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<td>10:35am - 10:45am</td>
<td>In vitro Characterisation of Aneurismal Haemodynamics With and Without a Flow Diverter Using Particle Image Velocimetry</td>
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<td>11:05am - 11:15am</td>
<td>Hemodynamic Study of Stent Effects on Cerebral Aneurysm Models Using Scanning Stereoscopic Particle Image Velocimetry</td>
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<td>11:15am - 11:25am</td>
<td>Comparison Between CFD and MRE with 2D Velocity Vector Field and 3D Streamline in the Cerebral Aneurysm</td>
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<td>11:25am - 11:35am</td>
<td>Validation of New Outlet Boundary Condition for CFD Simulation in Carotid Artery Stenosis Cases</td>
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<td>11:35am - 11:45am</td>
<td>Numerical Study on the Effect of STA-MCA Anastomosis Position on its Mass Flow Rate</td>
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<td>11:45am - 11:55am</td>
<td>Computational Fluid Dynamics (CFD) Analysis Using Perforated Media Modeling Predicts Angiographic Occlusion Status after Coiling of Unruptured Cerebral Aneurysms</td>
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<td>11:55am - 12:05pm</td>
<td>The Role of Patient-Specific Vessel Wall Thickness for the Rupture Prediction of Intracranial Aneurysms</td>
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<td>12:05pm - 12:15pm</td>
<td>Visualization of Flow Patterns through the Aneurysmal Orifice after Flow Diverter Optimizations with Different Objective Functions</td>
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<td>12:15pm - 12:25pm</td>
<td>Development of an Integrated 3D-4D Simulation System for Patient-Specific Cerebral Circulation</td>
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<td>12:25pm - 12:30pm</td>
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<tr>
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<td>In Vitro Model with Flow for Surface Treatment for Endothelialization</td>
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<td>2:00pm – 2:15pm</td>
<td>Connecting Hemodynamics and Wall Inflammation in Cerebral Aneurysms</td>
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<td>2:15pm – 2:30pm</td>
<td>An 'Onion-Skin' Multilayer Type of Model for Thrombus Formation</td>
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<td>2:30pm – 2:45pm</td>
<td>Patient-Specific Modelling of Leukocyte Transport in Cerebral Aneurysms</td>
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<td>2:45pm – 2:50pm</td>
<td>Modeling of Blood Flow with Pathology in Cerebral Aneurysms</td>
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<td>3:10pm – 3:45pm</td>
<td>Virtual Technology Application in Stent Treatment and Development</td>
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<td>3:10pm – 3:25pm</td>
<td>Analysis of Relationship Between Stent Structure and Flow Stagnation Using Self-Organizing Maps for Realistic Aneurysm</td>
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<td>Flow Competition as a Factor of Patency or Occlusion of Side Branches After Flow Diverting Stent Placement in Intracranial Arteries From Animal Translational Research to CFD Simulation and to Clinical Practice</td>
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<td>Impact of the Flow-Diverted Deployment Strategy on Side Branch Endothelialization: Over-Versus Understanding</td>
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<td>In Vitro Investigation of Contrast Flow Jet Timing after Flow Division in Patient-Specific Intracranial Aneurysm</td>
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<td>The Parent Artery Configuration can Induce Flow Pattern and its Stent Pattern?</td>
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<td>Flow Analysis in Recanalization of Cerebral Aneurysms After Coil Embolization using Magnetic Resonance Fluid Dynamics (MSFD)</td>
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<td>4:55pm – 5:05pm</td>
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<td>5:05pm – 5:20pm</td>
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<td>5:05pm – 5:20pm</td>
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<td>Moderator: Dr Kenichi Kono</td>
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K Lobotesis, R Veltkamp, I Carpenter and R Hodgson

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R Kabra, J-L Saw, TJ Phillips, C Phatouros, T Singh, GJ Hankey, D Blacker, D Ghia, D Prentice and W McAuliffe

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Mechanical thrombectomy of small calibre intracranial arteries using pREset-LITE: safety and efficacy
W Kurre, M Aguilar-Pérez, R Martinez, E Schmid, H Bätzner and H Henkes

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OA Berkhemer, J Borst, BJ Emmer, M Kappelhof, PS Fransen, D Beumer, LA van den Berg, HF Lingsma, DW Dippel, YB Roos, RJ van Oostenbrugge, WH van Zwam, CB Majoie and A van der Lugt

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OA Berkhemer, N Boodt, PS Fransen, D Beumer, LA van den Berg, HF Lingsma, A van der Lugt, CB Majoie, WH van Zwam, YB Roos, RJ van Oostenbrugge and DW Dippel

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A Kuntze Söderqvist, T Andersson, N Wahlgren and M Kaijser

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Preliminary Results of the Trevo Retriever Registry
R Gupta, R Budzik, B Xiang, J English, B Baxter, S Ge and E Veznedaroglu
008
Single center experience of proximal cerebral protection device for carotid artery stenting focusing on device failure and occlusion intolerance
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009
Comparison of embolization protection devices with proximal balloon device and filter device: procedural complication and embolic infarctions on DWI
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010
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013
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Catch Plus Thrombectomy Device in Acute Stroke: Initial Evaluation
A Peker, A Akgoz, T Kaya, EM Arsava, Topcuoglu and A Arat

015
Developing an Interventional Stroke Service: Improving clinical outcomes and reducing cost and delivering great cost saving benefits to health economy
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016
Thrombectomy in acute ischemic stroke: stentriever experience in Modena Hospital
S Vallone, F Menetti, C Moratti, L Verganti, P Carpeggiani, G Bigliardi, V Saia, D Toni, S Mangiafico and A Zini

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J Delgado Almandoz, Y Kayan, M Young, J Fease, A Milner, J Scholz, T Hehr, P Roohani, M Mulder and R Tarrel

Initial Experience with the Cover Device to Prevent Embolization in New Territories During Mechanical Thrombectomy
M Piotin and R Blanc

Endovascular Management Of Acute Ischemic Stroke With Tandem Occlusion: A Single-Center Experience
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T Worakijthamrongchai, S Pongpech, P Jiarakongmun, E Chanthanaphak and C Kobkitsuksakul

Intraprocedural complications of mechanical thrombectomy in elderly patients
MA De Miquel, L Aja, R Barranco, P Mora, S Aixut, P Cardona, H Quesada, L Cano and M Lemus

Artificial clot and endovascular training model of clot removal for acute embolic stroke
S Nemoto, K Miki, J Karakama, Y Yoshino and K Namba

Pre or postoperative transarterial embolization of middle meningeal artery in subdural hemorrhage: Clinical experience and literature review
H Chang, J Hong, C Kim, S Sohn, E Kim and C Lee

Change in retinal blood flow after carotid artery stenting
M Hayashi, S Iwabuch, F Yagi, K Aoki, K Sato, N Saito, H Kimura, T Yokouchi, M Ishi and Y Iizuka

Clot constitution does matter in recanalization therapy for acute ischemic stroke
PA Brouwer and T Andersson

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W Kurre, M Aguilar-Pérez, R Martinez, E Schmid, H Bätzner and H Henkes
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IGH Jansen, AB van Vuuren, WH van Zwam, RJ van Oostenbrugge, DWJ Dippel, YBW Roos, HA Marquering, CH Slump, CBL Majoie and R van den Berg

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Hemodynamics and functional MRI study in patients with carotid stenosis
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AR Honarmand, FH Syed, A Elmokadem, SA Ansari, MC Hurley and A Shaibani

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Analysis of the Endothelial Nitric Oxide Synthase (Enos) Gene Single Nucleotide Polymorphisms in Post-Aneurysmal Subarachnoid Hemorrhage: Amazon Indigenous Population
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Endovascular Treatment for Ruptured Intracranial Aneurysms Associated with Cerebral Vasospasm
J Zhu, D Lin, J Hu and J Shen
The Cost-effectiveness of Solitaire™ Revascularization Device as an adjunct to IV-tPA compared to IV-tPA alone for Acute Ischaemic Stroke in the United Kingdom

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Purpose: The clinical efficacy of Solitaire™ for the treatment of acute ischaemic strokes has been demonstrated in multiple clinical trials including SWIFT PRIME. The aim of this analysis was to evaluate the cost-effectiveness of Solitaire™ FR from the UK healthcare provider perspective.

Method: A Markov model was developed to compare treatment with Solitaire + IV-tPA versus IV-tPA alone over a lifetime time horizon. The model incorporated three phases; an acute phase (0–90 days), a rehabilitation phase (90 days to 1 year) and a rest of life phase (1 year +). The model health states were defined by modified Rankin Score (mRS). Patients were at risk of recurrent stroke after the acute phase. Within the rehabilitation phase, patients’ health status could improve, maintain or deteriorate by a maximum of one mRS. During the rest of life phase, a patient remained in the same health state until a recurrent stroke or death. Clinical efficacy and safety data were taken from SWIFT PRIME. Resource use and health state utilities were informed by published data.

Results: Over a lifetime time horizon, Solitaire + IV-tPA led to improved quality of life and increased life expectancy when compared with IV-tPA alone. The higher treatment costs associated with the use of Solitaire were offset by long-term cost savings due to improved patient health status. Deterministic and probabilistic sensitivity analyses demonstrated that the results were robust to a wide range of parameter inputs.

Conclusion: Solitaire + IV-tPA is cost-effective treatment for acute ischaemic stroke compared to IV-tPA alone.

Mechanical thrombectomy for anterior circulation stroke: 5 year experience in a state-wide service

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Purpose: To examine the efficiency of treatment delivery with mechanical thrombectomy and clinical outcomes for acute anterior circulation ischemic stroke when performed under optimal conditions in a specialised unit.

Materials and Methods: A retrospective, state-wide study of 87 patients presenting with acute anterior circulation ischemic stroke who underwent mechanical thrombectomy between May 2010 and February 2015 was performed. Patients with a significant neurological deficit at presentation, a normal or near-normal unenhanced CT head and a large vessel occlusion (carotid terminus, M1 or M2) demonstrable on unenhanced CT +/−/C0 CT angiography and CT perfusion were included. We identified the intervals between various time points in stroke treatment, including stroke onset (ictus), initial CT imaging, groin puncture and recanalisation. We recovered data on pre-treatment neurological status (using the National Institute of Health Stroke Scale (NIHSS)), recanalisation rates, immediate and delayed neurological complications and 90-day clinical outcomes using the Modified Rankin Score (mRS).

Results: Successful revascularization defined as modified Thrombosis in Cerebral Ischemia (m-TICI) grade 2b or 3 was achieved in 70/87 (80.5%) patients. Stentrieveres were used in 90.6% of cases; the remainder underwent suction thrombectomy only. The mean number of passes for maximal recanalization was 1.8 (SD 1.14). The median (mins) [quartiles] time from ictus to CT (excluding wake up strokes) was 108 [83–150]; from ictus to groin puncture was 171 [134–218], from ictus to recanalisation was 218 [184–291]; from CT to groin puncture was 48 [32–77]; from CT to recanalisation was 101 [77–139] and from groin puncture to recanalisation was 45 [30–75]. Completion of acquisition of clinical outcome data including rates of symptomatic intracranial haemorrhage and functional outcome at 3 months
(modified Rankin Scale score ≤2) is underway and will be presented.

**Conclusion:** The recanalization rates and time parameters presented here are comparable to the three recently published randomized control trials (Berkhemer et al., 2014, Campbell et al., 2015 and Goyal et al., 2015) and endorse findings on the clinical effectiveness of mechanical thrombectomy in large vessel occlusion.

**References**


**003**

**Mechanical thrombectomy of small calibre intracranial arteries using pReSet-LITE: safety and efficacy**

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**Purpose:** Distal vessel occlusion is occasionally encountered during endovascular stroke procedures and may impair perfusion of eloquent brain tissue. Few stent-retrievers are approved for the treatment of vessels <2 mm and their safety and efficacy has not yet been investigated. We present our experience with pReSet-LITE, a stent-retriever approved for vessels >1.5 mm.

**Methods:** From a prospectively maintained database we selected patients treated with pReSet-LITE in small calibre vessels (<2 mm) between August 2013 and March 2015 (N = 76). Average age was 71 years (36–93), median initial NIHSS 14 (0–27) and time from symptom onset to treatment 268 min (27–835). Onset was unknown in 16 subjects. mTICI ≥2b was achieved in 87.3% and 31.5% of patients achieved a modified Rankin score of 0–2 at 90 days. Within this population we identified small calibre target branches treated with pReSet-LITE. Efficacy was assessed analyzing the recanalization status of the target after thrombectomy with pReSet-LITE applying the mTICI score. Intra-procedural complications associated with pReSet-LITE and haemorrhages anatomically related to the target were reported.

**Results:** We identified 90 targets (63 MCA, 17 ACA, 10 posterior circulation branches) with an average diameter of 1.6 mm (1.3–2.0 mm), mTICI ≥2b was achieved in 63 vessels (70.0%) with an average of 1.3 (0–4) passes. Two devices could not be passed to the target due to vessel tortuosity. Significant vasospasm was observed in four vessels (4.4%) and resolved spontaneously or with intra-arterial vasodilators. Two vessel dissections (2.2%) were successfully treated with stents. One self-limiting extravasation (1.1%) was observed. Follow-up imaging revealed focal subarachnoid haemorrhage around the target vessel in 13 occasions (14.4%) with no impact on the overall clinical outcome.

**Conclusion:** Thrombectomy of small calibre vessels with pReSet-LITE is similarly safe and effective compared to thrombectomy of larger vessels. It can be considered for recanalization of branches supplying eloquent brain tissue.

004

**Interaction of extracranial carotid stenosis or occlusion with treatment effect in MR CLEAN – preliminary results of a prespecified subgroup analysis**

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**Purpose:** MR CLEAN showed benefit of intra-arterial therapy (IAT) in patients with acute ischemic stroke caused by a proximal intracranial occlusion of the anterior circulation. Controversy exists about the effect of IAT in patients presenting with intracranial and extracranial occlusions. We tested for interaction between treatment and extracranial stenosis (>50%) or occlusion, according to our prespecified statistical analysis plan.

**Methods:** MR CLEAN imaging corelab reviewed all patients with vessel imaging from at least common carotid artery bifurcation until the siphon on CTA, MRA or DSA. The carotid bifurcation was evaluated for the presence of atherosclerotic disease with stenosis (>50%) or occlusion. Primary outcome was the modified Rankin Scale (mRS) at 90 days. The primary effect parameter was the adjusted common odds ratio (acOR) for a shift in direction of a better outcome on the mRS, which was estimated with multivariable ordinal logistic regression analysis. Secondary outcomes included the rate of functional independence (mRS 0–2).
Results: The extracranial carotid artery could be analyzed in 476 patients. In total, 40 patients presented with >50% stenosis and 45 patients with an occlusion in the carotid artery ipsilateral to the intra-cranial occlusion. The overall acOR in MR CLEAN was 1.67 (95%CI:1.21–2.30). Interaction of atherosclerotic disease with overall treatment effect was not significant (p = 0.229). In patients with atherosclerotic disease (N = 85) the acOR was 2.65 (95%CI:1.13–6.22) compared to 1.51 (95%CI:1.05–2.17) in patients without atherosclerotic disease, both in favor of intervention. The absolute difference in rate of functional independence in patients with atherosclerotic disease was 23% (35% vs 12%; p = 0.019) in favor of intervention.

Conclusion: In MR CLEAN, no interaction was found between treatment and extracranial stenosis (>50%) or occlusion. Presence of ipsilateral with atherosclerotic disease is therefore not an argument to withhold IAT from patients with acute ischemic stroke caused by intracranial proximal occlusion.

005
Timing of the delivery of intra-arterial treatment for acute ischemic stroke in MR CLEAN

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Purpose: MR CLEAN showed benefit of intra-arterial therapy (IAT) in patients with acute ischemic stroke caused by a proximal intracranial occlusion of the anterior circulation. The intervention contrast was IAT versus no IAT against a background of best medical care including intravenous alteplase if indicated. The trial demonstrated a shift in the distribution of functional outcomes on the modified Rankin Scale in favor of intervention. Clinical outcome after acute ischemic stroke treatment is time dependent. We investigated if and when delays from stroke onset to IAT occurred and assessed factors related to such delay.

Methods: All 500 patients from MR CLEAN database were available for inclusion. Prospective evaluation of predefined time factors was conducted. We used multivariable linear regression models to analyze time factors influencing delays. Times are reported in mean minutes (min) with standard deviation (SD).

Results: Between December 2010 and March 2014, 500 patients were randomized to IAT or no IAT. Mean time from onset to IAT was 265 min (SD 68), mean time from onset to door was 122 min (SD 89), and mean time from door to IAT was 144 min (SD 65). Initial presentation to an intervention center decreased time from onset to door with 127 min (95%CI: 115–138) compared to referral for trial participation from outside hospitals. Patients without a transfer received IAT 59 min (95%CI: 43–76) earlier. Furthermore, for every minute a patient presented earlier, in-hospital time delay increased with 0.5 minutes (95%CI: 0.40–0.55). General anesthesia caused time delay of 16 minutes (95%CI: 7–24).

Conclusion: Improving time to treatment remains a major challenge in treatment of acute ischemic stroke. Our findings suggest that time to treatment could be shortened by reducing transfer delays or by avoiding transfer. Furthermore, there is room for improvement of in-hospital delay, especially in patients with early presentation.

006
Mechanical thrombectomy in acute ischaemic stroke – association between age, stroke severity, infarct size and good functional outcome

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Purpose: We have assessed to what extent age, sex, pre-intervention ASPECTS and NIHSS are associated with outcome of mechanical thrombectomy in patients treated for acute ischaemic stroke.

Methods: All patients treated with mechanical thrombectomy for acute ischaemic stroke from September 2005 through December 2011 were included in the study. Main outcomes were a modified Ranking Score (mRS) of 0–2, an improvement in NIHSS score post-thrombectomy and the occurrence of symptomatic haemorrhage. Exposure variables were sex, age, intravenous thrombolysis, pre-thrombectomy NIHSS, pre-treatment infarct size, time from onset of symptoms to groin puncture, thrombectomy device used, and the angiographic result from the thrombectomy (mTICI score).

Results: 192 patients with anterior circulation stroke were included in the study. For patients with no neurological symptoms prior to stroke onset (mRS = 0), those younger than 50 years of age achieved mRS 0–2 in 81%. For patients above 50 years outcome was independent of age group, ranging from 49% to 54%. There was also an association between pre-thrombectomy NIHSS-score and mRS at three months, as well as pre-thrombectomy ASPECTS and mRS, although the latter was not statistically significant.
Patients with wake-up stroke did not differ from other patients with regard to outcome. There was a statistically significant association between grade of recanalization (mTICI-score) and both NIHSS-improvement and good functional outcome.

**Conclusion:** Our results emphasize that when patients are selected on the basis of angiographic and perfusion imaging, both older patients and patients with wake-up stroke may experience a favourable outcome after mechanical thrombectomy.

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**007**

**Preliminary Results of the Trevo Retriever Registry**

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**Purpose:** With the recent results of clinical trials showing the marked benefit of reperfusion with stent retrievers compared to medical therapy, the Trevo registry is a real world study to assess self-reported reperfusion rates and outcomes. The study was originally planned to enroll 300 patients but has been expanded to 1000 patients.

**Methods:** A total of 1000 patients at a maximum of 75 sites internationally will be enrolled and analyzed. The aim of the study is for centers to enroll consecutive patients in whom the Trevo device (Trevo ProVue, XP 4 × 20 or XP 3 × 20) was used as the first device to remove a thrombus. Patients were eligible if the device was used in a patient suffering from an ischemic stroke and data was locally adjudicated and submitted to the sponsor for collation and analysis of the data. Data regarding key time points of the processes, reperfusion grade, adverse events and 90 day modified Rankin scores were collected.

**Results:** As of March 10, 2015 a total of 225 patients have been enrolled with a target enrollment of 300 at 40 centers by October 2015. The mean time from last known normal to arrival to the hospital was 3.7 hours and 65% of patients were treated under 6 hours from last known normal and 16% beyond 12 hours. The majority of patients were treated for posterior circulation or M2/M3 MCA occlusions. General anesthesia was employed in 67% of procedures and the vast majority of these were for the procedure itself. The mean procedure time was 59 ± 40 minutes with an average of 1.7 ± 1 pass with the device. Adjuvant devices were used in 28% of procedures with the majority of these being angioplasty and stenting of a suspected atheromatous plaque. The rate of TICI 2B or 3 was 91% and TICI 3 was achieved in 49% of patients. The median NIHSS was reduced from 17 at admission to 9 at 24 hours. A total of 33% of patients were discharged to home and 32% to inpatient acute rehab with only 14% of patients being discharged to a nursing home or hospice.

**Conclusion:** The Trevo Retriever Registry represents the first look at the real world data with stent retriever use in the era of clinical trials showing the overwhelming benefit of stent retrievers to treat acute ischemic stroke. The reperfusion rates, procedural times and complications appear concordant with the recent trials involving experienced centers. Future subgroup analysis of this large cohort will help to identify areas of future research to enhance outcomes further with this treatment modality.

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**008**

**Single center experience of proximal cerebral protection device for carotid artery stenting focusing on device failure and occlusion intolerance**

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**Purpose:** The Mo.Ma® Ultra device (MoMa) is one of the proximal anti-embolic devices for carotid artery stenting (CAS) by cessation of blood flow through temporary occlusion of the external and common carotid arteries (ECA, CCA). We are reporting our single center experience with the device for last three years focusing on the causes of the device failure and occlusion intolerance.

**Methods:** Between April 2012 and March 2015, 125 patients (107 men; median age 70) underwent elective CAS. MoMa was used for protect in 90 patients (72%). We analysed the device success (MoMa could be used as the protection device) rate, the causes of failure, and occlusion intolerance rate and its influence on the procedure. And then procedural success (CAS was done with less then 30% of residual stenosis rate) and 30-day clinical outcome was analysed.

**Results:** The device success rate was 92.2% (83/90). Both lesions were treated in 11 patients. The causes of failure was patient’s incooperation (n = 1), marked tortuosity of the aortic arch or supraaortic arteries (n = 3), intolerance to occlusion (n = 1), lesion cross failure (n = 1), and aspiration failure after stenting (n = 1). The procedure was switched to CEA in 2, done with distal protection device in 4, and aborted in 1. Patient became symptomatic during occlusion in 8.1% (7/86), however procedural switch to distal protection device was required in only 1. Procedural success rate was 96.7% (87/90). There was no mortality with any adverse event rate of 7.8% (7/90). On 30-day symptomatic rate was 3.8%.

**Conclusion:** For the successful application of proximal protection device, we should consider its technical limitations. Occlusion intolerance occurs not infrequently, however, device switch is required rarely.
Comparison of embolization protection devices with proximal balloon device and filter device: procedural complication and embolic infarctions on DWI

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Purpose: Embolic protection devices (EPDs) consisting of an internal carotid artery (ICA) filter or balloon occlusion are typically used during carotid artery stenting (CAS). This study compares the related complication and thromboembolic infarction on diffusion weighted image (DWI) encountered using these two types of EPD.

Methods: A retrospective review was conducted of patients undergoing CAS using a balloon occlusion EPD (MOMA) or filter EPD (Spider FX). Symptomatic stenosis, degree of stenosis, site of stenosis, and ulceration were evaluated. Complications were defined as minor stroke, NIH stroke scale < 3; major stroke, NIH stroke scale ≥ 3; transient ischemic attack (TIA), reversible focal neurologic impairment; technical, reversible neurologic compromise during EPD deployment, inability to cross lesion, ICA spasm requiring treatment, EPD-related factors that prolonged CAS. Procedure time, new infarctions on DWI after CAS (tiny: < 3 mm, small: < 10 mm, medium: < 20 mm, large: > 20 mm), and 30 days clinical result after CAS also were evaluated.

Results: CAS (n = 108) was performed in 106 patients (75.9% men) with a mean age of 70.6 of years. Demographic data between two groups was similar statistically except for age and stenosis percentage in statistical significance (P < 0.05). Symptomatic and asymptomatic complication rate was slightly higher in MOMA group (26.3%) than Spider group (20%) and new tiny infarctions on DWI was higher in Spider group than MOMA group (P < 0.05). The 30-day event rate was 1.9% major stroke, 3.7% minor stroke, no myocardial infarction, and no death. The overall combined 30-day stroke, death, and myocardial infarction rate was 5.6%. The 30-day stroke rate was 5.2% in the balloon group (n = 70) and 5.7% in the filter group (n = 38, P < 0.05). Technical difficulties included a 10% incidence of reversible neurologic compromise during balloon deployment compared with 0% in the filter group (P = 0.002) and 5.7% incidence of inability to cross the lesion before predilation in the filter group compared with 0% in the balloon group (P < 0.05).

Conclusions: During CAS, both balloon occlusion and filter devices provide acceptable results with similar complication rate and clinical results. Although Filter has higher new tiny infarctions than balloon occlusion, Filters have can be used preferentially to avoid a 10% incidence of reversible neurologic compromise associated with balloon occlusion, especially poor anterior communicating collaterals and bilateral severe stenosis.

Direct aspiration first pass technique for endovascular treatment of acute ischemic stroke: initial experience at 8 Italian stroke centres

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Purpose: Over the past decade, endovascular techniques for the treatment of acute ischemic stroke have emerged significantly. We report a retrospectively collected clinical experience of 8 neurointerventional Italian centres about a new technique utilizing a direct aspiration first pass technique with large bore aspiration catheter as the primary method for vessel recanalization.

Methods: Neurointerventional data base of 8 Italian medical centres was screened for patients who received mechanical thrombectomy for acute ischemic stroke using aspiration catheter on an intention to treat basis between August 2013 and January 2015. Procedural data, including Thrombolyis in Cerebral Infarction (mTICI) score, procedural timings, and complications, as well as National Institutes of Health Stroke Scale (NIHSS) at admission and discharge and mRS (modified Rankin score) at 90 days were analyzed.

Results: 92 patients received mechanical thrombectomy using the Penumbra 5MAX (34 cases), Penumbra 5ACE (56 cases) and SOFIA 5 F (2 cases). Median age was 69 (39–87) years (64% were men). Baseline NIHSS score was 20.5 (4–36); 51/92 (55%) patients received intravenous thrombolysis. Vessel occlusion sites were 85% in anterior circulation and 15% in posterior circulation. A successful recanalization result (mTICI ≥ 2b) was achieved in 74/92 (80%) of cases whist aspiration alone; among these, median time from groin puncture to recanalization was 44 min (7–123). Symptomatic intracranial haemorrhage occurred in 6/92 (7%) patients, and embolization to new territories (ENT) in 1/92 (1%) patients. Median NIHSS at discharge was 7.5 (0–24); 66% of patients (61/92) were independent at 90 days (mRS ≤ 2).
Conclusion: The first pass technique with large bore aspiration is a simple, efficient and safe strategy to achieve endovascular recanalization in patients with large vessel occlusion. This type of endovascular procedure, in our series, also proved to be fast and with very low percentage of ENT.

References

011
On intent to treat ADAPT Technique for 201 cases of anterior circulation acute ischemic stroke

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Purpose: We report our single center experience results of endovascular treatment of anterior circulation of ischemic stroke by the technique of direct aspiration.

Methods: We reviewed the data of 201 patients with large vessels anterior circulation occlusion for which the ADAPT technique was used in first intention and was associated with stentriever technique when necessary. An univariate analysis of the following factors: Age, prior antiplatelet or anticoagulative therapy, localization of the occlusion, an intravenous thrombolysis and its type, the time between onset and start of the procedure, the etiology of the stroke (TOAST) was performed to find predictors for success of the ADAPT technique on intent.

Results: Patients presented with an admitting median NIHSS score of 16 (1-26). Mean onset to femoral puncture time was 285 min. The localisation of arterial occlusion was the MCA in 59%, the ICA in 27%, a tandem occlusion in 14%. The treatments were performed under sedation (no general anesthesia) in 155 cases (77%). The aspiration technique alone was successful in achieving TICI 2b or 3 recanalization in 55% of cases. The additional use of stent retrievers improved recanalization rate to 83%. For the overall series there were 8% of procedural complications (3 non occlusive dissections, 8 emboli in new territory, and 5 subarachnoid hemorrhages) and 8 symptomatic intracerebral hemorrhages (3.9%) at day 1 imaging. Ninety day mRS was available for 126 patients, and 51% had good outcome (mRS 0-2).

Conclusion: In the anterior circulation, the ADAPT technique alone was effective in 55% of the cases (and with the use of other techniques (mostly stentriever) could achieve a recanalization rate of 83%. The ADAPT technique showed to be more efficacious on the MCA location. The thromboembolic events in other territories were low. The relevance of this technique and its use on first intent prior to the use of the stentriever needs to be studied in larger prospective multicentric studies.

012
Multicentre Experience with Aspiration only technique for acute stroke thrombectomy using ACE64

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Purpose: Mechanical thrombectomy has been shown to be an effective and safe therapy for patients suffering an acute stroke (Berkhemer et al., 2015). However, shortening the time span between onset of symptoms and recanalization has been partly achieved by a technical method known as aspiration thrombectomy (Turk et al., 2014; Kowoll et al., 2015). Our aim is to show the effectiveness of a new tool, the ACE 64, in order to further optimize neurological outcome and to minimize complications.

Methods: Between the December 2014 and March 2015 we identified 55 Patients with acute ischemic stroke and occlusion of large cerebral vessels. These were treated with an aspiration thrombectomy using a new large bore aspiration catheter, the Penumbra ACE 64 on an intention to treat basis in multicenter setting (Utrecht, Netherlands; Murcia, Spain; St. Gallen, Switzerland; Bochum, Germany; Recklinghausen, Germany; Odense, Denmark; Homburg, Germany).

Results: Between the December 2014 and March 2015 we identified 63 patients with acute ischemic stroke and occlusion of large cerebral vessels. These were treated with an aspiration thrombectomy using a new large bore aspiration catheter, the Penumbra ACE 64 on an intention to treat basis in multicenter setting (Utrecht, Netherlands; Murcia, Spain; St. Gallen, Switzerland; Bochum, Germany; Recklinghausen, Germany; Odense, Denmark; Homburg, Germany).

Results: Using the aspiration thrombectomy a Thrombolysis in Cerebral Infarction (TICI) Score of 2b or 3 was achieved in 61 of 63 cases (96,8%). In 17 of 55 evaluable cases, additional devices were used for the following reasons: Anchoring technique (9), distal vessel too small for ACE64 (5) and two cases were ACE64 could not pass preceding
stenosis. For 55 cases, further analysis was possible; in this group in the aspiration thrombectomy only cases, a TICI score of 2b or 3 of 100% was achieved. The average time of groin puncture to recanarization for all patients was 37 min. Patients presented with a median National Institutes of Health Stroke Scale (NIHSS) score of 16 (4.0–26.0) and improved to a median NIHSS score of 4.5 (0.0–35.0) at discharge. Median mRS at discharge was 2, 48% of patients presented a mRS ≤ 2 at discharge. There was each one case of major groin complication, vasospasm in preceding extracranial vessel, vessel dissection and of symptomatic intracerebral haemorrhage.

Conclusion: Due to the design of this new large bore aspiration catheter, trackability and navigation through the carotid syphon up to M1 / M2 is excellent. This means that approaching the clot in the target vessel is fast and because of the large lumen, aspiration is effective. The complication rate is low.

Most importantly, it is an extraordinarily fast method to achieving revascularization. In about 70% of patients, recanalization could be achieved by aspiration thrombectomy alone. As described with the method of aspiration thrombectomy before, there are various reasons for using additional devices. In about half of our cases, the stentretriever was used to maneuver the ACE64 to the thrombus. One other reason was the dislodgement of the thrombus to a distal part of the treated vessel or also called a distal embolization in the target downstream territory. In these cases, the aspiration catheter was too large to achieve a thrombectomy and a stent retriever was used.

In conclusion, we are able to demonstrate the aspiration thrombectomy using the ACE64 to be an effective, easy to use, fast and safe method for treating acute stroke patients.

References

004
Catch Plus Thrombectomy Device in Acute Stroke: Initial Evaluation

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Purpose: Experience with the Catch Plus thrombectomy device (CPD) (Balt, Montmorency, France) has not been reported previously. It is available in 4 sizes and can be used through microcatheters with an inner diameter of 0.017 to 0.027 inches. We evaluated the safety and efficacy of the CPD retrospectively in the treatment of acute stroke.

Methods: We performed an analysis of 25 consecutive patients (1 with posterior circulation stroke) with ischemic stroke secondary to acute occlusion of a major intracranial artery treated with CPD at our centre. Eight (32%) patients had received IV TPA before intervention to aid revascularization.

Results: The mean age was 66.7 years (range, 23–88 years; 60% women). The median NIHSS score at presentation was 20 (range, 8–38). The mean symptom-to-procedure start time was 240 minutes excluding 6 patients in whom the exact onset of stroke was unknown. Recanalization (TICI 2–3) was achieved in 77%. In 5 patients CPD was used after failure of other thrombectomy devices. Procedural complications occurred in 4 patients (2 clot fragmentations, 1 focal clinically silent subarachnoid bleed and 1 asymptomatic carotid artery dissection). Clinical follow-up data was available for 21 patients at 90 days, in 4 data is pending. Ninety-day mortality was 20%; clinically acceptable functional outcome (CAFO: mRS 0–3) at 90 days (mRS 0–3) was achieved in 40%. CAFO was significantly higher in patients with recanalization (Chi square test, P = 0.028).

013
Neuro-Thrombectomy France (NTF): preliminary results

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Purpose: Alongside the randomized trial “Thrace”, both French academic societies (SFNR and SFNV) joined forces in the creation of a prospective multi centric national registry, (NTF, Neuro-Thrombectomy France). NTF wants a representation of our daily practice in the real world of mechanical thrombectomy. This registry began in June 2013.

Methods: We prospectively included 232 consecutive patients in 18 centers. Inclusion criteria: Signing of the information consent, age >18 years, clinical and imaging data consistent with an ischemic stroke onset within 8 hours, thrombosis (TICI 0 or 1) of the carotid T, M1, M1-M2 bifurcation of the basilar artery, occlusion TANDEM ACI / M1. Exclusion criteria: Pregnant or lactating women, Rapid improvement of NIHSS (gain of more than 4 points) between two pre-treatment assessments, ASPECT score <7 on the CTscan or <5 of the diffusion imaging, intracranial hemorrhage, unable clinical assessments at 3 months, extensive brainstem lesions, refusal to participate in the study.

Results: 221 patients are analyzed at 3 months. Treatment options were thrombectomy alone (42.73%), “bridging” treatment combined with full dose of IV fibrinolysis (38.64%) and rescue thrombectomy after failure of IV fibrinolysis (13.64%). Angiographic result show a reperfusion score (TICI2b-3) of 74.89% and clinical assessment by mRS ≤ 2 at 3 months of 56.9%. Mortality of 7.5%.

Conclusion: The value of this registry (NTF) is to collect cases that are not included in randomized trial (as THRACE) without competition and add scientific data from our “real world” daily practice.
Conclusion: CPD appears to be safe and effective in achieving recanalization and improving 90-day outcome in patients with acute ischemic stroke.

015

Developing an Interventional Stroke Service: Improving clinical outcomes and reducing cost and delivering great cost saving benefits to health economy

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Purpose: To improve patient clinical outcomes and provide cost saving benefits to our local organization, community care and NHS within the United Kingdom, by treating patients presenting with large vessel occlusive stroke by Mechanical Thrombectomy.

Methods: All patients treated with mechanical Thrombectomy (MT) for acute stroke at UHNM, Stoke-on-Trent, UK, were entered into a prospective register. Baseline demographic, imaging and clinical data, outcome scores, duration of patient stay, discharge destinations and other relevant data for cost analysis were recorded. We performed a detailed analysis of clinical outcomes as measured by 90 days mRS score and correlated it to the resultant costs savings to our Hospital from the reduced bed days and the financial savings to the social care in terms of reduced costs due to patient clinical improvement and reduced disability.

Results: Our institution has the largest patient series in UK for patients undergoing mechanical Thrombectomy for severe strokes and between Jan 2010 to Dec 2014 we identified 198 patients. 47% of patients were alive & independent (mRS < 2) and the mortality rate was 17%. This reduced the length of stay to 14 days when compared to 90 days previously with 91% of live discharges to their own home. From our patient series this produced a net savings to health and social care costs of £3.2m or £684,000 per 100,000 populations served. These are summarised as follows; savings of £2.4million from a reduction in the length of stay in hospital, a reduction of £1.6million in social care costs. Extrapolating the data we estimate that around 20000 to 25000 potential patients could benefit from mechanical Thrombectomy within the UK if used as a mainstream treatment for large vessel strokes.

Conclusion: Mechanical Thrombectomy has shown benefit in improving clinical outcomes with significant cost saving benefit to our institution and the community care.

016

Thrombectomy in acute ischemic stroke: stentriever experience in Modena Hospital

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Purpose: To evaluate safety and efficacy of stentriever in endovascular treatment (ET) of ischemic stroke patients in Modena Hospital.

Methods: We analysed acute ischemic stroke patients admitted at the Modena Hospital in the period 2008–2014 and underwent to endovascular therapy. Efficacy measures were arterial recanalization (TICI 2b-3), 3-month functional outcome (mRS 0–2) and mortality.

Results: In the period 2008–2014 we treated 238 patients with ET. We analysed 222 patients with completed 3-month follow-up, excluding 7 not treated patients and 9 not occluded patients at the angiography. The patients are selected with advanced neuroimaging, including brain CT, CT angiography, and CT perfusion. Mean age was 71.7 years, male gender 52.7%, median baseline NIHSS 17. 98 patients (44.3%) were previously treated with intravenous thrombolysis. Intraarterial drugs were given to 95 patients (42.8%). The ET modality could enclose intra-arterial thrombolysis or mechanical approach or both. The subgroup of mechanical thrombectomy with use of 2nd generation stentriever was defined ‘stentriever group’ (n = 134) and compared with ‘non stentriever group (n = 88), including intra-arterial thrombolysis and other mechanical modalities. In the thrombectomy group (n = 201) 134 patients (66.7%) were treated with 2nd generation stentriever (in order of use: Trevo®, Solitaire®, Mindframe Capture®, Revive®, Penumbra Separator 3D®, Aperio®, Catch®, Eric®). The TICI score 2b-3 was reached in 77.6% in stentriever group (versus 70.4% in ‘no stentriever group’). 3-months mortality was 17.9% (vs 19.8%), and mRS 0–2 was 41% (vs 36%).

Conclusion: Stentriever in ET may be useful and safe in acute ischemic patients. In our ET open cohort in Modena the use of 2nd generation stentriever was constantly growing in last years and to date it is the current treatment of choice in ET.
Evaluation of the pREset Stent Retriever for Thrombectomy in Patients with Acute Ischemic Stroke: Data from the ARTESp trial

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Purpose: Purpose of this prospective, multicenter, single-arm study was to assess technical and clinical outcome after mechanical thrombectomy (MTE) with the pREset stent retriever in patients with acute ischemic stroke (AIS).

Methods: In 4 endovascular stroke centers, 100 patients (age 68.3 ± 13.8; 54 women; median NIHSS 15 (IQR 12–19) with proximal intracranial vessel occlusion and a NIHSS ≥ 8 at admission were included if initiation of MTE treatment using pREset as a single device was possible within 6 hours after symptom onset. Time parameters, technical and clinical outcome were assessed and imaging data was analyzed by a core lab.

Results: Occlusions were localized in the MCA (74.3%), ICA (13.8%), and BA (7.3%). Successful recanalization (TICI2b/3) was achieved in 86.2% after 1.9 passages in average. Median time from symptom onset to arrival at the stroke center was 140 min (9–369), 60 min (5–191) from arrival to groin puncture, 40 min (6–159) from groin puncture to reperfusion and 248 min (112–469) from symptom onset to reperfusion. Within 24 hours after MTE, 37.4% of the patients presented a NIHSS improvement of ≥10. After 90 days, clinical outcome was good/excellent in 62.5% (modified Rankin Scale 0–2) while mortality rate was 7.3%. There were no device-related complications; 5 patients (5.0%) showed an ICH, of which 1 was symptomatic. Patients referred from another hospital had significantly longer times from symptom onset to arrival in the stroke center (mean 196 ± 70 min vs. 73 ± 53; P < 0.001), and excellent clinical outcome was achieved significantly less often compared to patients directly admitted to the stroke centers (mRS 0, 17.8% vs. 44.1%; P = 0.011).

Conclusion: The pREset stent retriever is a safe and effective device for MTE in patients with AIS in the anterior and posterior circulation. Transfer times in referred patients significantly diminished rates of excellent clinical outcome.

An ADAPT-first approach is associated with significantly-lower symptomatic intracranial hemorrhage rates and improved clinical outcomes at 90 days in patients with acute ischemic strokes treated with mechanical thrombectomy

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Purpose: To compare rates of symptomatic intracranial hemorrhage (SICH) and good clinical outcomes at 90 days in patients with acute ischemic strokes from emergent large vessel occlusions (ELVO) treated with mechanical thrombectomy using either an ADAPT-first (Turk et al., 2014) or Solumbra technique at a comprehensive stroke center.

Methods: We compared clinical characteristics, procedural variables and clinical outcomes in patients with ELVOS treated with mechanical thrombectomy at our institution from March 31st, 2012 until January 31st, 2015. SICH was defined using the SITS-MOST criteria (Wahlgren et al., 2007). A good clinical outcome was defined as a modified Rankin Scale 0–2 at 90 days.

Results: Ninety-one patients were included, 57 in the Solumbra group (62.6%) and 34 in the ADAPT-first group (37.4%). There were no significant differences in patient sex, age, admission NIHSS (17.3 mean), iv-tPA administration, atrial fibrillation, puncture-to-reperfusion and onset-to-reperfusion time, or successful recanalization rates (85.7% TICI 2b/3) between the 2 groups. Patients in the ADAPT-first group had a significantly-higher proportion of internal carotid artery terminus thrombi (47.1%) compared to patients in the Solumbra group (19.3%, p-value 0.009). Seven patients in the ADAPT-first group required use of a stent-retriever to achieve successful (TICI 2b/3) recanalization (20.6%). Patients in the ADAPT-first group had a significantly-lower rate of SICH (0%) than patients in the Solumbra group (12.3%, p-value 0.04). Patients in the ADAPT-first group had a significantly-higher rate of good clinical outcome at 90 days (55.9%) than patients in the Solumbra group (31.6%, p-value 0.02). An ADAPT-first approach (p-value 0.034, OR 69, 95%CI 1.36–3,492.7) was an independent predictor of a good clinical outcome at 90 days in our cohort.

Conclusion: In our cohort, an ADAPT-first approach was associated with significantly-lower SICH rates and improved clinical outcomes at 90 days in patients with acute ischemic strokes treated with mechanical thrombectomy.

References

019

Initial Experience with the Cover Device to Prevent Embolization in New Territories During Mechanical Thrombectomy

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Purpose: With the Class I, Level of Evidence A indication that thrombectomy for acute stroke is beneficial, the intervention community must now work to continue to improve outcomes and refine thrombectomy technique. Embolic events can occur in up to 12% of cases of Stentriever thrombectomy and are associated with a 2-fold increase in mortality compared with cases without embolic complications. The Cover embolization protection device (Lazarus Effect, Campbell, California, USA) is a novel nitinol-braided mesh device that surrounds stent retrieval devices and thrombus during thrombectomy to mitigate clot fragmentation and embolization.

Methods: We report out initial experience using this novel technology. We report rates of target vessel recanalization and embolization in new territories achieved with the Cover device used in conjunction with 2 Stentrievers, the Solitaire Flow Restoration FR (Covidien, Irvine, CA) and the Trevo XP Retrieval System (Stryker Neurovascular, Freemont, CA).

Results: In a total of 10 patients, 10 thrombectomy procedures were performed. Large vessel occlusions concerned 6 M1, 3 M2 and 1 tandem (ICA + M1). Successful recanalization (TICI 2b-3) was achieved after only one pass in 6 out of the 9 cases of isolated M1 or M2 occlusions (4 with the Trevo XP, 2 with the Solitaire FR systems). For the case of tandem occlusion, the M1 segment was cleared in one pass (Solitaire FR) after cervical ICA balloon angioplasty followed by ICA clot debulking with the ADAPT technique. Overall, TICI 2B or 3 was obtained in 9 out of the 10 cases (6 cases with the Trevo XP, 3 cases with the Solitaire FR). Embolization of new (previously unaffected) territories occurred in none of the 10 patients.

Conclusion: Application of the Cover device when performing acute stroke thrombectomy is feasible, appears to be safe, and may result in good successful recanalization rates with less embolic events.

020

Endovascular Management Of Acute Ischemic Stroke With Tandem Occlusion: A Single-Center Experience

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Purpose: With the clear class I, level of evidence A, thrombectomy is now widely accepted for large vessel occlusion causing ischemic stroke. Among all ischemic strokes involving the anterior circulation, tandem occlusions have the poorest prognosis in terms of recanalization and clinical outcome. Very limited data are available for the optimal management of patients with these occlusions. We report the results of our single-centre experience with endovascular mechanical treatment of ischemic stroke with tandem occlusions.

Methods: From a prospectively gathered registry, we analysed the data of 70 consecutive patients who underwent mechanical endovascular treatment for acute stroke with tandem occlusion. Clinical (including demographics, NIHSS, and stroke etiology), imaging (including DWI-ASPECTS and collaterals), and endovascular data (including devices used) were assessed and reviewed in consensus by 2 observers. Good clinical outcome was defined as a modified Rankin Scale (mRS) ≤2 at 3 months follow-up.

Results: At 3 months follow-up, 49.3% patients had a good clinical outcome and 50.7% had a poor clinical outcome, including 13.4% deceased patients. A lower NIHSS (initial, at day 1 and at discharge) and a successful recanalization (TICI = 2b-3) were associated with a good clinical outcome (P < 0.05). There were no statistically significant difference between both groups in terms of intravenous tissue plasminogen activator use, delay between symptom onset and recanalization, initial DWI-ASPECTS, collaterals, and the endovascular technique used.

Conclusion: These results underline the efficacy of endovascular treatment of tandem occlusions, which usually respond poorly to intravenous thrombolysis. Guidelines for the endovascular management of tandem occlusions are needed.

021

Outcome Predictors of Endovascular Treatment for Acute Ischemic Stroke patients

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Purpose: Endovascular treatment in large vessel occlusion is an alternative therapy that could increase good functional
outcomes and improved survival in stroke patients. The purpose of this study was to evaluate the efficacy and safety of endovascular intervention in stroke-patient and prognostic factors for predicting clinical results.

**Materials and Methods:** This study is a retrospective cohort study. We analyzed 39 consecutive stroke patients who were treated with intra-arterial thrombolysis and mechanical thrombectomy. Successful recanalization was defined as Thrombolysis in Cerebral Infarction score (TICI) grade 2b or 3. Good clinical outcome was defined as mRS score of 0–2 at 3 months. Radiologic data and clinical outcome were compared between good and poor outcome patients.

**Results:** Thirty-nine patients were included in the analysis. The median age was 70 years. The median baseline NIHSS score was 17 (IQR 14–20). CT was performed for 92.3% of patients. The median of ASPECT score was 6 (IQR 6–7). Mechanical thrombectomy was treated in 38 (97.4%) patients and only one (2.6%) of them was treated by intra-arterial thrombolysis. Recanalization of TICI 2b and 3 were achieved in 64.1%. At 3 months, 43.6% of the patients had a good clinical outcome. In contrast, 15.4% of patients had postprocedure symptomatic intracerebral hemorrhage and the mortality rate was 5.1%. Prognostic factors for predicting good clinical outcomes at 3 months were angiographic efficacies of TICI 2b and 3, p = 0.006, OR 9 (1.65–49.14). The prognostic factor for predicting poor clinical outcome at 3 months was post-operative symptomatic ICH, p = 0.027.

**Conclusions:** The successful recanalization status represents the strongest predictor of clinical outcomes in stroke patients undergoing endovascular treatment. The post-operative SICH is the hallmark predictor of poor clinical outcome.

**Keyword:** acute stroke, endovascular treatment, mechanical thrombectomy, outcome.

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023

**Artificial clot and endovascular training model of clot removal for acute embolic stroke**

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**Purpose:** Stentriever has brought remarkable improvement of revascularization of acute embolic stroke. Emergency service depends on young physicians who may not have endovascular skills. Clot removing procedure is not too complicated. However proper training of endovascular procedure is necessary. No chronic cases are candidate for clot removal. There are no feasible training systems available.

**Methods:** Silicone cerebral vessel model is made from ABS polymer cast made according to the cerebral arteries of the patients using 3D printer. This silicone vascular device consisting of internal carotid artery, middle cerebral artery and anterior cerebral artery is connected with our systemic vascular model with pulsatile circulation. Artificial clot is made of polysaccharide. Artificial clot is injected into the middle cerebral artery. Stentriever in inserted into this model and artificial clot is removed under fluoroscopy. Advantage and disadvantage of clot removing devices including clot evacuation device are compared.

**Results:** Endovascular artificial clot removal was performed almost similar to real treatment. Hard clot was easily removed with stentriever. When soft clot was removed, distal migration of crushed clot was observed. Migration to the anterior cerebral artery territory was also noted. Proximal flow control is necessary to avoid distal migration of the clot.

**Conclusion:** Our vascular model with artificial clot is really a good training model for endovascular clot removal procedure.
024
Pre or postoperative transarterial embolization of middle meningeal artery in subdural hemorrhage: Clinical experience and literature review
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Purpose: There are no established treatment standards for recurrent subdural hematoma (SDH). In this study, we discussed the efficacy of middle meningeal artery (MMA) embolization in preventing recurrence of SDH.

Methods: We performed superselective angiography of MMA in 12 patients who suffered from recurrent SDH or SDH with risk factor. After angiography, we performed particle embolization of MMA.

Results: In all cases, there were diffuse abnormal vascular stains that seemed to represent the vascularities in the outer membrane of SDH. In all the patients, there were no recurrences or enlargements of SDH after the embolization of the MMA.

Conclusion: Middle meningeal artery embolization may be an effective adjuvant treatment modality for preventing the recurrence of SDH.

025
Change in retinal blood flow after carotid artery stenting
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Purpose: The ophthalmic artery is a major branch of the internal carotid artery. Severe carotid stenosis affects ophthalmic artery flow and causes ischemic ocular syndrome. Then, laser speckle flowgraphy (LSFG) uses a laser speckle pattern produced by laser refraction from red blood cells to measure retinal blood flow. The examination is repeatable and safe and is often used in ophthalmology. LSFG can easily assess retinal circulation, which is essential in evaluating circulation in ischemic ocular syndrome. We used LSFG to evaluate retinal blood flow before and after carotid artery stenting (CAS) for patients with carotid stenosis.

Methods: Between September 2012 and May 2015, 28 patients (30 lesions) were evaluated with LSFG before and after CAS. LSFG targeting the optic nerve head of the retina measured mean blur rate (MBR), an indicator of retinal blood flow, and skewness in the blood-flow waveform. Then, changes in MBR and skewness after CAS were analyzed.

Results: Seven of the 30 lesions were symptomatic stenosis. Average peak systolic velocity on carotid ultrasound was 392 cm/s. MBR was significantly higher after CAS in 21 (70.0%) of 30 lesions (p < 0.01). In contrast, MBR on the contralateral side did not significantly change (p = 0.10). Skewness significantly increased in 24 (80.0%) of 30 lesions after CAS (p < 0.01).

Conclusion: The present findings suggest that carotid artery stenting improves retinal blood flow and cerebral blood flow and prevents ocular ischemic syndrome.

026
Clot constitution does matter in recanalization therapy for acute ischemic stroke
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Purpose: Through several well-conducted randomized trials, the value of endovascular therapy in large vessel occlusions has been demonstrated. One of the important lessons from this work is that the faster and more complete the recanalization, the better the clinical outcome. While in highly selected populations, as high as 88% TICI 2b–3 was achieved, in trials more reflective of everyday practice, the TICI 2b–3 rate was more in the range of 59–72%. A better understanding of the clot characteristics and the nature of occlusions may help us achieve better reperfusion more rapidly in more patients. Published composition data obtained from stroke patients’ clots using semi-quantitative histology have shown a large variation in the ratio of constituent components such as fibrin and red-blood cells (RBCs). We have found that these variations in clot material composition can result in dramatic differences in the physical properties, and therefore retrievability, of clot in acute ischemic stroke.

Methods: Clot analogues reflecting a range of clots encountered clinically were generated using methods informed by published data under a range of simulated physiological conditions. In vitro testing was performed to characterize clot-device and clot-vessel interactions, thereby providing insight into observations seen in the clinical setting.

Results: Friction testing of blood clot analogues demonstrates that clot friction/stickiness increases as the fibrin to red blood cell (RBC) ratio increases. Compression further increases friction, which may make a clot compressed through mechanical manipulation more difficult to remove than an uncompressed clot. Whether occlusion is in a single branch or at a bifurcation varies not only by anatomy and flow conditions, but also by clot type.

Conclusion: The insights gathered from the observations with different types of clot, in various occlusion locations, and their interaction with devices provides us with a better understanding of clot behavior in thrombectomy cases. Our
results may help in improving reperfusion rates in endovascular stroke therapy.

027
Impact of cervical artery stenting on clinical outcome in endovascular recanalization of acute tandem occlusions
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Purpose: Cervical artery stenting is occasionally required during endovascular stroke treatment either to access the intracranial target or to restore the cervical vessel lumen. We aimed to assess whether cervical arterial stenting has a negative impact on clinical outcome.

Methods: Patients treated for an intracranial embolic vessel occlusion with the pREset retriever between August 2011 and October 2014 (n = 485) were divided into two groups depending on the necessity to place a cervical stent. We tested for imbalances between the two groups taking into account gender, age, NIHSS, atrial fibrillation, common cardiovascular risk factors, the proportion of patients with unknown time window, the proportion of patients receiving intravenous thrombolysis, location of occlusion, successful recanalization, duration of treatment, parenchymal (PH) and subarachnoid (SAH) haemorrhage and clinical outcome at 90 days using the dichotomized mRS approach (0–2 vs. 3–6).

The same parameters were tested as predictors for clinical outcome and significant predictors for outcome together with stenting vs. no stenting were included in a logistic regression model to control for confounders.

Results: Patients receiving cervical stents (n = 100) were significantly younger, preferentially male, active smokers and had less frequently atrial fibrillation compared to patients receiving thrombectomy only (n = 385). The rates of PH (9% vs. 10%), SAH (10% vs. 11%), successful recanalization (97% vs. 91%) and favourable outcome (41% vs. 40%) were similar. In univariable analysis diabetes, hypertension, peripheral artery disease, unknown time window, PH, recanalization failure, longer procedure time, more thrombectomy passes, advanced age and high NIHSS predicted poor outcome. In a logistic regression model including all of the above and stenting vs. no stenting only peripheral artery disease, unknown time window, PH, advanced age and higher NIHSS remained as independent risk factors for poor clinical outcome.

Conclusion: Cervical artery stenting in the setting of intracranial thrombectomy does not impair clinical outcome at 90 days.

028
An ongoing study to assess the agreement on the evaluation of ASPECT score in patients with acute stroke
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Purpose: Since the recent publication of randomized clinical trials proving the efficacy of thrombectomy in acute ischemic stroke, the Alberta Stroke Program Early CT Score (ASPECTS) has gained importance in the initial evaluation of patients. A threshold for the selection of patients who could benefit from endovascular revascularization has been defined in some of the studies. We assessed the agreement on the evaluation of ASPECTS in patients with acute stroke.

Methods: We used our local register of patients (EASI) in order to create a portfolio of 30 patients who suffered from acute ischemic stroke (with an anterior circulation occlusion) and underwent a brain CT. We selected various NIHSS and initial ASPECTS (as graded by the radiologist on-call).

Twelve observers (neuroradiologists, interventional neuroradiologists and neurologists) with various years of experience are currently reviewing these 30 brain CTs in order to assess the ASPECTS. For each patient, they are given basic clinical information, and have full access to the PACS commands for the lecture.

A second lecture with the same 12 observers will be performed in a month.

Results: All the results (ASPECTS as well as the localization of each radiological abnormality for each patient) will be used for the evaluation of inter-observer and intra-observer agreement. This is an ongoing study and all the lectures will be finished in July 2015.

Conclusion: This is, to our knowledge, the most important study evaluating the ASPECT score agreement in terms of observers’ number.

029
Experience with intracranial and extracranial stenting during mechanical thrombectomy at the Royal Stoke
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Purpose: Endovascular stents are used during mechanical thrombectomy to gain and maintain access to the cerebral arteries via a critically stenosed/occluded internal carotid artery. Rarely, stents are also used in the intracranial
circulation to maintain patency of a stenosed vessel. As most of the patients undergoing mechanical thrombectomy are also treated with thrombolysis, the need for concurrent antiplatelet agents may increase bleeding risk. To record and analyse the functional and flow outcomes of patients who were treated with intracranial or extracranial stents during mechanical thrombectomy for large vessel ischaemic stroke at our institution in the period December 2009 to March 2015.

Methods: All patients who had undergone intracranial or extracranial stenting were identified from the RSUH mechanical thrombectomy register. The following data were extracted: Pre-procedure NIHSS, TICI score, 90 day mRS, and complications.

Results: A total of 26 cases of stenting of the internal carotid artery were returned, with 24 resulting in restoration of flow (92.3%). Sixteen (66.7%) of these had a concurrent intracranial occlusion which was also treated. Eighteen (69.2%) were concurrently thrombolysed with alteplase. 24/26 (92.3%) had a good intracranial radiological flow outcome (TICI 2–3). Eleven patients (42.3%) were independent and 6 patients (23.1%) were dead at 90 days. Two patients (7.6%) had clinically significant intracranial haemorrhage. No patients were readmitted with recurrence of stroke within 90 days. Two intracranial stents were placed, both of which showed TICI 3 flow restoration and were functionally independent at 90 days.

Conclusion: Our case series of extracranial stents compares favourably to other smaller published series with excellent flow outcomes and comparable functional outcomes/mortality.

References
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5. Endovascular treatment of tandem internal carotid and middle cerebral artery occlusions.

030

Differences in clinical, radiological and interventional factors predicting outcome and mortality after mechanical thrombectomy for acute large vessel stroke comparing over and under 70 age groups – a five year retrospective study

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Purpose: To assess the differences in factors including recanalization time and functional and radiological scoring determining functional outcome and mortality between different age groups after mechanical thrombectomy (MT) for ischaemic stroke.

Methods: Patients treated between December 2009 and January 2014 (n = 137) for anterior circulation stroke were divided into age groups. Patient data including NIHSS and ASPECT scoring pre and post procedure and procedural timings were collected. Modified Rankin score was used as functional outcome measure at 90 days.

Results: For the <70 age group, ASPECTS correlated most strongly with outcome (ASPECTS > 7 – OR 3.75, 95% CI 1.04–13.5) and mortality (ASPECTS < 8 – OR 5.08, CI 1.1–23.3). In the ≥70 age group, only NIHSS correlated with both outcome (NIHSS < 20 – OR 4.17, CI 1.4–12.2) and mortality (NIHSS > 20 – OR 6.22, CI 1.4–26.7) (p < 0.05). Both NIHSS and ASPECTS done at 24 h were strongly associated with outcome at 90 days. Revascularisation > 5 h after onset in the <70 age group was associated with markedly poorer outcome with increased risk of malignant MCA transformation, while this trend was not seen in the ≥70 age group.

Conclusion: ASPECT scoring at admission is clinically helpful in patient selection for thrombectomy in the ≥70 age group as it correlates well with outcome and mortality, but less useful in the <70 age group, possibly due to the increased plasticity of remodelling. Revascularisation time appears to be much more important in the younger age group, and restoration of circulation within 5 hours should be the goal to reduce the risk of reperfusion injury.

031

The Stroke Risks of Parent Artery Sacrifice in Malignant Head and Neck Tumor Patients who passed carotid balloon test occlusion

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Purpose: To evaluate the Post Parent Artery Sacrifice (PAS) stroke risks in malignant head and neck tumor patients who passed the Carotid Balloon Test Occlusion (CBTO).

Methods: Retrospective review of 69 consecutive malignant head and neck tumor patients (M:F = 38:31, median age = 60 years) who had CBTO from 2005 to 2014, were performed for the preparation of permanent carotid occlusion. The CBTO protocols included various combinations of clinical examination, angiographic evaluation (venous phase delay more than 2 seconds), hypotension challenge, electroencephalography (EEG) and Nuclear Medicine (SPECT).

Results: The CBTO and PAS were technically successful in all patients. The combination of clinical examination, angiographic evaluation and EEG were the most frequently employed CBTO protocol (34.7%, 17/49) followed by the combination of clinical examination, angiographic
evaluation, hypotension challenge and SPECT (26.5%, 13/49). 11 patients (22%, 11/49) failed and 38 patients (78%, 38/49) passed the CBTO. Among 38 patients who passed the CBTO, the PAS was performed in 29 patients (surgical ligation: 6, endovascular occlusion: 23). CBTO procedure related ischemic stroke occurred in one patient (2%, 1/49). Two patient developed hemodynamic stroke after PAS (6.89%, 2/29) who had passed the CBTO. There were 3 embolic strokes immediate after PAS (10.3%, 3/29) procedure. There was 1 patient who failed CBTO but did not develop stroke after PAS after carotid blow out.

**Conclusion:** The CBTO procedure in malignant head and neck tumor patients is feasible and reasonably safe. Post PAS hemodynamic stroke risks in malignant head and neck tumor patients who passed CBTO is reasonably low.

032

**Intra-arterial thrombectomy beyond usual thrombolysis time window in acute ischemic stroke patients with early neurologic deterioration**

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**Purpose:** Even though recanalization is strongly associated with improved functional outcomes and reduced mortality, clinical benefit from thrombolysis is reduced as stroke onset to treatment time increases. In recent study, Intra-arterial thrombolysis (IAT) has been demonstrated to improve functional outcome in patients with acute ischemic stroke (AIS) within time window of onset to 6 or 8 hours. However, beyond usual thrombolysis time window, early neurologic deterioration(END) related with proximal artery occlusion is not uncommon in AIS. Hereby, we report AIS case series treated with IAT over usual thrombolytic time window because of END related proximal artery occlusion.

**Methods:** From January 2012 through October 2014, all 173 patients underwent IAT for AIS with anterior circulation stroke. Among them, forty one patients underwent IAT beyond 8 hours after stroke onset. In eighteen of 41, IAT was applied due to END. At admission, all eighteen patients showed near to complete occlusion of proximal artery and had diffusion-perfusion mismatch.

**Results:** Four patients were applied IAT beyond 8 hours to last seen normal time. Fourteen patients were applied IAT beyond 24 hours to last seen normal time. Mean age was 65. Initial mean initial National Institutes of Health Stroke Scale (NIHSS) was 4.7 and NIHSS after END was 10.6. All patients had diffusion-perfusion mismatch over 200%. Seven patients treated with IV-tPA before IAT. Good recanalization (TICI 2b/3) was achieved in 94.4%. Hemorrhagic complication was seen in the follow-up computed tomography scan in 3 of 18 cases: two were hemorrhagic transformation, another was subarachnoid hemorrhage. Thromboembolic complication was occurred 1. Ten patients had modified Rankin Scale ≤2 after 3 months. There was no mortality case.

**Conclusion:** In our report, IAT beyond usual 6 to 8 hours time window achieved safe and successful recanalization. And successful recanalization was associated with good clinical outcome. We think IAT could be a another method in case of END in AIS patients with proximal artery near to complete occlusion, even beyond usual 6 to 8 hours time window of thrombolytic therapy.

033

**Safety, efficacy and feasibility of mechanical thrombectomy with Revive stentriever for large vessels acute ischemic stroke: a single center experience**

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**Purpose:** The role of endovascular stroke treatment has recently been finally assessed. Since few years stentriever have been introduced for acute stroke treatment. Therefore, the purpose of this study was to evaluate technical feasibility, safety, and efficacy of mechanical thrombectomy for large vessels acute ischemic stroke using a Revive SE stentriever.

**Methods:** From May 2012 to May 2015 fifty-nine stroke patients with large vessel occlusion with symptoms onset within 6 hours underwent a mechanical thrombectomy with a Revive SE thrombectomy device stentriever. 48 patients (81.4%) had an anterior circulation stroke and in 11 patients (18.6%) a posterior stroke. If symptoms onset was within 4.5 hours an associated systemic endovenous thrombolysis was performed. In 12 cases the Revive SE was used after unsuccessful attempts of aspiration. Technical success, clinical outcome and mortality were measured 3 and 6 months after treatment.

**Results:** A successful recanalization was obtained in 49 patients (83%). No procedural complications were recorded. At 3 months follow-up 31 patients (52.5%) showed a clinical improvement with recovery of functional ability (mRS score ≤2). Overall mortality rate at 3 months was 22% (13/48).

**Conclusion:** Intra-arterial thrombectomy with stentriever is a safe and feasible technique to improve outcome of patients with acute ischemic stroke with large vessel occlusions.
Revive system demonstrated to be technically safe and highly effective without major complications.

034

Endovascular revascularization of non-acute total ICA occlusion: Can it be an alternative treatment for non-acute ICA occlusion?

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Purpose: The clinical outcome of the patients treated with endovascular revascularization (ER) of non-acute internal carotid artery (ICA) occlusion was evaluated and compared with that of the medical and surgical group of the carotid occlusion surgery study (COSS).

Materials and Methods: Sixty-eight cases with non-acute ICA occlusion were treated with percutaneous transluminal angioplasty (PTA) and stenting under flow reversal condition. All but one were symptomatic and their average age was 65.2 years-old. Duration of ICA occlusion was mean 2.9 month and mean follow-up period was 42 months.

Results: Endovascular recanalization was successfully performed in 60/68 cases (88.2%). Stroke within 30 days occurred in 4/68 (5.9%) and resulted in all minor stroke. Stroke within 2 years was 7.4% in all cases. Restenosis appeared in 1/60 follow-up case and re-occlusion was encountered in 4/60 cases. Two of four occlusion cases were recanalized with endovascular method.

Discussion: Clinical outcome of endovascular recanalization group was much better than that of COSS medical and surgical group from the view point of stroke prevention. The morbidity rate at 30 days in ER group was 5.9%, while that of COSS surgical group was 15%. Stroke rate within 2 years in ER group was 7.4%, while that of COSS medical and surgical group was 21% and 23%, respectively.

Conclusion: Endovascular revascularization may be effective for stroke prevention considering its low perioperative complication rate compared with COSS surgical group, although these groups were not equally compared due to the difference of patient's background.

035

A direct aspiration first pass technique (adapt) versus solitaire in patients with acute ischemic stroke: an observational comparative study

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Purpose: Mechanical thrombectomy (MT) using stent retrievers after ischemic stroke onset is effective. A new technique using a direct aspiration first pass technique (ADAPT) seems promising. We compared the efficacy and safety of ADAPT versus SOLITAIRE device, used as a first-line endovascular procedure.

Methods: We analyzed 244 consecutive patients with large intracranial artery occlusions of the anterior circulation, treated with MT, according to the use of the first-line thrombectomy device (ADAPT or Solitaire). Patients were eligible if they were treatable by MT within 6 h of stroke onset. Primary outcome was the rate of recanalization (TICI scores of 2b-3). Secondary outcome included procedural and clinical data.

Results: From January 2012 to November 2014, 120 patients were treated with Solitaire or 124 with ADAPT, as a first line MT approach. Median baseline NIHSS score (Solitaire group, 17(11–21) versus ADAPT group, 17 (12–21)) and time from onset to groin (Solitaire group, 235 mn (181–300) versus ADAPT group, 245 mn (205–305)) did not differ significantly. In the ADAPT group, patients achieved better recanalization rates compared to the Solitaire group (84 % vs 68 %; odds ratio [OR] 2.3 [95%, CI 1.27–4.39], p = 0.005). Time from groin to recanalization did not differ significantly (Solitaire group, 50 mn (25–80) vs ADAPT group, 43 mn (27–65), p = 0.24). The additional use of stent retrievers was more frequent in the ADAPT group vs Solitaire group (38.7% vs 13.3%, p < 0.0001).

Conclusion: The first-line ADAPT use during MT achieved better recanalization rates compared to Solitaire device. Further randomized controlled trials are warranted to address this issue.
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THERAPY: A randomized trial of intraarterial therapy for acute ischemic stroke from long occlusions


THERAPY: A randomized trial of intraarterial therapy for acute ischemic stroke from long occlusions

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Purpose: The THERAPY Trial evaluated the Penumbra System® in a stroke cohort with large anterior vessel occlusion, refractory to IV tPA due to an extensive clot burden.

Methods: This was a prospective, randomized, concurrent controlled study [planned N = 692]. Patients 18 to 85 years old with acute ischemic stroke, National Institutes of Health Stroke Scale (NIHSS) score ≥8, clot length ≥8 mm, treated with IV tPA were randomized 1:1 to combined treatment with the Penumbra System® (IA) or IV tPA therapy alone (IV). The primary endpoints were 90-day functional outcome and incidence of serious adverse events (SAEs). Secondary endpoints included incidence of hemorrhage, functional and neurological outcomes at discharge and one month. Images, SAEs, and modified Rankin scale (mRS) were adjudicated independently.

Results: Enrollment was halted after 108 patients due to a loss of equipoise after completion of MR CLEAN and ESCAPE. Subjects were enrolled at 36 of 48 active centers in the US and Europe (55 IA and 53 IV). In the IA group, the mean age was 67 ± 11 years with a median NIHSS score of 17 (IQR 13–22) and ASPECTS score of 7.5 (IQR 6.0–9.0). Baseline characteristics were not different between groups. In the intent to treat cohort, the dichotomized 90 day mRS was 38% and 30%, respectively, for the IA and IV patients (p = 0.5206). Unadjusted ordinal mRS odds ratio (OR) was 1.76 (95% CI, 0.86 to 3.59) in favor of the IA group. Rates of mortality, good neurological outcome and SAE’s were in favor of the IA group. In a pre-specified per protocol analysis, the OR for the ordinal mRS was 2.28 (95% CI, 1.05 to 4.96).

Conclusion: Although underpowered from early termination, THERAPY demonstrates a consistent trend towards clinical benefit across all outcome measures and an effect size comparable with current modern thrombectomy trials.

ClinicalTrials.gov number, NCT01429350.

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A novel coordinated system approach to treat acute ischemic stroke

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Purpose: Neurointerventionists should essentially perform endovascular thrombectomy in Japan. In our area, most healthcare organisations that have played an important role in the treatment of acute ischemic stroke do not have full-time neurointerventionists. We have developed a novel coordinated system approach of neurointerventionists travelling to requesting hospitals for performing catheter interventions in the interest of not having to transfer patients. The aim of the present study is to evaluate the effectiveness of this system.

Materials and Methods: We conducted a retrospective chart review to assess this new system. We assessed patients’ backgrounds, time course of treatment, mRS at 90 days, National Institutes of Stroke Health Scale at 24 h, and death at 90 days for the analysis of data. The obtained data were compared between the early period and late period to assess the improvement with experience.

Results: In the late period, patients with mRS 0–2 after endovascular treatment in this system were 50%. The time of ‘Door to puncture’ in the late period was significantly shorter than that in the early period (p < 0.05).

Conclusion: Our results show that our system is promising and can treat acute ischemic stroke in areas where few healthcare organisations have neurointerventionists.
Endovascular revascularization for nonacute intracranial vertebrobasilar artery occlusion

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Purpose: To evaluate the technical feasibility, safety and mid-term effect of endovascular revascularization of nonacute intracranial vertebrobasilar artery occlusion.

Materials and Methods: Consecutive data of patients who suffered nonacute intracranial vertebrobasilar artery occlusion beyond 24 hours and underwent endovascular revascularization, were retrospective collected and analyzed. Complications and recurrent events during the follow-up period were recorded. The modified Rankin scale (mRS) scores were used and compared between pre- and postoperative.

Results: All 27 patients but 1 (96.3%) obtained successful recanalization. After the procedure, 13 patients showed improvements, 11 were stable, and 3 worse. The decline of median mRS scores, which was 4 (Interquarter Range-IR, 2–5) preoperatively and 3(IR, 1–5) on discharge, showed significant statistical difference (P = 0.002, Z = 3.116). Five patients suffered procedural complications, namely 2 dissection, 1 in-stent thrombosis during the operation, 1 thrombus disruption and translocation during the operation and 1 acute reocclusion after operation. During 21 months after operation, which was the median clinical follow-up duration, 3 death, 1 stroke and 2 transient ischemic attack occurred. The latest median mRS scores were 1 (IR, 0–3). The ratio of patients with mRS ≤ 2 increased from 25.9% before operation to 63.0% at the latest. 17 patient received imaging follow-up during the 9 months, 6 restenosis occurred and 3 of them are symptomatic. Subgroup analyses revealed better functional recovery (lower mRS) both in patients with vertebral artery occlusion (P = 0.035, Z = 2.111) and those with basilar artery occlusion (P = 0.020, Z = 2.333).

Conclusion: Endovascular revascularization for the nonacute intracranial vertebrobasilar artery occlusion beyond 24 hours is technically feasible, and improves disability recovery. However, the rates of procedural complication and restenosis are high.

A Protocol-based decision for choosing a proper surgical treatment option for carotid artery stenosis

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Purpose: There are two established surgical treatment options for carotid artery stenosis. Carotid endarterectomy (CEA) has been accepted as a gold standard for surgical treatment while carotid artery stenting (CAS) has become an alternative option recently. Each treatment option has advantage and disadvantage for the treatment outcomes. We propose a protocol to choose a proper surgical treatment option for carotid artery stenosis.

Methods: One hundred ninety-two published articles on management of carotid artery stenosis were reviewed. We selected preoperatively considerable factors which had been repeatedly noted in those articles for the risk/benefits of CEA or CAS. According to those factors, a protocol with four categories was established.

Results: CEA or CAS is indicated when the patient has a symptomatic stenosis ≥50%, or when the patient has an asymptomatic stenosis ≥80%. Each treatment option has absolute indications and favorable indications. Each absolute indication is scored with three points, and each favorable indication, one point. Based on the highest scores, a proper treatment option (CEA or CAS) is selected.

Conclusion: We have been treating the patients according to this protocol and evaluating the outcomes of our protocol-based decision because this protocol might be helpful to assess risk/benefit for choosing a proper surgical treatment option in patients with carotid artery stenosis.

Internal carotid artery dissection treated with self-expandable stents: A single-centre experience

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Purpose: Treatment of choice for dissection of the internal carotid artery (ICA) is anticoagulation for at least three to six months. Endovascular procedures may be a promising alternative for patients with haemodynamic impairment, recurrent ischaemic symptoms or symptomatic pseudoaneurysms. Thus the purpose of this study was to evaluate the efficacy and safety of carotid artery stenting in treatment of selected patients with internal carotid artery dissection (ICAD).

Methods: This study involved 19 symptomatic patients and 2 asymptomatic patient (10 female and 11 male) with the mean age of 44.9±10.0 years with ICAD treated with the use of self-expandable stents. Six months after primary procedures, patients were readmitted to hospital and physical examination followed by cerebral angiography was performed. In the late follow-up period, clinical evaluations completed by duplex Doppler ultrasonography were carried out every six months and at the end of the follow-up period.

Results: Nobody died and no life-threatening adverse events were observed during either the in-hospital stay or postdischarge follow-up period (median 18 months). Stent deployment immediately restored flow in the true lumen of ICA in all cases. However, residual blood flow through the false lumen was observed in one patient. Complete resolution of clinical symptoms was observed in 17 patients (80%), partial improvement in 2 (10%) and persistence of neurological deficit in 2 (10%).

Conclusions: Implantation of self-expandable stents in treatment of selected ICAD cases is safe with no mortality and almost no morbidity. This method may enable us to restore immediately and usually permanently proper arterial blood flow in the ICA and in consequence lead to significant clinical improvement in the late follow-up period.

Purpose: To evaluate the indications for and results of the endovascular reconstruction of extra- and intracranial arteries after subacute and chronic occlusion.

Materials: A retrospective analysis of clinical and angiographic data of 35 patients who underwent this treatment was performed. All endovascular procedures were carried out under general anaesthesia with dual platelet inhibition. An individual combination of balloon angioplasty and stent deployment was used.

Results: A total of 35 patients and 36 occlusions treated between 2007 and 2014 were evaluated. Treatment indications were acute clinical symptoms in 21/35 (60%) patients. Target vessels were ICA (n = 5), MCA (n = 2), VA (n = 13), BA (n = 7) or a combination thereof (n = 9). The attempted vessel reconstruction was achieved in 32/36 (88.8%) procedures. Clinical improvement was confirmed in 30 patients (83.3%), two of them despite failed attempt. At follow-up, permanent neurological deficit was encountered in 16 patients. Four patients died, one as a consequence to the procedure.

Conclusion: Haemodynamic compromise of the dependent circulation is a possible reason for the endovascular reconstruction of extra- and intracranial vessels in the status of subacute or chronic occlusion. The procedure can be quite demanding (e.g., for basilar and MCA reconstruction). Long-term dual antiaggregation, angiographic follow-up and treatment of in-stent restenoses are part of the concept. Clinical results reach from considerable improvement to major morbidity and procedural mortality.

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042
Natural history and endovascular treatment of intracranial vertebrobasilar artery dissection
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Purpose: acute intracranial vertebrobasilar arterial dissection may clinically present as headache and evolve to a hemorrhagic or ischemic form or present directly to one of two ways. The endovascular treatment is indicated when patient presents hemorrhage or in some other situations. We reviewed all cases of intracranial vertebrobasilar artery dissection that we performed digital angiography in the last 19 years of our services.

Methods: Between January 1996 and April 2015, we performed angiographic diagnostic imaging of intracranial vertebrobasilar dissection in 101 patients.

Results: 26 patients presented directly hemorrhagic form, 40 patients ischemic form and 32 patients present initially headache and/or neck pain. Ten of them evolved to hemorrhagic form, 14 to ischemic and 8 remain stable. Five patients were incidental findings. Sixty-three patients were
treated by endovascular procedure. Of the 36 patients with hemorrhagic form, 6 were not treated, 2 due to late diagnosis (2 months after the stroke), 2 had spontaneous occlusion of the carrier vessel, one bled again before embolization and one had severe vasospasm. Thirty-three patients with non-hemorrhagic form were treated by endovascular procedure, 26 due to the presence of pseudo aneurysm and 7 due to stenosis. The techniques used for the endovascular treatment were trapping (n = 17), proximal occlusion (n = 17), stent assisted coiling (n = 17), stent only (n = 6) and flow diverter (n = 7). We had no evolution from ischemic to hemorrhagic form. In all cases that we performed trapping or flow diverter treatment, we obtained a total occlusion of the lesion in late angiographic controls. **Conclusion:** When presented as prodrome, this disease can develop into ischemic or hemorrhagic form in a short time. Treatment with flow diverter seems to be a good option due to other types of endovascular treatment.

**References**


**043**

Recanalization of distal vertebral artery occlusion in patients with contralateral vertebral artery insufficient flow

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**Purpose:** The feasibility and safety of recanalizing the acute symptomatic distal vertebral artery (dVA) occlusion with insufficient contralateral flow is not well documented. We report our experiences of endovascular recanalization of those lesions.

**Methods:** From our last 4 years of posterior circulation revascularization database, there were 18 patients presented with acute stroke due to occlusion of dVA. The contralateral VA was occluded (n = 8), aplastic with PICA ending (n = 3), stenotic (n = 6), or occluded proximally (n = 1). We analyzed the clinical presentation, infarct pattern on DWI, procedural success, recanalization techniques, periprocedural complications, and outcome (modified Rankin Scale) at 3 months.

**Results:** Clinical symptoms were variable and fluctuating. DWI revealed variable sized infarcts in the posterior circulation and diffusion-perfusion mismatch. Occlusion length was relatively long due to superimposed thrombosis and pre-existing stenosis. Successful recanalization was achieved in all patients with use of balloon PTA and/or self-expanding stent. Clot retriever was used in 3. Hemorrhagic transformation was seen in 2 with PICA territorial infarcts, and re-occlusion of the stent in 2. Outcome at 3 months showed mRS ≤ 2 in 13 (72.2%).

**Conclusion:** Patients with acutely symptomatic dVA occlusion with contralateral insufficient VA perfusion usually presents with fluctuating clinical presentation. Endovascular revascularization of the lesion is technically feasible but the risk of reperfusion injury should be considered in case of large infarct burden.

**044**

Endovascular Treatment for Extracranial stenosis

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**Purpose:** Cerebral atherosclerosis is responsible for about 30% of cases of ischemic stroke. These ischemic events are mostly resulting from cerebral embolism due to change in the atherosclerotic plaque biology.

**Methods:** Retrospective analysis of 1.358 consecutive patients with atherosclerotic stenosis in the service of Neurosurgery, undergoing angioplasty with stent. 1.181 patients with extracranial stenosis were selected from November 2005 to May 2015, observing the variables: age, sex, presenting symptoms, degree and location of the stenosis, events and associated complications.

**Results:** Male (57.9%), mean age 63.2 years (55–93). 74% of patients were symptomatic at diagnosis, and 61.5% of those had ischemic stroke, transient ischemic 23.4% and 15.1% persistent dizziness. The vessels of the anterior circulation were responsible for stenosis in 90% of cases, predominantly in the internal carotid artery with 1.036 cases followed, vertebral artery (182 cases), subclavian (36 cases). All cases of internal carotid angioplasty were treated using cerebral protection filter. Eighty-one percent of patients with critical stenosis. The morbimortality rate was 3.3%, death in 3 cases, ischemic stroke in 12 cases, attack isquemic transient in 8 cases, stent occlusion in 2 cases.

**Conclusion:** Endovascular treatment is constituting a safe and effective treatment for ischemic stroke, with low morbidity and mortality rate.
045

Carotid artery stenting in patients with contralateral carotid occlusion

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Purpose: In patients with contralateral carotid occlusion (CCO) carotid stenting (CS) is an alternative to carotid endarterectomy (CEA). We determined the periprocedural and midterm outcome of CS.

Methods: Medical records of 25 consecutive patients with clearly documented CCO who underwent CS by a single operator between September 2010 and May 2015 were retrospectively evaluated. CS was performed using the same technique and procedural protocol. NIHSS and modified Rankin Scale (mRS) scores before and after CS, periprocedural cerebrovascular complications and restenosis rate were analysed by an independent stroke neurologist.

Results: Of 25 patients included (mean age 64.6, range 53–84, 7 females) the median mRS score was 1 (range = 0–4) before and after CAS. Patients were treated with closed-cell stents under distal protection. There were no technical failures or technical complications with clinical sequela. All of the patients had follow-up examinations, mean follow-up duration was 11 months. Thirty day mortality and permanent morbidity rates were 0%. One patient had postprocedure hyperperfusion presenting with seizures and without an intracranial bleed, was managed medically and had stent occlusion after 30 days which resulted in a decline of the patients pre-procedure mRS from 4 to 5, otherwise there was no decline of mRS during post-discharge follow-up.

Conclusion: In this largest single-operator series and based on independent analysis, CS is safe and effective for the treatment of patients with CCO.

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Long-term clinical outcome of carotid artery stenting

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Purpose: Carotid artery stenting (CAS) was officially approved in Japan since April 2008. Today, CAS is an alternative treatment to carotid endarterectomy and is performed nationwide. The short-term clinical outcome from Japanese retrospective survey reported the efficacy and safety of CAS. However, a long-term clinical outcome is still unknown. The aim of this study is to analyse a long-term clinical outcome in patients with cervical carotid artery stenosis treated with CAS.

Methods: We retrospectively reviewed the pooled database on CAS and selected patients who underwent CAS at least 5 years before. A total of 222 patients (237 procedures) underwent CAS with embolic protection devices between April 2008 and December 2009. Among them, the clinical records of 158 patients were reviewed for a long-term analysis. All cause of death, ipsilateral stroke, and target vessel revascularization (TVR) were defined as adverse event. The favorable outcome was defined as modified Rankin scale of 0 to 2 at latest follow-up.

Results: Successful revascularization was achieved in 232 procedures (97.9%). Periprocedural complications occurred in 16 procedures (6.8%), including ischemic stroke (16), hemorrhagic stroke (3), and hyperperfusion phenomenon (1). Nine (3.8%) of which resulted in clinical deterioration. Long-term clinical adverse events were as follows. Thirty patients (19.0%) died during follow-up. The causes of death were malignant tumor (10), pneumonia (8), stroke (4), cardiovascular (4), renal failure (1), and unknown cause (3). Ipsilateral stroke occurred in 8 patients (5.1%) and TVR was required in 2 patients (1.3%). The favorable outcome was achieved in 111 patients (70.3%) at latest follow-up.

Conclusion: The long-term clinical outcome of CAS appears to be acceptable with low percentage of ipsilateral stroke and TVR. On the other hand, malignant tumor revealed the highest cause of death in our analysis.

047

Endovascular management of acute ischemic stroke: A single centre study

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Purpose: To study the outcome of endovascular management in the patients of acute ischemic stroke.

Methods: Data of 110 patients treated from April 2007 to April 2015 was analyzed retrospectively to study the clinical outcome. Mean age 55 years. Patients were treated with either IA TPA (before 2010) or stent-retrievers (2011–2015). Mean treatment window was 6–8 hours. Modified Rankin Scale (mRS) scoring system was used to assess the clinical disability and TICI (thrombolysis in cerebral ischemia) for judging the recanalization rates.

Results: Of the total 110 cases, 70 had good functional outcome (mRS 0–2). Eighteen had residual deficit (mRS 2–3), sixteen were left with significant deficit (mRS > 3). Six patients expired. One had hemorrhagic transformation of the infarct.

Conclusion: Endovascular therapy showed favorable results in patients of acute ischemic stroke when treated within the time window.
Mechanical Thrombectomy: Balloon occlusion or intermediate catheter? No, both!

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Purpose: Several studies demonstrated improved recanalization and clinical outcomes with retrievable stents (RS) combined with proximal balloon occlusion (PBO) or distal thrombus aspiration (DTA) through an intermediate catheter alone. The goal of this study was to evaluate recanalization rates and safety for both PBO and DTA employed simultaneously.

Methods: Thirty-three patients with proximal intracranial occlusion in the anterior circulation were treated with RS and simultaneous PBO/DTA between February 2014 and April 2015. Additional treatment included intravenous thrombolysis (20/33) and percutaneous transluminal angioplasty/permanent stent placement of the cervical internal carotid artery (10/33). Recanalization was assessed by means of the TICI score. Clinical outcome was determined at discharge (NIHSS).

Results: Median NIHSS score on admission was 19; median duration of symptoms was 233 minutes. Successful recanalization (TICI 2b/3) was achieved in 30/33 patients (91%). Neither embolization to a new territory nor vessel dissection or symptomatic intracranial bleeding was detected. Median NIHSS at discharge was 4. Mortality during hospitalization was 6% (2/33).

Conclusion: In our series, application of RS combined with PBO and DTA in acute proximal intracranial occlusion in the anterior circulation resulted in very high recanalization rates without procedural complications.

Endovascular management of extra-intracranial tandem obstructions in acute ischemic stroke

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Purpose: Acute tandem obstructions of the extracranial ICA and intracranial ICA/MCA cause severe form of ischemic stroke. Endovascular treatment with stent-retrievers with or without concomitant extracranial stenting of the underlying obstructive lesion is an emerging treatment option. However, endovascular treatment is challenging and optimal treatment strategies are still unclear. We describe our experience in the endovascular management of tandem obstructive lesions in the anterior circulation with special regard to technical aspects and outcome.

Methods: Consecutive patients undergoing mechanical stent-retriever thrombectomy with extra-intracranial tandem obstructions of the anterior circulation treated with or without extracranial stent implantation between 01/2010–09/2014 were reviewed. Clinical data, procedural aspects, recanalization rates, complication rates and clinical outcome were analysed.

Results: 62 patients (mean age 67, mean admission NIHSS 15) were included. Occlusion sites were extracranial ICA-M1/M2 in 82.3%, extracranial ICA-intracranial ICA in 17.7%. Extracranial obstructive ICA lesions were caused by atherosclerotic disease in 70.9%, dissection in 22.6% and large cardioembolism in 6.5%. Recanalization was performed using a retrograde approach in 77.4% and using an antegrade approach in 22.6%. Stenting of the extracranial ICA was performed in 75.8%, PTA alone in 11.4% and no treatment in 12.9%. Rate of stent occlusion within 24 h was 6.5% (3/46) after stenting and 42.8% (3/7) after PTA. Successful recanalization (TICI 2b/3) was achieved in 77.4%. Procedural complications occurred in 11.3%, distal thromboembolic events in 21% (13/62). Rate of sICH was 3.2% (2/62). Mean time-to-treatment was 388 min (range 190–842), mean intervention time was 112 min (range 49–282). Good clinical outcome after 90 days (mRS 0–2) was 49.2% (29/59) and mortality 13.6% (8/59).

Conclusion: Endovascular treatment of tandem obstructions is technically feasible, achieve high recanalization rates and acceptable rates of good clinical outcome. In case of acute ICA stenting the risk of stent occlusion and sICH seems to be low.

Poor CTA collateral scores in acute ischemic stroke do not predict DSA collaterals

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Purpose: The absence of pial collaterals predicts larger infarct volumes and unfavorable clinical outcomes in patients with large vessel, acute ischemic stroke. This study examines the correlation between computed tomography angiography (CTA) and digital subtraction angiography (DSA) collateral scoring systems in stroke patients eligible for thrombectomy.

Methods: We conducted a retrospective analysis of 74 acute stroke patients who underwent initial CTA followed by cerebral angiography from January 2009 to December 2013. To be included, subjects had a complete occlusion of the middle cerebral artery first segment (M1) on both CTA and subsequent DSA. Subjects were excluded if DSA did not confirm M1 occlusion or revealed additional occlusions of anterior cerebral or internal carotid arteries.
CTA and DSA collateral circulation scores were determined using the Massachusetts General Hospital (MGH) collateral and angiographic pial scoring systems, respectively. Both scores have been validated, utilize a 5-point system, and were dichotomized in our study for Fisher’s exact, sensitivity, and specificity analyses. The MGH and the angiographic pial scoring systems were dichotomized as poor (0) or good (>0) and poor (5) or good (<5), respectively.

**Results:** 21 subjects were included in the analysis. The average age was 66 years (range, 39–91); 33% were men. The average time between CTA and DSA was 155 minutes. The Fisher’s exact test showed a trend for CTA and DSA correlation (p = 0.13). CTA was sensitive for predicting good DSA (93.8%, 95% CI: 69.7–99.0) but not specific for predicting poor DSA (40%, 95% CI: 6.5–84.6).

**Conclusion:** In our study, CTA collateral scores predicted good, but not poor, subsequent DSA collaterals. Poor CTA predicted poor DSA status less than half of the time. Our findings suggest that CTA has limitations as a screening test, and therefore, fewer patients should be excluded from thrombectomy based on CTA collaterals alone.

**References**


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**Favourable Outcomes in Endovascular Stroke Treatment Following Clinical and MRI-Based Selection**

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**Purpose:** To evaluate the effectiveness of specific MRI and clinical criteria in patient selection for thrombectomy.

**Methods:** 72 patients with MCA or terminal ICA occlusion by CTA, followed by core infarct volume determination by MRI, underwent thrombectomy after meeting institutional criteria. Patients were prospectively classified as Likely to Benefit (LTB) or Uncertain to Benefit (UTB) using DWI lesion volume and clinical criteria (age, NIHSS, time from onset, baseline mRS, life expectancy). Outcomes were 90-day modified Rankin score (mRS), favourable defined as 90 day mRS of ≤2.

**Results:** 40 patients were prospectively classified as Likely to Benefit (LTB), 32 as Uncertain to Benefit (UTB). Reperfusion and prospective categorization as LTB were powerfully associated with favourable outcomes (p < 0.001 and p < 0.005, respectively). Successful reperfusion positively impacted the distribution of mRS scores of the LTB cohort (p < 0.0001). Reperfusion was achieved in 68% of the LTB patients and 75% of UTB patients (non-significant). Favorable outcomes were obtained in 53% and 25% of LTB and UTB patients that were treated, respectively (p = 0.016; Fisher exact test). Favorable outcomes were observed in 74% of LTB patients that had successful reperfusion compared to 33% of successfully reperfused UTB patients (p = 0.004; Fisher exact test).

**Conclusion:** Prospective classification as Likely to Benefit by MRI and clinical criteria predicts a high likelihood of favourable outcome after thrombectomy, particularly if reperfusion is successful. MRI selection compares favourably to advanced imaging selection using CT techniques. A randomized clinical trial to compare MRI to CT selection for acute stroke intervention is warranted.
Absence of opacified cortical veins in patients with acute anterior circulation stroke is related to a very limited benefit for intra-arterial treatment

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Purpose: Symmetrical opacification of the cortical veins after parent vessel occlusion indicates tolerance of occlusion. In anterior circulation stroke patients the opacification of cortical veins is usually asymmetric. We hypothesized that asymmetry in venous drainage reflected in poor opacified veins is associated with a reduced treatment benefit from intra-arterial therapy (IAT).

Methods: From the MR CLEAN database all 500 baseline CTA studies were reviewed. For each hemisphere, opacification of the vein of Labbe, sphenoparietal sinus, and superficial middle cerebral vein was graded 0 (not visible), 1 (faint opacification), or 2 (full opacification). The Cortical Vein Ratio (COVER) was calculated by dividing the sum of opacification by the sum of total veins in the hemisphere. Results were dichotomized into 0 and >0, with 0 representing complete absence of venous opacification in the hemisphere. The primary outcome was the modified Rankin scale score at 90 days (mRS). Benefit from IAT was estimated with ordinal logistic regression as a common odds ratio, adjusted for pre-specified prognostic factors (stroke severity at baseline (NIHSS), age, time of symptom onset to randomization, presence of T-top occlusion and clinical histories of stroke, diabetes and atrial fibrillation). This adjusted common odds ratio (acOR) describes the likelihood that IAT would lead to improved mRS. We tested for interaction of COVER with treatment effect.

Results: 114 patients with absent venous opacification due to suboptimal scan-timing were excluded from analysis, leaving 386 patients for COVER assessment. The acOR was 1.1 [CI 0.64–2.01] for COVER 0 (n = 160) and 3.0 [CI 1.83–5.02] for COVER >0 (n = 226). The interaction of COVER with treatment was statistically significant (p = 0.050).

Conclusion: Patients with complete absence of venous flow in the affected hemisphere (COVER 0) showed almost no benefit of IAT. As soon as venous flow was observed however, a clear IAT benefit was seen.

Arterial spin labeling MRI can identify the occlusion site and collateral perfusion in patients with acute ischemic stroke - Comparison with digital subtraction angiography

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Purpose: Determining the occlusion site and collateral blood flow is important in acute ischemic stroke. The purpose of this study was to test whether arterial spin labeling (ASL) MRI could be used to identify the occlusion site and collateral perfusion using digital subtraction angiography (DSA) as a gold standard.

Methods: Consecutive 521 patients who presented with acute ischemic stroke at our institution from January 2012 to September 2014 were retrospectively reviewed. Image data were included in this study if (1) the patient presented symptoms of acute ischemic stroke; (2) MRI was performed within 24 hours of symptom onset; (3) DSA following MRI was performed (n = 32 patients). We defined proximal intra-arterial sign (IAS) on ASL as enlarged circular or linear bright hyperintense signal within occluded artery and distal IAS as enlarged circular or linear bright hyperintense signals within arteries inside or surrounding the affected region. The presence or absence of the proximal IAS and distal IAS were assessed, along with their inter-rater agreement and consistency with the presence of occlusion site and collateral flow on DSA.

Results: Inter-rater agreement was good for both proximal IAS detection (κ = 0.73) and distal IAS detection (κ = 0.61). Sensitivity and specificity for identifying occlusion site with ASL were 0.82 and 1.0, respectively. Those for identifying collateral flow with ASL were 0.97 and 1.0, respectively.

Conclusion: The proximal IAS and distal IAS on ASL imaging can provide important diagnostic clues for the detection of arterial occlusion sites and collateral perfusion in patients with acute ischemic stroke.

Presentation withdrawn

MRI analysis of intraprocedural emboli during carotid artery stenting using filter-protected device or proximal flow blockage device

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Objective: The main concern regarding transfemoral carotid artery stenting (CAS) is the possible dislodgement of cerebral emboli during the procedure. CAS with endovascular...
proximal flow blockage (PFB) is deemed able to reduce the cerebral embolization observed during filter-protected CAS. We evaluated clinical outcome and intraoperative embolization rates in a series of patients undergoing CAS with filter-protected device (FPD) and PFB. 

Method: During 4 year, a series of 58 consecutive patients with symptomatic or asymptomatic internal carotid artery stenosis ≥70% were included to undergo CAS with FPD and PFB, obtained with the MoMa system. The FPD in 21 patients and PFB in 30 ones were used during CAS. All patients underwent diffusion weighted magnetic resonance image (DW-MRI) before and after CAS, in order to detect new ischemic lesions. We compared clinical outcome and postoperative embolization rates in each.

Result: CAS was successfully performed in all 38 patients. No deaths or neurological events occurred in the postoperative period with FPD and PFB. The FPD in 21 patients were successfully used during CAS (technical success: 96.6%). Mean age was 70.9 year old and mean stenosis was 83%. Symptomatic was 43%. DW-MRI disclosed 96 new ischemic lesions in 20 patients (71.4%). Twenty four lesions in 7 patients were contralateral to the treated carotid artery. Whereas, the PFB was successfully used in 30 patients (technical success: 93.8%). Mean age was 70.6 year old and mean stenosis was 86%. Symptomatic was 60%. No fail of intolerance to balloon occlusion was observed. DW-MRI disclosed 45 new ischemic lesions in 17 patients (57%). Three lesions in 3 patients were contralateral to the treated carotid artery. The number of ischemic lesion, per patient when present, was lower in the PFB compared to FPD (p = 0.028, Mann-Whitney U test). Symptomatic or asymptomatic and cell type of stent had statically no significant between the PFB and FPD. 

Conclusion: Transfemoral CAS with PFB achieves good technical and clinical results. The use of PFB might be effective to reduce cerebral embolic load during CAS compared to FPD. Further studies, directly comparing the results of DW-MRI after CAS with FPD and PFB, are needed to confirm this result.

055

Hemodynamics and functional MRI study in patients with carotid stenosis

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Purpose: To study the clinical characteristics of cognitive impairment and magnetic resonance diffusion tensor imaging manifestations in patients with carotid artery stenosis.

Methods: The Mini-Mental State Examination and Montreal cognitive assessment scale were used to evaluate the cognitive function in 11 cases of patients with severe carotid artery stenosis and the control group. Diffusion tensor magnetic resonance scanning was performed for the patients, and evaluate the ipsilateral and contralateral FA value by using ROI method.

Results: The MMSE scale scores of patients with carotid artery stenosis were not significantly different compared with the control group, but less MoCA scale score were found in patients with carotid artery stenosis than those in the control group, which is statistically significant. FA values from the region of interest suggested that white matter damages were mainly located in the border-zone regions (Watershed area).

Conclusion: Cognitive impairment was present in the patients with carotid artery stenosis compared with the controls, and diffusion tensor imaging can provide the information of white matter injury.

References


056

Database of pathological and physiological tissue attenuation curves for simulation and modelling of brain perfusion

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Purpose: The tissue attenuation curves (TAC) of the brain parenchyma and vessels after the injection of contrast agent have a large variety. Both the pathological curves differ from the physiological ones and every patient has a specific curve progress. The development of perfusion imaging using flat detector computed tomography (CT) requires a solid knowledge as a ground truth of the TACs to be measured. To deploy a developed hardware perfusion phantom in a reasonable way and improve modelling algorithms, a database of clinical TACs was created.

Methods: A total number of 32 conventional clinical perfusion CTs (30 seconds, 80 kVp, 200mA) of patients with stroke symptoms were analysed retrospectively. In both
hemispheres an 8 x 8 voxel region of interest (ROI) was placed into five recurring areas in the temporal cortex and one in the arteria cerebri media. The exact time course of the TACs were extracted and stored with a note about the exact location and a reference to the morbidity of the patient according to a perfusion CT if applicable.

Results: A number of 24 datasets could be processed properly without motion or other interferences, leading to a total number of 288 tissue attenuation curves. A large variety of different curves with 13.87 +/- 3.05 seconds duration between wash in and wash out and 161.79 +/- 63.18 Hounsfield units (HU) peak amplitude in arterial tissue and 13.95 +/- 5.33 HU peak amplitude in parenchymal tissue.

Conclusion: It can be assumed that the resulting database is a sufficiently extensive tool for the development of models of the brain-tissue perfusion on the one hand and a good base to adjust proper parameters in the developed perfusion phantom on the other hand. Additional datasets or ROIs can be added afterwards to improve the quality or to check the quality of a developed model or system.

057
Baseline CT ASPECTS and Admission Neutrophil-Lymphocyte Ratio Correlation in Anterior Circulation Stroke with Favorable Perfusion Profile for Endovascular Therapy

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Purpose: We studied the association between the baseline Alberta Stroke Program Early Computed Tomographic Score (ASPECTS) with admission neutrophil-lymphocyte ratio (NLR) in acute ischemic stroke (AIS) patients due to ICA/MCA occlusions. Secondarily, we investigated further association of ASPECTS and NLR in patients with favourable or unfavourable perfusion profile for intra-arterial reperfusion therapy (IRT).

Methods: Consecutive AIS patients with CTA/MRA verified ICA/MCA occlusion presenting in acute setting were recruited. Patients with other vascular pathologies, prolonged hospitalization, corticosteroids medication, and associated systemic/infectious diseases prior to stroke were excluded. Admission NLR was obtained using baseline white blood cell differential by dividing the percentage of neutrophils by the percentage of lymphocytes. ASPECTS were obtained after 2 blinded observers evaluated the baseline CT examinations. ASPECTS was dichotomized into >7 (favourable) and <=7 (un-favourable) and NLR was sub-classified into high (>5), and low (<=5) groups. Intraclass Correlation Coefficient (ICC), Chi-square, Mann-Whitney U, receiver operating characteristic (ROC) curve and Pearson’s correlation coefficient (r), were used for statistical analyses.

Results: Sixty five patients (33 F/32 M, mean age ± SD: 69.77 ± 14.87) were studied. Interobserver agreement for ASPECTS was good (ICC = 0.82). After dichotomizing the patients based on ASPECTS and NLR, all groups were comparable in terms of demographics and risk factors. In perfusion-guided selected patients (n = 52) a significant inverse correlation was observed between ASPECTS and admission NLR (P = 0.01, r = -0.33). Un-favourable ASPECTS (<=7) was significantly associated with high NLR (>=5) (P = 0.002). ROC curve analysis revealed that NLR of <=5 can discriminate favourable (>7) from unfavourable (<=7) ASPECTS (Sensitivity: 80.8%; Specificity: 65.4%; P = 0.009; AUC = 0.69). In 13 perfusion-guided excluded cases there was no correlation and association between ASPECTS and NLR (P = 0.06 and P = 0.93, respectively).

Conclusion: ASPECTS and admission NLR are inversely correlated in AIS patients with favourable perfusion profile for IRT.

058
Favourable Baseline CT ASPECTS, DWI ASPECTS and DWI Brainstem Scoring are Poor Predictors of Good Functional Outcome in Perfusion-guided Selected Acute Basilar Artery Stroke

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Purpose: To study baseline CT posterior circulation (PC) Alberta Stroke Program Early Computed Tomographic Score (ASPECTS), DWI PC-ASPECTS, and DWI brainstem scores in acute basilar artery (BA) ischemic stroke patients selected for intra-arterial reperfusion therapy (IRT) based on perfusion imaging profile (PIP) and the association with final outcome.

Methods: Consecutive patients of with CTA/MRA verified BAO presenting in <12 hours were studied. Patients were selected for IRT based on their PIP. Demographics, THRIVE scores, and clinical outcomes (90-day mRS score) were obtained. Two neuroradiologists assigned PC-ASPECTS to all baseline CT exams. One observer scored brainstem DWI and DWI PC-ASPECTS. CT and DWI MR PC-ASPECTS were dichotomized into >7 (favourable) and <=7 (un-favourable) and brainstem DWI was dichotomized to >2 (favourable) and >=3 (un-favourable). Chi-square, independent sample t test, Pearson’s correlation coefficient (r), and intraclass correlation coefficient (ICC) were used for statistical analyses.

Results: Thirteen patients (9 M/4 F mean age ± SD: 63.27 ± 13.36 years) were recruited. Interobserver agreement for baseline CT PC-ASPECTS was excellent (ICC = 0.93). Both favourable and unfavourable CT PC-
ASPECTS, DWI PC-ASPECTS and DWI brainstem groups were comparable in demographics (P > 0.05). The median CT PC-ASPECTS, DWI PC-ASPECTS and DWI brainstem scores were favourable in perfusion-guided selected patients for IRT (9, 8, and 2 respectively). CT PC-ASPECTS was not correlated with DWI PC-ASPECTS and DWI brainstem scores (P = 0.3 and P = 0.5, respectively). A significant inverse correlation was observed between DWI PC-ASPECTS and DWI brainstem scores (r = -0.58, P = 0.04). Good outcome and successful recanalization (TICI 2b, 3) rates were 46% and 77%, respectively. CT PC-ASPECTS, DWI-ASPECTS, DWI brainstem scores, and successful recanalization were not associated with final outcome (P = 0.9, P = 0.9, P = 0.1, P = 0.56, respectively). THRIVE score was significant predictor of final functional outcome (P = 0.01).

**Conclusion:** BA stroke patients with favourable PIP for IRT had favourable baseline CT PC-ASPECTS, DWI PC-ASPECTS and DWI brainstem scores; however none of them could predict favourable outcome.

059

**Which evaluation should we take among various infarct core volume measurement methods?**

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**Purpose:** To evaluate the prediction power of various infarct core volume measurement methods for clinical outcomes in patients treated with intraarterial thrombectomy.

**Methods:** We retrospectively selected 79 patients (65.1 ± 15.7 years; range, 39–81 years) with acute ischemic stroke in unilateral anterior circulation territory and treated with intra-arterial thrombectomy using Penumbra, stent retriever (Solitaire) or combination of these. For assessing infarct core volume, ASPECTS was scored based on noncontrast CT (NCCT), postcontrast CT (PCCT) and DWI by one neurologist and neuroradiologist independently. Infarct core volume was also quantitatively measured with the manually outlined hyperintense lesion on diffusion MRI by two independent readers and calculated with the multiple margin thresholds of ADC value as 500 x 10^-6 mm^2/s, 550 x 10^-6 mm^2/s, 600 x 10^-6 mm^2/s, 650 x 10^-6 mm^2/s and 700 x 10^-6 mm^2/s. Intracllass correlation coefficients (ICC) were estimated to assess interreader reliability for ASPECT scoring and quantitative infarct core volume measurement. ROC curve analyses were done for determining the proper threshold of each imaging protocol to predict subsequent parenchymal hematoma formation, good outcome (mRS 0–2), futile outcome (mRS 5, 6) and mortality, respectively.

**Results:** A total of 55 of 79 patients (69.6%) demonstrated successful revascularization after intraarterial thrombectomy. Interrreader agreement between neurologist and neuroradiologist was excellent for measuring the infarct core volume (ICC, 0.973) and scoring ASPECTS based on DWI (ICC, 0.940). Interrreader reliability for scoring ASPECTS was decreased based on CT (ICC on NCCT, 0.694; ICC on PCCT, 0.859). There were no statistically significant difference among CT ASPECTS, MRI ASPECTS and MRI infarct core volume for predicting subsequent hematoma formation after endovascular treatment and good outcome. ASPECTS based on NCCT showed significantly smaller AUC (p < 0.05) for predicting futile prognosis and mortality.

**Conclusion:** Assessing infarct core volume based on MRI was more predictive to clinical outcome after intraarterial thrombectomy, especially for futile outcome and more reliable.

060

**New MRI BioMarker for favorable clinical outcome after Mechanical Thrombectomy**


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**Purpose:** The susceptibility vessel sign (SVS) on MRI has been reported to indicate acute occlusion from erythrocyte rich thrombus. The purpose of this study was to evaluate the influence of the SVS seen on MRI before treatment on the clinical outcome after mechanical thrombectomy (MT) for anterior circulation acute stroke (ACAS).

**Methods:** We retrospectively included 73 consecutive patients who were treated for ACAS by MT from December 2009 to September 2013. Each patient had an MRI before MT. Presence (SVS+) or absence of SVS (SVS-) was recorded. MT was performed either alone or in association with IV tPA according to the site and time after occlusion. Good functional outcome was defined by a mRS < 2 at 3 months in SVS+ and SVS- groups. Patient’s clinical characteristics, initial NIHSS and ASPECTS, site of occlusion, time between onset to groin puncture, TICI after MT, NIHSS at day 1 and spontaneous hyperdensity on CT at day one were also analyzed.

**Results:** 53 SVS+ patients and 20 SVS- patients were included in our study. mRS <=2 at 3 months occurred in 65% patients in the SVS+ group and 26% in the SVS- group (p = 0.004). On Multivariate analysis, SVS was the only parameter before treatment that could predict mRS <=2 at 3 months (OR 8.7, 95%CI[1.1–69.4], p = 0.04).

**Conclusion:** Our study strongly suggests, that SVS on MRI before treatment is predictive of favorable clinical outcome for patients presenting with ACAS and treated with MT.
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Parametric imaging for the objective grading of collateral flow in MCA occlusion: a feasibility study

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Purpose: This study presents a quantitative and objective way of leptomeningeal collateral assessment using parametric color coding digital subtraction angiography (DSA) and evaluates its reproducibility and validity.

Methods: Fifteen consecutive acute middle cerebral artery occlusion cases which compensated by ipsilateral anterior cerebral artery and received endovascular reperfusion therapy were recruited. Target downstream territory (TDT) of Middle Cerebral Artery in AP view and reference point (for data normalization) of each patient was drawn by 5 raters separately. Two parameters, relative maximum density of TDT (\(r_{\text{Density}_{\text{max}}}\)) and peak time interval between reference and TDT (\(\Delta \text{PT}\)) were measured and tested for inter-rater reliability using intra-class correlation coefficients (ICC). Parameters with sufficient inter-rater reliability were assessed for correlation with both the American Society of Interventional and Therapeutic Neuroradiology (ASITN) collateral grading (ACG) system and clinical outcome to evaluate its efficacy in characterization of collateral quality.

Results: ICC of both \(r_{\text{Density}_{\text{max}}}\) and \(\Delta \text{PT}\) showed perfect inter-test reliability (ICC = 0.982 (95% CI 0.968–0.992, \(P < 0.001\) and 0.796, 95% CI 0.636–0.914, \(P < 0.001\), respectively). The parameter \(r_{\text{Density}_{\text{max}}}\) shows strong correlation with ACG score (r of Spearman correlation test is 0.928, \(P < 0.001\), yet \(\Delta \text{PT}_{\text{average}}\) doesn’t (\(r = 0.327, P = 0.159\)). Correlation coefficient between \(r_{\text{Density}_{\text{max}}}\) and modified rankin scale at 3 month is 0.643, \(P = 0.013\); that of \(\Delta \text{PT}\) and mRS at 3 month is 0.171, \(P = 0.560\), adjusted by the state of reperfusion.

Conclusion: The relative maximum density of TDT \(r_{\text{Density}_{\text{max}}}\) measured based on color coding DSA is feasible for quantitative assessment of collateral flow in appropriate MCAO cases.

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Study on relationship of cognitive impairment and CT perfusion image in patients with asymptomatic severe unilateral internal carotid artery stenosis

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Purpose: To study cognitive impairment in patients with asymptomatic severe carotid artery stenosis by CT perfusion image (CTP).

Methods: 52 patients with asymptomatic severe unilateral internal carotid artery stenosis (the rate of unilateral stenosis is more than or equal to 70% with the contralateral stenosis rate of less than 30%) were divided into 2 groups by MoCA (Montreal Cognitive Assessment) scores: 12 cases without cognitive impairment (MoCA is equal to or more than 26 points), and 40 cases with cognitive impairment (MoCA < 26). All patients were confirmed severe unilateral carotid stenosis by DSA (Digital subtraction angiography) and underwent CTP image. Evaluate the following parameters: relative cerebral blood flow (relative cerebral blood flow, rCBF), relative cerebral blood volume, relative cerebral blood volume, rCBV), relative mean transit time (relative mean transit time, rMTT) and relative of peak time (relative time to peak, rTTP). Compare the relative perfusion parameters of 2 groups.

Results: No statistical difference was found between the two groups in vascular stenosis and in distribution of the vascular stenosis in left or right side. Patients with cognitive impairment were higher in rTTP and rMTT than those without cognitive impairment with statistically significance (\(P < 0.05\)). No significant difference were found between the two groups in rCBF and rCBV.

Conclusion: Most patients with asymptomatic severe carotid artery stenosis had cognitive impairment. And the impairment had no relation with degree of stenosis and distribution on the left or right side of stenosis. But the impairment was related to the degree of hypoperfusion.

063

Endovascular treatment of carotid stenosis: 106 cases

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Purpose: Ischemic stroke is a major cause of adult disability and the 3rd leading cause of death. Approximately 15–30% of ischemic strokes are caused by obstructive carotid
atherosclerosis involving the carotid bifurcation. The purpose of this study is to determine safety, short and mid-term outcomes of CAS (Carotid Artery Stenting) during the last 5 years in a single cerebrovascular disease specialized hospital.

**Methods:** Between January 2006 and December 2014, 106 successful CAS out of 106 attempted procedures in 96 patients were included in this study. The indications for CAS were symptomatic carotid-artery stenosis 60% and asymptomatic stenosis of at least 80%. There were 74 men and 22 women and their age range was 50–79 years (mean 71.1). Self-expanding stents with cerebral protection devices were used in all cases. Acetylsalicylic acid (100 mg/d) and clopidogrel (75 mg/d) were applied for at least 4 to 5 days prior to procedure. Weight-adjusted (70U/kg) heparin was used. Atropine (1 mg) was given intravenously, if needed, to reduce bradycardia and hypotension potentially associated with carotid dilation. Acetylsalicylic acid (100 mg/d) and clopidogrel (75 mg/d) was continued for 3 months after the interventional procedure. Mono antiplatelet therapy (aspirin, clopidogrel, or ticlopidine) was continued indefinitely. One hundred six stents (56 Protege, 37 Precise, and 20 Acculink) and distal filters (94 Spider Rx, 9 Filter-wire, 3 Embo-shield) were used.

**Results:** There were one death (huge ICH), 4 minor strokes (3.7%), 9 bradycardia (8.4%), and 3 groin hematoma (2.8%) as procedural complications. Follow-up angiography was done in 78 patients (73.5%) for 6–58 months (mean 17.3), there was only one restenosis (0.9%). Clinical follow-up was done for 94 patients (88.6%) for 6–60 months (mean 32), there were two deaths (1.8%), one myocardial infarction, one rectal cancer, one major stroke (basilar artery, 21 months), and one minor stroke (cerebellum, 10 months).

**Conclusion:** CAS is an effective treatment modality and as safe as CEA for carefully selected patients. Judicious selection of the procedure is made on a case-by-case after considering the patient (physiological), lesion, and access (anatomical) factors that increase the risk of CAS and CEA in that particular patient.

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**Quantifying Cerebrovascular Reactivity and Identifying Regions at Risk from Cerebrovascular Steal with Arterial Spin Labelling**

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**Purpose:** Arterial spin labelling (ASL) is an emerging MRI technique that uses magnetically labelled arterial blood water as an endogenous tracer for absolute cerebral blood flow (CBF) measurement without need for exogenous contrast agent. Multiple repeat measurements are possible to evaluate pharmacologic or interventional effect on CBF. We present our experience using ASL added to routine brain MRI to provide supplementary quantitative information on cerebrovascular reactivity (CVR) to identify regions of the brain at risk from cerebrovascular steal.

**Methods:** Patients at risk for ischemia from cerebrovascular disease have non-contrast brain MRI with ASL at our institution. ASL sequence is 3D pCASL with TI (PLD) 2500 ms. In cases where CVR mapping is requested, we acquire a pre-acetazolamide ASL followed by slow infusion of acetazolamide 14 mg/kg up to maximum 1000 mg IV given over 15 min in MRI scanner. During acetazolamide infusion, non-contrast brain MRI sequences are acquired, including DWI, T2 FLAIR, GRE, and 3D T1 SPGR. At end of acetazolamide infusion, we acquire a post-acetazolamide ASL. CBF maps from pre- and post-acetazolamide ASL are generated in mL/100 g/min. Imaging analysis software (FSL) is used to co-register pre- and post-acetazolamide CBF maps to SPGR brain-segmented regions. CVR map is constructed by subtracting pre-acetazolamide CBF map from post-acetazolamide CBF map with red-blue color scale to identify regions with normal positive change (red) from regions with abnormal negative change (blue), consistent with cerebrovascular steal. Significant change is defined as >10 mL/100g/min or >20% from baseline based on prior voxel-level reproducibility study.

**Results:** Acetazolamide is a carbonic anhydrase inhibitor that interferes with CO₂ clearance from the brain, resulting in cerebral vasodilatation and increased CBF in normal brain tissue. Hemodynamically compromised regions of the brain are identified as those with negative CVR (blue regions with decreased CBF from baseline due to cerebrovascular steal) after acetazolamide challenge. We present several cases of complex occlusive cerebrovascular disease and Moyamoya with negative CVR. In regions of the brain with negative CVR, we have identified two patterns of baseline CBF – (1) decreased CBF relative to normal brain tissue, and (2) increased CBF relative to normal brain tissue, presumably compensatory hyperemia. We hypothesize regions of the brain with negative CVR in absence of infarction would benefit from endovascular treatment with angioplasty/stenting or extracranial-intracranial microsurgical bypass, with regions having decreased baseline CBF more at risk than those with increased baseline CBF.

**Conclusion:** ASL with acetazolamide challenge can be easily added to routine brain MRI to provide supplementary quantitative information on CBF and CVR for managing patients with cerebrovascular disease.
Evolution of Intraparenchymal Hyperdensity After Intra-arterial Therapy in Patients with Ischemic Stroke

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Purpose: Non-contrast CT scan is obtained immediately after intra-arterial thrombolysis to assess for hemorrhagic complication. But sometimes it is difficult to distinguish iodinated contrast extravasation from hemorrhage. The aim of this study is to determine the incidence, appearance, and clinical significance of lesions mimicking hemorrhages.

Method: Forty-six patients were treated with intra-arterial (IA) thrombolysis between January 2012 and April 2015. All patients underwent noncontrast CT scans immediately after IA thrombolysis, and follow-up CT scan or MRI scan were obtained after 24 hours. Contrast enhancement was defined as a hyperdense lesion that disappeared on a 24-hour follow up CT scan or as negative finding on MRI gradient echo. The lesions were categorized into three types according to their volume, shape and density: round shape (soft HD: hounsfield unit < 80 unit, metallic HD: hounsfield unit > 80 unit) and diffuse shape HD.

Result: Hyperdense lesion was found in 26 of 46 patients (56.5%). 16 of 26 patients (61.5%) showed hemorrhage of their lesion. All of the soft HD lesions (n = 10, 38.5%) showed spontaneous resolution and no hemorrhagic transformation. All of the metallic HD resulted in hemorrhagic transformation. All of the soft HD lesions showed spontaneous resolution and no hemorrhagic transformation. All of the metallic HD lesions (n = 16) resulted in hemorrhagic transformation; among them, four cases (15.4%) with a maximum CT value more than 150 HU (Hounsfield unit) subsequently but was not prognostic factor (p = 0.186). And in our study, regardless of the CT density or the location of hyperdense lesion, the volume of the hyperdense lesion could be considered as a prognostic factor (p = 0.035). The patients' prognosis, which volume of hemorrhage was more than 10 cc, was worse than other patients. Contrast extravasation was not prognostic factor (p = 0.572).

Conclusion: The parenchymal hyperdense lesions observed on the CT obtained immediately after IA thrombolysis in ischemic stroke patients exhibited varying features and they were not always hemorrhagic transformation. Most of the soft HD lesions were not became hemorrhagic transformation, and large proportion of the metallic HD lesions became hemorrhagic transformation. And the volume of hyperdense lesions could be considered as a prognostic factor.

Cerebral Hyperperfusion Syndrome

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Purpose: Cerebral hyperperfusion syndrome (CHS) is a serious complication of carotico-cerebral revascularization procedures and the mechanism is not fully understood. We retrospectively review our experiences of CHS among the cases of carotid stenting (CAS) and investigate the pathogenesis of CHS.

Methods: Retrospective analysis included 244 patients treated for their carotid stenosis by CAS between 2002 and 2014. They were all treated under distal protection. Post-procedural neurological examination and neuroimaging study including CT & MRI were performed at immediate & delayed interval after the procedures.

Results: Among 244 treated patients 4 patients developed intracranial hemorrhage and three patients could be related to CHS. Two patients developed hemorrhage within 9 hours after CAS (early bleeding). They all developed sulcal enhancement on CT taken immediately after the procedure. Remaining one patient bled after 6 days (late bleeding). They all survived with significant neurological deficits.

Conclusion: We have experienced 2 early bleeding cases with sulcal enhancement on CT. Sulcal enhancement may suggest blood brain barrier (BBB) disruption. Not only the restoration of flow, but also the breakdown of BBB could be the important factor for the clinical manifestation of CHS.

Efficacy of Middle Meningeal Artery Embolization in Recurrent Chronic Subdural HemATOMA with Arachnoid Cyst

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A chronic subdural hematoma (CSDH) is an “old” collection of blood and blood breakdown products between the surface of the brain parenchyma and the outermost layer called dura. The most common treatment option for chronic subdural hematoma is usually burrhole trephination operation.
However, the treatment option for recurred CSDH is still under the debate. Arachnoid cysts are cerebrospinal fluid-filled sacs that are located between the brain or spinal cord and the arachnoid membrane, which is one of the three meninges covering the brain and spinal cord. Arachnoid cyst is the congenital disease, which sometimes is associated with CSDH in the juveniles. In such cases, the recurrence rate of CSDH was increased. Based on some of the literature, the preventive role of middle meningeal artery embolization in the recurred CSDH was reported. We report a case of a thirteen-year old patient with recurred CSDH and an arachnoid cyst where the early intervention of a middle meningeal artery embolization was proven to be effective in preventing the recurrence of CSDH.

068

Spinal cord arteriovenous shunts – a retrospective study

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Purpose: To analyse clinical and angioarchitecture of Spinal Cord Arteriovenous Shunts, their management and outcome.

Methods: Clinical & imaging records of 150 cases of SCAVS recognized by digital subtraction spinal angiograms between 1988 to December 2014 were analyzed.

Results: 64 (43%) were spinal cord arteriovenous malformations (SCAVMs), 86 (57%) spinal cord arteriovenous fistulae (SCAVFs) – 71 microfistulae and 15 macrofistulae. 72% were male, most presenting in second (26%) and third (29%) decades of life. Mean age 28 years. Macrofistulae predominated in first two decades (87%) and filar fistulae above forty years (87%). No patient with microfistulae presented in first decade of life. SCAVMs had high incidence in second (34%) and third decade (41%). Dorsal cord was most common location (37%), conus (26%), cervical cord (21%), filum (11%) and radicular (5%). Cervical cord lesions were not seen above fifty. 68% had progressive myelopathy – motor weakness, sensory defects and sphincter disturbances. 58% of cervical cord lesions presented with acute onset symptoms. Haematomyelia or SAH was seen in 45% of cases with acute symptoms and in only one patient with progressive myelopathy. 89 received endovascular treatment and 27 underwent surgery. Better obliteration rate (>80%) could be achieved in SCAVF (80%) as compared to SCAVM (58%). Improvement or stabilisation of the lesion was observed in 42 (84%) embolized patients with SCAVF and 30 (77%) embolized cases with SCAVMs. 16 surgical patients showed improvement or stabilization in 11 and deterioration in 5.

Conclusion: Microfistulae were more numerous, compared to AVMs. Endovascular treatment is effective for these shunts & surgery reserved for filar AVFs or failed embolizations.

070

3T High Resolution Black Blood T1 (SPACE) Imaging for Evaluation of Intracranial Arterial thrombosis

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Purpose: Black blood (BB) T1 SPACE sequence has high spatial resolution that currently is considered as emerging sequence to evaluate the different arterial wall diseases. We are reporting the usefulness of the high resolution T1 SPACE imaging in detection of intracranial arterial thrombosis.

Methods: We retrospectively identified 6 patients with intracranial arterial occlusion who had MR imaging including non-enhanced and contrast enhanced high resolution BB T1 SPACE sequence. The presence of arterial occlusion was confirmed by digital subtraction angiography (DSA) or computed tomographic angiography (CTA) rather than the time of flight (TOF) MR angiography. The T1 SPACE findings were evaluated by 2 independent neuroradiologists blinded to the other angiographic studies performed for the patients as well as the other conventional MRI sequences and clinical presentation of the patient.

Results: Arterial occlusion appeared on T1 SPACE as a focal hyperintensity and enhancement within the lumen. T1 SPACE sequence showed high sensitivity and specificity for the detection of the intracranial arterial occlusion.

Conclusion: T1 SPACE imaging is a valuable marker of arterial occlusion and support the diagnosis of non-invasive angiographic imaging as TOF MRA.
071

Thermo-Responsive PPCN-Contrast Complex: a Novel Liquid Embolic Agent for Embolotherapy

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Purpose: Polyethylene glycol citrate-co-N-isopropylacrylamide (PPCN) is a novel, thermo-responsive, biodegradable, anti-oxidative copolymer with gel-sol phase transition at 29°C. We evaluated the feasibility of the PPCN as a novel permanent biodegradable liquid embolic agent for embolotherapy.

Methods: Water soluble iodine contrast agent (Visipaque™ 320, GE healthcare) was added to provide radio-opacity (25Vol% of contrast). Physiochemical characteristics of the Poly (PPCN-contrast complex), such as Dynamic modulus, Viscosity and Gel-Sol transition time were evaluated. Fluoroscopic visibility, injectability through microcatheter and durability of embolic effects through both end arterial system (Rabbit renal artery, n = 8) and non-end arterial system (Swine Rete Mirabile, n = 12) were evaluated.

Results: The dynamic modulus (G', Pa) of 25Vol% PPCN Complex increased from 0 to 120 at the temperature of 29°C. In end arterial system model, all embolization attempts were successful and accomplished complete occlusion of the target artery with demonstrating sustained complete occlusion status on follow up angiographies without recanalization with histologic evidence of total ischemic necrosis of renal parenchyma. In non-end arterial system (Swine Rete Mirabile, n = 12) were evaluated.

Conclusions: The PPCN Complex is a promising biocompatible novel liquid embolic agent for fluoroscopy guided endovascular embolotherapy.

072

Flow diverter stents in bifurcating arteries. A computed fluid dynamic study using Surpass stent to predict arterial occlusions in idealized and patient-specific geometries

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Background: Flow diverter stents (FDS) for the treatment of intracranial aneurysms at bifurcations can occlude opposite artery in some situations. This unpredictable effect does not happen in side wall arteries.

Aims: Effect of FDS on intracranial artery bifurcations with a focus on the adverse effect on bifurcating vessels' haemodynamic and occlusion. The identification of variables of strongest influence, and virtual platform have the potential to make an impact on clinical decision.

Methods: 7 idealized and 7 patient-specific numerical representations of the physics of the problem were created and analysed. 3D computed fluid dynamics (CFD) models were used in both groups before and after stenting simulation. The FDS used was Surpass (Stryker, California, USA) because their predictable geometry after deployment. Several parameters were extracted: alterations of pressure and velocity, alterations of artery angulations, diameter of the vessels, flow recirculating areas, haemodynamic load on arterial wall in the regions of interest, proximal and distal resistance, and wall shear stress.

Results: Proximal and distal resistance were the most important factors to predict artery occlusion. Diameter and angles did not have important direct influence. All parameters were useful to predict the resistance.

Conclusion: Proximal and distal resistance might determine artery occlusion after FDS deployment. The clinical application depends on developing a daily quick analysis of patient specific haemodynamic before aneurysm treatment.

073

Predicting thin-wall regions in unruptured cerebral aneurysms using computational fluid dynamics modeling

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Purpose: Prediction of thin-wall regions in cerebral aneurysms is useful in the safe treatment of such aneurysms, especially in endovascular surgery in which the aneurysm wall surface, including blebs, cannot be seen during the procedure. Hemodynamic stress plays an important role in the degeneration process of aneurysm walls (Xiang et al., 2011). A previous study reported that pressure elevation and low wall shear stress (WSS) were seen at thin-wall regions, however, this observation has not been fully evaluated (Kadasi et al., 2013). In this study, we evaluated the most relevant hemodynamic parameters in the prediction of thin-wall aneurysms.

Methods: After analyzing 50 unruptured middle cerebral artery aneurysms, pressure and WSS were calculated to assess their correlation with thin-wall regions. Through intraoperative observations, thin-wall regions of aneurysm domes were identified thin, red, and translucent areas relative to healthy, non-calcified proximal parent vessels.

Results: In 41 out of 50 cases (82.0%), areas of maximum pressure (Pmax) corresponded to thin-wall regions and high pressure areas were seen in relatively thin-wall regions. However, no significant correlation between WSS and thin-wall regions was found. Furthermore, we assessed pressure difference (Pd), which was calculated by subtracting the average pressure (Pave) from Pmax and divided by the aneurysm inlet mean velocity for normalization. The Pd values in the correspondence group were significantly higher than in the non-correspondence group (p = 0.0013), and a receiver operating characteristic curve demonstrated that the Pd value could accurately predicting thin-wall regions at Pmax areas (area under the curve: 0.810 [95% confidence interval: 0.636–0.984]; sensitivity: 70.0%; specificity 87.5%).

Conclusion: High pressure may be the key factor in predicting thin-walled aneurysms, and computational fluid dynamics has the potential for clinical use in the treatment of aneurysms.

References

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The Biological Role of Ca2⁺-activated K⁺ channel (KCa3.1) on Hemodynamic Induced Cerebral Aneurysm Initiation Mechanism

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Purpose: This study aims to investigate whether KCa3.1 is the biological target that sensing the harmful mechanic stress and responding to it.

Methods: We established the hemodynamic-induced cerebral aneurysm model of rat with the ligation of one common carotid artery and contralateral external carotid artery and pterygopalatine artery. Clotrimazole was used as the specific blocker of KCa3.1. Batson’s #17 was used for vascular corrosion casting to obtain the arterial cast. The aneurysmal changes of the vessel were examined with SEM scanning analysis. The artery of Willis’ circle was separated from the rat brain. The expression level of KCa3.1 mRNA and the protein of KCa3.1 channel were tested with rt-PCR and the confocal laser-scanning microscope. The key downstream target NF-κB and iNOS were detected with immunohistochemical staining.

Results: SEM scanning results demonstrated that the aneurysmal change incidence was decreased by the blockade of KCa3.1. The result of rt-PCR revealed that the expression levels of the KCa3.1 mRNA in the CLT groups of different time were significantly lower than those in aneurysm groups correspondingly and the significantly upregulated expression in aneurysm groups comparing to the control group. The fluorescence of KCa3.1 channel presented the same tendency. The specific blockade of KCa3.1 also decreased the NF-κB and iNOS expression in the artery wall.

Conclusion: KCa3.1 might be the key converter to transduce the hemodynamic stress to the biological reaction signal. The blockade of KCa3.1 could decrease the inflammatory reaction, oxidative stress in the artery wall and aneurysmal changes.

References
075
Outcome Predictors of Intracranial Arteriovenous Malformations Treated with Endovascular Embolization Approach in the Paediatric Population

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Purpose: To investigate the potential predictors of long-term outcome in endovascular management of intracranial arteriovenous malformations (AVMs) with/without surgical resection in the paediatric population.

Methods: This is an ongoing retrospective study. Consecutive paediatric patients (<18 years) presenting with intracranial AVMs verified by CT/MR/DSA imaging studies were enrolled in the study. Baseline demographics, presenting symptoms, angioarchitecture characteristics (location, compact/diffuse nidus type, maximum nidus diameter, superficial/deep drainage, associated flow-induced aneurysm and/or venous varix/stenosis/ectasia, number of arterial feeders/draining veins, Spetzler-Martin Grading (SMG) scores, and ruptured/unruptured lesions), treatment strategy (endovascular embolization and/or surgical resection vs. conservative management), procedural complication, recurrence, and long-term functional outcome were obtained. Ninety days modified Rankin Scale score of ≤2 and achieving developmental milestones were used to determine good functional outcome as appropriate. Independent samples T test, chi square, and logistic regression analyses were performed for statistical analyses.

Results: Thirty one cases (m/f: 20/11; mean age(range) = 4.09 years) presented with 15 ruptured and 16 unruptured AVMs. Presenting symptoms included severe headaches (%45), occasional mild-moderate headache (%22.6), incidental finding (%16.5), seizure (9.4) and focal neurological deficits (%6.5). Single or multi-session endovascular embolization was performed either alone or prior to surgical resection while 3 cases were managed conservatively. Procedural complication and lesion recurrence were encountered in %6 and %3 of cases, respectively. Good functional outcome was achieved in %77.5 of cases. No significant association was observed between SMG and final outcome (P = 0.80). Regression analysis of clinical presentation, lesion characteristics, and treatment-related variables revealed that rupture and severe onset of headache were independent predictors of poor long-term functional outcome (P = 0.006, OR:3.5).

Conclusion: In our study, size, eloquent location, and complex angioarchitecture of intracranial AVMs were not predictors of outcome in children. Presentation and ruptured/unruptured status of the lesions were significant predictors of long-term clinical outcome in treatment strategy with endovascular approach.

076
Origins, Pathophysiology, & Natural History of DAVF

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Purpose: DAVF is an acquired and progressive arteriovenous shunt on or between the dura mater. It is located in very specific parts of the cranium and comprises DAVF drainage through an affected sinus (sinus type) and direct reflux to cortical vein (non-sinus type).

Methods: Some consensus has been reached about the background: the distribution of emissary veins definitely corresponds to the location of DAVF; the dura has innumerable dural veins that partially form a congenital arteriovenous shunt; and the affected sinus often becomes occluded during the development of DAVF. According to the new hypothesis based on this information, this disease might initiate at emissary veins. Firstly, inflammation occurs at the point of penetration of the dura due to idiopathic causes such as allergy and thrombosis, or secondary to trauma and infection. Local inflammatory reactions induce vessel dilation and neovascularization. Arteriovenous connections are subsequently created at the arteriole level via existing AV channels. Although emissary veins communicating with the dural arteries might play initial roles as draining routes, they become occluded or degenerate due to compression by enlarged emissary arteries or a hemodynamic shift to a less resistant pathway via larger drainage vessels.

Results: After drainage to emissary veins disappears, main drainage into the sinus or cortical veins might develop, resulting in the establishment of the initial form of clinical DAVF. An AV shunt expands to surrounding dura associated with the recruitment of feeders from distant sites. Such development of an arterial side might be caused by expansion of the inflammatory reaction induced by cytokines, neovascularization due to the expression of angiogenic factors and a shift in the hemodynamic balance. Secondary changes of the drainage side in sinus-type sinuses become progressively compartmentalized and finally occlude (usually at the caudal side first) due to thrombogenesis along with activated coagulopathy or hemodynamic hypertrophy of the sinus wall, resulting in the mature or final stage of DAVF with drainage impairments (the so-called aggressive type). Previous investigations of the etiology of DAVF have focused on sinus hypertension and sinus thrombosis, which is the secondary change and does not explain the pathogenesis of the non-sinus type of DAVF.

Conclusion: As for the treatment strategy the ventral sinus type (CS, ACC) whose shunt point is located at the epidural site has the absolute indication of TVE, and the dorsal one
(SSS, TS, SS) is usually treated with TVE, but targeted TAE with liquid material is preferred for the isolated sinus or focal dural vein. All the non-sinus type (lateral type) including spinal DAVF is unexceptionally treated with TAE. **Abbreviation:** DAVF: dural arteriovenous fistula, CS: cavernous sinus, ACC: anterior condylar confluence, SSS: superior sagittal sinus, TS: transvers sinus, SS: sigmoid sinus, TVE: transvenous embolization, TAE: transarterial embolization.

**077**

**Hemodynamic Changes caused by Flow Diverters in Patient-specific Aneurysm Models: Comparison of Virtual FD model and Porous medium**

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**Purpose:** The Tubridge flow diverter (FD) is a novel device aimed at reconstructing the parent artery and occluding the aneurysm. Numerical simulations based on virtual FD deployment allow the assessment of the complex nature of aneurismal flow but are demanding on computational resources. Here, we evaluated the feasibility of an alternative strategy of modelling the FD effects using a porous medium to reduce time demands.

**Methods:** Ten patient-specific aneurysm models were reconstructed from retrospectively collected diagnostic 3D-DSA images. Virtual FDs were deployed (SolidWorks, Meshmixer) and porous medium patches were constructed using a research CFD prototype (Siemens Healthcare GmbH) at the ostium. Hemodynamic parameters based on these two approaches were calculated (cd-adapco) and Pearson correlation coefficients (r) determined.

**Results:** Both approaches showed similarity in flow patterns and magnitude. The use of porous medium patches reduced preparation and simulation times by approximately 50%. Mean wall shear stress (WSS) and mean pressure of the aneurysmal wall were in correlated statistically significant (r = 0.8, r = 1.0, p-value < 0.05) as did mean velocity, mean pressure at a region inside the aneurysm, at the ostium and at a cross section containing the main vertex (for velocities r = 0.9; for pressures r = 1.0, p-value < 0.05).

**Conclusion:** Simulating the effects of FDs as porous medium yields comparable hemodynamic results and at the same time greatly reduces modelling complexity and computation time.

**078**

**Gene Expression Profiling of Rabbit Basilar Artery Smooth Muscle Cells in High Flow Induced Vascular Remodeling**

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**Purpose:** Sustained blood flow, especially high blood flow causes the remodeling of arteries which could potentially induce various vascular diseases, such as aneurysms, atherosclerosis and arteriovenous malformations. The molecular mechanism of vascular remodeling has been mainly investigated in cultured cells. However, the in vivo molecular mechanism of vascular remodeling is poorly understood. Objective of this study was to identify the mRNA expression profile of smooth muscles cells during high flow induced vascular remodeling.

**Methods:** High flow of rabbit basilar artery model was established by ligation of both common carotid arteries. Smooth muscle cells were isolated and microarray analysis was performed. Gene ontology and pathway analysis were used to analyse the data. A subset of genes was selected to be validated using realtime PCR, immunohistchemistry.

**Results:** By using microarray analysis, we found that 947 genes were differentially expressed in smooth muscle cells responding to high flow insult compared with the sham control, of which 617 genes were up-regulated and 330 genes were down-regulated using 2-fold-changes and P < 0.05 as the cut-off values. Gene ontology analysis revealed that the altered genes were most highly enriched in cell communication, cell development process, the intracellular component, the extracellular regions, and pattern binding. Pathway analysis showed major functional gene clusters involved in vascular remodeling.

**Conclusion:** This work provided molecular factors underlining high flow induced vascular remodeling which may facilitate future functional studies in vascular remodeling and diseases.
Transarterial embolization of Galenic dural arteriovenous fistulas using Onyx

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Purpose: Galenic dural arteriovenous fistulas (GDAVFs) are a rare subtype of the tentorial dural arteriovenous fistulas, which are often associated with hemorrhage or progressive dementia. Despite the deep location, the lesions are usually treated surgically. This clinical study summarizes our preliminary experience in the transarterial embolization of GDAVFs.

Methods: We retrospectively reviewed the data for twelve patients with GDAVFs who underwent transarterial embolization with the Onyx Liquid Embolic System at our institute between 2004 and 2014. According to the Cognard classification of DAVF, three fistulas were type III, and the other nine were type IV. In Seven patients, there is anterograde flow in the Galen Vein while in the other five patient, there is venous reflux in the deep veins. Altogether, fourteen transarterial procedures were performed in all of the patients.

Results: The fistulas in ten patients were immediately obliterated in the first procedure via twelve pedicles, and the lesions in the other two patients were partially embolized and were totally embolized in the second procedure. One of the patients encountered rebleeding of the fistula eight months after the lesion was partially embolized. No signs of rebleeding or symptom progression were observed after total obliteration was gained at a mean follow-up of 40.1 months, while recanalization of the fistula was found in two patients at six-month angiographic follow-up. Gamma knife was conducted to them and obliteration of the recurrent fistula was gained in one of them after two-year angiographic follow-up.

Conclusion: Transarterial embolization using Onyx is therefore feasible and effective for the management of GDAVFs. Close angiographic follow-up is still needed for this subtype of fistula even if the lesion is totally obliterated.

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Embryologic approach in understanding spinal cord vascularization

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Purpose: Spinal cord arteriovenous malformations are infrequent conditions. Their treatment implies a high risk of medullary lesions, while the low number of cases frequently prevents of getting a reasonable experience in the therapeutic approach. In an attempt to attain a better understanding of the vascular distribution in the spinal cord, we have reviewed it in the late embryonic period.

Methods: Embryos between six and nine postovulatory weeks (13, 15, 22, 27,5, 35 and 39 mm Crown Rump Length), processed in serial cuts, have been included in this study.

Results: Approaching the eight week of gestation, the embryo develops a full pail network covering the spinal cord, relating the connection of intramedullary arteriovenous and venules with the subarachnoid vessels. In younger stages, branches of anterior spinal arteries (paired), accessing in a medial position in relationship with the anterior roots, enter directly to distribute themselves following a somewhat characteristical pattern. Postero medial venous structures with a firm pial attachment is also a quite constant feature.

Conclusion: The relationship of intramedullary, pial, subarachnoidal and spinal cord dural vascular structures is hard to study due to the small calibre of spinal cord vessels. Morphological studies of embryonic development are good tools regarding peri- and intramedullary vascular distribution.

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Endovascular treatment of Borden type III dural arteriovenous fistulas without using ONYX

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Purpose: Borden type III Intracranial dural arteriovenous fistulas (DAVFs) carry a high risk of aggressive clinical manifestations, which require curative treatment. Although many physicians recently treat DAVFs with using ONYX because of its ease of use, serious complications have been reported. In this paper, we evaluate the effectiveness and safety of our endovascular techniques without using ONYX for the treatment of Borden type III DAVFs.

Methods: Between April 2004 and March 2015, thirty-eight consecutive patients with type III DAVFs underwent endovascular treatment were retrospectively reviewed. There were 25 cases of sinusal DAVFs and 13 cases of non-sinusal DAVFs. The location of the DAVFs were the transverse-sigmoid sinus in 14, the superior sagittal sinus in 7, the cavernous sinus in 5, tentorium in 5, anterior fossa in 3, the superior petrosal sinus in 2, and falcotentorial junction, falk cerebelli in 1 each. In our strategy, transvenous embolization (TVE) of the shunted pouches or the isolated sinus through the occluded sinus was the first-line treatment option for the sinusal DAVFs, and transarterial glue embolization was that for the non-sinusal DAVFs.

Results: Technical success has been reached in 94.3% pts. Results of endovascular treatments are as following: total occlusion – 85%, subtotal – 4%, partial – 11%. In the post-operative period at the majority of patients had significant regress of symptoms. There was no morbidity and mortality. Long-term results were evaluated at 51% of pts within 1 to 4 years after operation. Fistula recurrence has not been noted. In 11% cases oculomotor disorders are remained.

Conclusion: Technique of a transvenous occlusion has shown an excellent efficiency at DAVF CS.
DAVFs showed markedly regressed. There were no complications related to the procedure was observed. **Conclusion:** Borden type III DAVFs could be successfully treated by endovascular techniques without ONYX with high curative rate and very low complication rate.

### 084

**Risk factors for dural arteriovenous fistula intracranial hemorrhage**

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**Purpose:** To our knowledge the risk factors for intracranial hemorrhage of dural arteriovenous fistula (DAVF) have not been systematically described, due to the complexity of their anatomy and low incidence rate. We performed this retrospective study to investigate the DAVF factors influencing prediction of intracranial hemorrhage.

**Methods:** A 10 year database of 144 consecutive patients with DAVF was reviewed. Data collected and analyzed were demographics, morphologic features of DAVF, sex, age, fistula flow rate, artery supply, lesion location, and venous drainage pattern. Linear univariate and multivariate logistic regression analyses were used to evaluate the association between influencing factors and hemorrhage.

**Results:** A first linear univariate analysis was performed for all influencing factors, and showed that sex, lesion location, and venous drainage pattern were statistically significant in predicting intracranial hemorrhage ($p < 0.05$). Secondary multivariate logistic regression analysis with sex, lesion location, and venous drainage pattern showed that only venous drainage pattern was statistically significant in predicting intracranial hemorrhage ($p < 0.05$).

**Conclusion:** Consequently, venous drainage pattern, especially the cortical venous drainage, has statistical significance in predicting intracranial hemorrhage of DAVF. Both sex and lesion location may be confounding factors in predicting intracranial hemorrhage of DAVF, while the other factors may not be associated with haemorrhage.

### 085

**Presentation withdrawn**

**ONYX results in higher chances of complete embolization of Intracranial Dural arteriovenous fistulae versus nBCA and coils**

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**Purpose and Background:** Intracranial Dural arteriovenous fistulae (DAVFs) with cortical venous drainage have a significant morbidity and mortality. Complete closure of these lesions is necessary to reduce these risks. This study retrospectively compares the outcomes of all the local endovascular embolization of DAVFs from 1998 to 2015. We propose that Onyx embolization resulted in fewer complications, similar procedure time and a higher chance of complete obliteration with no need for post-embolization surgery for the DAVF rather than other embolization methods.

**Methods:** 117 patients with endovascular embolization for intracranial vascular malformations from 1998 to 2015 were retrospectively reviewed. Patients with arteriovenous malformations or carotid cavernous fistulas were excluded. 27 patients had DAVFs which were treated with embolization during this time period. Inclusion criteria was patients that had DAVFs which were treated with embolization and had imaging on our archiving system. 23 patients met this criteria. Onyx cases were defined with intention to treat principle- any time Onyx was used, it was defined as Onyx case. 11 cases were treated with Onyx embolization, 9 cases were treated with nBCA (N-Butyl Cyanoacrylate) and 3 cases were treated with coils. Successful closure rates, complications and procedure time were compared between the various embolization treatment types.

**Results:** Post embolization surgery was required for only 2 out of 11 patients treated with ONYX, 7 out of 9 patients treated with nBCA and 1 out of 3 patients treated with coils. The chances of not requiring post embolization surgery with Onyx (81.8%) was significantly higher ($p = 0.008$) than nBCA (22.22%). Although the complication rate with onyx (9.1%) was lower compared to that of nBCA (22.22%), it failed to reach statistical significance because of small sample size. Procedural time was not significantly different between Onyx (mean of 267 mins) and nBCA (mean 288 mins) ($p = 0.59$). The odds ratio of a DAVF being treated with only ONYX and then requiring no follow up surgery was 15.75.

**Conclusion:** Over a 17 year period, our institution finds Onyx superior in completely obliterating DAVFs to nBCA. It was also found to be as safe and as fast as nBCA, as DAVF embolization with nBCA needed multiple catheterizations and multiple injections.

### 086

**Endovascular treatment of Dural Arteriovenous Fistulas with the SQUID**

**G Gal**

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**Purpose:** To report our experience in the endovascular treatment of dural arteriovenous fistulas (DAVF) using a recently developed, modified Ethylene-Vinyl Alcohol copolymer (EVOH).

**Methods:** SQUID® (Emboflu, Gland, Switzerland) is a new, modified EVOH copolymer dissolved in DMSO and mixed with micronized Tantalum powder. The more homogenous
and smaller sizes of tantalum particles results in a decreased viscosity and is thought to improve the flux of the embolic agent as well as the radiographic visualization during long injections when compared to Onyx®.

Between December 2011 and October 2014, 15 patients with DAVFs underwent endovascular treatment using either transarterial or transvenous injections of SQUID®. Eight patients presented with hemorrhage, 3 with headaches, 3 with bruits. Six fistulas were located at the transverse sinus, 3 at the confluence sinus, 3 on the tentorium, and 2 involved the superior petrosal sinus. One spinal DAVF was located at T12 and presented with progressive paraparesis. There was one grade I, one grade IIa, three grade IIa + b, three grade III, 6 grade IV, and one grade V fistula (Cognard classification). 12 fistulas were treated by transarterial embolisation and three by transvenous occlusion using a combination of coils and SQUID®.

Results: Total occlusion was achieved in 14/15 fistulas in 1 session, confirmed by follow-up angiographies. In one case, a subtotal occlusion was achieved and treatment was completed by surgical removal, also confirmed by angiography. In one patient microcatheter entrapment due to significant reflux occurred without clinical sequelae. There was no other complication. All patients had good clinical recovery.

Conclusion: Endovascular treatment of DAVFs with SQUID® is feasible and safe. In the authors’ experience, this new embolic liquid offers promising advantages when compared to Onyx®, making it a potentially more efficient embolic agent in the endovascular treatment of DAVFs.

087
Use of multiple venous balloons in dural fistulae
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Purpose: Dural fistulae can be treated with the combined use of a venous remodelling balloon and arterial injection of Onyx. In some situations, multiple balloons may be required.

Methods: Since 2006, we treated 135 patients with a dural fistula with assistance of a venous balloon. The use of several balloons was required in 12 patients due to either the excessive diameter of the sinus or to the extension of the dural fistula to another sinus.

2 balloons were used in 11 patients and 3 balloons were used in 1 patient.

Results: Cure of the dural fistula could be obtained in all patients without compromise of the sinus. There were no technical or clinical complications. Follow-up results after one year are presented.

Conclusion: The use of multiple balloons may be required to cure dural fistulae involving ectatic sinus segments or extensive dural fistulae.

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Endovascular treatment of dural arteriovenous fistulas: single center experience
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Purpose: Treatment of intracranial dural arteriovenous fistulas (dAVFs) remains a challenge. However, after introduction of Onyx, transarterial approach is the preferred treatment option in many centers. We report our experience of dAVFs embolization with special emphasis on transarterial approach.

Methods: Seventeen embolization procedures were performed in 13 patients with dAVFs between Jan 2009 and Oct 2014. Clinical symptoms, location and type of fistulas, embolization methods, complications, radiological and clinical outcomes were evaluated using charts and PACS images.

Results: All 13 patients had symptomatic lesions. The locations of fistulas were transverse-sigmoid sinus in 6, cavernous sinus in 3, middle fossa dura in 3, and superior sagittal sinus in 1 patient. Cognard types were as follows: I in 4, IIa in 2, IIa + IIb in 5, and IV in 2. Embolization procedures were performed ≥2 times in 3 patients. Nine patients were treated with transarterial Onyx embolization alone. One of these required direct surgical exposure and puncture of middle meningeal artery. Complete obliteration of fistulas was achieved in 11/13 (85%) patients. There were no complications except for 1 case of Onyx migration in cavernous dAVF. Modified Rankin scale score at post-operative 3 months were 0 in 11, and 3 in 2 patients.

Conclusion: Transarterial Onyx embolization can be a first line therapeutic option in patients with dAVFs. However, transvenous approach should be tried first in cavernous sinus dAVF because of the risk of intracranial migration of liquid embolic materials. Furthermore, combined surgical endovascular approach can be considered as useful option in case of inaccessible route.

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Transarterial embolization with Phil for intracranial dural arteriovenous fistulas with cortical venous drainage
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The natural history of intracranial dural arteriovenous fistulas with cortical venous reflux is unfavorable, and prompt treatment is recommended. Complete occlusion of the arteriovenous shunt is essential and curative. We present our initial experience using a new nonadhesive liquid embolic
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Gammar Knife Treatment for Dural Arteriovenous Fistulas

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Purpose: Dural AVF often presents a treatment challenge. We reviewed all cases of dural arteriovenous fistulas (DAVFs) treated at our institution with Gamma Knife radiosurgery independently, or following failed/refused endovascular management.

Methods: Patients with intracranial DAVFs treated by Gamma Knife from 2009 to 2015 were evaluated retrospectively. These included Borden I-III lesions spanning any angioarchitecture. Patient’s clinical files, radiological images, catheter angiograms, and surgical reports were reviewed.

Results: 14 patients with dural AVFs treated by Gamma Knife radiosurgery were identified. All 14 patients reported symptomatic palliation or cure of symptoms. 4 fistulae were benign and 10 were aggressive. Marginal dose ranged from 15 to 25 Gray. Target volume ranged from 0.04 to 4.47 cm3. Angiographic cure was achieved in 4 cases, 2 possess small residual DAVFs and occurred at a mean time of 2 years following radiosurgery. The remainder have not reached the 3-year follow-up point yet (to be completed by the conference). There was only one mild complication. No haemorrhage occurred during the follow-up period. There was no significant association between Borden type and cure-rate, and failed endovascular treatment was not associated with lower rates of palliation or cure.

Conclusions: Stereotactic radiosurgery is a safe treatment for dural AVF. It is very effective in palliating symptoms both as a de novo approach or as an adjunct to endovascular embolotherapy. In our experience it is only somewhat effective in achieving cure.

Reference

balloon dilatation and stenting in 4; SA, trans-arterial embolization and radiosurgery in 2. Time-density-curve (TDC) was obtained by placing vasculature-of-interest (VOI) on DSA. Time difference between two VOI defined regional transit time (RTT).

Results: All 5 patients, who received stenting and/or SA, presented sinus stenosis with cortical veins reflux and venous congestion (4 intra-cerebral hemorrhages). Their RTT across the stenotic sinus prolonged and inferred a pressure gradient. SA and stenting immediately relieved the pressure gradient, cortical vein reflux and cerebral edema, afterwards. The pressure gradient was proved by direct peri-procedural pressure measurement in 2 DAVF. 21/38 (55%) DAVF presented multi-peak and 17/38 (45%) presented single-peak TDC of sinus flows. Multi-peak TDC indicated a sinus draining both AV shunting blood and blood from brain parenchyma. It is physiological favourable to keep sinus patent when consider a treatment of DAVF presenting multi-peak TDC in sinus. Of the 17 DAVF with single-peak TDC, 10 presented ipsilateral transverse-sigmoid sinus stenosis/occlusion and reverse venous drainage; the other 7 drained antegrade into bilateral transverse-sigmoid sinuses. Conclusion: TDC obtained from DSA quantitatively demonstrate the peri-therapeutic sinus hemodynamics of DAVF. The peri-therapeutic hemodynamic changes indicate the value of keeping sinus patency for reconstituting intracranial circulation in the management of intracranial DAVF.

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Technical Innovation: A New Liquid Embolisation Agent- Squid, for the Treatment of Intracranial Dural Arteriovenous Fistulas

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Purpose: We report the novel use of Squid for endovascular embolization of intracranial dural arteriovenous fistulas (DAVF). Liquid embolic agents (N-butyl cyanoacrylate (n-BCA) and ethylene vinyl alcohol copolymer (EVOH, as Onyx)) are effective treatments for DAVFs. Squid, an EVOH copolymer, has four formulations (18,18LD,12, and12LD). Because micromanized tantalum particles in Squid are smaller than in Onyx, the Squid solution is more homogeneous. LD versions, with 30% less tantalum, improve visibility behind dense embolic casts.

Methods: From May 2014 to February 2015, 7 patients (4 men and 3 women; age range 34–58 years, mean 50.2 years) were treated for intracranial DAVFs. 3 patients presented with hemorrhage, 3 with tinnitus, and 1 with tinnitus and headache. Congaed classifications were: two type Ila, one type IIb, one type III, two type IV, and one type V. All 7 patients were treated trans-arterially with Squid via Echelon micro catheter (1 feeder), and Sonic 1.2 micro catheter (7 feeders). Copernic (8x80) balloon was inflated in 3 cases in the Transverse Sigmoid Sinus during Squid injection. Follow-up was by MR/MRA in 7 and diagnostic angiography in 3 patients.

Results: Complete obliteration was achieved in all 7 patients. 6 cases were occluded from one feeder and one case from two feeder vessels. All 7 Sonic micro catheters were detached. Mean amount of 2.3 cc of Squid was injected through a single feeder. 4 patients had complete resolution of tinnitus (4) and headache (1) after the procedure. Of 3 cases with intracerebellar hemorrhage, 2 had near complete resolution but one showed no clinical improvement.

Conclusions: Complete obliteration of all 7 intracranial DAVFs using SQUID for embolization holds promise. Using low viscosity Squid 12 transarterially with long injection time fills the fistula with optimal penetration compared to other formulations. Larger series are underway to confirm the safety and effectiveness of Squid.

References
1. Abut & Houdart 2011.

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Occipital Artery: a not so poor artery for the embolization of lateral sinus dural arteriovenous fistulas with Onyx®

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Purpose: Endovascular techniques have gradually become the option of choice for the treatment of dural arteriovenous fistulas (AVF). In particular, liquid embolic agents such as Onyx® are considered to produce the most effective results. Cure is obtained only if distal penetration is achieved. Arterial feeders to the fistula arising from the occipital or superficial temporal arteries are known to be poor candidates for onyx embolization since it’s difficult to obtain a good distal penetration without an excessive proximal reflux. The adoption of recently developed Onyx®-compati-

ble double lumen balloons may offer a solution to this issue. We present a series of 3 cases of treatment of dural AVF in which complete obliteration of the shunt was achieved by onyx injection through a double lumen balloon.

Methods: Three non-consecutive patients presented with a dural arteriovenous fistula of the lateral sinus fed by the middle meningeal, occipital or superficial temporal artery. Embolisation was carried out via Onyx® injection through a DMSO-compatible microcatheter. Since the result was judged incomplete after injection within the middle meningeal artery, a further embolisation through a double lumen balloon-microcatheter inflated within the occipital artery was performed in all 3 cases.
**Results:** Distal penetration with complete obliteration of the arteriovenous shunt was obtained in all 3 cases. No perioperative or post-operative complications occurred. Indeed, balloon inflation allowed both to control proximal reflux and to overcome the transosseous feeders by increasing pressure injection. In one case, balloon deflation allowed for a partial repositioning of the microcatheter.

**Conclusion:** Our experience, although limited to 3 cases, shows how the use of a double lumen balloon catheters may increase the chances of a successful embolization by overcoming the intrinsic limitations usually encountered during Onyx® injection through the occipital or superficial temporal arteries in the treatment of lateral sinus dural AVF's.

**References**


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**Diagnosis and treatment of dural arteriovenous fistula at the craniocervical junction**

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**Purpose:** To explore the clinical features, diagnosis and surgical treatment of dural arteriovenous fistula at the cranio-cervical junction.

**Methods:** The clinical data from 13 patients with dural arteriovenous fistula at the cranio-cervical junction were analyzed retrospectively. 10 patients received C1 semi-vertebral plate resection and interruption of the draining vein through posterior median suboccipital approach. 3 patients were given a follow-up observation.

**Results:** 9 presented as subarachnoid hemorrhage among the 13 patients. 2 patients suffered a progressive motor and sensory disturbances. One patient had trigeminal neuralgia and the last with ventricular hemorrhage was found by accident. All 13 patients were finally diagnosed with digital subtraction angiography. The follow-up was carried out in 10 patients who underwent surgery. 9 presenting with subarachnoid hemorrhage had no significant postoperative neurological deficit. The pain in the patient who had trigeminal neuralgia relieved obviously after surgical operation. During a follow up period of 2 months to 5 years, no recurrence was found in the patients who underwent surgery.

**Conclusion:** Dural arteriovenous fistula at the cranio-cervical junction has nonspecific clinical symptoms. Comprehensive DSA should be performed to avoid misdiagnosis. Interruption of draining vein for dural arteriovenous fistula at the cranio-cervical junction through posterior median suboccipital approach is the most effective surgical treatment.

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**Imaging characteristics and treatment of the dural arteriovenous fistulas at the cranio-cervical junction**

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**Purpose:** Cranio-cervical junction dural arteriovenous fistulas are a rare type of intracranial vascular malformation. Now the main treatment of cranio-cervical junction DAVF is still microsurgical interruption and the curative effect of interventional embolization therapy is controversial. The rapid development of interventional materials and imaging technology promote the diversified changement of surgical treatment. We summarize our cases with transarterial embolization of cranio-cervical junction DAVF to explore the imaging characteristics and surgical treatment especially the effectiveness and safety of interventional embolization.

**Methods:** We retrospectively reviewed the data for 21 patients (16 males and 5 females) with cranio-cervical junction DAVF at our institute between January 2007 and September 2014, the mean age of these patients was 50.5 years. Their symptoms included subarachnoid hemorrhage (n = 13), myelopathy (n = 7), and dizziness(n = 1). The Cognard classification included III(n = 8), IV(n = 5), and V(n = 8). 15 patients underwent transarterial embolization, 2 patients underwent microsurgical interruption and 4 patients underwent microsurgical interruption after transarterial embolization. 9 patients underwent preoperative rotational angiography, double volume reconstruction and DynaCT reconstruction and had 6 months follow-up rotational angiography.

**Results:** Imaging results: Cognard classification of the 13 patients presenting with SAH include III or IV(n = 12) and V(n = 1). The 7 patients presenting with myelopathy were cognard V. Double volume reconstruction and DynaCT reconstruction can demonstrate the feeding arteries, fistulous points, draining veins in detail, and the relationship with bony structure.
Post-operative results: In the patients with transarterial embolization fistulas were completely obliterated in 10 patients, and partially obliterated in 9 patients. There were no complications in the 6 microsurgical patients, and the angiography showed complete obliteration 7 days later. Follow-up results: 14 patients had follow-up angiography, there were no relapse in the completely obliterate patients, and no fistulas visualization in 2 partially obliterate patients. The 6 months follow-up angiography showed no relapse in the 4 surgical patients. At the last clinical follow-up (mean 58.3 months), no rebleeding event or symptom progression were observed. In the 6 patients suffered myelopathy, 1 patient died of pulmonary infection and 5 patients had significant improvement of neurologic defect.

**Conclusion:** DAVF at the cranio cervical junction is highly incident in male patients, the symptoms include SAH or (and) myelopathy depended on the direction of drained veins. The precise pre-operative imaging analyses can help to determine embolization strategy. Interventional embolization is feasible in this disease, but embolization through branches of VA may lead to the infarction of oblongata. Microsurgical interruption is still the preferred method because of the safety and efficiency.

**References**

**Isolated One shot session Squid SD12**

Endovascular Treatment of Dural Arteriovenous Fistulas (DAVFs)

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**Purpose:** To evaluate the effectiveness, safety and clinical and angiographic results after isolated endovascular treatment (IEVT) for patients with symptomatic high grades dural arteriovenous fistulas.

**Methods:** From January 2012 to May 2015, 32 patients (10 women, 22 men; mean age, 52.4 years old) diagnosed with hemorrhagic intracranial DAVFs were treated by endovascular route alone in one session until angiographic objective achievement was observed. In all cases only Squis12SD was used. Clinical and angiographic data were recorded, and retrospectively evaluated.

**Results:** Three fistulas were cured by trans-venous approach (dural sinus sacrifice), and the rest fistulas were embolized through trans-arterial route. In all cases no more than one session was needed, treating an average of 3.1 feeding pedicles per patient in the intraarterial group. After treatment, total exclusion of the DAVs was achieved in 22 patients and a residual shunt was observed in 10 patients (no residual dural or leptomeningeal reflux was observed) considering the treatment as therapeutic. A median time to get endovascular goal was 139 minutes per patient. Complications occurred after IEVT in 4 patients (2 cases of skin necrosis in posterior auricular region after Squid12SD reflux, one case with transitory XI and XII nerves palsy, and one patient with transitory disfasia). No mortal complications were observed. Angiographic follow-up result was obtained in all cases, with complete obliteration in 26 of them. Clinical follow-up outcomes were excellent, with 100% patients reporting modified Rankin Scale of 0 or 1. No patient presented recurrent intracranial hemorrhage during follow-up.

**Conclusions:** Isolated one session EVT was effective and safe in management of complicated high grade intracranial DAVFs, with complete cure in most lesions. Clinical outcomes showed excellent performance even in patients presenting with intracranial haemorrhage.

**Recanalization and Stenting in Type IIb dural fistulae**

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**Purpose:** Dural fistulae can be treated with the combined use of a venous remodelling balloon and arterial injection of Onyx.

**Methods:** We report on type IIb dural fistulae where we treated with assistance of a venous balloon. Primary recanalization of a sinus was required to enable placement of the venous balloon. In addition to recanalization, a stent was placed in the diseased segment to keep the sinus patent.

This technique was used in 20 out of 135 patients in whom a dural fistula was treated with a venous balloon assistance since 2006.

**Results:** The technical specifications and clinical results are demonstrated, as well as the rate of dural fistula cure and patency of the recanalized sinus.
Intracranial dural Arteriovenous fistulas: Clinical presentations, angioarchitecture, classifications and treatment modalities of dural AV-fistulas in Durban

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Purpose: Dural Arteriovenous fistulas (DAVF’s) are abnormal fistulous connections between the dural arteries and venous sinuses and/or cortical veins. The objectives of this study is to describe the clinical features and imaging characteristics together with classification systems that influence treatment modalities of this lesions.

Method: A retrospective review of the prospectively collected data from patient’s clinical notes, charts, radiological imaging such as CT-Scans, CT-Angiography, MRI, MRA/MRV and digital subtraction angiography (DSA) of patient whom presented with DAVF’s in Durban over the period of 7 years. Patients were managed in both private and public hospitals. Each patient had at least 2 DSA after the last management session. IBM SPSS version 2 was used for analysis.

Results: 29 patients were treated for dural arteriovenous fistulas between January 2007 and May 2015. Median age of 45 years. There was no gender predilection, M:F 1:2:1. Bruits/ tinnitus (59%) were the most common presentation. 46% of the tinnitus/bruits were unbearable requiring intervention. 38% presented with headache and 17% with focal deficit. 10.3% presented with intra-cerebral haemorrhage Of 3(10%) cases presenting with bleed, 2 (66%) were Tentorial in location and all had retrograde venous drainage and were high flow fistulas. Of the 18 cases managed by endovascular means 14 (77.7%) achieved complete occlusion with remission of symptoms and 16% were partially embolized with stabilization of symptoms and 5% had worsening of their symptoms. All low flow fistulas managed expectantly maintained their benign angio-architecture and innocuous clinical course.

Conclusion: Expectant management of low grade dural arteriovenous fistulas remain effective with low risk of complications and relatively low propensity to progress to the high flow fistula. Endovascular management achieved 77.7% occlusion rate with low complication rate of only 6.7%.

References
with a complication rate comparable to those of conventional treatment options.

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De novo Arteriovenous Malformation with the Patient of Hereditary Hemorrhagic Telangiectasia


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Hereditary hemorrhagic telangiectasia (HHT) is an autosomal dominant systemic disorder characterized by enlargement of capillaries, recurrent nosebleeds, and multiple arteriovenous malformations (AVM). Although cerebral AVMs are traditionally considered to be congenital lesions, some reports describe de novo AVMs and AVMs are thought to be dynamic conditions. We describe the case of a 5-year-old boy in whom HHT was diagnosed and de novo cerebral AVM was detected despite the negative result in the screening MRI at 5 months. This is a first report of a de novo AVM in a patient with HHT. In patients with family histories of HHT, de novo AVMs are possible, even though no lesions have been detected at the first screening. Regular screenings need to be carried out, and it is important that the family must be informed of the possibility of development of AVMs even when not detected on screenings.

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Targeting intranidal aneurysms in treating brain avms: a case report

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Purpose: Patients with ruptured brain AVMs are at considerable risk of repeat hemorrhage, particularly when associated intranidal aneurysms are present. In many cases, targeting AVM’s intranidal aneurysms can be very difficult, especially when they are located on small perforating arteries. By presenting 3 different cases, we demonstrate our technical experience in dealing with those kind of aneurysms in treating ruptured AVMs.

Methods: 3 cases of ruptured AVM with intranidal aneurysms are included. All are young (28, 33 and 35 years old), 2 with AVMs at the basal ganglia area, and 1 with AVM in the left cerebellum. They all bled badly and are all drowsy when admitted to hospital. Head CT and DSA are done right away to identify the bleeding causes as soon as possible. In all three patients, an AVM with intranidal aneurysms was found, all of which can only be reached through small perforators. We could not select into those small perforators by conventional technique in treating AVMs using flow-directed, very soft tip and small (1.2–1.5 F) microcatheters.

Results: We had to change to a 1.2 F microcatheter with a stiffer tip to give a better support for superselection. With that better support, we have been able to reach the intranidal aneurysms and fully secure them with glue. Further treatments were done (EVDs and surgical removal of the hematoma, not the AVMs) and all 3 patients fully recovered.

Conclusion: Intranidal aneurysms in ruptured AVMs should always be targeted during endovascular treatment, but sometimes this can be really tricky. The conventional devices may not be enough for cases with very small perforator arteries. A variety of microcatheter and microguidewire stiffness may be very helpful and make it much easier for us to reach difficult vessels.

References

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Improvement of Onyx delivery in Hypervascular lesions using double lumen balloons

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Purpose: Embolization of hypervascular lesions requires making a “proximal plug” to allow forward penetration and prevent reflux and non-targeted embolization. This can cause procedures to be lengthy with extensive fluoroscopy.

We reviewed our experience with balloon-augmented Onyx embolization of hypervascular lesion of the head and neck using a double lumen balloon microcatheter technique to minimize these challenges.

Methods: Retrospectively acquired data for all dual lumen balloon-assisted Onyx embolization performed between November 2011 and August 2014. For each procedure, at least one dual lumen balloon catheter was advanced to a main feeder and Onyx embolization was performed through the inner lumen while the balloon was kept inflated.

Results: We have a total of 87 patients with AVMs, AVFs and tumors using 110 dual lumen balloons (12 Ascent and 98 Scepter). There was no vessel injury, unwanted embolization, retained microcatheter or microcatheter rupture. There were no procedural complications in our series.

Conclusions: Our experience indicates that the use of dual lumen balloon microcatheter to inject Onyx is safe and facilitates the penetration for embolization of hypervascular lesions.
Silk Suture and Particle Embolization of Intracranial Arteriovenous Malformations: Long-Term Durability and Outcomes after Gamma Knife Radiosurgery

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Purpose: A general supposition among neurointerventionalists is that embolization of cerebral arteriovenous malformations (AVM) with silk suture and polyvinyl alcohol (PVA) particles does not yield durable occlusion. Therefore, our aims were to determine the long-term durability of silk suture and PVA particle embolization (SPE) of AVMs and evaluate the outcomes following multimodality management of AVMs with combined SPE and Gamma Knife radiosurgery (GKRS).

Methods: We performed a retrospective review of all AVM patients treated at our institution with combined SPE and GKRS. After extracting the baseline, embolization, and GKRS data for each patient, the durability of SPE was determined by evaluating for post-embolization recanalization between the last procedural angiogram and the most recent neuroimaging.

Results: Four AVM patients, who underwent a total of nine SPE procedures through 21 arterial pedicles, were included for analysis. The nidus volume was 5.8–75 cm³, and the Spetzler–Martin grades were II and V each in one patient and III in two patients. The median degree of devascularization per procedure was <25%. There were no procedural complications, with all patients maintaining functional vesselization (modified Rankin Scale score 0–2) after embolization. After a median follow-up duration of 27 months (range 23–36 months), there were no cases of recanalization. GKRS (margin dose 13–18 Gy) resulted in 40% to >95% volume reduction. Following GKRS, one patient remained asymptomatic, two patients improved, and one patient deteriorated due to latency period AVM hemorrhage.

Conclusion: SPE can safely provide durable AVM devascularization. Thus, appropriately selected nidi can be effectively treated with combined SPE and GKRS.

References
Purpose: Intracranial high flow vascular malformations are an abnormal connection between the arteries and vein in the brain. These lesions can present various symptoms and occasionally, make serious problems. We would like to report the experience for embolization of abnormal intracranial high flow vascular shunting lesions.

Methods: In 20 patients, 25 embolization procedures were performed with Onyx or coils. Clinical presentation included seizures in 1 patients (5%), hemorrhage in 13 patients (65%), ophthalmic symptoms in 2 patients (10%), hemiparesis in 1 patient (5%) and in 3 patients (15%) were an incidental finding.

Results: 16 procedures were performed in Arteriovenous malformations (AVMs) and 5 procedures in dural arteriovenous fistulas (DAVFs). Onyx was used in embolization of AVMs and DAVFs. 4 procedure were in direct carotid cavernous fistula (DCCF) and the patients with DCCF were treated with coils. In 11 patients, total and near total obliteration without shunting and reflux were achieved by embolization alone. In one of 11 patients, complete obliteration was not achieved in end of first sessions, but 4 weeks later, spontaneously complete occluded without subsequent treatment. Other one of 11 patients, complete obliteration was possible in second session due to gradually reduction of flow velocity after first session. The size and flow reduction were achieved in 9 patients and partial embolization was followed by surgery in 1 patient and by radiosurgery in 5 patients. There was no rebleeding in hemorrhagic lesions and no procedure related complications. In 1 patient, visual impairment was occurred after few days of embolization.

Conclusion: The endovascular treatment is feasible and safe in intracranial high flow vascular malformations. Especially, Onyx has several advantages over previous embolic materials. Although one embolization session was not sufficient to obtain satisfactory results or complete occlusion, secondary hemodynamic change may be occurred due to thrombosis or flow reduction.
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Endovascular and surgical treatment of conus medullaris arteriovenous malformations

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Purpose: To evaluate the experience in the endovascular and surgical treatment of conus medullaris arteriovenous malformations (cAVMs).

Methods: We retrospectively reviewed the charts of 26 patients with a cAVM evaluated at our department. For each patient, the clinical data, type of treatment and follow-up were collected. The pre- and postoperative spinal cord functions were evaluated with the Aminoff-Logue Scoring.

Results: 23 of the 26 patients were treated. 9 patients underwent embolization only, 5 underwent embolization followed by microsurgical resection, and 9 patients underwent microsurgical resection only. 18 patients were followed up for 3–60 months, 13 patients neurologically improved, 3 were stable, and 2 patients worsened compared with before treatment. A significant improvement in Aminoff-Logue Scoring was observed in the follow-up patients.

Conclusion: Although cAVMs are challenging to treat, excellent outcomes can be achieved with a combined endovascular and microsurgical approach. The importance of early treatment should be underscored.

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Micro AVM, neurosurgical and neuroradiological vision: With regard to 3 cases

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Purpose: Micro arteriovenous malformations (AVM), defined by Yasargil represent a subset of cerebral AVMs nidus diameter of <1 cm, corresponding to <7% of all AVMs and 21% of AVMs after stroke. Structural and hemodynamic factors may predispose bleeding, small size and flow characteristics prevent normal presentation with symptoms such as compression or convulsions. We present three different cases handled differently between neurosurgery and interventional neuroradiology.

Methods: Between 2011 and 2013, three patients (one female and two male) with micro-AVM were treated. Two patients had intracerebral hematoma and 1 with temporal seizures are difficult to control. All with monitoring by neurosurgery. The first, male, long-time crises in use of multiple anticonvulsants, uncontrolled seizures, with angiographic diagnosis of Micro temporal left AVM no indication for neurosurgery or surgical / endovascular treatment. The second, female, with an intracerebral hematoma in the motor area and neurosurgical follow-up with MRI and MRA normal and without DSA, treated as a spontaneous bleeding; the third, male, diagnosed with temporal intracerebral hemorrhage 6 years ago, neurosurgical follow-up with MRI, MRA and DSA, with the diagnosis of MAV Micro right temporal and semi seizures, but no indication of surgical / endovascular neurosurgery by Neurosurgeon.

Results: All were submitted to the examination of digital subtraction angiography and all had a diagnosis of micro AVM. All patients treated with endovascular approach embolization with Onyx™ 18 with complete occlusion and no complications.

Conclusion: The digital subtraction angiography remains the “gold standard” method for diagnosis Micro AVM’s. In case of doubt may be required selective microcatheterization. In the presence of cerebral hematoma should always repeat angiography after hematoma absorption, even with the negative initial examination. Cases of temporal lesions with seizures should consider the endovascular treatment.

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Endovascular treatment for spinal arteriovenous malformations

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Purpose: to study the effect of endovascular treatment on spinal arteriovenous malformations (SAMVs).

Materials and Method: We prospectively studied patients who were diagnosed with spinal AVMs and treated endovascularly with NBCA glue at the University Medical Center_HCM City and Gia Dinh Hospital_Viet Nam from January 2010 to January 2015. The Aminoff-Logue disability scale was used to evaluate clinical features of the patients.

Results: Eighty SAVM patients were treated by endovascular occlusion. 40% were type 1, type 2 and type 3 together made up 20%, and 40% were type 4. Endovascular treatment deemed effective with absolute occlusion achieved in 94% of type 1 and 60% of type 4 patients. Failure rate was 7.5%, and recanalization occurred in 15%. Complications existed in 11% of cases, 2 of which is severe with 1 death due to subarachnoid hemorrhage and 1 tetraplegia after treating a type 2 cervical SAVM. After the mean follow-up time of 19 ± 9.7 months (from 2 to 37 months), clinical recovery was achieved in 80% of cases.
10 patient (12.5%) has fluctuating clinical progression and finally became worse during follow-up, mostly in type 2 and 3. Only the patients’ clinical presentation before treatment was found to be statistically related with clinical outcome.

**Conclusion:** Endovascular treatment for spinal AVMs were found to be effective, with some minor limitation.

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Endovascular treatment of posterior fossa arteriovenous malformations: risk factors, architecture and outcomes

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**Purpose:** Infratentorial arterio-venous malformations (AVM) are not frequent, their clinical presentation, and angiographic characteristics, and mainly their behavior, are totally different from anterior fossa AVM, even more after the ARUBA study. They represent only between 7–11.8% of cerebral AVMs. The preponderant clinical neurological pattern and the high rate of bleeding presentation of AVMs in this location shows a totally different entity from anterior fossa AVM and treatment, even though, no double blinded prospection studies are available, endovascular treatment, have definitely modified the outcome of patient affected by them.

**Methods:** Between 2012 and 2015, baseline, clinical and angiographic data of cerebral AVMs were prospectively collected. Data from 39 patients treated presenting posterior fossa AVM, mainly targeting on risk factors for bleeding, and clinical and angiographic outcomes, were included.

**Results:** Thirty-nine patients (mean age 45 years, male to female ratio 1:2) were treated endovascularly. Twenty nine (29) presented with hemorrhage and 10 with focal neurologic deficits. The Spetzler-Martin grade was higher than IV in 29 cases. Associated intra-nidal aneurysms were observed in 63.5% of cases, and venous ectasia in 34% patients. All patients were treated by endovascular procedures, followed with stereotactic radio-surgery in 6 cases. No long time morbidities or mortality were observed during follow-up. Mean follow-up was 28.5 months, with total angiographic exclusion of the AVM in 72.5% of cases; 21.7% of patients presented a modified Rankin Score ≥1 at follow-up. 2.8 average procedures per patients were necessary to achieve therapeutic goal.

**Conclusion:** Endovascular embolization is first choice and safe procedure in posterior fossa AVMs although a considerable number of procedures are necessary. Intra-nidal aneurysm is the main independent angio-architectural element to predict bleeding.

**References**


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Complications and midterm clinical outcome of endovascular treatment in patients with cerebral arteriovenous malformations: a prognostication attempt using artificial intelligence and machine learning algorithms

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**Purpose:** Brain arteriovenous malformations (BAVM) have a complicated and somewhat poorly understood natural course, and accurately predicting the outcome of these patients is an important aspect of clinical work, which can assist in identifying high-risk patients and guide treatment approaches, thus potentially decreasing mortality. The usual approach is to develop logistic regression models; however, machine learning algorithms have been proposed as an alternative, and previously shown to be successful in similar complicated conditions, such as acute ischemic stroke. The focus of this study was to investigate the potential of artificial intelligence and machine learning techniques in predicting the outcome of those patients with BAVM undergoing endovascular treatment, either alone or in combination with any other treatment.

**Methods:** Using a set of advance statistical and data-mining software, in addition to standard linear modeling, a two-layer feed-forward neural network, with sigmoid hidden and output neurons, and a support vector machine with ANOVA kernel were designed to classify predictor vectors, into potential survival or mortality outcomes post endovascular intervention of BAVMs. These two models were then trained, and subsequently validated and tested using randomly divided data from 199 prospectively collected cases who underwent treatment in our institution over a course of approximately 22 years, with the final performance of the models monitored, evaluated and compared using mean squared error.

**Results:** Using classical methods, a linear model was defined with approximately 42% accuracy. In this model, the type of treatment complication was proposed as the most influential predictor of the final outcome (mortality), with relative predictive value of ~0.4. However, the accuracy of machine learning models was significantly better,
estimated more than 90%, with the most important predictive factor suggested to be the presence or absence of nidal fistulae, in the neural network model. The final confusion matrix, demonstrated a congruency of ~90% between the Target and Output Classes, with a relatively favourable Receiving Operative Characteristic curve.

Conclusion: Numerous factors can influence the final outcome of patients undergoing endovascular treatment for BAVMs, with varying significance and mechanisms, making conventional modelling challenging and perhaps inaccurate. On the other hand, machine learning models with neural network algorithms, relatively independent of the unknown potential underlying interactions between these factors, are able to simulate the eventual result of such a complex system. As well, these models, can be used as a tool in predicting the outcome under different circumstances, and be used as a potential assistant in decision making regarding a variety of possible treatment options.

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Medial Vein of the prosencephalon and Vein of Galen. Embryologic development

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Purpose: To review the venous arrangement in the brain embryo with special interest in the Medial Vein of the Prosencephalon (MVP) development in order to better understand the Vein of Galen venous relationships.

Material and Methods: Study of serial cuts of 19 embryos and fetusses from 13 to 50 mm Crown Rump Length (CRL).

Results: The Primary Head Sinus is a lateral main channel, draining an anterior, a median and a posterior venous plexus in the early embryonic stages. It is located at each side of the embryo inside the primitive dural layer. The development of the choroid plexus of the lateral ventricles carries a primitive choroidal vein, both joining in a main midline venous trunk called the MVP aposed to the roof of the diencephalon, as a main subarachnoid channel at this stage. Our review of the venous arrangement in this region shows that, at the end of the embryonic period, a new venous plexus is developed in the habenulo-pineal region. It connects with the distal portion of the midline trajectory of the MVP as a venous dilatation, representing the Vein of Galen, before it reaches one of the marginal sinuses (usually at the right side). In initial states of the fetal development, it becomes clear that this location of the MVP helps in establishing the basis for the deep venous drainage of the brain.

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Dural Carotid-Cavernous Fistulas: An analysis of transvenous approach and treatment outcome

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Purpose: To analyze the treatment outcome of dural carotid-cavernous fistulas (CCF) by the use of transvenous endovascular technique with a correlation between angiographic results and patient outcomes.

Methods: A total of 115 patients with dural CCFs who were treated at Siriraj hospital, Bangkok, between 1998 to 2014 was retrospectively reviewed. The benign and aggressive types were classified depending on absence or presence of the retrograded venous drainages, respectively. Endovascular treatment was considered in all patients with aggressive type and some benign type who had severe eye symptoms. Transvenous approach via the inferior petrosal sinus (IPS) and use of fibered coil as the embolic material were the initial attempt. The angiographic outcome and patient outcome of each type were analyzed.

Results: There were 61.74% benign dural CCFs (female 76.1%, mean age 55.7 years) and 38.26% aggressive types (female 86.4%, mean age 59.7 years). Of 71 patients with benign type, 49.2% had endovascular treatment. All 44 aggressive dural CCFs had transvenous embolization, 41 had trans IPS approach, the other 3 had direct superior ophthalmic vein puncture. Of total 61/79 patients with trans IPS approach, 61.4% had no visualized IPS from initial angiography. The fibered coils were used in 96.7%. No major complications occurred. Initial complete obliteration was seen in 87.3% with a favorable outcome in 91.1%. Further thrombosis of the subtotal angiographic occlusion was demonstrated averaged at 96 days. Spontaneous regression of the benign disease was found in 86.1% whereas 2.8% had worsening symptoms.

Conclusion: Transvenous approach via IPS approach has a high technical success for a treatment of dural CCF, even no visualization on cerebral angiogram. The fibered coil was an effective embolic material. Endovascular treatment of benign type had promising favorable outcome than nature. Subocclusion had a high tendency to induce further thrombosis of a fistula.

References


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Endovascular Management of Anterior Cranial Fossa Dural Arteriovenous Malformations. Choosing the safe route
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Purpose: Anterior cranial fossa dural arteriovenous malformations (DAVM) are generally associated with cortical venous drainage and therefore considered high risk lesions. Traditionally, these lesions have been treated surgically. However, embolization of these malformations has also been used as a form of treatment either through an arterial or venous approach. As opposed to the retrograde venous approach, trans-arterial embolization carries the added risk of visual loss.

Methods: In this report, we describe our rationale for the endovascular treatment of D ACM involving the cribiform plate and floor of the anterior cranial fossa.

Between 2009 and 2014, five patients harboring an anterior cranial fossa DAVM were treated using an endovascular approach. Mean age of presentation was 57 years. There were four males and one female. Two of the DAVMs were incidental, two patients presented with seizures and one patient had diplopia. In all these DAVMs, the arterial feeders arose bilaterally from distal ethmoidal and dural branches of the ophthalmic artery and from distal branches of the internal maxillary artery. The main venous drainage was through frontotemporal corticovascula r veins and superior sagittal sinus in four of them, and through the basal vein of Rosenthal in one patient.
Results: In three of the five patients, the fistula was completely obliterated through a sole retrograde venous approach using the liquid polymer Onyx. In one patient the fistula was obliterated with Onyx using a combined trans-arterial and trans-venous approach. In one of the five patients, a combined trans-arterial and trans-venous approach failed due to inaccessibility of the nidus. In this patient, there was a procedural trans-venous wire perforation resulting in subarachnoid hemorrhage. The patient recovered completely without any deficits.

Conclusion: Retrograde trans-venous obliteration of DAVMs located in the anterior cranial fossa is both achievable and safe. It represents a reasonable alternative to the surgical clipping of these lesions.

Selective shunt point occlusion for dural arteriovenous fistulae patients
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Purpose: We studied dural AVF cases with treated in our department, and evaluated the visualization of convergence to one point of A-V shunts angiogram and success rate of selective shunt point occlusion.

Methods: Thirty-seven patients of d-AVF (including 16 cases of cavernous sinus d-AVF, and 11 cases of transverse sigmoid sinus d-AVF) who underwent endovascular treatment between 2007 and 2014.

Results: In all 14 patients of the cavernous d-AVF, arterial convergence to one point is supposed by the external carotid angiogram in 13 cases. Especially, arterial convergence to one point is clear by the 3D rotation angiogram (RA). 93% of the cavernous dural AVF visualized one shunt point in 3DRA. In angiographic image, it was thought that 36% of the cavernous d-AVF might be treated with selective shunt point TVE. However, it was 21% that shunt point TVE succeeded. In all 11 cases of T-S dural AVF, 10 cases (91%) showed diffuse AV shunts and only one case had one shunt point. Therefor, only one patient could cure by selective shunt point TVE. The success rate of the shunt point TVE in the T-S dural-AVF cases becomes 9%.

Conclusion: 3DRA is effective to visualization of shunt point in the dural AVF patients. Success rate of shunt point TVE for cavernous d-AVF was 21%, and T-S dural AVF was 9%.

Treatment of dural arteriovenous fistula by transvenous embolization combining Onyx and detachable coils with parallel technique
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Purpose: Complex dural arteriovenous fistula remained a challenge to treatment despite advance in endovascular therapies. Transarterial approach is often limited due to tortuous supplying vessels, small calibre of the arteries and multiple supplies.

Methods: Transvenous approach is gaining favour in selected case.

Results: We would like to report three cases of transvenous occlusion of dural arteriovenous fistula, by combined Onyx and detachable coils with parallel technique.

Conclusion: By combining Onyx and coils, site of occlusion is precise and enable excellent radiological and clinical outcome for our patients.

References
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evaluate its efficacy by digital subtraction angiography and clinical follow-up.

**Results:** 7 patients with cavernous sinus DAVF were treated by intervention, including 5 cases through inferior petrosal sinus and 2 through the Facial Vein. Immediate postoperative complete angiography indicated that the fistulas were completely occluded in all cases along with the disappear of abnormal draining veins, the total effective were 100%. One patient appeared irregular expansion of the pupil at the same side after the operation, we thought it may due to the embolus’s oppression of oculomotor nerve, but fully recovered by symptomatic treatment. The follow-up period in all cases were ranged from 3 months to 4 years, none worsened or died.

**Conclusion:** Transvenous embolization by using onyx and coils is an effective and safe therapeutic method in the treatment of patient with cavernous sinus DAVF.

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**Onyx embolization of cavernous sinus dural arteriovenous fistulas via direct transorbital puncture under the guidance of three-dimensional reconstructed skull image (reports of six cases)**

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**Purpose:** Because of complex angioarchitecture, the transarterial or venous pathway is not feasible for some cavernous sinus dural arteriovenous fistulas (CS DAVFs). We present six cases in which onyx embolization of a CS DAVFs was made possible through direct transorbital puncture.

**Methods:** In the present study, all patients were penetrated through one third of the medial-lateral of the inferior orbital rim under the guidance of fluoroscopy superimposed on the three-dimensional reconstructed skull image to complete embolization (onyx with or without coils). The records of patient demographics, clinical manifestation, fistula features, procedures, clinical outcome and angiographic outcome were reviewed and analyzed.

**Results:** In our series of six patients, the immediate angiographic result showed complete occlusion in all patients. The six patients experienced retrobulbarhematoma and eye swelling right after embolization, while the swelling significantly subsided after 3-5 days of conservative treatment. During the postoperative angiography and clinical follow-up (4-10 months), one of the patients had decreased visual acuity; the other five patients did not have neurological dysfunction.

**Conclusion:** Onyx embolization via direct transorbital puncture provides a method to be considered to treat CS DAVFs when the conventional transvenous approaches are inaccessible.

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**Posterior fossa dural sinus occlusion in vein of Galen malformations**

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**Purpose:** Spontaneous occlusion of the posterior fossa dural sinuses is often observed in patients with vein of Galen malformation (VGM), which can affect the clinical course. We analyzed the clinical and angiographic course of sinus occlusion in VGM patients.

**Methods:** We retrospectively reviewed 61 consecutive children with VGM who were referred to Center for Endovascular Surgery at Roosevelt Hospital and performed angiographic analyses focusing on the outflow of the posterior fossa dural sinuses.

**Results:** Twenty patients (32.8%) demonstrated sinus occlusion, almost always in the sigmoid sinus. This condition was not observed in neonates and first discovered during infancy or childhood. In these patients, primary symptom was hydrodynamic disorder, such as macrocranium, prominent facial and scalp veins, and hydrocephalus. Ten patients (50%) had hydrocephalus and 8 patients (40%) had developmental delay. Progression of sinus occlusion was seen in 10 patients and 6 of them deteriorated in accordance with progression of sinus occlusion. After total or subtotal obliteration of the VGM by trans-arterial glue embolization, 13 patients recovered to normal, 3 patients had only mild developmental delay, and 4 patients remained neurologically disabled.

**Conclusion:** Spontaneous sinus occlusion is not rare condition in VGM patients, generally develops during their infancy, and aggravates hydrodynamic disorder. Therefore, early intervention and shunt flow reduction by trans-arterial glue embolization is essential to prevent permanent brain damage.
Temporary Surgical Clipping of Flow-Diverted Arteries in an Experimental Aneurysm Model

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Purpose: Surgical management of recurrent aneurysms following failed flow diversion (FD) may pose difficulties in securing vascular control with temporary clips. The authors tested the efficacy and impact of different types of aneurysm clips on flow-diverted arteries.

Methods: Six wide-necked experimental aneurysms were created in canines and treated with Pipeline flow diverters. In four aneurysms, occlusion of the artery at the level of the proximal and distal landing zones (n = 2 per aneurysm) was attempted, using temporary, fenestrated, single, and double permanent aneurysm clips. Two aneurysms served as unclipped controls. Serial angiography was performed to look for efficacy of clip occlusion, flow diverter deformation, and thrombus formation. After euthanasia, the flow diverted aneurysm constructs were opened and photographed looking for neointimal or device damage as a result of clipping.

Results: Angiography-confirmed clip occlusion was only possible for 4/8 of the tested flow-diverted arterial segments. Clip application attempts led to filling defects consistent with thrombus formation in 2/4 flow-diverted constructs, and to minor damage of the flow diverter with neointimal fracture in 1/4 cases.

Conclusion: Aneurysm clips placed on canine parent arteries bearing a Pipeline flow diverter were unable to reliably stop blood flow. Application of aneurysm clips can cause mild damage to the device and neointima, which might translate into thromboembolic risks. If possible, vascular control should be sought beyond the terminal ends of the implanted device.

CCC (Color Coded Circulation): A novel technique to detect shunt points in dural arteriovenous fistulae

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Purpose: In treating dural arteriovenous fistulae (dAVFs), the therapeutic goal is to occlude the dural vein close to the shunt point, whether by transarterial or transvenous approach. Thus, detection of the shunt point is crucial. We have recently established an intelligible technique named color coded circulation (CCC) to detect shunt points, and investigated its usefulness over the combination of conventional DSA and parametric color coding (time to peak: TTP) images.

Methods: The principle of CCC is that determining the arrival time of contrast media by time-density curve obtained from conventional DSA pixel by pixel, followed by converting the arrival time to circulatory color phases. By this technique, blood flow is demonstrated as sequential color imaging. CCC and TTP/DSA images obtained from 19 dAVFs were presented to four experienced and 4 less experienced observers in a randomized order. And the observers were then asked the location (s) of the shunt and the venous drainage pattern recognized on each image. The time to detection was also recorded. The comparison between CCC and TTP/DSA were analyzed using chi-square test.

Results: CCC was superior to TTP/DSA in accuracy of shunt detection (81.6% vs 34.2%, p < 0.0001), recognition of the venous drainage pattern (94.7% vs 78.3%, p = 0.0001), and the time to detection (22.8 sec. vs 36.4 sec, p < 0.0001). These effects were observed in both experienced and inexperienced physicians.

Conclusion: CCC provided more accurate and comprehensible information of blood flow by sequential, color-coded imaging in a single window compared with combination of static, color-coded TTP images and sequential DSA images. Considering its efficacy for both experienced and younger physicians, CCC would be a very useful tool in educational and therapeutic process of managing dAVFs.
Utility of Arterial Spin Labelling 3.0-T Perfusion MR Imaging in Diagnosis of Dural Arteriovenous Fistula

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Purpose: 3T-ASL showed the good signal to noise ratio CBF imaging in a lot of arterial disease including brain main trunk occlusion or internal carotid artery stenosis. And, 3T-ASL is very helpful study in arteriovenous shunt disease like DAVF using short time post labelling delay (PLD).

Methods: This study included 10 patients who were diagnosed as DAVF by angiography. There were 4 males and 6 females. Their age ranged from 24 to 100 years. 2 cases were anterior condylar confluence DAVF, 2 cases were cavernous sinus one, 4 cases were transverse-sigmoid one, a case was superior sagittal sinus one, and a case was middle meningeal artery one. Short time post labelling delay was defined 1024 ms after pulsing in ASL MR imaging.

Results: ASL showed the shunt lesion as increased blood flow in all cases. 6 cases had the indication of IVR and increased blood flow was not found after treatment in all cases. Normal time PLD and short time PLD demonstrated the direction of the shunt flow, because increased blood flow moved.

Conclusion: Blood flow of shunt diseases including DAVF tend to exhibit low pressure and fast blood flow. SPECT could not show the shunt lesion, however, ASL, especially short time PLD ASL, could demonstrate the shunt lesion, because labelled normal blood flow doesn’t arrive yet. (Iryo et al., 2014) ASL may be a very useful modality to diagnose and follow up the DAVF. (Alexander et al., 2014).

References

In vitro evaluation of radio-density dynamics during injection of Onyx

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Purpose: The poor and inconsistent radiopacity of the precipitates during plug formation has been one of the technical difficulties in using Onyx. The purpose of this in vitro experiment is to evaluate the X-ray radio-density dynamics during the Onyx injection.

Methods: On a radiolucent plate, we placed a microcatheter (Apollo) simulating a real microcatheter positioning during brain AVM embolization. The Onyx was injected at a rate of 0.05 mL/min throughout the experiment and the Onyx droplets were collected for radio-density measurement. Forty droplets were collected during continuous injection (injection period) and then 5 droplets were collected during intermittent injection (1 min. pause and 2 sec. injection) (pause period). Three bottles of Onyx was injected while serial radiographs were obtained. Using ImageJ, time to radio-density curves were obtained for both injection and pause periods and their difference was analyzed.

Results: There were 9 phases of both injection and pause periods. Serial radiographs of the microcatheter showed intermittent sedimentation of the dense material at the concave parts of the microcatheter. The radio-densities of pause period were significantly lower than those of the injection groups (P < 0.05). We could note that there was a tendency of gradual decrease of the radio-density during pause period.

Conclusion: We could observe intermittent sedimentation of radiodense materials at the concave parts of the microcatheter curvatures and poor radiopacity problem during pause period. This may explain heterogeneity of the Onyx radiopacity and why the precipitates were difficult to see during plug formation.
Evaluation of atherosclerotic plaques in acute ischemic stroke of middle cerebral artery territory using high-resolution intracranial vessel wall imaging

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Purpose: High-resolution (HR) intracranial vessel wall imaging shows arterial wall pathologies and hidden arterial wall pathologies in the arteries which are not stenotic on MRA. Atherosclerotic plaque with contrast enhancement is considered as vulnerable. Aim of study was to evaluate atherosclerotic plaque with contrast enhancement on middle cerebral arteries (MCA) with unilateral noncardioembolic acute ischemic stroke.

Materials and Methods: 28 patients who had unilateral non-cardioembolic acute ischemic stroke of MCA territory underwent HR vessel wall imaging (13 males; ages, 32–82 years; mean, 60 years) using 3.0 T. 3D TOF MR angiography and contrast-enhanced black-blood T1-weighted volumetric isotropic TSE acquisition (VISTA) image were acquired with 0.5 mm isotropic voxels. Type of infarction (striatocapsular or borderzone), presence of stenosis, location (proximal / middle/distal MCA), and type (anterior/posterior/inferior/superior wall or circumferential) of enhancing wall thickening of ipsilateral and contralateral MCA were analyzed. Atherosclerotic plaque burdens were calculated from sum of involved segment on MCA.

Results: 67.9% (19/28) showed ipsilateral MCA stenosis. Borderzone was more common than striatocapsular infarction (P = 0.039). In stenotic segment, circumferential (63.2%) was most common followed by superior wall thickening (21.1%). In case of striatocapsular infarction, superior (43.8%) was most common followed by circumferential (25%) wall thickening.

100% of ipsilateral and 85.7% of contralateral MCA shows enhancing wall thickening. Burden of atherosclerotic plaque on ipsilateral was significantly larger than contralateral MCA (2.32 vs 1.82, P = 0.010). On ipsilateral MCA, culprit lesion shows circumferential (42.9%) followed by superior (28.6%) wall thickening, but on contralateral MCA, it shows anterior (35.7%) followed by posterior (28.6%) wall thickening.

Conclusion: High-resolution intracranial vessel wall imaging may reveal atherosclerotic plaque of vessel wall even the stenosis is not evident on the MRA. Atherosclerosis with luminal stenosis, circumferential or superior wall involvement and larger plaque burden were correlated with ipsilateral acute ischemic stroke.

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Very Late Ischemic Complications in Flow Diverter Stents: a Retrospective Analysis of a Single Center Series

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Purpose: To evaluate the rate and discuss the pathomechanisms of very late (≥4 months) ischemic complications after flow diverter stents (FDS) placement for intracranial aneurysms.

Methods: We retrospectively reviewed the clinical data of the patients treated in our institution from January 2010 to September 2014 with FDS for intracranial aneurysms. Patients received dual anti-aggregation therapy (clopidogrel and aspirin) 5 days before and 3 to 6 months after the procedure and then aspirin alone during 6–9 months. Ischemic complication was defined as a sudden focal neurological deficit documented on diffusion-weighted images.

Results: Eighty-six consecutive patients were included. Three patients (3.5%) treated with the Pipeline Embolization Device (PED; Covidien, USA) presented a delayed acute ischemic stroke (2 cases of perforator/side-wall branch infarction and one thrombo-embolic stroke) with an average delay of 383 days (4 months; 1 year and 8 months; 1 year and 1 month, respectively). The aneurysmal locations were respectively: left SCA, right AchoA and left carotid-ophthalmic. The complication occurred after they completed the anti-aggregation protocol except for case 1 (Aspirin alone due to a spontaneous hematoma). At the acute phase, no in-stent thrombosis was found on DSA. In case 2, the covered AchoA was occluded 20 months after the procedure. In case 3, a focal stenosis (≥40%) of the distal end of the FDS was seen, probably caused by intimal hyperplasia. Clinical outcome was satisfactory in all 3 cases (mRS 0–2).

Conclusions: Very late ischemic complications after FDS treatments were observed in 3.5% of the cases in our series and may occur as late as more than one year.
References


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Basilar tip aneurysms treated by endovascular flow reversal: a case series

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Purpose: The treatment of large, giant, or recurrent basilar tip saccular aneurysms is challenging. Stent-assisted coiling and flow-diverters have shown poor results (Chalouhi et al., 2012) (Brinjikji et al., 2013). Reversing the flow at the basilar tip by occluding both vertebral arteries is one of the numerous therapeutic options. Nevertheless, its safety and efficacy are impossible to define, due to lack of literature. We report the results of 14 consecutive patients treated in our centre with this technique.

Methods: We retrospectively reviewed the records of all our patients treated by flow-reversal for the treatment of basilar tip saccular aneurysms in the past 20 years. Clinical and radiological data were retrospectively assessed and reviewed by 2 observers (RF and AW).

Results: Fourteen patients (3 male, mean age: 52.9 ± 9.3 years old) have been treated by flow reversal since 1996. Among these patients, 11 had a symptomatic aneurysm (i.e brainstem compression and/or hydrocephalus). Nine patients have already had one or several coiling treatments, but all of them presented aneurysm recanalization and/or clinical deterioration despite coiling. Clinical follow-up was available in 13/14 patients: 4 patients improved, 1 patient remained asymptomatic, 2 patients remained unchanged, 4 patients continued to deteriorate, 1 patient presented an unexpected worsening, and 1 patient died of acute stroke 2 days after the procedure. No patient suffered from aneurysm rupture/re-rupture after flow-reversal. Mean clinical follow-up was 56.8 ± 55.7 months. Radiological follow-up was available in 11/14 patients: 1 aneurysm remained completely occluded, 3 aneurysms showed a stable residual neck, and 7 aneurysms had a
stable residual dome filling. Mean radiological follow-up was 64.7 ± 57.4 months.

**Conclusion:** The technique seems to be safe, but clinical results are unpredictable and overall unsatisfying.

References


126 Presentation withdrawn

Endovascular treatment for ruptured basilar artery dissection

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**Purpose:** Ruptured basilar artery dissection (BAD) is a rare clinical entity, difficult to treat, and has a poor outcome. The purpose of this study is to clarify the effectiveness of the endovascular treatment for ruptured BAD.

**Methods:** Authors extracted patients with acute ruptured BAD from clinical database in our hospital. Ruptured BAD was defined as having angiographic findings such as intimal flap, double lumen, string, pearl-and-string signs, or fusiform dilatation unrelated to branching site, and confirmed as a bleeding point with CT or MRI.

**Results:** Fourteen patients (10 women; mean, 66.7 years old) were admitted in our hospital for 19 years. All patients presented with subarachnoid hemorrhage. Six but 1 patients with conservative therapy were dead within a couple of days due to rerupture; a patient of which BAD was spontaneously occluded was treated conservatively and had a good outcome. Endovascular treatment during acute stage was performed with parent artery occlusion (PAO) in 3 and acute stenting in 5 patients. Postoperative rerupture occurred in 1 with PAO and 2 patients with stenting, and 2 patients (1, PAO; 1, stenting) were dead. A patient with postoperative rerupture underwent stent-in-stent therapy and had no more rupture.

**Conclusion:** Conservative management cannot prevent acute rerupture of BAD, and some surgical management is needed. Surgical management includes constructive surgery with preservation of anterograde basilar arterial flow and deconstructive surgery with intentional occlusion of basilar artery. Constructive surgery using intracranial stent for prevention of BAD rerupture seems to be a promising approach, although a further large prospective study is warranted for proving this.

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Double (‘Nutcracker’) stent retriever for recanalization of resistant basilar tip occlusion

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**Purpose:** We describe successful thrombectomy of acute occlusion of a basilar artery (BA) tip and proximal segments of posterior cerebral arteries (PCAs) by using 2 stent retriever devices simultaneously.

**Methods:** A 71-year-old man was referred to our institution 6 hours after loss of consciousness with a Glasgow Coma Score of 3. Initial cranial computed tomography (CT) showed a dense BA. Cranial CT angiography showed thrombosis of left vertebral artery (VA), distal third of the BA, proximal posterior cerebral arteries (PCAs) and superior cerebellar arteries. Tissue plasminogen activator had not been started due to delayed presentation and thrombectomy was requested at 7 hours of the onset of symptoms.

**Results:** Thrombectomy was attempted five times by placing the thrombectomy device sequentially from right and left PCA and distal BA and pulling the device back. Finally two Echelon 10 catheters were placed in each PCA and two Catch Plus thrombectomy devices (CPD) (Balt, Montmorency, France) were placed from the PCAs proximally to the BA in a kissing fashion. Both stentriever devices were pulled back simultaneously and the clot was gaoled within the devices similar to a nutcracker. Postprocedure angiography showed a complete recanalization of the BA and proximal PCAs.

**Conclusion:** Due to snagging phenomena, thrombi located in major arterial bifurcations may be difficult to retrieve with a single stentriever device. Simultaneous retrieval of two CPDs to entrap an intralarterial clot may be nescessary in selected cases.

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INVOSTM date analysis for 37 cases of carotid artery stenting

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**Purpose:** INVOSTM is a technology used clinically to monitor regional cerebral O2 saturation (rsO2). It allows noninvasive, continuous real-time detection of changes in the ratio of oxyhemoglobin to deoxyhemoglobin in the frontal cortex, thus providing indirect information on cerebral oxygenation. Several studies using INVOSTM during CEA have demonstrated that INVOSTM system can detect deceased cerebral oxygenation resulting from internal carotid artery (ICA) clamping and can predict post-CEA cerebral hyperperfusion syndrome (CHS). Thus the aim of the present study was to
evaluate the application of INVOS™ during carotid artery stenting (CAS) for prediction of CHS (Ogawa et al., 2003).

Methods: Between December 2013 and February 2015, 52 patients with ICA stenosis underwent CAS. Periprocedural rSO2 was monitored in 37 cases of CAS (31 men, 6 women; 74 ± 6.7 years). The average degree of carotid stenosis was 76.0 ± 15.8% by North American Symptomatic Carotid Endarterectomy Trial criteria. Bifrontal rSO2 was monitored during the procedure using NIRS. Twenty-two patients were symptomatic and 15 were asymptomatic.

Results: CHS was not observed. Cerebral hyperperfusion on INVOS™ (not CHS) was observed 2 cases. Two cases had no collateral flow through anterior communication artery and posterior communication artery on MRA. One case was treated with CAS using both distal and proximal protections, on the other case was treated with CAS using only distal protection.

Conclusion: INVOS™ might be able to detect the intolerance cases in CAS using the distal protection and / or the proximal protection at an early date during an operation.

Reference

129 Presentation withdrawn

Intraoperative Spinal Digital Subtraction Angiography: Indications, Technique, Safety, and Clinical Impact

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Purpose: This study evaluates the safety and efficacy of intraoperative spinal angiography (ISpA).

Methods: Demographics Nineteen patients (16 males, 3 females, age range: 10 to 76 years) underwent a total of 37 ISpAs between 2005 and 2015, either immediately prior to surgery for localization purpose (n = 9) and/or after (n = 28) to confirm the intervention’s efficacy. The spinal pathologies included 5 (26.3%) dural arteriovenous fistulas (AVFs), 5 (26.3%) epidural AVFs, 6 (31.6%) perimedullary AVFs, 1 spinal arteriovenous malformation (5.3%), and 2 (10.5%) cases of diaphragmatic crus compression syndrome (8.3%). ISpA was performed in the operating room in the prone position using a C-arm. Vascular access was obtained under general anesthesia in the supine position. A 5-French 55- or 30-cm-long femoral sheath was inserted and secured to the access site, with the hub positioned on the lateral surface of the thigh to enable catheter maneuvering with the patient in the prone position.

Results: No peri- or post-procedural angiographic complications were noted.

All the targeted intersegmental arteries (ISA) were successfully catheterized. ISpA changed the course of surgery in 6 instances (31.6%). In one case, ISpA for lesion localization revealed spontaneous resolution of an epidural AVF, preventing unnecessary surgical exploration. In another case of a perimedullary AVF, 6 ISpAs were necessary before all the feeding branches were successfully addressed. In a patient undergoing treatment for anterior spinal artery (ASA) compression by the diaphragmatic crus, ISpA showed thrombosis of the ISA and non-visualization of the ASA. Full recanalization was obtained by immediate intraoperative intra-arterial thrombolysis, without postoperative clinical consequences.

Conclusion: ISpA is a safe and useful adjunct to surgical treatment for spinal vascular conditions. ISpA changed the surgical strategy in 6 patients (31.6%), and technically successful in all cases.

130 Utility of intra-arterial cone beam CT angiography in detection of intracranial microarteriovenous malformations

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Purpose: To assess the diagnostic value of intra-arterial cone-beam CT angiography (CBCTA) relative to digital subtraction angiography (DSA) in the anatomic identification and localization of intracranial microarteriovenous malformations (mAVM) as well as the significance for surgical/ endovascular treatment planning.

Methods: Retrospectively, two blinded observers scored DSA and intra-arterial CBCTA images of 5 patients with mAVM based on a qualitative scale with the following parameters: detection of arterial feeders, venous drainers and nidus. The total score was defined as the overall diagnostic value. Differences between CBCTA and DSA scores were defined as the CBCTA efficacy value. Observers described the treatment strategy at the end of DSA and CBCTA grading.

Results: We had good interobserver agreement of overall diagnostic value for CBCTA with no significant variance between the two observers. Significantly higher scores were assigned to CBCTA for overall diagnostic value. Observers found CBCTA helpful, enabling a more confident treatment approach.
**Materials and Methods:**

The purpose of this study was to describe the clinical features and outcomes of BA steno-occlusion. The purpose of this study was to describe the clinical features and outcomes of BA steno-occlusion. The purpose of this study was to describe the clinical features and outcomes of BA steno-occlusion. The purpose of this study was to describe the clinical features and outcomes of BA steno-occlusion.

**Materials and Methods:** From 2004 to 2014, 132 consecutive patients with severe stenosis (n = 92) or occlusion (n = 40) of BA based on either MR or CT angiography were enrolled. They were 59 men and 73 women (71 ± 13.3 years of mean age and 24.2 ± 27.5 months of mean follow-up). Upon the diagnosis of intracranial steno-occlusive disease, patients were properly medicated with antiplatelets. Clinical features, radiological findings, and outcomes were assessed.

**Results:**

Men were younger than women (68.1 ± 14.1 vs. 73.3 ± 12.2, p = .023) with higher smoking rates (57.4% vs. 6.3%, p < .001). The etiologies were atherosclerosis (n = 111), embolism (n = 12), dissection (n = 7), and developmental (n = 2). The incidences of compromised in-flow (i.e., coexisting vertebral arterial steno-occlusion or undetectable posterior communicating artery) in patients with neurologic deterioration (70%) or poor outcomes (66.7%) were not different from the control (67.2% and 67.4%, respectively). Four patients (stenosis 3 and occlusion 1) underwent stent insertion. The rate of new infarct in the same territory in 104 patients who could be followed up over 2 months without stent insertion was 2%/year (5 new infarcts in 244 patient-years of follow-up). Patients with BA stenosis showed no relevant symptom at presentation in 54.3%, no infarct initially and during the follow-up period in 52.2%, neurologic deterioration in 6.3% poor clinical outcome 5.1%. Patients with BA occlusion were more symptomatic (80%, p < .001) with higher incidence of neurologic deterioration (20.7%, p = .03), and poor outcome (17.2%, p = .04).

**Conclusion:** BA stenoses were clinically benign in more than half of the cases and could be maintained stable under the appropriate medical treatment.

**References**


month stroke and/or death rate following intracranial stent placement.

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Enterprise stent for the treatment of symptomatic intracranial atherosclerotic stenosis: An initial experience of 44 patients

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Purpose: Stenting for intracranial stenosis have a relatively high risk of complication, particularly for those with tortuous pathways, extremely angulated lesion or arterial bifurcation involved. Whether undersized balloon angioplasty followed by deployment of a stent with higher compliance is safe and effective needs further investigation. We performed this retrospective study to assess the clinical safety and efficacy of the Enterprise stent for treatment of complex symptomatic intracranial stenosis.

Methods: Forty-four patients with a symptomatic 70–99% stenosis of a major intracranial artery treated with balloon angioplasty followed by Enterprise stent deployment between July 2009 and August 2013 were enrolled in this study. Pre- and post-medication included combined antiplatelet therapy and intensive management of risk factors. Primary endpoint was defined as ischemic stroke, hemorrhagic stroke or death within 30 days after intervention. Clinical and angiographic follow-up were also typically scheduled.

Results: The technical success rate was 100%. Median pre- and post-procedural stenosis rate was 79.3 ± 8.1% vs 14.9 ± 12.3%. Three ischemic strokes (6.8%) and 1 hemorrhagic stroke (2.2%) occurred during peri-procedural period. Thirty-eight (86.4%) patients received DSA follow-up (mean, 11.5months). In-stent restenosis (>50%) was observed in 3 (6.81%) cases after 22 months of mean follow-up. During the median 25.6 months follow-up, there was no recurrence of transient ischemic attack or stroke in 42 available patients.

Conclusion: Angioplasty with undersized balloon followed by Enterprise stent is safe and effective for the treatment of symptomatic intracranial stenosis, even in those cases with tortuous vascular pathways, long segment lesion or arterial bifurcation involved.

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The 30 days outcome of a multicenter registry study of stenting for symptomatic intracranial artery stenosis in China

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Purpose: Although recent trials have been suggested that endovascular stenting in patients with severe symptomatic intracranial atherosclerotic stenosis (ICAS) were worse than medical therapy, it is not clear if this conclusion applies to the Chinese population. We performed a multicenter prospective registry study to evaluate the safety and efficacy of endovascular stenting within 30 days for patients with severe symptomatic ICAS in China.

Methods: Patients with symptomatic ICAS caused by 70–99% stenosis combined with poor collaterals would be enrolled. The endovascular treatment included the balloon-mounted stent or balloon pre-dilation plus self-expanding stent.
The primary outcome within 30 days is stroke, transient ischemic attack and death after stenting. The secondary outcome is the successful revascularization rate. The baselines and outcomes of two types of endovascular treatment were compared.

Results: From September 2013 to January 2015, among 354 consecutive patients, 300 patients (ages 58.3 ± 9.78) were recruited, including 159 patients treated with balloon-mounted stent and 141 patients with balloon plus self-expanding stent. The 30-day rate of primary outcome was 4.3%. The successful revascularization rate was 97.3%. Compared with balloon plus self-expanding stent, patients treated with balloon-mounted stent were older, less likely to have middle cerebral artery lesion and more vertebral artery lesion, more likely to have Mori A lesion and less Mori C lesion, and lower degree of residual stenosis.

Conclusion: The short-term safety and efficacy of endovascular stenting for patients with severe symptomatic ICAS in China is acceptable. Balloon-mounted stent may have lower residual stenosis than self-expanding stent. Clinical Trial Registration-URL: http://www.clinicaltrials.gov. Unique identifier: NCT01968122.

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Perforator proximity is the strongest independent risk factor for peri-procedural stroke in intracranial stenting for atherosclerotic disease with aggressive management of anti-platelet therapy

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Purpose: To compare platelet function testing in patients pre-medicated with aspirin and clopidogrel for elective endovascular intracranial procedures using three different whole blood platelet aggregometers: two point-of-care (VerifyNow and Multiplate) and one laboratory (Chrono-Log).

Methods: Patients undergoing elective endovascular intracranial procedures at this institution were prospectively identified from July 2011. Patients received 100–150 mg of aspirin for 6–8 days (or 300 mg for 2 days) and 75 mg of clopidogrel for 6–8 days (or 300 mg for 2 days). Blood was drawn just prior to the intervention and tested on each aggregometer. Operators were blinded to the Multiplate and Chrono-Log results. Clopidogrel: % inhibition (VerifyNow) was compared to hADP (MultiPlate) and
ChronicADP (Chrono-Log). Aspirin; ARU (VerifyNow) was compared with hASPI (Multiplate) and ChronoCol 5.0 (Chrono-Log) results. Manufacturers references ranges were used to classify patients as non-responders or responders. Pearson’s rank coefficient and kappa statistics were calculated for direct comparisons.

Results: 73 patients consented to the study (ages 23–74yrs, mean 54yrs). Complete data was available for clopidogrel in 55 patients and aspirin in 46 patients. Patients with incomplete data or non-standard anticoagulation schedules were excluded. For clopidogrel: VerifyNow and Multiplate had 52.7% agreement ($k = 0.22$, $r = -0.69$). VerifyNow and Chrono-Log had 76.4% ($k = 0.326$) agreement between non-responders/responders. For aspirin: VerifyNow and Chrono-Log had a weak positive correlation ($r = 0.25$). VerifyNow and Multiplate had a weak positive correlation ($r = 0.25$). VerifyNow and Chrono-Log had 67.4% agreement.

Conclusion: Point-of-care devices are convenient for testing platelet inhibition after premedication with clopidogrel and aspirin. However, different devices produce different results for platelet inhibition. Interventional Neuroradiologists should be aware of this, particularly if patients require follow up testing at a different institution. VerifyNow and Multiplate correlate well for clopidogrel testing but only weakly for aspirin testing. VerifyNow agreed more with Chrono-Log for clopidogrel than aspirin.

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Dual antiplatelet therapy combining aspirin and ticagrelor in intracranial aneurysm embolization. A 18 month French experience

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Aspirin + clopidogrel is the most common dual antiplatelet treatment prescribed in neuroradiology units even clopidogrel efficacy is unpredictable

Aims: We evaluated the association aspirin + ticagrelor in a prospective group of 88 patients submitted to stent procedures for intracranial aneurysms.

Methods: 91 intracranial stent procedures for intracranial aneurysms were performed from 12/2014 to 03/2015 in 88 patients. Aspirin 160 mg was started 1 week before procedure and continued for 1 year. Charge dose of 180 mg ticagrelor was administered the evening before and the morning of the intervention. 90 mg ticagrelor were given the evening of the intervention, followed by 90 mg twice per day for 3 months.

Results: 26 stent assisted coiling procedures and 65 flow diverter stents were included. No death or intracranial hemorrhagic event was observed. 3 patients presented minor neurologic impairment in the first 24h after intervention and MRI confirmed the presence of ischemic lesions. One patient did not receive the two 180 mg doses of ticagrelor. Another patient received one charge dose the day of the intervention because the stent procedure was urgent. The third patient presented a severe arterial hypotension at the flow diverter stent delivery (systolic 70 mmHg and diastolic 50 mmHg) and a low flow ischemic lesion was detected without any sign of thromboembolic complication. 4 patients developed femoral hematomas not requiring surgery.

Conclusion: Ticagrelor is a more efficient P2Y12 inhibitor than clopidogrel, with short half-life allowing quicker platelet function recovery desirable in emergent interventions. However, little experience with ticagrelor in neurovascular procedures was available until now. In this cohort of 88 patients, no severe neurologic impairment was observed and only 3 cases presented small ischemic lesions with minor defect. In addition, only 4 nonsurgical femoral hematomas were observed. Further prospective trials are mandatory for confirming the good benefit/risk ratio of ticagrelor in this setting.

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Platelet reactivity testing in neuroendovascular surgery: a nail without a hammer

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Purpose: Periprocedural antiplatelet medication management in neuroendovascular surgery remains controversial, notably with flow diverting stents. Hemorrhagic and thromboembolic complications have been associated with hyper- and hyporesponsiveness to antiplatelet medications. While “testers” report strong correlation between complications and platelet responsiveness at the time of complication, “non-testers” report no improvement in outcomes with testing. Our experience as “testers” has shown variability in not only platelet responsiveness but also test reliability. We present results of simultaneous impedance aggregometry and VerifyNow® testing, demonstrating the challenges of achieving reliable platelet inhibition.

Methods: 175 blood samples from neuroendovascular patients on clopidogrel were evaluated with impedance platelet aggregometry and VerifyNow® platelet testing, measured as Ohms and Platelet Reactivity Units (PRU), respectively. Samples were drawn and evaluated concurrently. A scatterplot was evaluated with a linear regression model to determine the correlation between the two tests. “Therapeutic” values for neuroendovascular devices were defined: PRU 60–240 and impedance aggregometry of 3–7 ohms. Three groups were defined: (1) therapeutic by both tests, (2) non-therapeutic by both tests, (3) therapeutic by one test and non-therapeutic by the other test.
Results: The $R^2 = 0.35$ for linear correlation of aggregation and VerifyNow®. “Therapeutic” platelet inhibition was documented by both tests in 45/175 (26%) samples. “Non-therapeutic” platelet function was documented by both tests in 30/175 (17%) samples. The results were “therapeutic” by one test and “non-therapeutic” by the other in 100/175 (57%) samples.

Conclusion: Impedance aggregometry and VerifyNow® results were conflicting in more than half of the samples tested. The correlation between these two tests was poor. Some evidence suggests that complications after neuroendovascular procedures are linked to antiplatelet medication response. We continue to test platelet reactivity and titrate antiplatelet medications, but there is clearly a need for reliable testing and reliable medications to maximize the safety of neuroendovascular procedures requiring platelet inhibition.

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The safety of cessation or dose reduction of antiplatelet therapy after Enterprise-assisted stent-coiling; Long-term result in a single center study

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Purpose: The aim of this retrospective study is to investigate the delayed cerebrovascular complications after Enterprise-assisted stent-coiling, and to assess the safety of cessation of dose reduction of antiplatelet therapy from long-term result in our institution.

Methods: Fifty-six patients (mean age, 60.0 ± 10.6 years; 43 female, 13 male) with 59 intracranial aneurysms (mean size, 11.5 ± 4.7 mm) were treated with Enterprise-assisted stent-coiling between December 2007 to December 2011. Five patients with 5 aneurysms were lost to clinical follow up beyond 36 months after procedure. Radiological imaging, clinical symptoms and the period of antiplatelet therapy beyond 36 months after procedure. Radiological imaging, clinical symptoms and the period of antiplatelet therapy beyond 36 months after procedure.

Result: Delayed (>30days) hemorrhagic complication was 1 case (1.9%); 35 days post-procedure, DAPT period), symptomatic ischemic complication was 1 case (1.9%); 11 months post-procedure, DAPT period), asymptomatic ischemic change in MR FLAIR image was 3 cases (5.9%), in-stent thrombosis was 1 case (1.9% asymptomatic). The average time points of switching DAPT to SAPT was 7.2 ± 8.7 months after procedure, SAPT to antiplatelet free was 26.5 ± 14.5 months after procedure. In the latest follow up, SAPT was 27 cases (52.9%), antiplatelet free were 24 cases (47.1%).

Conclusion: The antiplatelet therapy after Enterprise-assisted stent-coiling can be stopped with safety 26.5 months after procedure.

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Safety of Using Self-Expandable Leo Stent for Treatment of Ruptured Wide-Neck Brain Aneurysms – Single-Center Experience

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Purpose: The aim of this study was to analyze clinical outcome and prevalence of thromboembolic complications during endovascular treatment of ruptured saccular intracranial aneurysms with use of self-expanding stents performed in our Department.

Methods: The data was collected in the Department of Neurosurgery and Neurotraumatology, Poznan University of Medical Sciences between years 2004–2015. Database included 80 patients with subarachnoid hemorrhage due to ruptured saccular aneurysms treated with self-expandable stents. All patients received acetylsalicylic acid (150 mg) and clopidogrel (600 mg) 2 hours before the procedure. Clinical presentation (Hunt and Hess Scale), extension of subarachnoid hemorrhage (Fisher Grade) and outcome of the therapy (Glasgow Outcome Scale) were analyzed.

Results: All 80 stents were implanted successfully. In two cases stent was implanted due to coil protrusion into the lumen of parent vessel. In 19 cases (23.75%) thromboembolic complications were diagnosed during control angiography (in-stent thrombosis) in the first 60 minutes after stent placement. In these cases abciximab was administered and complete patency of the artery was achieved in all of them. In one patient with basilar tip aneurysm, after abciximab infusion, fatal rebleeding occurred during ad-hoc coiling procedure. 23.75% of all treated patients were admitted in poor neurological condition (Hunt and Hess Grade IV or V). In total, eleven patients (13.75%) died before discharge (GOS I) and seven (8,75%) were transferred to another hospital without regaining consciousness (GOS II). 52.63% of patients who were given abciximab during the procedure and 65% of patients with no thromboembolic complications achieved good outcome (GOS IV or V).

Conclusions: Self-expandable stents are effective method of aneurysm treatment even when they ruptured. In fusiform aneurysm they are the most appropriate therapeutic option. The most common complication is blood clotting in the lumen of the stent, which is effectively threatened by abciximab.
How risky is the complete interruption of antiplatelet therapy after flow diverter stents placement: a single center experience

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Purpose: Several endovascular approaches have been used to treat complex intracranial aneurysms with wide necks or fusiform shape. Flow diverter stents (FDS) deployment in the treatment of aneurysm usually requires the administration of dual antiplatelet therapy for 3–12 months. Thromboembolic complications after termination of antiplatelet therapy as well as bleeding complications related to the maintenance of dual therapy are the key morbidity factors in post-stents age. Our goal is to analyze the rate of ischemic complications after complete discontinuation of antiplatelet therapy in patients with FDS.

Methods: We performed a retrospective analysis of medical records of 178 patients treated with FDS between January 2008 and December 2014. We analyzed the occurrence of thromboembolic events through the use of antiplatelet therapy and its association with possible resistance, in addition to the incidence of hyperplasia intimal after complete discontinuation of antiplatelet therapy in patients with FDS.

Results: Early thromboembolic events were observed in 12 patients (6.7%) and we can’t determine whether the irregularity in the use of medication or drug resistance. In 3 cases (2%) where we observe persistent aneurysm after 1 year of treatment, we opted for full discontinuation of antiplatelet therapy. In all cases, the patients showed a severe intimal hyperplasia, resolved after return of antiplatelet therapy.

Conclusion: According to our series, a complete interruption of antiplatelet therapy in patients using flow diverter stent is associated with increased thromboembolic events. This fact is surely the greatest intimal hyperplasia rate associated to this treatment modality.

4D Omniplane Fluoroscopy: A Technique For Obtaining Unlimited Working Projections and Virtual Endoscopic Views During Endovascular Procedures

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Purpose: Ideal working views during endovascular procedures are often suboptimal because of limitations in gantry positioning. This work assesses a novel image reconstruction algorithm that uses a vascular volume and biplane fluoroscopic images to create virtual endoscopic and unlimited virtual fluoroscopic views of catheters and devices without gantry movement.

Methods: For the reconstruction of these virtual views the centerline of a device is extracted from simultaneous biplane fluoroscopic images. The algorithm then correlates the two centerlines by finding the corresponding point of each point along the device in the opposing plane. This allows for a point by point reconstruction of the three dimensional shape. Repeated application of the algorithm on every time frame enables the rendering of virtual endoscopic views or projections from arbitrary view angles. The operator is presented with standard fluoroscopic working views acquired by the angiography system as well as virtual working views and virtual endoscopic views with the catheters and devices to aid in maneuvering and positioning in difficult vasculature.

Results: Data obtained from vascular phantoms allowed creation of virtual endoluminal visualization of vascular anatomy and devices as well as for creation of virtual fluoroscopic views from any desired angle without gantry movement. Initial human cases, in a variety of cerebrovascular pathologies and treatments, demonstrated the feasibility of visualizing virtual 2D and endoscopic device movement and vascular anatomy at any desired angle without gantry movement. Error between device position derived from Omniplane Fluoroscopy and actual 3D position was less than 1 mm.

Conclusion: 4D Omniplane Fluoroscopy shows promise as a modality that will enhance the visualization and understanding of device movement and placement in complex cerebrovascular cases.
Flow diversion enhanced by finite element modeling of cerebral aneurysms

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Purpose: Deployment of flow diverting stents can be complicated by patient specific factors, such as vessel tortuosity, position of branch vessels and stent intrinsic factors. We present a novel computational paradigm based on finite element modeling to simulate patient-specific cerebral aneurysm treatments.

Materials and Methods: Finite element (FE) computational models of the pipeline embolization device (PED) were modeled using micro CT. Validation of the approach was performed using mechanical tests and both bench-top and clinical deployments in patient anatomies. Simulated deployments and fluid dynamics were then validated against physical deployments and flow measurements in anatomical urethane models.

Results: We carried out deployments and simulations in 11 patients. Deployment simulations were found to correctly predict regions where the physical device stenosed and poorly apposed to the vessel wall to within 11% of the actual deployment. Figure 1 demonstrates an example of a deployment.

Conclusions: Finite element modeling based simulations have the potential of allowing the surgeon to study device placement and optimise stent size and deployment zones to improve patient outcomes.

Efficacy of high-resolution cone-beam CT in the evaluation and detection of dural AVF

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Purpose: Currently, higher spatial resolution imaging can be obtained with cone-beam CT (CBCT) and it provides the precise localization of the shunt as well as the angioarchitecture of DAVF. We retrospectively analyzed location of shunt point and angioarchitecture with CBCT based on 16 cases of DAVF and evaluated the efficacy of this radiological modality.

Methods: Consecutive 16 patients who underwent embolization were performed high resolution CBCT to identify the exact shunt point as well as the terminal feeding arteries and initial exit venous drainage system. CBCT was undertaken using a flatpanel detector biplane angiography unit (Allura Clarity FD20/20; Philips Medical Systems) based on motorized rotational angiography acquisition. All CBCT images were reconstructed with a 512 cubic matrix centered about the expected shunt lesion and optimized to visualize the microscopic terminal feeders and initial exit venous drainage system. Superselective angiography was applied to confirm the shunt point and draining system.

Results: The location of DAVF were 8 cases of carotid cavernous, 5 cases of transverse-sigmoid, 1 case of tentorial, 1 case of olfactory groove and 1 case anterior condylar confluence. In all cases, the angioarchitecture surround the shunt point could be depicted identically and these findings were well corresponded to the superselective angiography.

Conclusion: High resolution CBCT is feasible for the detection and identification of shunt point as well as associated angioarchitecture in the treatment of DAVF. This modality is quite effective as the navigator to make the strategy of embolization especially for the complex sinus architecture like a carotid cavernous DAVF.

Reference


Are current classification systems of aneurysms treated by flow diversion sufficient? A proposal for a grading system based on cross-sectional imaging

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Purpose: To evaluate the current grading schemes for the evaluation of intracranial aneurysms (IA) treated by flow diverters (FD, Grunwald et al. 2012, Kamran et al. 2011, O’KELLY et al. 2011) and to propose a new grading system based on cross-sectional imaging (Arat & Kaya 2015).

Methods: Our database was assessed for imaging studies (including cerebral angiograms, cerebral CTAs and MRAs) obtained during follow-up of IAs treated with FD. The points where current classification systems fail to inadequately define treated aneurysms were noted.

Results: The following were identified as pitfalls: a) Failure to define status of side branch when FD is placed across major arterial bifurcations b) Inability to account for IAs which enlarge or become symptomatic (e.g. develop edema or rupture) inspite of a “negative DSA” showing no
intra-aneurysmal filling c) Less than ideal ability to predict aneurysms that are clearly excluded from arterial circulation or those that are prone to be excluded. These pitfalls were overcome by classifying the morphologic outcome based on the size of the aneurysm, occlusion of the aneurysmal sac and status of major side branches when jailed by an FD (in addition to the parent artery) on cross-sectional imaging. Conclusion: The proposed classification for the evaluation of aneurysms treated by FD is able to overcome drawbacks of the currently used systems.

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The efficacy of a novel metal artifact reduction software applied in C-arm cone-beam CT imaging for patients with intracranial aneurysms

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Purpose: C-arm cone-beam CT (CBCT) offers rapid examination of intraprocedural complications in the endovascular suite, however, it has the critical problem that artifacts caused by implanted metal objects degrade the images. We evaluated the CBCT image quality changes by the use of a novel metal artifact reduction software (MAR), provided by the vendor of our C-arm system, in patients with intracranial aneurysms treated with coils or clips.

Materials and Methods: The uncorrected- and MAR-corrected-CBCT image datasets were obtained from 22 patients with implanted coils or clips to treat intracranial aneurysms (17 patients; immediately following coiling, 5 patients; surveillance of previously performed surgical clipping). The images were evaluated by two expert physicians for the degree of metal artifacts present by using a 3-point scale. The experts also evaluated whether new information such as intracranial hemorrhage, air or surrounding anatomical structures was provided after application of MAR or not.

Results: The metal artifacts in the MAR corrected-CBCT images were significantly lower compared with uncorrected-CBCT image (p < 0.001). The additional information was obtained from 50.4% of patients after application of the MAR to the CBCT images.

Conclusion: The MAR software is effective to improve CBCT images degraded by metal artifacts. It provides us the possibility to rapidly detect intraprocedural complications, which might provide the needed information for judging about the necessity of an additional treatment without wasting time.

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4D Flow MRI Indicates Redistribution of Intracranial Hemodynamics During Staged Endovascular Embolization of Vein of Galen Aneurysmal Malformations

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Purpose: To investigate the feasibility of serial 4D flow MRI for the comprehensive in-vivo assessment of regional and global intracranial 4D (3D + time in the cardiac cycle) hemodynamic alterations in paediatric Vein of Galen aneurysmal malformations (VGAMs) patients treated by staged endovascular embolization.

Methods: Serial ECG-gated 4D flow MRI was performed in VGAM patients on 1.5/3 T scanners to measure in-vivo time-resolved 3D blood flow velocities with full 3D volumetric coverage of the cerebral VGAM vascular network. Blood flow patterns and velocity distribution within the intracranial vasculature were visualized using time-integrated 3D pathlines. Blood flow ratio between the PCA and ipsilateral MCA was calculated to evaluate the redistribution of blood flow across multiple embolization procedures.

Results: Twenty 4D flow MRI scans were performed in 6 paediatric VGAM patients (3f/3m, mean age ± SD (range) = 2.1 ± 4.0 years, (1 day-11.6 years)). Blood flow ratio between the PCA and ipsilateral MCA revealed considerable cerebral blood flow redistribution in both left and right hemispheres during serial embolization. Following embolization, blood flow dropped in both left (from 4.71 ± 2.23 mL/s to 2.22 ± 1.19 mL/s) and right (from 6.85 ± 5.91 mL/s to 2.26 ± 1.13 mL/s) PCAs by 52.9% and 67.0%, respectively, corresponding to an increase of blood flow in the left (from 2.27 ± 1.50 mL/s to 4.20 ± 2.25 mL/s) and right (from 2.12 ± 1.50 mL/s to 4.74 ± 2.37 mL/s) MCAs by 85.0% and 123.6%, respectively. Initial ipsilateral PCA/
MCA flow ratios were asymmetric and markedly decreased in the left (LPCA/LMCA: from 1.82 ± 0.92 to 0.54 ± 0.32) and right (RPoCA/RMCA: from 6.58 ± 8.58 to 0.55 ± 0.11) vascular territories by 70.3% and 91.6%, respectively.

Conclusion: We demonstrated the potential of serial 4D flow MRI for quantitative measurement of intracranial hemodynamic alterations in paediatric VGAM patients treated by staged endovascular embolization. In addition to anatomic shrinkage of the VGAM lesions, we were able to identify the remarkable intracranial blood flow redistribution following endovascular treatment.

Evaluation of a fast 3D rotational angiography in patients with intracranial aneurysms—radiation dose and image quality compared to the standard 3D rotational angiography protocol

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Purpose: 3D rotational angiography (3D RA) is a useful tool in the work-up of intracranial aneurysms. Even if radiation dose is in the range of a 2D-DSA series, efforts should be made to save dose and contrast material (CM). In this study, a new 3D RA protocol to reduce both was evaluated.

Methods: 3D RAs were performed on an Artis zeego (Siemens Healthcare GmbH, Germany). Differing parameters between the new and the standard protocol were rotation time (3 s vs. 5 s), number of projections per rotation (67 vs. 133) and tube current (340 mA vs. 370 mA). For both protocols, voltage was 70 kV. Dose area products (DAP) and volume of CM were documented and compared to the standard protocol. Two experienced neuroradiologists blinded to the used protocol evaluated the 3D RAs after anonymization in a random order for image quality and visualization of the target lesion on a four-point scale.

Results: Thirty patients with thirty-five aneurysms had a 3D RA following the new protocol. Twenty-eight of these patients also had thirty standard 3D RAs at different time points during follow-up. Mean DAP with the new protocol was 1104,22 (±143,96) µGym² and 2219,64 (±303,48) µGym² with the standard protocol, which is equivalent to a reduction by approximately 50%. Average volume of CM was 8,1±1,8) ml for the new protocol, as compared to 20 ml with the standard protocol. Both readers judged the image quality and the visualization of the target lesions of all 3D DSAs as good or excellent in all cases. Interobserver agreement was near perfect for both protocols.

Conclusion: With the new protocol, radiation dose and the amount of contrast material can be reduced by 50% and 60% respectively without loss of information concerning the target lesion.
Conclusion: High-resolution angiographic Volume-of-Interest-CT (VOI-CT) of flow diverters with a flat detector CT using a truncation robust algorithm – radiation dose and image quality compared to standard angiographic flat detector CT

Purpose: Flat detector CT after intravenous contrast injection offers high spatial and contrast resolution, which makes it a useful tool in the evaluation of flow diverters (FD) during deployment and for follow-up. However, radiation dose is substantial and assessment of the lumen may be impaired especially due to motion artefacts. With smaller scan volumes dose can be reduced, but additional artefacts due to data truncation might impair visualization of the implant. We evaluated the impact of a very small scan volume (VOI-CT) on radiation dose and artefacts.

Methods: All examinations were performed on an Artis Q (Siemens Healthcare GmbH, Forchheim, Germany). For VOI-CT a detector area of 11.7x11.7 cm² was used, equivalent to a field of view reduction of 43% compared to the standard protocol of our institution. Images were reconstructed with a truncation robust algorithm. All other parameters were identical (rotation time 20 s, rotation angle 200°, angulation step 0.4°, tube voltage 70 kV, tube current 300 mA, no binning, matrix 1024x1024, 60 ml intravenous contrast material at 5 ml/s). Dose area products (DAP) were documented and compared. Two neuroradiologists blinded to the acquisition protocol evaluated the examinations after anonymization in a random order regarding image quality, artefacts, wall apposition, presence of intimal hyperplasia and aneurysm status.

Results: Seventeen patients with 18 FD (anterior circulation 14, posterior circulation 4) had examinations with both protocols at different time points. Mean DAP was approximately 42% lower with the VOI-protocol. Artefacts in VOI-CT were more pronounced only outside the circular VOI, thus this did not impair the evaluation of the implant. No differences between the protocols were found regarding image quality, wall apposition, presence of intimal hyperplasia and aneurysm status. Interobserver reliability was near perfect.

Conclusion: VOI-Imaging of intravascular implants such as FD is feasible. Radiation dose can be saved without loss of information.

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Usefulness of DynaCT in the endovascular treatment of direct carotid-cavernous fistula

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Purpose: The optimal treatment of direct carotid-cavernous fistula (CCF) is exclusion of the fistula from the circulation while preserving the patency of the ICA. But the most of time, because of the high blood flow shunts, we cannot get a clear imaging of fistula by conventional radiology. We use DynaCT to visualize anatomy of CCF by DynaCT, and determine the treatment strategy.
Methods: From January 1st 2014 to June 30th 2014, eight patients underwent Dilute contrast enhanced DynaCT before transarterial or transvenous obliteration of the fistula. Results: After the reconstruction of DynaCT at the workstation, we can get the images such as multiple 3D volume types and CT-like cross-sectional slices that are similar to a CT angiogram in the sagittal, coronal, axial, and section in any other angle. These helped to analyze the anatomical structure and make the treatment strategy. All the patients with high-flow CCF were successfully treated and got good outcomes. The fistulas were not visualized in postoperative angiograms. Three cases were coil embolization, two were Onyx embolization, and the other three were embolized with both of the two materials. None of them have showed recurrence of the symptoms during the clinical follow-up. Conclusion: The DynaCT can provide detailed information for the CCF treatment strategy. It is very beneficial for the pre-procedure and postprocedure evaluation.

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“Selfie” video recording system designed for neuro-endovascular education

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Purpose: Selfie video recording is useful in skill upgrading for baseball, golf and so on. Same might apply to training of endovascular interventions. However, only fluoroscopy and runs are recorded in usual angiography video recording systems. Unlike angiography rooms, operating rooms usually equip ceil mounted camcorder. When our hospital recently installed an angiography unit into an operating room, we designed a new video-recording system in which “selfie” hand motions and fluoroscopic images were laid out into a single picture. Here, initial experiences are presented.

Methods: Single plane angiography unit with a 60-inch large flat display (Flexion, Philips Medical Systems) was installed in our operating room. All the media sources in the operating room such as live fluoroscopy, 3D-RA, vital sensors, microphone and ceiling mounted camcorders were connected to a video switcher. This video switcher laid out up to 8 video images into one big image, which was transferred to the large display and the professional-use blue-ray recorder. The recording was continuous during procedures in our system.

Using this system, 24 interventional procedures were recorded and evaluated by an attending doctor and three trainees.

Results: The trainees put a high value to the point that the recording included 1. preparation of the devices, 2. the shape of steam-shaped microwaters, 3. verbal coaching. The trainees put a low value to the point that much more time was required to edit the blue-ray than the DVD.

The attending doctor found that his hand movements during NBCA injections were ruder than expected. The attending could teach how to manipulate catheters showing the differences in between the attending and the trainees using the recordings.

The recorded video looked as if live demonstration.

Conclusion: Our “selfie” video recording system was useful for skill upgrading of both trainees and attendings.

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Endovascular Occlusion of Intracranial Vessels using NBCA Embolization, Controlled by Adenosine Induced Asystole

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Purpose: To evaluate the efficacy and safety of adenosine induced asystole during the intra-arterial injection of NBCA, aiming at controlled endovascular occlusion of intracranial vessels.

Methods: A retrospective analysis of patient files and procedure documentations was performed. Between August 2010 and July 2014, adenosine induced asystole was applied in 29 consecutive procedures, performed in 24 patients (12 female). A total of 21 AVMs, 4 dural AV fistulas, three intracranial aneurysms and one arterial vessel injury were treated. The procedures were evaluated according to the following criteria: 1) was asystole achieved? 2) was the NBCA injection sufficiently controlled? 3) was a complication of the adenosine injection encountered? 4) did the NBCA embolization cause adverse effects, related to venous passage or arterial displacement?.

Results: Asystole was induced in all 29 attempts. The injection and propagation of NBCA was well controlled in all procedures. All patients returned spontaneously to rhythmic cardiac action, without any circulatory issues. No complication related to venous passage or distal arterial migration of NBCA was observed.

Conclusions: Adenosine induced asystole per se is safe. In high-flow arteriovenous shunts and in rare arterial embo- lizations (e.g., dissecting aneurysm occlusion), NBCA injection is well controlled if performed under cardiac arrest.
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Stentectomy: Retrieval of stents after stent assisted coiling

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Purpose: We share our experience in the retrieval of self-expanding stents placed for the treatment of aneurysms.

Methods: Since January 2007, we treated 2731 aneurysms by endovascular approach in our institution with placement of a stent in 1156 procedures. A stentectomy was attempted in 20 patients in whom 28 stents had been delivered. Stentectomy was attempted because of stent thrombosis, misplacement or lack of expansion. The stentectomy was achieved either with a microsnare or a stentriever used in isolation or in combination.

Results: 26 out of 28 stents could be retrieved.

Conclusion: The specifications of the various techniques with their respective complications and efficiency rates are demonstrated.

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T, Half T and extended Half T stenting in bifurcation aneurysms

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Purpose: The development of double lumen remodeling balloons (Scepter XC and Eclipse 2L) and of small self-expandable microstents (Baby Leo and Lvis Junior) that can be inserted through these balloons enables a new approach in the placement of stents.

Methods: We have been using the stent through balloon technique in 411 procedures out of 1192 endovascular treatments for aneurysms since January 2012 in our department. We describe the T stenting, half T and extended half T stenting in bifurcation aneurysms, that were achieved in 58 procedures (T stenting) and 120 procedures (Half T and extended Half T stenting).

Results: The technical specifications of each technique, clinical results and complications are demonstrated.

Conclusion: Half T is preferable as T stenting carries a higher risk of stent thrombosis.

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Direct Carotid-Cavernous Sinus Fistulae can be treated with Flow Diverters

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Purpose: We evaluated the safety and efficacy of flow diverting implants (FD) for the endovascular treatment of direct carotid-cavernous sinus fistulae (CCF).

Methods: 11 consecutive patients with direct CCF (8 women, 3 men, median age 65 years at the time of the diagnosis) underwent endovascular treatment, which involved the use of FD, in a single center. As FD, either Pipeline or p64 or a combination thereof was used. Technical details, safety and efficacy aspects were evaluated in retrospect.

Results: The number of treatment sessions varied between 1 and 3 (median 1.5 sessions). In 7 out of 10 patients, coils were inserted into the cavernous sinus in addition. The number of FD deployed per patient was 4, 3, 1, 10, 2, 6, 3, 2, 8, 1 and 6. No periprocedural complications were encountered. No CCF was occluded immediately after the treatment. The first follow-up DSA after the last treatment session after 2.2 months (median) confirmed the occlusion of the CCF with a patent ICA in 5 patients. Two ICAs were occluded together with the CCF, which was in both patients related to inconsistencies in the dual platelet function inhibition. ICA occlusion remained asymptomatic in both patients. A mid-term follow-up DSA after 21.5 months (median) in 11 patients confirmed both the fistula occlusion and the patent ICA in all 9 remaining patients.

Conclusion: The perfect device for the treatment of direct CCFs would probably be a self-expanding stent graft. Balloon expandable stent-grafts are too rigid. FDs are a potential alternative. A direct CCF can be reliably occluded using FDs, however, the treatment costs are high, a latency period between treatment and occlusion of the fistula of several weeks has to be expected and the patients need a continuous (dual?) antiplatelet function inhibition.

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Flow diverting characteristics of LVIS Jr stents to treat cerebral aneurysms

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Purpose: Flow diverting stents have established a role in aneurysm treatment; however, there is concern for branch vessel occlusion in certain regions, particularly perforator-rich zones. The technique of intraluminal, extrasaccular
aneurysm treatment has been achievable in our practice with the braided LVIS Jr stents (Microvention Inc, Tustin CA, USA). While we have utilized stent-within-a-stent and Y-stenting techniques for flow diversion previously with other aneurysm bridging stents, we feel that the LVIS Jr provides improved flow diversion and aneurysm bridging without compromise of branch vessels. The small microcatheters used for delivery provide a huge advantage in difficult anatomy. The risk to perforator-rich territories and the problem with access through the wall of the flow diverting stents may be mitigated with less aggressive flow diversion provided by braided stents with intermediate porosity compared to both classic stents and flow diverters.

**Methods:** In the treatment of recent aneurysms, we have overlapped and Y-stented with LVIS Jr stents to both bridge the aneurysm neck and achieve flow diversion. We have deployed the stents through both Headway 17 and Headway Duobead Microcatheters (Microvention Inc), allowing both stent and coil deployment through the same microcatheter.

**Results:** Two refractory recurrent anterior communicating artery aneurysms (1 large and 1 giant) were treated with multiple overlapping LVIS Jr stents. Two basilar apex aneurysms were treated with LVIS Jr constructs including Y-stenting. After stent placement, the flow diverting properties of the LVIS Jr constructs left contrast layering in the aneurysm dome, consistent with the "parfait sign" observed with designated flow diverting stents.

**Conclusion:** Follow-up imaging (MRI/A and angiography) has shown no perforator occlusion and complete occlusion of the aneurysms.

**159 Presentation withdrawn**

**LVIS Jr ‘shelf’ technique– an alternative to Y stent**

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**Purpose:** Y stent has been used for wide neck bifurcation intracranial aneurysms particularly when both branch arteries are incorporated into the aneurysm dome or neck. With the advent of braided stent like LVIS Jr, these stent can potentially be used with the pull and push technique to create a ‘shelf’ at the neck of the aneurysm that can obviate the need for Y stents. The purpose of our study is to describe this ‘shelf’ technique with LVIS Jr stents in wide neck intracranial aneurysms.

**Method:** We retrospectively reviewed our prospectively maintained interventional neuroradiology database for use of LVIS Jr stents. We assessed the aneurysms for their size, neck diameter and location. We used the ‘shelf’ technique in all but one of these patients. We assessed the immediate post-coiling results of these aneurysms. We assessed the perioperative mortality and morbidity and short term follow up of these patients.

**Results:** We have total of 7 patients (5 Female and 2 Male; mean age- 55 yrs) with 1 ruptured, 2 previously ruptured and 4 un-ruptured aneurysms located at anterior communicating (2), Basilar tip (3), parapophysal (1) and internal carotid termination (1). The average diameter of the aneurysm was 7.5 mm (range-3–12 mm). All of these aneurysms were wide neck aneurysm with average diameter of the neck was 5.4 mm (range 3–8 mm) and average dome to neck ratio was 1.4 (range 1–1.8). One patient had an in-stent thrombosis which dissolved with use of Reopro. One patient needed another stent to jail a stretched coil. None of these resulted in any clinical morbidity or mortality.

**Conclusion:** Our small study shows that LVIS Jr ‘shelf’ technique is safe and can obviate the need of Y stent in wide neck intracranial aneurysms.

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**Spectrum and frequency of complications from the usage of flow diverters (PED and p64)**

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**Purpose:** Flow diverters became an important tool within the neuroendovascular armamentarium. We analyzed in retrospect the spectrum and frequency of complications associated with the use of Pipeline and p64.

**Methods:** Since 9/2009 a total of 653 consecutive procedures (PED: 232, p64:421) in 552 patients were evaluated. Target lesions included 346 saccular aneurysms, 200 fusiform aneurysms, 70 dissections, 11 CCF, 26 acute vessel occlusions. Evaluation was performed procedure- and case-wise.

**Results:** No complication was encountered in 573 procedures. Any complication occurred in 78 procedures (12%). Manifestation was within 24 hrs after the procedure in 26 (4%, periprocedural), within 30 days in 14 (2%, postprocedural) and after 30 days in 38 (6%, during follow-up) procedures. Of 26 periprocedural complications, 13 were ischemic, 2 hemorrhagic and 11 of any other kind. In the postprocedural phase, 10 ischemic and 4 hemorrhagic complications occurred. Beyond 30 days, 21 ischemic, 4 hemorrhagic and 13 other complications were registered.

**Conclusion:** Severe complications directly related to the use of PED or p64 occur infrequently. Management complications are often related to the general circumstances, not to the device per se. Ischemic complications illustrate the need for flow diverters with improved hemocompatibility.
Evaluation of occlusion rate of aneurysms treated by Flow Diversion Stenting in patients under double anti-aggregation therapy

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Purpose: To evaluate the rate of occlusion in a consecutive series of 150 aneurysms treated by Flow Diversion Stenting in 118 patients under double anti-aggregation therapy.

Methods: The aneurysms were located in the anterior circulation in 90% of cases and in the posterior circulation in 10%. All patients were under double anti-aggregation therapy (Aspirin and clopidogrel in most of cases). Stent used were PED/PED flex stents in 54 aneurysms, Surpass/Streamline stents in 39, p64 stents in 29, Silk stents in 25 and Fred stents in 3.

Angiographic studies were performed the day after the Flow Diverter Stenting procedure and at 3–6 month follow-up before stopping the clopidogrel or the ticagrelor therapy. The modifications of the parent artery, especially regarding the intimal hyperplasia, were also evaluated. The rate of occlusion were compared to that observed at 1 year follow-up and/or at an intermediate MR or angiographic follow-up when available.

Results: Results are still under analysis. Intermediate results seem to show that double anti-aggregation therapy does not significantly affect the aneurysm occlusion process especially in large/giant lesions.

Conclusion: Double anti-aggregation therapy is mandatory in the management of patients with aneurysms treated by a Flow Diverter Stent, however the pharmacological therapy does not seem to affect significantly the aneurysm occlusion.

WEB assisted embolisation in the acutely ruptured aneurysm

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Purpose: The WEB (Sequent Medical) is a novel intrasaccular device for the endovascular treatment of intracranial aneurysms. It allows for treatment of wide necked aneurysms without the need of placing stents, eliminating the use of dual antiplatelet therapy. This is especially important in the treatment of the ruptured aneurysm. So far, since stock is still limited, the WEB has been used for the treatment of the unruptured aneurysm. By working together closely with the local representative we have managed to treat ruptured aneurysms. We evaluate safety and efficacy of WEB assisted coiling in patients with SAH.

Methods: Between February and May 2015, 17 ruptured wide necked aneurysms were treated with the WEB device. Aneurysms were treated both with the .027 and with the lower aspect .021 system. The latter has been available as of March. At this rate, by the time of presenting at WFITN, we estimate that 45 aneurysms will have been treated and have three month angiographic follow up available. Procedural complications, rebleeds, occlusion rates and clinical outcome will be evaluated.

Results: At this time results are not complete. It was technically possible to place the web device in all aneurysms. The lower aspect 0.21 system can be easily navigated into tortuous vessels. 1 of 17 aneurysms had a small neck remnant. So far, no rebleeds were recorded. 2 of 17 patients had thromboembolic complications. 1 patient developed infarction.

Conclusion: Data collection is still ongoing. By the time of presentation at WFITN a group of 45 treated ruptured aneurysms with angiographic and clinical follow up will be available. In ruptured aneurysms, alternative therapies without the need for antiplatelet medication such as surgery, balloon-assisted coiling or WEB-device should be encouraged. The WEB device could reduce the number of aneurysms treated by surgery.

The use of the WEB device in acutely ruptured aneurysms. Early experience and safety outcomes

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Purpose: To assess the safety of the WEB device in treating acutely ruptured cerebral aneurysms.

Methods: We retrospectively analysed 25 patients treated with the WEB device In the acute setting looking at demographics, SAH grade, procedural complications and early safety outcomes.

Results: In our series the WEB device has comparable outcome to the current treatment methods in terms of safety and periprocedural complications with good early follow-up results. This is particularly the case in an otherwise difficult, wide neck, cohort of aneurysms that usually require adjunctive methods of treatment such as balloons or stents.

Conclusion: The WEB embolisation device can be safely used in acutely ruptured aneurysms.

The use of the Pipeline embolisation device in complex cerebral aneurysms. Early experience and safety outcomes

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Purpose: To assess the safety of the Pipeline Flex embolisation device (PED) with shield technology in treating complex cerebral aneurysms.
Flow diverter devices in treatment of unruptured complex and wide neck intracranial aneurysms

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Purpose: Endovascular treatment of complex, wide necked and fusiform aneurysms by redirecting blood flow is a novel and promising treatment option. The redirection is based on a significantly densely braided mesh tube in comparison to conventional stents. Dense meshes of the wall keep the blood inside of the device and on the other hand significantly reduce the blood flow into the aneurysm. Stagnation of blood inside the aneurysm sac promotes thrombus formation and subsequent occlusion of the aneurysm.

Methods: Twenty-one subsequent patients with randomly detected, enencrypted complex and wide necked aneurysms of the ophthalmic and communicating segment of internal carotid artery and M1 segment of middle cerebral artery were treated. The majority of patients were treated using a Pipeline flowdiverter device (PED) and in last year also with flow redirection endoluminal device (FRED), which were placed over the aneurysm neck. Treatment success was assessed clinically and with angiography using O’Kelly Marotta scale (OKM), respectively.

Results: Control angiography immediately after the release of the devices showed stagnation of the blood flow in the aneurysm sac. We did not observe any procedural clinical and technical complications. Six and twelve months follow-up digital subtraction angiography and MR angiography, showed occlusion of the aneurysms, except in one case and normal blood flow in the treated artery. There were no in stent thrombosis and delayed aneurysmal ruptures. Neurological status six months after the procedure was normal in all patients.

Conclusion: Treatment of aneurysms with flow diverter device is a safe and significantly less time consuming method in comparison to standard stent assisted coiling techniques. This method is a promising approach in treatment of complex, giant, wide necked, fusiform and also blister type aneurysms. It is also very useful in treatment of remnants of aneurysms after surgical clipping.

The FRED flow-diverter device for treatment of cerebral aneurysms: preliminary results of a prospective study of 43 consecutive patients

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Purpose: Endovascular flow-diverting devices are increasingly used for treatment of various types of cerebral aneurysms. We assessed safety and efficacy of the Flow-Redirection Endoluminal Device (FRED) in a consecutive group of patients.

Materials and Methods: A consecutive series of 43 patients harbouring 44 aneurysms were treated with 47 FREDs between 01/2014 and 01/2015; 17 patients underwent combined treatment with FRED and coils. Treatment criteria were wide-neck, giant or fusiform/dissecting aneurysms. Aneurysm size was between 1.5 and 18.5 millimeters. End-points were successful deployment, aneurysm occlusion, bleeding, major ischemic stroke or death. Occlusion rate was assessed at three months with flat detector computed tomography with intravenous contrast application and at six months with digital subtraction angiography using the Raymond classification (RMR) and O’Kelly-Marotta scale (OKM), respectively.

Results: FRED deployment was successful in all cases. There was one microwire-associated hemorrhage and nine cases with punctual ischemic lesions detected with diffusion-weighted imaging, each of them without neurological consequences. There were no late complications so far, no treatment-related mortality. Preliminary follow-up at three months in 31/44 cases showed an overall complete occlusion (RMR 1) of 75%. Complete occlusion was achieved in 16/22 (73%) FRED-only cases and in 8/9 (89%) cases with combined treatment. Six months follow-up with angiography in 24/44 cases revealed total and remnant-neck occlusion (RMR 1/2) in 18 (88%) of overall cases. Thereby RMR 1/2 was achieved in 12/14 (86%) FRED-only cases and in 9/10 (90%) cases with combined FRED and coil treatment.

Conclusion: FRED is a safe and easy-to-deploy device for cerebral aneurysms. Occlusion rates are within the range of other flow diverters.
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Novel dual lumen catheter for placement and angioplasty of flow diverters

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Purpose: Flow diverting (FD) stents are frequently used for treatment of complex intracranial aneurysms. Following deployment of FD stents, a balloon angioplasty is sometimes a requisite, to open the FD stent to optimal dimensions, so as to appose the internal arterial lumina.

Methods: We present our case series, where we have used a new double lumen Copernic 2 L microcatheter (BALT Extrusion, Montmorency, France). This is an intuitive microcatheter, in allowing deployment of the FD stent as well as subsequent balloon angioplasty, in order to attain maximal innate memory of the stent.

Results: This is achieved without losing position of the microwire and having to re-pass the deployed stent, thus simplifying the process for balloon angioplasty.

Conclusion: We suggest that Copernic 2 L is a useful adjunct in cases of complex intracranial aneurysms and FD stents, where balloon angioplasty is felt necessary for optimal positioning of the stent.

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The DERIVO Flow Diverter Stent in the Treatment of Intracranial Aneurysms

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Purpose: In this study, we evaluate the safety and efficacy of the DERIVO, a new flow diverter stent, in the treatment of intracranial aneurysms and present the short-term results.

Methods: We treated 22 aneurysms using 16 devices in 14 patients with wide-necked, fusiform, blister-like, or giant aneurysms. Of the patients included in the study, 8 were females and the other 6 were males. Their ages were between 32 and 77 years (mean: 53.1). Only one of the aneurysms had ruptured. This patient had two paraphthalmic aneurysms, the larger of which was ruptured. The aneurysms were coiled in the acute stage and treated with a DERIVO stent 3 months later. Twelve aneurysms were coiled before the DERIVO implantation. The first two follow-up angiograms were planned for 3 and 9 months later.

Results: In all patients, the treatment was successful. While in one patient, two DERIVO stents were used for one aneurysm due to the stent’s fish-mouthed formation, in another patient with two aneurysms in either side, two DERIVO stents were implanted. All patients were discharged without any neurological deficit. A patient with a posterior communicating artery aneurysm treated with coil and DERIVO was admitted 4 days later due to a right side hemiplegia and aphasia. The patient had stent occlusion caused by thrombosis and treated with thrombectomy and IA tPA. In five patients, 3-month follow-up angiograms were performed and the aneurysms of all were totally closed but one. Periprocedural morbidity and mortality were zero. The 30-day major stroke rate and general mortality were both 7.1%. During presentation, all patients’ 3-month follow-up angiograms will have been performed and their results will be presented.

Conclusion: The flow diverter DERIVO stent is as effective as other flow diverter stents in the treatment of intracranial wide-necked, fusiform, blister-like, and giant aneurysms.

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Low profile braided “Baby Leo” stents in coiling of wide-necked distal intracranial aneurysms – Initial experience in 21 cases

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Purpose: Treatment of wide necked intracranial aneurysms is technically challenging and there is an increasing trend for the use of stent assisted embolization in such cases (Wanke I et al., 2008, Piotin M et al., 2010, H Nishido et al., 2014). The purpose of this study was to determine the ease of use, safety profile and effectiveness of the “Baby Leo” [BALT] stent in the treatment of wide necked distal intracranial aneurysms. We report a case series of 21 consecutive cases from a single neurosciences centre in the United Kingdom.

Methods: We performed a retrospective study of 21 consecutive cases in which the “Baby Leo” stent was used for stent-assisted coil embolization of intracranial aneurysms in our centre from March 2014 to June 2015. Clinical, angiographic data as well as the available mid-term clinical and imaging follow-up records were assessed for intra/peri-procedural complications and aneurysm recurrence.

Results: The median age of the patients treated was 58 years (range 46–75) and 17 (80.9%) were women. There were no acutely ruptured aneurysms. 18/21 aneurysms had no previous treatment and 3 cases were of neck remnants in patients with previous SAH. There were 18 Anterior circulation aneurysms- 10 Anterior communicating artery (ACOM) and 8 middle cerebral artery (MCA) aneurysms; and 3 posterior circulation aneurysms. Median size of aneurysm treated was 6 mm. Only a single stent was used in all the cases.
Stent deployment was possible in 19/21 (90.47%) cases. In 2 cases the stent was retrieved after “stent jacking” as it did not open completely. 2 cases of intraprocedural clot formation were noted which were treated successfully with Reopro (Abciximab). There were no mortalities, 1 case of procedure related hemiparesis (which fully recovered within 24 hours) and 1 groin pseudoaneurysm which required thrombin injection. All patients were neurologically intact and independent at discharge.

3 month clinic review and 6 month MRA data is available in 15 patients. All patients remain well with no new neurological events. Coil compaction was noted in 3 cases (2 with small \((\leq 2 \text{ mm})\) remnants managed conservatively and 1 requiring recoiling).

**Conclusion:** “Baby Leo” stents are safe, effective and enable us to treat intracranial distal aneurysms due to their lower profile, with acceptable mid-term results.

**References**


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**Tubridge flow diverting device for the treatment of large or giant intracranial aneurysms: a single center mid-term and long-term follow up result**

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**Purpose:** Tubridge Flow Diverter is a novel flow diverting device developed in China, previous study had demonstrated excellent short-term result. We conducted this study to evaluate its mid-term and long term safety and efficacy for the treatment of large or giant internal carotid artery aneurysms.

**Methods:** During a period of 4 years, 63 patients with 63 large or giant or giant aneurysms were treated with Tubridge flow diverters in our institution. We prospectively collected and analyzed clinical and angiographic data of these patients.

**Result:** A total of 74 Tubridge flow diverters were successfully implanted except for one poor mid-stent opening, which resulted in a technical success rate of 98.6%(73/74).

Peri-procedure ischemic complications occurred in one of them, which resulted in mild weakness of limbs. At least one follow-up angiography was available for 55 aneurysms of them. Overall complete occlusion rate was 70.9%. 30 patients harbored angiographies beyond 12 months(12–48 m, mean 21 m). of them, 26(86.7%) aneurysms were completely occluded, 2 were improved, 1 was stable, and one was recanalized. All of the visible covered branches and parent arteries were patent with no stenosis or obliteration. During a follow-up period ranging from 20 to 54 months, no ischemic or hemorrhagic complications occurred.

**Conclusion:** Our mid-term and long-term follow up result shows that Tubridge flow diverter is a safe and effective tool for treating large and giant internal carotid artery aneurysms. And the result improves with the time.

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**The effect of experience on intra- and peri-procedural complication rates in the treatment of intracranial aneurysms with SILK stents: an analysis of 92 cases in five years**

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**Purpose:** Treatment of intracranial aneurysms with flow-diverters including SILK stent is technically challenging. In this study, we investigated if there was a decrease in our rate of procedure-related complications with time and experience.

**Methods:** Patients with intracranial aneurysms treated with SILK stents between April 2010 and May 2015 were divided in two cohorts and compared retrospectively for intra- and peri-procedural complications such as stent foreshortening, in-stent thrombosis, vessel perforation, aneurysmal bleeding, failure to obtain optimal stent apposition, failure to obtain optimal stent apposition.

**Results:** Ninety-two procedures were included in the study. The first group was consisted of first 46 procedures whereas the second group represented the last 46 procedures. Total number of complications was 18 (19%). Both group have the same number of complications, i.e. 9 in each cohort. The comparison of complications between two groups was as follows: failure to obtain optimal stent apposition 4 and 2, in-stent thrombosis 4 and 2, stent foreshortening 0 and 3, vessel perforation 0 and 1, dissection 1 and 0, aneurysmal bleeding 0 and 1; respectively. The complications in the first group resulted in minor morbidities in 2 patients, but no mortality. The complications in the second group caused one mortality and one major morbidity.

**Conclusion:** Our expectation was that the complication rate would be found lower in second group. However, the
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Rescue angioplasty or salvage “telescopic” stenting is not always necessary in cases of ineffective stent expansion of low profile braided stents

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Purpose: There is an increasing move towards using stent assisted coiling for the treatment of intracranial aneurysms to ensure long term stability of the coiled aneurysm and reduce recanalization (Piotin M et al., 2010). Low profile braided “nitinol” stents have been recently introduced with an acceptable safety profile and mid-term results (K. Aydin et al., 2015, Turner R D et al., 2012). These stents are considered akin to “mini flow-divertors” by many operators with very similar risks of associated thrombo-embolic complications.

One of the inter-procedural complications encountered during stent deployment is inadequate stent apposition of the proximal portion of the stent after stent delivery. This is conventionally treated by either balloon angioplasty or by “telescoping” another “salvage” stent through the first stent (K. Aydin et al., 2015, Turner R D et al., 2012). Whilst these techniques may be possible in a large proportion of such cases, these salvage procedures also carry a risk of dislodging the stent into the aneurysm or inducing trauma to the vessels with inadvertent dissection or rupture of the vessels.

We describe a series of three patients treated with low profile braided stents, in which the complication of ineffective stent expansion and inadequate apposition of the proximal end of the stent was successfully managed using a conservative “wait and watch” policy with no peri-procedural clinical sequelae. Coiling of these aneurysms was completed in a second “interval” procedure.

Methods: A retrospective analysis of “low profile braided” stent assisted coiling cases performed in our unit from March 2014– June 2015 was made. 26 intracranial aneurysms were treated using “low profile braided” intracranial stents in our centre during this period. Inadequate stent expansion and apposition of the proximal portion of the stent was encountered in 3 out of the 26 cases.

Results: All 3 cases were of “wide necked”, unruptured anterior communicating aneurysms. Two of the three cases were treated with “baby Leo” [BALT] stent and one was treated with ELVIS junior [MICROVENTION] stent.

Inadequate stent expansion and apposition of the proximal portion of the stent was encountered during stent delivery in all three cases. However there was no associated flow compromise in the vessels. We adopted a conservative “wait and watch” policy in all the three cases as distal access across the stent was difficult. One of the aneurysms was partially coiled; the other two did not have any coiling performed in this instance. All these patients recovered without any neurological deficit.

Subsequent angiography in 6–12 months’ time showed complete expansion of the previously unexpanded portion of the stents with satisfactory stent apposition. We then proceeded to complete the coiling of these aneurysms. There were no procedure related complications with immediate satisfactory post embolization results. All these patients were discharged within 24–48 hours post embolization.

6-month follow up MRA is available for one of the patients which does not show any aneurysm recanalization. The mid-term MRA results on the other two patients are awaited.

Conclusion: Immediate rescue angioplasty or salvage “telescopic” stenting is not always necessary in cases of ineffective stent expansion/ inadequate apposition of the proximal stent portion, especially when re-accessing the distal vessel through the unexpanded stent is deemed difficult or hazardous. “Memory retention” is one of the intrinsic properties of “nitinol” (Ö. Krischek et al., 2011). Given time there is a possibility that these stents will achieve satisfactory expansion and apposition on their own. It is then possible to re-access the aneurysm through the stent struts without much difficulty and complete the coiling procedure.

References


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Single center experience with the Single Layer Woven Endbridge Device (WEB™ SL) in the treatment of ruptured intracranial aneurysms in 20 cases

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Purpose: Retrospective evaluation and safety of the acute treatment of ruptured intracranial aneurysm with the Single Layer Woven Endbridge Device (WEB™SL) in 20 consecutive cases.

Methods: From July 2014 20 ruptured intracranial aneurysms have been treated with the WEB™SL in our center. Decision for treatment with WEB™SL and sizing was done on basis of a 3D-rotational angiogram. Patients with Hunt and Hess grade from 1 to 4 were included. Aneurysm locations: 6 at PCOM, 4 at ACOM, 3 at basilar artery tip, 2 at SCA, 2 at MCA bifurcation, 1 pericallosal artery aneurysm, 1 peripheral PICA aneurysm and one at the carotid-T. All aneurysms have been treated during the first 24 h after SAH in general anesthesia.

Results: At the end of the treatment procedure 11 of 20 aneurysms showed complete occlusion in the without neck remnant, 6 showed residual inflow in the device itself but no contrast filling of the aneurysm, 2 aneurysms had a neck remnant with one of them having a dog ear. No obvious rupture or perforation of the treated aneurysms were noticed during the treatments though twice a contrast leakage was observed: one directly after placement of the device, the second during retrieval of the initially placed WEB™SL device which proved to be too big. In both cases immediate contrast stasis was obtained after final deployment of the WEB™SL. No thromboembolic complications were observed. Clinical and Imaging Follow up is ongoing and was not finished at submission deadline.

Conclusion: The acute treatment of ruptured intracranial aneurysm with the WEB™ SL seems to be feasible and safe in our single center case series, with the WEB™ SL providing a fast flow arrest inside the treated aneurysms.

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p64 Flow Modulation Device for treatment of intracranial aneurysms

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Methods: Between November 2014 and June 2015, twenty nine intracranial aneurysms and one dural arteriovenous fistula in thirty patients (twenty one women, nine man, average age: 58 (range 30 - 73) were treated with the p64 Flow Modulation Device.

Results: The primary technical success rate was 100% without using any adjunctive devices. Immediate post-treatment angiography showed reduced flow into 58% of aneurysms, complete occlusion of the aneurysm with fully patent parent artery was observed in 75% of patients who underwent a six months follow-up. No periprocedural or delayed aneurysm rupture was noticed even in four blister-like aneurysms treated in acute phase, no morbidity or death were seen in follow-up.

Conclusion: p64 Flow Modulation Device has greater neck coverage due to the 64 Nitinol wire braid which maximizes hemodynamic flow effect in the aneurysm. Complete deployment and recoverability ensures optimal and safe placement of the device.

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TICI Quantified: Proposed Semi automated Cerebral Revascularization Grading in Acute Ischemic stroke

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Purpose: Cerebral angiographic revascularization grading is the primary method for measuring the angiographic success of acute ischemic stroke (AIS) endovascular therapy and is one of the strongest predictors for clinical outcome. Of the many reported scales, the modified Treatment in Cerebral Ischemia (mTICI) scale is the preferred grading scale for assessment of revascularization. Currently, mTICI grading is based on visual crude estimations by the operator, which may introduce error and bias in to the evaluation. Here, we present an update on our on-going study to automate mTICI and provide a more accurate and precise grading tool: Quantified TICI (qTICI).

Methods: We have developed a data base of patients with an aplastic/hypoplastic anterior cerebral artery (ACA) in order to establish the standard average and predicted 100% qTICI for the isolated middle cerebral artery (MCA) territory. To map the MCA territory, a retrospective review of patients between the ages of 18-85 was performed from our Digital Subtraction Angiography (DSA) database at the Medical College of Wisconsin. All consecutive cases with aplastic/hypoplastic ACA (to minimize contaminating blood flow from the ACA territory) are included in this study. Existing Siemens software was used to estimate the territory of normal capillary blush and establish normal blood flow values in this database.

Result: We have identified 25 consecutive patients with aplastic/hypoplastic ACA between the ages of 18-85, from our DSA database. Six patients had completely aplastic A1 segments (A0), 11 had hypoplastic A1 segments (A1) and 7
had very small A1 segments (A2). To establish and automa-
tize the normal capillary blush of the isolated MCA territory, time versus region of interest contrast (ROI) intensity graph was used in both AP and lateral planes. The mean ROI area for AP plane is 6032 mm\(^2\) with a standard deviation of 1501 mm\(^2\) and the mean ROI area for lateral plane is 14623 mm\(^2\) with a standard deviation of 2876 mm\(^2\). Now that the normal capillary blush of the MCA territory has been computed, these normalized values per age are cur-
cently in use to compare the capillary blush and blood flow of the pathological cases - a cohort of 20–25 patients who have stroke secondary to MCA occlusion. Values of qTICI will be compared and validated using standard visual estimation of mTICI. Clinical correlation of qTICI with outcome will also be performed. The goal is to establish software that will accurately grade mTICI on a continuous scale rather than using the current crude visual estimation with wide range four strata, which will eliminate the operator dependent bias and increase the precision and accuracy of the revas-
cularization grading.

**Conclusion:** The qTICI Grading Software once developed will have the potential to revolutionize the way clinicians and interventionalists grade revascularization post AIS endovas-
ter therapy. The clinical implications of establishing auto-
mated and quantified revascularization scale is critical in improving treatment safety and efficacy.

### 176 Presentation withdrawn

#### Dose Reduction Strategies in Spinal Angiography

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**Purpose:** Complete spinal subtraction angiography (SpDSA) typically includes catheterization of each pair of interseg-
mental arteries, a pelvic aortogram, and studies of subcla-
vian and cervical arteries. Care must be placed on keeping radiation doses to patients and physicians as low as possi-
ble. We present several dose reduction strategies routinely used in our practice.

**Methods:** Besides techniques relying on optimal geometric factors and strict collimation, the following 4 strategies are illustrated:

- Low dose protocols.
- Variable frame rate (VFR) protocols.
- Gridless angiography.
- Low magnification factors.

**Results:** The choice of specific low dose protocols depends upon patient’s habitus (BMI, bowel artifacts), the region investigated, and the indication. The 1.8 and 2.4 Gy/fr pro-
tocols offer dose reductions of about 50% and 33%.

VFR protocols (e.g., 2 fr/sec for 3 seconds, 1 fr/sec for 2
seconds, 0.5 fr/sec thereafter) are based on the fact that less information is gained during the venous phase. Compared to 2 and 3 fr/sec protocols, the dose is reduced after an 11-second run by 52% and 68%, respectively.

In our practice, anti-scatter grids are removed by default. They may be re-installed in specific situations, e.g., to better detail a venous phase of poor quality or, occasionally, in patients with high BMIs.

Keeping the magnification factor as low as possible signifi-
cantly reduces patients and staff exposure. Using a wide display mode with a zoom factor of 2 instead of 4 in a standard display mode results in a 50% to 60% dose reduc-
tion, depending on whether collimation is used or not, while keeping a working image of the same size on the monitor.

**Conclusion:** The simple dose reduction techniques presented here are easily implemented at no additional financial cost on the vast majority of modern angiography equipment.

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**Balloon angioplasty with Sceptor-C Balloon in treating patient subgroups with large strokes secondary to ICA dissections where stent placement is not possible and also in patients with intracranial stenosis**

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**Purpose:** Limited clinical and angiographic data exists for patients treated with balloon angioplasty for acute large stroke secondary to occlusive ICA dissection where stent placement is not possible due to anatomic vessel tortuosity and in also patients with intracranial stenosis.

**Methods:** In a retrospective analysis of our Stroke Thrombectomy database (n = 222), we identified 9 patients who underwent extra-cranial ICA angioplasty within tortu-
ous occlusive cerebral loop secondary to dissection and another separate subgroup of 11 patients who underwent intracranial MCA angioplasty with Scepter-C balloon. The patients with ICA dissections also had tandem MCA occlu-
sions which were treated with mechanical thrombectomy. We examined neurological improvement defined by ≥8 point reduction of National Institutes of Health Stroke Scale (NIHSS) score at 7 days and an improved modified Rankin Scale (mRS ≤ 2) score at 90 days. A CT angiography (arch to circle of Willis) was carried out at 6 months and 1-
year.

**Results:** Balloon angioplasty restored flow in the true lumen of ICA in all cases. 9 (55%) patients with ICA dissections were alive and independent with mRS ≤ 2 and there was no mortality. 6 patients (54%) in the MCA angioplasty group achieved a mRS ≤ 2 score with 5 patients requiring addi-
tional intracranial stenting and there was 1 mortality. Follow up CT angiography showed no re-occlusions but minor non-
occlusive narrowing was seen in 2 patients with ICA angioplasty.

**Conclusion:** Angioplasty with Scepter-C balloon is safe in treatment of patients with large stroke secondary to ICA dissections where stenting is not possible due to anatomic
reasons. Intracranial balloon angioplasty is safe and may need adjunctive stent placement. This method may enable us to restore immediately and usually permanently proper arterial blood flow in the ICA and intracranial circulation and in consequence lead to significant clinical improvement in the late follow-up period.

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Purpose: Endovascular occlusion of fistulae is currently the treatment of choice for CCFs; however, various treatment modalities have been attempted previously with variable outcomes. The combination of coil and Onyx is intriguing in the treatment of CCFs, but it has been rarely reported, and case numbers are limited. The purpose of the current study was to evaluate our preliminary experience with the combined use of coils and Onyx for the treatment CCFs in 15 patients.

Methods: Between April 2009 and July 2014, 15 patients with 16 CCFs were treated with the so-called “armored concrete” therapy modality via the transarterial approach.

Results: Obliteration of the CCFs was obtained with good preservation of the parent artery in all 15 cases. Follow-up DSA demonstrated stable occlusion of the fistulae. No worsening of the cranial neuropathies was observed during the follow-up averaging 35 months.

Conclusion: The “armored concrete” modality that utilized coils, Onyx, and balloons promises to be an effective and safe alternative in the treatment of CCFs.

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Efficacy of coaxial system with compliant balloon catheter for navigating reperfusion catheter of Penumbra system in patients with tortuous artery: technique and case experience
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Purpose: In the acute treatment for major intracranial vessel occlusion, we often experience cases those have difficulties to lead reperfusion catheter of Penumbra system to thrombus in patients with tortuous artery. We describe a method by which we can lead large bore reperfusion catheter of Penumbra system to thrombus easily using a compliant balloon catheter as coaxial system.

Methods: A retrospective review of 7 cases performed between May 2014 and March 2015 in which coaxial system with a compliant balloon catheter was used. At first, we achieved a stable guiding sheath position, and delivered coaxial system with a compliant balloon catheter and reperfusion catheter besides the curvature. Then, balloon was inflated when the tip of balloon was placed out of the edge of reperfusion catheter, and we lead coaxial system to thrombus over 0.014 inch guiding wire. Aspiration with reperfusion catheter was started after balloon was deflated.

Results: We used this technique in 6 cases of middle cerebral artery occlusion and 1 case of basilar artery occlusion (aged 67–84 years, mean 77.4 years; 6 males). As a reperfusion catheter of Penumbra system, SMAX ACE in 6 cases, SMAX in 1 case was used. As a compliant balloon catheter, Scepter C in 6 cases, TransForm C in 1 case was used. The technique was successful in all cases. No parent artery dissections or catheter induced vasospasm were noted in any cases.

Conclusion: Coaxial system with a compliant balloon catheter can be efficient and safe for navigating reperfusion catheter of Penumbra system to thrombus in patients with tortuous artery.

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Cerebral Sinuses Thrombosis involving both transverse sinuses and Torcular a serious condition and aggressive endovascular treatment with mechanical and chemical thrombolysis and stenting
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Purpose: Cerebral venous sinus thrombosis is an unusual and potentially life-threatening condition with variable and nonspecific clinical symptoms with high mortality rates. Standard therapy consists of anticoagulation, although there is no definite evidence for the best choice of treatment, intravenous heparin is used as the first line treatment modality. Intra sinuses thrombolysis can be an effective and relatively safe treatment for acutely deteriorating patients who have not responded to conven- tional anticoagulant therapy.

Methods: The purpose of this case report was to evaluate the efficacy and safety of an aggressive management with mechanical thrombolysis balloon, thrombolytic (Actilyse™) and multiple stents in patients with thrombosis involving the two lateral sinus and Torcula.

Results: A 57-year-old woman presented with a 24 hours history of severe headache, agitation and confusion evolving rapidly with seizures and numbness even after staring
heparin. The diagnosis of dural sinus thrombosis involving both lateral sinus and Torcular. We decided by endovascular approach with transfemoral venous punction and left sinus catheterization with Guider 8 F, initially performing mechanical static and dynamic thrombolysis (Viatrac™ 6x20mm balloon angioplasty) and then intra sinuses thrombolysis with Actilyse® and finally sinuses reconstruction with multiple stents(Xact™) with full clinical and tomographic recovery and angiographic recanalization of both sinuses and Torcular.

**Conclusion:** This result show mechanical, chemical intrasinus thrombolysis and the reconstruction of wall sinuses with carotid stents is a safe and effective treatment modality in cases with thrombosis involving both lateral sinuses and Torcular and rapidly worsening of neurological symptoms. Although this type of treatment provided rapid recanalization of occluded sinuses, further comparative and randomized studies are needed to clarify its efficacy versus other therapeutic modalities for the treatment of severe CVT.

**Reference**

1. Mohammadian R et al., 2011 and 2012; Chow K et al. 2000.

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**Double catheters technique for disconnecting very high flow intracranial arterial venous fistulas**

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**Purpose:** The purpose of this report is to review our experience for treatment of direct and very high flow intracranial AV fistulas by disconnecting at the AV junction.

**Methods:** From 2006 to 2015 among the 200 cerebral AVMs there are 10 cases with direct and very high flow intracranial AV fistulas. There are four males and 6 females. The mean of age is 27. The main symptoms of these patients were seizures and fainting and cerebral bleeding. The direct AV shunt was located in posterior cerebral artery in 4 cases the others 5 in anterior circulation: 3 from ACA, 2 from MCA, one case from dural branch of occipital artery. The draining vein was connected to the vein of Galen in 3 and draining to the superficial cerebral vein in 5 and 2 to traverse sinus. The first case was treated in 2006 by injection pure glue but failed to stop the AV shunt because of enlargement of the feeder artery and very high flow AV shunt. Then the AV junction was approached with 2 microcatheters and deployed two coils to work together against coil migration to the huge venous pouch. The first coil is play a role of prevention the following coils fly to the venous pouch. When the second deployed coil was stable; it was detached. And then, we continue with next coils using the second microcatheter until we can low down or stop the AV shunt. If coiling alone cannot control the AV shunt; we will inject diluted glue to fix the coils mass and finally the first distal coil was detached.

**Results:** 10 cases of direct and very high flow intracranial AV fistulas were treated successfully by using the double coils technique without any related procedure complication. Clinical symptoms after the procedure had improved dramatically. Follow up clinical is no more seizures and fainting. Follow up angiograms reveal the AV fistulas were cured in all 10 cases and draining venous pouches shrunk themselves.

**Conclusion:** In our experience, double catheters technique can be performed safely to disconnect the very high flow intracranial AV fistulas. The benefit of this technique is to reduce the amount of coils and eliminate the risks of mass effect or recanalization because we don’t coiling the venous pouch.

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**Endovascular Cooling Catheter for Selective Brain Hypothermia in Acute Stroke: an Animal Feasibility Study of Cooling Performance**

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**Purpose:** Therapeutic hypothermia (TH) represents a promising neuroprotective treatment in acute ischemic stroke. Selective cerebral hypothermia applied early prior and during endovascular mechanical recanalization therapy may be beneficial in the critical phase of reperfusion. We aimed to assess the feasibility of a new intracarotid cooling catheter in an animal model.

**Methods:** 9 adult sheep were included. Temperature probes were introduced into frontal and temporal brain cortex bilaterally. The cooling catheter system was introduced to a common carotid artery (CCA). Selective blood cooling was applied for 180 min. Systemic and local brain temperatures were measured during cooling and rewarming. CCA diameters and flow were measured angiographically and by Doppler ultrasound.

**Results:** CCA diameter was between 6.7–7.3 mm. CCA blood flow increased moderately during cooling and after catheter removal. Maximum cerebral cooling in ipsilateral temporal cortex was −4.7 (−5.1;−4.0) °C [95%-CI]). Ipsilateral brain temperatures dropped significantly faster and lower compared to contralateral cortex with mean ΔT of 1.3 (−1.5;−1.0 [95%-CI]) °C (p < 0.0001) and to systemic temperature (−1.4 [−1.7;−1.0] °C; p < 0.0001).
Conclusion: Sheep proved feasible animal model for intra-carotid cooling catheter. Fast induction of selective mild hypothermia was achieved within cooled cerebral hemisphere with stable temperature gradients to contralateral brain and systemic blood. Further studies are required to demonstrate any therapeutic benefit of selective cerebral cooling in a stroke model.

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Combined Selective Brain Hypothermia and Mechanical Artery Recanalization in Acute Ischemic Stroke: Animal Study with Endovascular Cooling catheter in Temporary MCA Occlusion Stroke Model

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Purpose: Therapeutic hypothermia (TH) represents a promising neuroprotective treatment in acute ischemic stroke. Selective cerebral hypothermia applied early prior and during endovascular mechanical recanalization therapy may be beneficial in the critical phase of reperfusion. Successful selective brain cooling using a new intracarotid cooling catheter has been recently demonstrated in a sheep model (≈−4.5°C after 3 hrs). We aimed to assess the therapeutic benefit of selective TH in a sheep model of temporary middle cerebral artery occlusion (MCAO) and recanalization.

Methods: 20 adult sheep were randomized to TH (n = 10) and normothermia (n = 10). MCAO was achieved by temporary neurosurgical clipping of MCA M1 segment (2 hrs.of ischemia) in all animals. 20 min prior to clip removal, endovascular selective TH was initiated by cooling catheter placement in common carotid artery (CCA) and maintained for 3 hrs. In normothermia group, cooling catheter was perfused with 37°C normal saline. Systemic and nasal temperatures were monitored continuously. Primary endpoint was infarct volume on MRI at day 2 and day 30. Secondary endpoints were clinical outcome (assessed on dedicated veterinary neurological 27 point score) which was analyzed daily (until day 30) and histopathological analysis of final infarct at day 30. Safety endpoint was histopathological analysis of CCA specimen (day 30; assessed for dissection and thrombi).

Results: The study was still ongoing at time of abstract submission. Results from pilot experiments with 2 sheep (MCAO with [n = 1] and without [n = 1] selective TH) showed marked reduction of MCA territory infarct (4.2 ml vs. 21.9 ml) and better neurological outcome (initial assessment at day 1: 7/27 vs. 22/27; final assessment 1/27 vs. 5/27) with MCAO and selective TH compared to normothermia.

Complete report of clinical and imaging outcomes from 20 randomized animals including histopathological brain infarct and carotid safety analysis will be presented at the conference.

Conclusion: Induction of combined selective mild hypothermia initiated prior and maintained during and early after recanalization ("cold reperfusion") appears promising to reduce final infarct size and improve clinical outcome in a sheep model of acute ischemic stroke due to temporary MCAO.

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Management of tandem intracranial and extracranial occlusion causing hyper acute ischemic stroke with extracranial cervical stenting in conjunction with mechanical thrombectomy- Initial Experience with Casper and Cristallo hybrid carotid stents

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Purpose: To assess the clinical outcome of major stroke secondary to tandem occlusions using extra-cranial internal carotid stenting and mechanical thrombectomy (MT) - Initial experience with Casper and Cristallo hybrid stents.

Methods: In a retrospective analysis of our Stroke Thrombectomy database (n = 222), we identified 24 patients who underwent extra-cranial ICA stenting in conjunction with MT for tandem ICA/MCA (TIM) occlusions. We examined neurological improvement defined by ≥8 point reduction of National Institutes of Health Stroke Scale (NIHSS) score at 7 days and an improved modified Rankin Scale (mRS ≤ 2) score at 90 days. Successful recanalization based on thrombolysis in cerebral infarction (TICI) score of 2b or 3 was also evaluated. We also looked at complications including reperfusion haemorrhages and any re-occlusion rates.

Results: 46%(n = 11) had a reduction in the NIHSS score by ≥8 points at 7 days. 50%(12 patients) had a good outcome with a mRS ≤ 2. 88%(n = 21)achieved TICI 2b/3 signifying successful recanalization following MT. Mortality was 20%(n = 5) with 3 deaths due to malignant MCA and 1 death due to pneumonia. 1 patient died due following reperfusion haemorrhage. There were no incidences of re-occlusions with either of the ICA stents used in this subgroup.

Conclusion: Major Strokes due to TIM can be successfully treated by extra-cranial internal carotid artery stenting. Initial results with Casper and Cristallo stents are promising and can be safely used in conjunction with MT.

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Purpose: Efficacy and safety of manual aspiration thrombectomy using Penumbra in acute occlusion of intracranial artery has been proved in many previous studies. Our study aimed to retrospectively assess the efficacy and safety of a manual aspiration thrombectomy using Penumbra in patients with small vessel occlusion (M2 segment of MCA).

Methods: We conducted a retrospective review of 32 patients who underwent manual aspiration thrombectomy using Penumbra 4 MAX reperfusion catheter for treatment of M2 occlusion between January 2013 and November 2016. We evaluated immediate angiographic results and clinical outcomes through reviewing of patient's electrical medical records.

Results: Male was dominant sex in this study (M:F = 18:14) and median age was 72.5 (age range, 41–90). The rate of successful recanalization (TICI grade ≥ 2b) was 86% (27/32). Median initial NIHSS score was 10 (range, 4–25) and was 4 (range, 0–14) at discharge. Favorable clinical outcomes (mRS score at 3 months (range, 0–14) at discharge. Favorable clinical outcomes (mRS score at 3 months ≤ 2) were seen in 25 patients out of 32 (78%). There was no procedure related symptomatic intracerebral hemorrhage. One patient was died after discharge due to cardiac problem.

Conclusion: Manual aspiration thrombectomy appears to be safe and is capable of achieving high rate of successful recanalization and favorable clinical outcomes in patients with distal cerebral vessel occlusion (M2).

The new carotid Braided Stent CASPER™. An initial experience

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Purpose: Stenosis of the carotid artery is one important etiological factor of Ischemic stroke and one of the leading causes of death. Endovascular angioplasty with stenting is a promising option for treating carotid artery stenosis. There exist a quickly increasing number of different stent types with different materials. The bare-metal stent is the most commonly used stent with acceptable results. Among the many factors influencing CAS, the stent material plays an important part. In the history of the development of carotid stent material, every single material has its merits and drawbacks. A new braided Nitinol sheathable stent (CASPER™, Microvention) have the superelasticity and shape-memory properties presente in nitinol stents, combined with re-sheathable and repositionable, improving stent placement accuracy in a closed cell stent. We presented an initial experience with a new device for treatment in 3 patients.

Methods: In the last 6 months, 3 males patients were dual antiplateled with subocclusion carotid artery disease with a complex symptomatic stenosis with greater than 70% they were treated with use of the new device for carotid disease stent CASPER™ low profile coaxial way of cerebral protection filter Emboshield™ in 6 F sheath, and after apposition performed angioplasty with Viatrac™ balloon.

Results: There were no complications and recanalization in 100% in all cases. In doppler control at 6 months we did not observe thrombosis or intra re stenosis.

Conclusion: CASPER™ stent is a braided Nitinol stent that conforms to tortuous anatomy, provides excellent wall apposition to diseased carotid artery and with a good conformation in tapered ICA-CCA segments in repositionable delivery system. Up to 50% deployment is re-sheathable and repositionable, improving stent placement accuracy. But we need long-term follow up to better assess the efficiency of this new device.

References

Mid-term Experiences with the Pele®

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Purpose: To report our experience with a recently developed intermediary catheter for the endovascular treatment of intracranial vascular malformations.

Methods: Between December 2011 and May 2015, 25 patients with intracranial vascular malformations were treated using the Pele® intermediary catheter (Rapid Medical, Yokneam, Israel). 18 of the malformations were arteriovenous (AVM), and seven duaral fistulas (DAVF). All of them were considered “difficult to treat” lesions, either with very tortuous access, far distal location, or the combination of both. The device is 115 cm long, has 6.3 F outer and 0.047” inner diameter (OD/ID) was introduced through a 6 F long sheath, and navigated over a Sonic 1.5 F or 1.2 F microcatheter (mc) and Hybrid 0.088” or 0.007” guidewire (Balt, Montmorency, France) into the supraclinoid portion of the Internal Carotid, the Anterior, Middle or Posterior Cerebral Artery.

Results: The device gave excellent support to the mc to reach the target lesion. Due to its large ID, good quality DSA with
the mc inside could be performed, to help the navigation of the mc, and to evaluate the angiographic result before removing the mc. No complications related to the use of the Pele occurred during the procedures. The target lesions could in all patients be occluded with a fluid embolic agent, and the mcs safely detached and removed with the support of the Pele.

Conclusion: The Pele® is a promising new device for the endovascular treatment of intracranial AVMs and DAVFs that would be difficult or impossible to reach otherwise. The triaxial navigation procedure is technically easy and can be performed through a 6 F long sheath. Placement of the Pele in the arteries beyond the Circle of Willis is feasible, safe, and facilitates the evaluation of the anatomy and the endovascular occlusion of intracranial AVMs and DAVFs.

A Novel Mechanical Thrombectomy Device

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Purpose: Stroke is the second leading cause of death and a leading cause of disability worldwide. Early reperfusion in patients experiencing acute ischemic stroke is critical. While thrombolysis has been shown to improve patient outcomes, mechanical revascularization techniques have been proposed to expand the treatment time window and enhance revascularization. Yet, with available devices and techniques success rates are limited, special skills or dedicated setup are required, and the risk of clot breakdown and distal embolization exists. The aim of this study was to evaluate the safety and efficacy of a novel device designed to address these unmet needs.

Methods: The RadioleTM was used in this study. It allows an efficient, one-pass, robust clot retrieval and revascularization. It’s composed of several units of stranded wire tubes, engaging the clot in a corkscrew manner through the entire length of the clot, ensuring firm trapping of the clot and efficient retrieval, with minimal risk of distal embolization, regardless of clot morphology and size.

The RadioleTM is compatible with >0.016” inner diameter microcatheter, easily deployed and requires no additional setup or dedicated tools. Operating the device is achieved through its custom-made handle, allowing easy, controlled deployment and retrieval.

Porcine and ovine animal models of acute arterial occlusion were used.

Results: A total of 4 internal carotid arteries (ICA) and 8 profunda femoral arteries (PFA) were occluded with radiopaque clots. One-pass clot removal with successful recanalization and flow restoration was achieved in 4/4 (ICA) and 7/8 (PFA) of arterial occlusions. In another PFA (1/8) the clot was removed on the 2nd attempt. Except for temporal arterial spasm documented in 4 arteries, no distal thromboemboli or other adverse events occurred.

Conclusion: This study demonstrates the safety and efficacy of a novel thrombectomy device, designed to overcome current limitations and provide superior, efficient, one-pass, enhanced revascularization.

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Intraarterial chemotherapy (IAC) as an alternative therapy for treatment of intraocular retinoblastoma

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Purpose: To describe our 3-year experience of Intraarterial chemotherapy as first-line or salvage therapy for patients with intraocular retinoblastoma, its efficacy and safety.

Methods: Retrospective observational cohort study with review of charts of children with retinoblastoma staged as groups A to E according to International classification (IC) in the period from 2012 August to 2015 July. Cannulation of ophthalmic arteries via the femoral artery under general anesthesia and heparinization to perform IAC cycles every three weeks of IAC as monotherapy with melphalan for first-line treatment or melphalan and topotecan for salvage treatment; addition of carboplatin to all patients with no response or progression of the disease. The addition of local therapy was indicated between IAC procedures. Systemic chemotherapy (SC) was performed for all patients with vitreous seeds after IAC. Primary outcome was defined as rate of enucleating after IAC and IVC. Secondary outcome was defined as objective response of therapy by Retcam every cycle of IAC.

Results: There were enrolled 45 patients (54 eyes), median age at the first cycle diagnosis was 2 months (range of 4 month to 5 years), 66% as salvage therapy and 33% as first-line therapy. Patient’s IC stage: 3 group A, 5 group B, 11 patients group C, 25 patients group D, 7 patients group E and 3 patients not staged. The median of cycles was 2,98 (1–7) and drugs were 2 (1–3). 27 (50%) eyes were preserved, 8 (15%) eyes were enucleated and 19 (35%) still under treatment. IAC complete response (CR) in 19 (35%) of eyes, partial response in 9 (17%) and no response in 7 (13%). 5 patients (11%) had severe adverse toxic events grade 3 and 4. No deaths, strokes, or complications at the site of femoral artery puncture were observed.

Conclusion: The IAC as salvage treatment and first-line were well tolerated and showed a high rate of complete response and preserved eye, therefore an alternative to enucleation. This procedure should be included in the multimodal treatment strategy for retinoblastoma.
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New perspective regarding endovascular treatment of brain tumors and the role of the blood-brain barrier and the new ways to by-pass it

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Purpose: Malignant gliomas (MG), remain challenging to treat due to their unresponsiveness to therapy. Promising new drugs are being evaluated, and new techniques have improved drug delivery through the blood brain barrier (BBB). Our aim is to assess the advantages and disadvantages of intra-arterial (IA) chemotherapy for treatment of MG and to investigate new ways to alter the BBB.

Methods: All the recent works were reviewed, from January 2002 till May 2015, regarding how to by-pass the BBB. We also have assessed the improvement of chemotherapy and clinical results after these treatments.

Results: We have found new experimental techniques, such as focused ultrasound and new drugs, that could maximize the chemotherapy delivery through BBB.

Conclusion: IA chemotherapy has been reported to be a promising new therapy; clinical studies are necessary to correlate this technique to the new ways of altering the BBB. Furthermore, these new methods could also be used in future scenarios before infusion of stem cells after stroke or brain trauma.

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The value of preoperative embolization in large Solid Cerebellar Hemangioblastoma

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Purpose: Cerebellar hemangioblastomas (HGB) although are the most common primary posterior fossa tumors in adults, still uncommon lesions. 70% are cystic while 30% are solid. 5-30% associated with Von Hippel lindau (VHL) syndrome. These lesions are surgically challenging cases due to high vascularity that make surgical removal sometimes difficult, incomplete, or even impossible. The concept of surgery without Embolization is to control feeders first then surface coagulation using bipolar blades with no entry inside the tumor dealing with it as if an AVM.

Methods: We present nine patients presented with large solid cerebellar HGB. Four of them associated with VHL. All Patients under went preoperative embolization using PVA or onyx 2 Weeks preoperatively aiming for tumor filling with the embolic material and preservation of the feeders.

Results: All patients are operated via sub occipital approach. The concept of surgery after Embolization is totally different because we can cut the tumor in piece-meal fashion. Surgical control of the tumor bleeding was feasible. Total removal can be achieved safely. Patients were followed for 6 M clinically and radiologically. Total tumor removal was achieved in all patients.

Conclusion: These tumors although being benign they are considered as vascular challenging cases. Pre-operative embolization is strongly recommended aiming for tumor filling and identifications of the feeders. Preoperative embolization of haemangioblastoma changes the concepts of the surgical treatment.

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Early Experience of Transluminal Balloon Angioplasty Using Dual Lumen Balloon Catheter for Angiographic Cerebral Vasospasm after Subarachnoid Hemorrhage

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Purpose: Recently new dual lumen balloon catheter was developed. So we introduce our experience of transluminal balloon angioplasty for cerebral vasospasm after aneurysmal subarachnoid hemorrhage.

Methods: Three cases were treated with dual lumen balloon catheter for angiographic cerebral vasospasm.

Results: Angiographic outcomes can achieved all excellent. Clinical outcome was excellent for three patients. There was no procedural complication.

Conclusion: Newly developed dual lumen balloon catheter can be useful tool for transluminal balloon angioplasty after subarachnoid hemorrhage.

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Emergency Endovascular Intervention for Delayed Cerebral Ischemia Concurrently with Angiographic Vasospasm in Fisher Grade III Subarachnoid Hemorrhage without Prior Medical Therapy

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Purpose: The current treatment regimen for delayed cerebral ischemia (DCI) concurrently with vasospasm in subarachnoid hemorrhage (SAH) includes primary medical and secondary endovascular therapy. However, assessing an adequate response to medical therapy and its maintenance
time remains difficult, and it can lead to delayed endovascular procedures.

**Methods:** An analysis of 21 consecutive patients with Fisher grade II SAH was carried out to assess the early endovascular approach for DCI concurrently with significant vasospasm, without prior medical treatment.

**Results:** Early neurological response, angiographic results, clinical outcome, and infarction rate were assessed. Endovascular treatments were performed on 75 vasospastic segments [(transluminal balloon angioplasty (TBA) for 63 segments (84%), and intra-arterial nimodipine for 12 segments (16%)]. Regarding the distal arteries, TBA was conducted on 26 segments. Early neurological response was observed in 17 patients (89.5%). Fifteen patients (78.9%) showed good angiographic results. Repetitive intervention was conducted in two patients (10.5%) on 4 segments. Three cases of cerebral infarction were found; of these, two were symptomatic. Good outcomes (mRS ≤ 2) at 6 months were observed in 17 patients (89.5%).

**Conclusion:** Emergency endovascular treatment could be beneficial in Fisher grade II SAH patients at high risk for DCI concurrently with significant vasospasm. However, the absence of a comparative analysis should be taken into consideration.

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Acquisition of DWI burden in early subarachnoid hemorrhage

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Purpose: To determine the natural history of diffusion weighted imaging (DWI) abnormalities in early acute subarachnoid hemorrhage (SAH).

Methods: Patients with diffuse SAH at our institution were offered enrollment in a prospective registry in which serial MRI, including DWI, FLAIR, PWI, and ASL sequences, was performed at admission, 7 days, 30 days, and upon the development of signs/symptoms of vasospasm. Patient demographics, Hunt-Hess grade, modified Fisher score, and underlying lesion and treatment technique were recorded. Between November 2013 and May 2015, 27 patients were enrolled, 19 women, mean age 56, 14 current smokers. Hunt-Hess grade mean was 3.1. Modified Fisher score mean was 3.5. All underlying vascular lesions were treated endovascularly: 9 ACA aneurysms, 8 ICA aneurysms (including PCOM), 4 MCA aneurysms, 2 basilar tip aneurysms, 1 posterior fossa AVM, and 3 angiographically-negative SAHs. 16 patients (59.3%) had DWI abnormalities on their admission scan; all had undergone a catheter angiogram or endovascular treatment of the underlying lesion prior to the MRI. The total number of DWI abnormalities amongst these patients was 119 (103 < 5 mm, 9 5–9 mm, and 7 > 10 mm). 15 were FLAIR hyper-intense. 5 lesions were within non-catheterized vascular territories. At 7 days, the total number of DWI abnormalities was 178 (147 < 5 mm, 20 5–9 mm, 11 > 10 mm), 49 FLAIR hyper-intense, 10 within non-catheterized vascular territories. 8 patients (29.6%) had an increase in the total number of DWI abnormalities without additional intervention. Of these, 2 patients (7.4%) had an increase in the number of DWI abnormalities outside of the territory of the treated lesion, without focal neurological symptoms. No patient had perfusion abnormalities at PWI or ASL. Conclusion: The acquisition of additional multifocal ischemic injury to the brain is common in early SAH. This phenomenon is independent of cerebral perfusion and large-vessel vasospasm.

Short-term intraarterial Milrinone infusion for the treatment of posthemorrhagic vasospasm

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Purpose: The treatment of secondary cerebral vasospasm (CVS) still poses a challenge in the treatment of patients with aneurysmal subarachnoid hemorrhage (SAH). Lately continuous intra-arterial infusion of calcium channel blockers has been used in severe symptomatic SAH (SAH)."
Utility of a coaxial micro-catheter system for the treatment of extra-dural vascular lesions

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Purpose: We describe the utility of a coaxial micro-catheter system for the treatment of extra-dural vascular lesions.

Materials and Methods: We treated 7 patients with extra-dural lesions using a non-tapered 1.9 French micro-catheter (Carnelian Marvel, Tokaimedical products, Japan) and a 2.7 French high flow micro-catheter (Carnelian HF, Tokaimedical products, Japan). In the cases of intracranial dural arterio venous fistula (d-AVF), we introduced the 5 French guiding catheter (Chaperon, Terumo, Japan) to the external carotid artery, before introducing a 2.7 French micro-catheter to the distal part of the middle meningeal artery as far as possible. Finally, we introduced a 1.9 French micro-catheter proximal to the lesion.

Results: We treated 3 cases of d-AVF, spinal d-AVF, dural branching arterio venous malformation, meningo-ma, and carotid-cavernous fistula. We used n-butyl-cyano-acrylate (NBCA) glue for 5 cases, Onyx (eV3, USA) for one case, and a coil for one case. We employed a 0.014 inch guide wire to pass through the 1.9 French micro-catheter to facilitate selection of the target vessel. We show that the 2.7 French micro-catheter can support the 1.9 French micro-catheter. Thus, we can navigate the 1.9 French micro-catheter to the proximal areas of the lesions and successfully use NBCA, Onyx, and a coil for treatment.

Conclusion: The coaxial micro-catheter system with a combination of the non-tapered 1.9 French micro-catheter and 2.7 French high flow micro-catheter is a very useful and safe treatment system for extra-dural vascular lesions.

Utilization of Blood Sampling Global Oxygen Extraction Fraction to anticipate Cerebral Hyperperfusion Syndrome Following Elective Carotid Artery Stenting

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Purpose: The purpose of our retrospective study was to investigate whether or not blood sampling oxygen extraction fraction (OEF) had relation to CHS following CAS.

Materials and Methods: Included in our analysis were patients (1) who underwent elective CAS in our institution between October 2010 and May 2014, and (2) who underwent blood sampling for OEF calculation before and immediately after CAS. OEF was calculated from cerebral arteriovenous oxygen difference. Arterial blood was sampled from the common carotid artery and venous blood from the dominant-sided superior jugular bulb. CHS was defined as pulsatile headaches, restlessness, delusion, and/or new neurological symptoms not due to cerebral ischemia following CAS. Evaluated were baseline features in patients, pre-CAS OEF, post-CAS OEF, and CHS.

Results: During the study period, 134 patients matched our criteria for analysis. Pre-CAS OEF was 0.41 ± 0.06, post-CAS OEF was 0.42 ± 0.08. Nine patients presented CHS. Among them, pre-CAS OEF was significant (p < 0.05). Logistic analysis showed that pre-CAS OEF of p < 0.05) and ROC curves showed that pre-CAS OEF of 0.46 was a cut-off value (sensitivity; 0.67, specificity; 0.84).

Conclusion: Elevation of pre-CAS OEF by simple blood sampling was strongly related to CHS.

References

Utility of ultrasound guided femoral arterial access and analysis of risk factors for access site hematoma

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Purpose: The utility of ultrasound guidance for arterial access has not been fully investigated (Gedikoglu M et al., 2014). We conducted the prospective cohort study on US-guided femoral artery access in a neuro-interventional institute.

Materials and Methods: This study included 64 consecutive patients who underwent US-guided femoral artery access through 66 sites for diagnostic and/or neurointerventional purposes. During femoral artery access, both the number of attempts required for sheath insertion and the success of anterior wall puncture were recorded. In addition, the occurrence of major complications and hematoma formation on the access site examined by US were analyzed.

References
Results: The median (IQR) number of attempts was 1 (1–2) and first-pass success rate was 63.6%. Anterior wall puncture was achieved in 98.5%. In one case (1.5%), pseudoaneurysm was observed as a major complication. Post-procedural hematoma was detected in 13 cases (19.7%), most of which were ‘tiny’ or ‘moderate’ in size. Low body mass index (BMI) and antiplatelet therapy were independent risk factors for access site hematoma.

Conclusion: US-guided common femoral artery access was useful and helpful for a safe and minimally invasive performance of the procedure. We should particularly take care of the access site to prevent hematoma formation in patients with low BMI and who are on antiplatelet therapy.

Reference

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Percutaneous embolization: an easy approach for challenging vascular lesions

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Purpose: Treatment of several hypervascular lesions in the head and neck region may be challenging due to tortuosity or size of the feeding vessels, location of the lesion or thrombosis of the veins that will not allow to access to the lesions. These lesions include tumors, dural fistulas, venous vascular malformations and tumors. Direct percutaneous approach may be an alternative to intravascular access, allowing better and more effective embolization.

Methods: We reviewed the clinical records, preembolization and post embolization imaging studies of a consecutive series of 15 patients with variety of vascular where the percutaneous approach was used. Onyx and nBCA were used as embolization materials.

Results: 15 cases were as follows: 3 carotid paragangliomas, 2 juvenile angiofibromas 1 cervical spine tumor, 1 intradural spinal hemangioblastoma, 3 scalp arteriovenous fistulas (cirsoid aneurysms), 2 hypervascular skull tumors, 1 bilateral dural CCF, 1 transverse sinus dural fistula and 1 superior sagittal dural fistula. In 13 cases onyx was used as only embolization material, in one case the combination of Onyx and coil I deployment to prevent onyx extrusion through the fistula and in one case (cirsoid aneurysm) nBCA was used. No technical or clinical complications related to embolization procedures occurred.

Conclusions: Direct percutaneous embolization of vascular lesions of the head and neck are feasible, safe and effective. Our preliminary experience suggests that Onyx is an excellent agent to be used due to the controllable injection and a good penetration. In presurgical embolization of tumors, Onyx may offer a good degree of devascularization which facilitates an easier surgical resection with lower blood loss.

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Carotid Stenting with Optimized Filter Protection: Close Meshed Clinical Monitoring and MRI Control

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Purpose: To evaluate a simplified technique of protected carotid artery stenting (CAS) by neurological, MRI and ultrasound monitoring.

Methods: 90 consecutive patients with symptomatic and asymptomatic high grade stenosis were treated by CAS in the neuroradiological department. To shorten the procedure the post dilatation balloon and the filter were retrieved at once by the coaxial catheter, which was advanced through the stent with the balloon as a guide (sparing 2 steps of the procedure).

All patients were monitored by the anaesthesiology department during and 24 hours after CAS by the neurointensive care unit and received a NIHSS score on the day before and 6 hours after intervention by the neurological department. The patients were supposed to receive a MRI including diffusion and perfusion imaging (to document initial stroke, potentially new stroke, hyperperfusion and possible post treatment hyperperfusion) on the day before and not more than 72 but not less than 12 hours after intervention. The angiological result was verified by ultrasound after 6 months.

All patients were on sufficient double antiplatelet therapy at least one day before, verified by impedance aggregometry, if necessary clopidogrel dosage was doubled.

Results: CAS was accomplished in all cases, and successful in 99%, 1 patient still had a high grade rest stenosis. 65% of the patients were symptomatic before. Most of them were treated 5 to 10 days after TIA / stroke. 6 hours after intervention no patient had a worsened NIHSS, 6 patients had improved in the NIHSS (p = 0.03) and 84 were unchanged. Mortality, major, and minor stroke until discharge were 0.

Most of the patients had a MRI the day before, but only 38 patients (42%) received the planned follow-up MRI. 14 patients (37%) showed new lesions of 3 to 5 mm in the diffusion weighted MRI (11 patients 1 or 2 spots, 3 patients 3 and more). 2/3 of the lesions were within the borders of the initial perfusion deficit. Perfusion was ipsilaterally normalized except in previous infarcted areas.
13% of the patients had restenosis >50% after 6 months, no surgical or endovascular therapy was performed.

**Conclusion:** The used filter protected technique of CAS was safe with no new major or minor stroke or death until discharge.

Patients significantly improved in NIHSS after CAS within one day, probably because of the early treatment regimen after initial stroke.

MRI compliance was poor in this retrospective study. One third of the patients had new MRI diffusion lesions (corresponding to the literature), which did not lead to worsening of NIHSS.

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**Neurovascular Applications Of Bioabsorbable Stents**

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**Purpose:** Bioabsorbable stents (BAS, Absorbtm Abbott Vascular, USA) have recently been introduced for coronary use to decrease some of the untoward consequences of regular stenting such as long-term angioplastaggage, risk of occlusion of covered side branches by neointima and possible impairment of future endovascular treatment options. The neurovascular use of BAS has not been previously reported.

**Methods:** 7 patients (ages: 21 to 74) were treated with BAS for cerebral aneurysms (4 patients) or vertebral origin (2 patients) or intracranial carotid stenosis. The rationale for BAS use was to avoid long-term angioplastaggage in patients with aneurysms and keeping angioplastag as a viable future treatment option for possible restenosis in patients with atherosclerotic disease. In one of the aneurysms, a need for a flow diverter emerged during the procedure, the remaining aneurysms were coiled.

**Results:** There were no clinical complications or failures. One stent demonstrated distal migration during the procedure due to size mismatch between the stent and the parent artery. This stent was asymptomatically occluded on follow-up. Otherwise, of the 6 patients with a follow-up angiogram (DSA), there were no occlusions or significant stenosis and at a mean follow-up duration of 7 months and no artifacts on MRA and/or CTA. 3 out of 4 aneurysms were occluded.

**Conclusion:** Our preliminary results in a selected series of patients suggest that BAS is safe to use for intracranial interventions. High stent profiles, a relatively rigid deployment system, lack of large diameter devices and minimal visibility are the shortcomings of BAS whereas possibility of discontinuation of antiaggregation, absence of MRA/CTA artifacts and minimal interference with further endovascular treatment after reabsorbtion are the advantages.

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**Endovascular MR-Guided Embolization Using a Magnetically Assisted Remote Controlled (MARC) Catheter System**

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**Purpose:** A MARC catheter was developed to improve navigation in endovascular interventional procedures using MR image guidance. The MARC catheter has coils at the tip that create a magnetic moment that cause the tip of the catheter to deflect in the MR environment. The purpose of this study is to assess in vivo performance of the MARC catheter system for endovascular embolization in a swine model.

**Methods:** The MARC catheter has a saddle shaped micro-coil fabricated by laser lithography attached to a custom 1.2 mm diameter microcatheter (Penumbra Inc., Alameda, CA). Electrical connections to the micro-coil were made using a pair of copper wires embedded in the catheter wall. Renal embolization (100–300 uM particles) was performed on three animals (40–45 kg) using a hybrid suite consisting of a 1.5 T MR scanner and a C-arm DSA system. After catheterizing the targeted renal artery under real-time MRI, embolic beads suspended in dilute gadolinium contrast were delivered while obtaining a MR angiogram. Embolization of the contralateral kidney was performed under X-Ray guidance. Flow rates and perfusion for both kidneys were measured using a velocity encoded MR scan and 4D THRIVE sequence, respectively.

**Results:** Average renal artery navigation time was 60 ± 22 seconds for X-ray versus 93 ± 56 seconds for MRI. Average change in renal blood flow was 1.9 ± 0.2 mL/min/g for X-ray versus 2.1 ± 0.2 mL/min/g for MRI guided embolization. Navigation, blood flow, and perfusion were similar between X-ray and MRI guidance (p > 0.05).

**Conclusion:** This study demonstrates feasibility of endovascular embolization using the MARC catheter. This is the first in vivo intervention model developed for this technology. Comparing performance parameters demonstrates that MR guidance is as effective as X-ray guidance for this particular renal intervention model. Future work will focus on testing MARC prototypes relevant to the human neurovasculature.
A single centre experience with the new liquid embolic agent Precipitating Hydrophobic Injectable Liquid (PHIL) in treatment of arteriovenous malformations, dural arteriovenous fistulas and hypervascular tumour embolisation in more than 30 patients

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Purpose: Precipitating Hydrophobic Injectable Liquid (PHIL) is a new liquid embolic agent available for clinical use in neurovascular applications. Our single centre experience with the use of PHIL in treating AVMs, dural arteriovenous fistulas and hypervascular tumour embolisation is presented.

Methods: 31 patients were treated with PHIL as the sole embolic agent in a variety of pathological conditions such as brain AVMs, cranial dural arteriovenous fistulas, spinal dural arteriovenous fistulas and embolisation of hypervascular tumours of the skull base and spine.

Results: PHIL shows good forward flow and penetration of the embolic bed and also retrograde filling of other collateral feeders. PHIL can be injected through DMSO compatible balloon catheters, potentially increasing the chance of successful embolisation in vascular malformations, which may be difficult to access. Venous penetration was achieved in most cranial and spinal dural arteriovenous fistulas. Good penetration of tumour embolic bed was achieved with PHIL in hypervascular tumours.

Conclusion: PHIL appears to be an excellent liquid embolic agent with potential advantages compared to other liquid embolic agents currently available for use in neurovascular applications.

A Prospective Multi-Center Trial of TransForm™ Occlusion Balloon Catheter (TOBC): Trial Design and Results

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Purpose: To evaluate safety and efficacy of TransForm™ Occlusion Balloon Catheter (TOBC). It is the first prospective registry trial of Balloon-assisted coil embolization (BACE) for intracranial aneurysms.

Methods: The TOBC registry is a prospective multicenter registry trial. 7 sites in the USA and 1 in Spain were selected to enroll. Final analysis of data collected for 81 patients enrolled from November 2013 through January 2015 was performed.

Results: Mean age was 54.78yrs (SD ± 14.51). 30.86% were male. TOBC was used for BACE in 73.9%, test occlusion 5.7%, safety 9.1% and others (vasospasm and post flow divertor placement) 11.4%. Most common arteries where TOBC was used were internal carotid artery (35.9%), MCA (18.5%), ACA (13.0%) and BA (10.9%). Mean proximal vessel diameter was 3.29 mm (SD ± 1.19). Mean distal vessel diameter was 2.89 mm (SD ± 1.26). Most common contrast concentrations used were 70/30 (35.87%) and 50/50 (30.43%). Most common balloon types used were Compliant 4 × 10 mm (31.40%) and Super compliant 4 × 7 mm (17.64%). Most common guide wires used were Transend (54.9%) and Syncho14 (15.9%). Mean dome to neck ratio of the aneurysms treated was 1.31 (SD ± 0.69). 50% were at bifurcation, 45.8% of the aneurysms were sidewall and 4.17% were terminal aneurysms.

Following were the means scores*; for visibility under fluoroscopy 1.78 (SD ± 0.84), ability to reach intended site 1.59 (SD ± 0.78), stability during first positioning 1.54 (SD ± 0.63), stability during inflation 1.56 (SD ± 0.68), stability during deflation 1.57 (SD ± 0.64), ability to temporarily stop flow 1.55 (SD ± 0.67), ability to assist in coil embolization 1.71 (SD ± 0.80). Mean time to inflate the balloon was 4.85 seconds (SD ± 3.17) and mean time to deflate was 5.64 seconds (SD ± 4.53). Complete obliteration of the aneurysm (Raymond class I) was achieved in 69.44%. Thrombus formation occurred in 4/81 (4.8%) cases. In all cases thrombus resolved with medications and no patient suffered infarction. In all cases an underlying hyper coagulable state from subarachnoid hemorrhage was considered a contributing factor. Vessel rupture/perforation occurred in 1/81 (1.2%) case but was unrelated to TOBC.

Conclusions: BACE using TOBC was safe and effective. The balloon catheter performed as intended in the treatment of cerebral aneurysms in our cohort of patients. The short inflation and deflation times and ability to use a 0.014 guidewire allowed improved performance of this balloon catheter.

* 1 = Excellent, 2 = Very good, 3 = Good, 4 = Fair, 5 = Poor.

Changing the stiffness of vascular catheters intra interventional

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Purpose: Commercially available catheters for neurovascular interventions differ in the specific composition of the multiple layers, which in turn influence mechanical
properties like torque-, push- and trackability. High flexibility of catheters facilitates navigation to the target lesion especially in tortuous vessels, but on the other hand less support and pushability are drawbacks. We present a new catheter with modifiable elastic properties of the tip.

**Methods:** As opposed to standard neurovascular catheters, in the new catheter the low-friction inner layer is not firmly attached to the braided or coiled middle layer or the bio-compatible outer coating. On the middle layer a special nitinol braiding is attached on the tip. This nitinol braiding is only fixed to the inner and outer layer at the very distal end so that the inner layer is moveable inside the braiding (moving layer concept, MLC). A hand piece with a lever was attached to the inner and outer layer at the proximal catheter end. In the uncompressed state the MLC segment is highly flexible. Operation of the lever leads to compression of the nitinol braiding and thus to an increased stiffness.

**Results:** A first catheter prototype (4 F) with changeable stiffness was created. The braided MLC (40 mm) segment is highly flexible in the uncompressed condition. By pulling the steering lever of the hand piece, the braiding on the tip is compressed (30 mm) and the stiffness increases, release leads to flexibility again.

**Conclusion:** The MLC allows modification of mechanical properties of catheters without alter the lumen or the configuration of the tip. This new functionality may facilitate vascular interventions and is suitable for additional functionalities (e.g. bending) as well. The MLC can be miniaturized for the use in micro catheters.

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**Flow diversion with p64: safety parameters and occlusion rate in 130 saccular sidewall aneurysms**

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**Purpose:** Flow diverters are important tools for the treatment of intracranial aneurysms. We report a retrospective evaluation of the safety and efficacy of p64, a fully re-sheathable, detachable flow diverter, in the endovascular treatment of intracranial sidewall aneurysms.

**Methods:** Results of 121 patients with 130 aneurysms (neck 3 mm, fundus 4 mm, medians), treated from 4/2012 through 10/2014, were analyzed. Aneurysms were unruptured or beyond the acute SAH phase. Fifteen aneurysms were located in the posterior circulation. Twenty-three aneurysms had previous saccular treatment, but no previous parent vessel stenting. In 19 aneurysms a combination of coiling and flow diversion was performed.

**Results:** Successful p64 deployment was achieved in 127/130 aneurysms. The average number of p64 used was 1.1 per aneurysm. The rates of transient and permanent morbidity and mortality were 5%, 1.7% and 0.8%, respectively. Three month DSA follow-up in 123/130 aneurysms showed complete occlusion in 58.5%. Nine month DSA follow-up in 93/106 (87.7%) eligible aneurysms showed complete occlusion in 79.6%. Late follow-up (496 days, median) has already been performed in 35 aneurysms, showing complete occlusion in 30 (85.7%).

**Conclusion:** p64 offers an efficacious treatment option for intracranial sidewall aneurysms with a high aneurysm occlusion and an acceptable complication rate. The possibility to reposition or remove the device was appreciated. p64’s high density may lead to fewer devices per case and early aneurysm occlusion. Long-term follow-up data is pending.

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**Medina® coils in the treatment of wide neck intracranial aneurysms: Single-center Preliminary Experience**

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**Purpose:** We report our preliminary experience with the use of the novel Medina coils featuring a 3D configuration and an intrasaccular flow-disrupting effect for the treatment of wide neck bifurcation aneurysms.

**Methods:** From January 2015 to June 2015, 10 aneurysms in 9 patients (5 F, 3 M, mean age 58.8, range 35–72) were treated endovascular. Three aneurysms were treated at day 1 from a SAH and 7 were unruptured. Two patients had been treated previously for another ruptured aneurysm. Eight aneurysms were located at an arterial bifurcation; the remaining 2 were sidewall aneurysms. The sizes of the aneurysms ranged from 4–10 mm and they all had a dome/neck ratio >1.

No stents were used, one balloon. Medina coils were deployed through a triaxial system in all patients.

**Results:** In 3 cases complete or near complete exclusion of the aneurysm was achieved after 1 or 2 Medina coils. For the first cases, even if we had no intrasaccular circulation we put some coils (between 3–5) In 2 aneurysms (9 mm and 5 mm) we used only one medina coil.

We had a thrombus formation in the parent artery (A2) at 48 hours post treatment of an acutely ruptured Acom aneurysm that disappeared after Aspirin 75 mg/day intake. All aneurysms had complete or near complete occlusion after procedure. Clinical and angiographic follow-up at 6 month will be presented.

**Conclusion:** Our initial experience shows the Medina Coils as a promising, safe and effective tool the treatment of wide neck ruptured and unruptured aneurysms, especially on arterial bifurcations.
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Initial experience regarding intracranial balloon catheters with flat delivery systems
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Purpose: Balloons with flat delivery systems (BFDs), Eclipse 2L (E2L) and Copernic 2L (C2L, Balt, France) were developed as adjuncts to the treatment of cerebral aneurysms and arteriovenous malformations (AVMs). In contrast to the already available double-lumen microballoons, the flat delivery system in E2L enables the use of dual 6 mm balloons together with a microcatheter through conventional guiding catheter/sheath systems whereas C2L stands out as the only intracranial balloon catheter currently available through which flow diverters (FD) can be deployed. The purpose of this study is to report the first experience with BFD for the treatment of AVMs and intracranial aneurysms.

Methods: Ten patients with 11 aneurysms/AVMs who were treated using a BFD were retrospectively evaluated.

Results: Mean age was 47.9 years (range, 17–74 years; 8 women). There were no cases with permanent morbidity or mortality. The unique delivery system of BFD was compatible with 5 F distal access catheters and did not alter navigability during the procedures. In 3 AVMS (one spinal) BFD was used to treat macrofistulae with liquid embolic agents under flow arrest. Three aneurysms were treated with BFD-assisted coil embolization. C2L was used for FD delivery in 3 cases and wall apposition without a need for exchange manoeuvre 2 of these 3 cases. In 2 E2L was used after an exchange manoeuvre to appose a deployed FD.

Conclusion: In this case series, the newly developed BFDs appear to be safe and their performance was similar to regular double-lumen intracranial balloons. We expect that larger balloon and luminal diameters of BFDs will broaden the spectrum of intracranial application of double-lumen balloons.

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Emergent fractal structures in perianeurysmal blood flows
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Purpose: While in clinical practice, the natural history of unruptured aneurysms is estimated based on aneurysm geometry (such as size, shape and dome to neck ratio), flow conditions, such as wall shear stress (WSS) or the oscillation of the WSS may play a significant role. It is also known that flows inside pathologic vessels can turn chaotic. The fractal properties of chaotic blood flow in the vicinity of the aneurysmal sac are significantly influenced by both the geometric and hemodynamic features of the aneurysm. To better understand this effect, the presence and robustness of such chaotic behaviour was investigated.

Methods: The fractal properties of the aneurysms of 10 patients were examined. For each case, the geometry of the involved vessel section was segmented from DSA-Angiography records. Afterwards, a transient computational fluid dynamics (CFD) simulation was carried out to obtain the accurate flow field. The chaotic behaviour can then be extracted from computing the trajectories of small particles travelling in the bloodstream.

Results: The investigations showed that the chaotic behaviour was present in all aneurysmal flows to some extent. This effect was strongly reduced or vanished after reconstructing the vessel geometries to their pre-aneurysmal state. Several quantitative parameters of the emerging fractal structures were measured, such as the fractal dimension. This short investigation suggests a strong connection between the measurable fractal dimension and both the geometric and the fluid flow properties of the aneurysm.

Conclusion: The presence of an aneurysm imposes chaotic behaviour upon the blood flow in its vicinity. The fractal dimension of this behaviour incorporates several important properties of the aneurysmal segment and might be used as a quantification number.

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Bioactive vs. Bare Platinum Coils: The MAPS 5 Year Results
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Purpose: The Matrix and Platinum Science Trial (MAPS Trial) was initiated with two objectives. Firstly, this non-inferiority trial was designed to compare results of polymer-modified coils (specifically Matrix2 coils) vs. bare metal coils in the treatment of intracranial aneurysms. Secondly, the trial was intended to examine the correlation between angiographic results and clinical failure. Clinical failure was defined as “Target Aneurysm Recurrence” (TAR). TAR, a composite end point, was said to have occurred if any of the following events were observed: 1) Target aneurysm rupture after treatment (first or recurrent). 2) Sudden unexplained death. 3) Target aneurysm retreatment.
While previous randomized trials have compared bare metal coils to polymer-modified coils, none have included follow up beyond 2 years.

Methods: Details of the materials and methods have been published previously together with the findings at follow up after one year. (1) Briefly, this multicenter trial randomized 626 patients undergoing endovascular treatment for an intracranial aneurysm to either bare metal coils (BMC) or to biopolymer-modified coils (Matrix2). Both ruptured and unruptured aneurysms were included in the trial. Clinical and imaging follow up were obtained one year after treatment, and clinical follow up continued until completion of the study at 5 years. The primary outcome was TAR at 5 years. Imaging outcomes were based upon blinded independent core lab readings.

Results: At 5 years TAR was observed in 46 BMC patients and in 44 Matrix2 patients.

Ruptures of the target aneurysm occurred after treatment in 3 (1%) BMC and 2 (0.6%) Matrix2 patients.

Retreatment without rupture occurred in 42 (13.3%) BMC and 40 (12.9%) Matrix2 patients.

Sudden unexplained death occurred in 1 (0.3%) BMC and 2 (0.6%) Matrix2 patients.

After 5 years of follow up, TAR was observed in 18/176 (10.2%) patients that originally had immediate post procedure Raymond Grade I angiographic occlusion of their aneurysm. Similarly 11/128 (8.6%) patients that originally had immediate post procedure Raymond II angiographic occlusion experienced TAR as did 47/184 (25.5%) patients that originally had immediate post procedure Raymond III angiographic occlusion. 3/228 (1.3%) patients with ruptured aneurysms experienced rehemorrhage after coiling during their initial hospitalization. After 5 years of follow up only 2/626 (patients are known to have had target aneurysm rupture following discharge from hospital. Both of these patients had large aneurysms that were unruptured at the time of initial treatment, and both had Raymond III residual aneurysm filling at completion of treatment. For the MAPS trial the annualized rate of known delayed rehemorrhage after coiling was 2/398/5 = 0.001 (0.1%) per year for unruptured aneurysms and 0 for ruptured aneurysms.

Conclusion: While non-inferior to bare metal coils, no benefit to Matrix2 coils was demonstrated.

Residual aneurysm filling at the completion of aneurysm treatment (Raymond Score) is predictive of TAR (p < 0.0001).

Delayed rupture of coiled aneurysms is uncommon and in this study was observed only in aneurysms with residual filling of the aneurysm dome (Raymond III) after treatment.

Reference


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Remote intracerebral hemorrhage after endovascular treatment of unruptured cerebral aneurysms

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Purpose: Remote intracerebral hemorrhage (rICH) rarely occurs after endovascular treatment of unruptured aneurysms without any intraprocedural aneurysmal rupture or thromboembolic event. The authors collected data of rICH after endovascular treatment of unruptured aneurysm from multicenter registry and analyzed incidence, clinical characteristics and risk factors.

Methods: The cases with rICH were identified from the prospectively collected database from four university hospitals containing a series of 1844 unruptured aneurysms treated using endovascular methods during five years. Data related to this complication were retrospectively reviewed including incidence of rICH, demographic data, aneurysmal geometry (location, aneurysmal diameter and neck size), used stent, prescription of antiplatelet or anticoagulation agent, presentation of remote hemorrhage (onset time, location, and amount of hematoma), treatment of hematoma and clinical outcome (modified Rankin scale score at 30 days after ictus).

Results: Eleven patients (0.6%, 11/1844) had delayed rICH after uneventful aneurysmal coiling and were between the ages of 45 and 70 years (mean age 59.9 years). Among them, stent assisted coil embolization was performed in 8 cases (6 Enterprise and 2 Neuroform). Most rICH occurred within 10 days (n = 8, 72.7%) after procedures. rICH occurred more frequently as lobar hemorrhage (n = 9, 81.8%) than deep ganglionic hemorrhage (n = 2, 18.2%) (p = 0.035); and in ICA aneurysm (n = 8, 72.7%) than other territory (n = 3, 27.3%) (p = 0.020). Hematoma volume ranged 8 to 66 ml (mean: 36.5 ml) and seven of them (63.6%) needed surgical intervention. Most patients had aneurysmal neck size greater than 4 mm (n = 10, 90.9%, p = 0.007). Use of periprocedural dual antiplatelet (n = 9, 81.8%, p = 0.035) and heparin (n = 9, 81.8%, p = 0.035) were frequently observed in these patients group. Seven of the patients (63.6%) had poor outcome of mRS greater than 3.

Conclusion: Delayed rICH is rare but could complicate the clinical course even after successful coil embolization of unruptured aneurysms with or without stent insertion. The possibility of rICH should be also considered in addition to thromboembolic complication in case of delayed neurological change after uneventful coil embolization.
Comparison of clinical outcomes among 3 coiling generations in unruptured intracranial aneurysms

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Purpose: To evaluate relationship between coil types, packing density and recurrence in coil embolization of unruptured intracranial aneurysms (UIA).

Materials and Methods: From July 2008 to December 2013, 431 UIAs were treated. UIAs volume was measured by semi-automatic cerebral aneurysm measurement software—NeuroVision (Cybernet Systems, Tokyo, Japan) and explored the value of volume embolization ratio (VER). In 1st period (from July 2008 to Sep 2011), we used Matrix2 and GDC. In 2nd period (from Oct 2011 to Dec 2012), we used Matrix2, Target I and GDC. In 3rd period (from Jan 2013 to Dec 2013), we used Matrix2, Target I, II (Longer length), III (OD = 1.5 mm) and GDC (Stryker Neurovascular, Fremont, CA, USA). According to the volume, the aneurysms were divided into four groups. Groups A, B, C and D included small – less than 4.9 mm, medium – 5 to 9.9 mm, large – 10 to 14.9 mm and Giant – more than 15 mm aneurysms respectively. We compared VER (%) and retreatment ratios for these periods. Results by coiling generation were reported according to 1) Raymond classification at immediate after treatment and at 1 year and 2) TAR (Target aneurysm recurrence).

Results: Four hundred and twenty four UIAs were included in this study. VERs in each period were 24.5% in the 1st, 23.7% in the 2nd and 24.2% in the 3rd period. In Group A, VER in 3rd period (27.1%) was higher than that of other periods (24.9% in 1st period, 25.1% in 2nd period). In all groups, retreatment ratios after more than 1-year follow-up were 10% in the 1st, 6% in the 2nd and 3% in the 3rd period.

Conclusions: Evolution of coils may improve clinical outcome of coil embolization for UIA.

One hundred per cent endovascular management of intracranial aneurysms: Six-year, single center cohort study

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Purpose: Endovascular treatment strategies for intracranial aneurysms are gaining an increasing role in management of these lesions. While for ruptured aneurysms coiling is already established as emergency treatment choice, for unruptured aneurysms the rapidly evolving, wide choice of endovascular techniques has made it possible to treat every aneurysm by minimally invasive approach, no matter their localization and anatomic challenges.

Methods: We present a 6-year cohort of patients harbouring ruptured and unruptured intracranial aneurysms, managed 100% by endovascular means. From the 1st January 2009 until 31st December 2014, 723 patients with 776 aneurysms were treated. Clinical and imaging follow up (with MRI and DSA) ranged from 6 months to 4 years. Techniques used included simple coiling, balloon-assisted coiling, double balloon remodelling, stent jailing techniques, remodelling with subsequent stenting, Y and T stenting techniques, flow diversion with or without adjunctive coiling and parent artery sacrifice.

Results: Total number of embolization sessions was 823. All endovascular procedures were feasible. Six-year overall mortality rate was 3.3% for the cohort, overall procedure-related complications were of 4.8%. Annual percentage of surgical hematoma evacuation was 1.1%. Treatment strategies according to the clinical presentation, imaging data, patient history and anatomical challenges are discussed. Statistical analysis of the cohort, subgroup analysis and time trends are presented, as well as hospitalization length and cost.

Conclusion: Endovascular management of intracranial aneurysms is feasible in all cases nowadays. With careful choice of the technique, anatomic results are complete and stable over time, with good clinical outcomes.
Analysis on HR-MRI Features, Treatment Strategies and Follow-up of Vertebrobasilar Dissecting Aneurysms

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Purpose: The treatment opportunity and strategies of vertebrobasilar dissecting aneurysms is still in dispute. This paper analyzed the different features in HR-MRI of vertebrobasilar dissecting aneurysms, when the angiography showed the same result, and their role in treatment opportunity and strategies.

Methods: 47 patients with Vertebrobasilar Dissecting Aneurysms who were diagnosed by CTA or DSA and underwent treatment in Beijing Xuan Wu Hospital between August 2013 and September 2014 were enrolled and evaluated. Clinical and follow-up data were collected. Follow-up date included clinical follow-up and image follow-up. Results in 47 cases, vertebral arteries were simply involved in 31 cases, and basilar arteries were involved in 16 cases. The imaging date pre and post treatment include CT, CTA, DSA.

Results: Four features of Fusiform enlargement vertebrobasilar dissecting aneurysms diagnosed by angiography could be found by HR-MRI, including thick wall with no thrombus type, thick wall with thrombus type, pure thin wall type, dual-chamber or intimal flap type. Individual treatment strategies could be made, according to the four features in combination with enhancement in different regions of aneurismal wall. The reexamination by HD-MRI at half year after operation in 3 cases showed the intima grew along the surface of the stent, and angiography showed the aneurysms were cured. The reexamination by HD-MRI at 3 month after operation in 1 case showed intima partially grew, and angiography showed a residual aneurysm. The reexamination by HD-MRI at half year after operation in that case showed intima completely covered the aneurysm neck, and angiography showed the aneurysm was cured.

Conclusion: HD-MRI can observe the vessel wall of vertebrobasilar dissecting aneurysms clearly and have guiding significance for treatment strategies and opportunity. Dissecting aneurysms involved basilar arteries have worse outcome than dissecting aneurysms simply involved vertebral arteries.

Quantitative Assessment of Giant Intracranial Aneurysm after Flow Diverting Stent using Volumetric CT Angiography

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Purpose: Flow diverting stent provides a safe and efficacious treatment for giant intracranial aneurysms, resulting high occlusion rate and low incidence of complication. Angiographic follow-up is necessary to determine the optimal treatment that leads to the highest rate of obliteration and the best clinical outcome. We present a case of the giant thrombosed aneurysm treated with Pipeline Embolization Device and follow-up assessment of residual sac change on volumetric CT angiography.

Methods: Conventional CT angiography was obtained with 256 MDCT. Volumetry including volume data (mm³ with HU) and 3D volume rendering images was performed by semi-automated methods on dedicated workstation.

Results: Sixty-two year-old female with a giant, thrombosed, right cavernous internal carotid artery aneurysm (25 mm in maximal diameter, 5.5 mm neck) was treated with endovascular obliteration using a single PED. A completion angiogram with Dyna CT showed appropriate position of the PED in relation to the aneurysm with decreased jet flow. Patient was premedicated with clopidogrel 75 mg and aspirin 100 mg daily for 1 week prior to the procedure and followed after PED. Preoperative aneurysm volume was measured 3883.8×10⁻³ mm³ (except of thrombosed portion, 100%) and progressive shrinkage was observed at 1 week after PED (756.6×10⁻³ mm³, 19.5%). However, aneurysm volume was inversely increased with morphologic change at 1 month (1385.4×10⁻³ mm³, 35.7%) and at 3 months (1565.7×10⁻³ mm³, 40.3%). There was no stent shifting or endoleak on CT angiography. We presumed patient's coagulant status might be the cause of progressive aneurysm recanalization. We decided to change anti-coagulant of low dose aspirin alone and further follow-up. Aneurysm steadily decreased in volume at 4 months (954.7×10⁻³ mm³, 24.6%) and a small remnant at 6 months (413.6×10⁻³ mm³, 10.6%). On the basis of sequential CT scans with volumetry, we decided to further follow-up rather than apply additional PED. Patient was uneventful during follow-up period.

Conclusion: Quantitative assessment of residual sac change using volumetric CT angiography is feasible method for determine optimal treatment in patient of PED.
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New measurement methods of flow disrupters
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Purpose: Woven flow disruptors (FDR) are being increasingly used to treat bifurcation aneurysms. Unlike flow diverters (FD), these devices produce a flow resistance across the neck of the aneurysms from inside the aneurysmal sac. Similar to FD-s, the effect is strongly dependent on the Metal Surface Area (MSA) produced by the device within the neck. Due to the woven nature of FDS-s, the effective MSA is influenced by compression of the device. As in the clinical practice FDR-s are generally oversized, the sub-sequent compression may impact the actual effect of the FDR. The purpose of this study was to investigate the relationship between compression and MSA (Pierot, 2014).

Methods: One double-layered (DL) (ø7 mm) and two single-layered (SL) (ø6 mm and ø9 mm) WEB implants were studied. The MSA changes were measured by tensile test machine after 30% and 60% radial compression of the implants (compared to its expanded diameter) using stereo microscopic images. The examination windows had the same dimensions. After compression, the metallic covered surface area within the window was determined. Moreover, with these results, the whole MSA was calculated.

Results: The MSA of the proximal surface of the non-compressed DL implant was 20.8% and that of the SL devices 21.7% and 27.3%. Following 30% radial compressions, the MSA of the DL FDR increased by 2.4%, while that of the single-layered implants by 5.4% (ø6 mm) and 3.8% (ø9 mm) respectively. Compression 60% further increased the MSA value of the DL device by 3%, and the SL devices by 16% (ø6 mm) and 60% (ø9 mm) respectively.

Conclusion: Oversizing and subsequent device compression increases the effective MSA of FDR-s. This may positively impact the clinical results.

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A fast blood flow simulation method for patient specific vessel geometries
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Purpose: The computational fluid dynamics (CFD) simulation of the emergent flow field inside vessels is a generally employed technique that has several applications from virtual stenting to stenosis quantification. The current mainstream methods carry specific properties that significantly limit their application in medical practice. We propose a complete solution that targets several of these shortcomings by making the preparation of the numerical mesh more automated while reducing the average runtime to a clinically relevant time-scale on a single desktop workstation.

Methods: A study involving 10 patients with intracranial aneurysm was carried out using the presented fast simulation method. The vessel geometries were obtained from DSA-Angiography records. The segmented meshes of the geometries were considered as the input. The CFD solver is based on the lattice Boltzmann method which is known to be a highly parallel numerical scheme. To take advantage of this property, the solver was implemented for graphics processing units (GPUs), which excel at executing parallel computations. Depending on the use-case, either a stationary velocity snap-shot or the full transient cardiac cycle can be computed. In our study the run-times for both stationary and transient cases were evaluated.

Results: Using a commonly available single workstation configuration with the average numerical cell number of 3 million for the numerical meshes, each transient simulation was completed in less than 15 minutes while the stationary ones were completed in less than 3 minutes. The sole human interaction required for the process, the selection of the boundary conditions, might add a few minutes at most to the total investigation time required for one patient.

Conclusion: The numerical blood flow simulation short study demonstrates that with the proper methods the computation can be carried out in clinically relevant time-scale on a single workstation with moderately little required human interaction.
An ongoing study to assess whether knowledge of the prices of the different coils has an impact on the cost of coiling

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Purpose: Endovascular treatment of aneurysms with coils is among the most frequent treatment in interventional neuroradiology (INR). The cost of coils, and the number of embolizations per year make it a very important expense for each INR centre. Each manufacturer has created several types of coils, and, like in our centre, prices can vary a lot from one brand to the other and from one type of coil to another. In our hospital, we have a wide variety of coils available from several companies. Prices are not negotiated by physicians but by the administrators; and from September 2015 to September 2016, we had the insurance from them that prices would not change. We wanted to assess whether giving the coils price sheet to each operator would have an impact on the cost of their interventions.

Methods: We retrospectively reviewed all the aneurysms coilings in our centre from September 2014 to February 2015. Physicians were not aware of the price of each coil back then. We gathered all the data related to the coils used for each patient, and calculated the price of each embolization. Since March 2015, physicians have been given the price sheet containing all the information regarding the price of each available coil. They were asked to look at this sheet every day in the morning. They were given no other recommendation but to always choose the coil which they found to be the most accurate for each situation.

Results: Eight of the 11 unstable aneurysms increased in size after follow-up. The remaining 3 aneurysms decreased in size. Growing aneurysms demonstrated a median increase of all 3D morphological parameters, indicating an increased risk of rupture. Changes in the aspects ratio and the bottleneck factor were most prominent. Changes in shape parameters for the shrinking aneurysms were inconsistent.

Conclusion: In growing aneurysms, the greatest increase was observed for the aspects ratio and the bottleneck factor, suggesting that these parameters are the most robust for growth and rupture risk assessment.

Three-dimensional morphological changes in unstable intracranial aneurysms

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Purpose: Growth of intracranial aneurysms has previously been associated with aneurysmal rupture. Little is known about the 3D morphological changes of growing aneurysms over time. In this study we investigated changes in morphological characteristics after growth to identify associations with rupture risk.

Methods: From 9 patients with a total of 11 unstable aneurysms, 3D vascular models were created at baseline and at follow-up. All aneurysms were isolated from the vasculature by manually defining the aneurysm neck planes. Six 3D morphological parameters were assessed; aspects ratio, bottleneck factor, height-width ratio, undulation index, ellipticity index, and the nonsphericity index.

Results: Eight of the 11 unstable aneurysms increased in size after follow-up. The remaining 3 aneurysms decreased in size. Growing aneurysms demonstrated a median increase of all 3D morphological parameters, indicating an increased risk of rupture. Changes in the aspects ratio and the bottleneck factor were most prominent. Changes in shape parameters for the shrinking aneurysms were inconsistent.

Conclusion: In growing aneurysms, the greatest increase was observed for the aspects ratio and the bottleneck factor, suggesting that these parameters are the most robust for growth and rupture risk assessment.

Endovascular treatment of very small (<2 mm) intracranial aneurysms

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Purpose: Coiling of very small aneurysms is controversial because of a potential high risk of procedural rupture. This risk can potentially be reduced using very small and soft
coils. The purpose of this study was to report on clinical and angiographic results of coiling of aneurysms of 2 mm or less using Target nano coils.

Methods: Between April 2013 – April 2015 a total of 11 patients with 11 very small intracranial aneurysms (10 ruptured, 1 additional unruptured) were treated with a single Target nano coil. Aneurysm locations were Acom (n = 4), pericallosal artery (n = 1), MCA (n = 2), SCA (n = 1), Pcom (n = 2) and PICA (n = 1). Aneurysm size varied between 1.5–2 mm. Ten patients were female. Mean age was 58.6 years (range 44–69 years).

Results: Complete occlusion with 1 coil was achieved in all patients after coiling and persisted at 6 months follow-up imaging. One procedural rupture occurred without clinical sequelae. All patients were functional independent at 6 months follow-up.

Conclusion: Good clinical and angiographic results of endovascular treatment of very small aneurysms are obtained with the use of Target nano coils.

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Procedural and angiographic outcomes in a cohort of 210 patients with 238 anterior cerebral artery aneurysms treated with modern endovascular technology

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Purpose: Endovascular treatment is becoming first-line therapy for cerebral aneurysms. We aimed to analyze treatment outcomes in a consecutive cohort of patients with anterior cerebral artery (ACA) aneurysms treated with modern endovascular technology at a comprehensive stroke center.

Methods: We analyzed baseline characteristics, procedural variables and outcomes in patients with ACA aneurysms treated endovascularly at our institution from January 1st, 2008 until November 30th, 2014.

Results: 210 patients with 238 aneurysms were included, 126 females (60%), 152 smokers (72%), 122 had hypertension (58%), 45 had brain aneurysm family history (21%), and 87 presented with subarachnoid hemorrhage (41%). 27 procedures were re-treatments of previously-endovascularly-treated aneurysms (11.3%). Aneurysm location was 189 anterior communicating artery (79%), 23 pericallosal artery (10%), 18 A1-segment (8%) and 8 A2-segment (3%). Mean aneurysm size 5.4 mm, mean neck size 2.8 mm and mean dome-to-neck ratio 1.6. 234 aneurysms were treated successfully (98.3%), 167 with balloon-neck-remodeling (71%), 36 simple-coiling (15%), 23 stent-assistance (10%), 6 Pipeline (3%), and 2 parent-artery-sacrifice (1%). Mean packing-density in successfully-coiled aneurysms was 37.5%. Intra-operative complications included 9 aneurysm ruptures (3.8%), 5 leading to a new permanent neurological deficit (2.1%); and 22 thromboembolic events (9.2%), 1 leading to a new permanent neurological deficit (0.4%). Post-operative complications up to 30 days included 2 delayed aneurysm ruptures (0.8%) and 1 ipsilateral intracerebral hemorrhage (0.4%), none leading to a new permanent neurological deficit; and 18 thromboembolic events (7.6%), 12 leading to a new permanent neurological deficit (5%). 30-day treatment-related permanent morbidity/mortality was 7.6%. Angiographic follow-up was completed in 212 aneurysms (91%), mean time to last-follow-up 27 months. 119 aneurysms had Raymond 1 (56%), 78 Raymond 2 (37%) and 15 Raymond 3 (7%) occlusion at last-follow-up. 14 aneurysms were re-treated (6.6%).

Conclusion: Endovascular treatment of ACA aneurysms with modern technology is safe and effective, with low medium-term re-treatment rates.

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Follow-up of intracranial aneurysms treated by SILK flow diverter: comparison of three-dimensional time-of-flight MR angiography (3D-TOF-MRA) and contrast-enhanced MR angiography (CE-MRA) with digital subtraction angiography (DSA) as the gold standard

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Purpose: Follow-up of intracranial aneurysms treated by flow diverter with MRI is complicated by imaging artifacts produced by these devices. This study compares the diagnostic accuracy of three-dimensional time-of-flight MR angiography (3D-TOF-MRA) and contrast-enhanced MRA (CE-MRA) for the evaluation of aneurysm occlusion and parent artery patency after flow diversion treatment, with digital subtraction angiography (DSA) as the gold standard.

Methods: Patients treated with SILK flow diverter between August 2012 and October 2014 followed by MRA (3D-TOF-MRA and CE-MRA) and DSA within 3 weeks period were retrospectively reviewed from a prospective single-center database. Aneurysm occlusion was assessed with full and simplified Montreal scales and parent artery patency with two-grade scales.

Results: Twenty-two patients harboring 23 treated aneurysms were included. Interobserver agreement using simplified scales for occlusion (Montreal) and parent artery patency were higher for DSA (0.88 and 0.61) and CE-MRA (0.74 and 0.55) than for 3D-TOF-MRA (0.51 and 0.02). Intermodality agreement was higher for CE-MRA (0.88 and 0.32) than for 3D-TOF-MRA (0.59 and 0.11). CE-MRA yielded better accuracy than 3D-TOF-MRA for aneurysm remnant detection (sensitivity 89% vs 50%; specificity 100% vs 100%) and for the status of the parent artery (specificity 63% vs 32%; sensitivity 100% vs 100%).
Conclusion: At 3[1]/T, CE-MRA is superior to 3D-TOF-MRA for the evaluation of aneurysm occlusion and parent artery patency after flow diversion treatment. However, intraluminal evaluation remains difficult with MRA regardless of the sequence used.

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Estimating the factors for recanalization of cerebral aneurysm using computational flow dynamics.: A Multicenter registry study in Japan
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Purpose: To establish factors for recurrence of embolized aneurysms by computational flow dynamics (CFD) simulation.

Methods: Eighteen institutes in Japan participated in this study, registering patients with cerebral aneurysms. Primary endpoint was recanalization or retreatment of target aneurysm within a year. Computational fluid dynamics analysis was performed using DICOM data extraction from pre-embolization 3DDSA. CFD parameters were compared between recanalized and non-recanalized aneurysms.

Results: From April 2012 to March 2014, 273 patients (273 aneurysms) were enrolled. Nine patients were lost to follow up and excluded, leaving a total of 264 aneurysms for analysis. Thirty-two aneurysms (12%) aneurysms reached primary endpoint. Thirteen aneurysms (5%) were retreated and 19 aneurysms (7%) recanalized without retreatment. Primary endpoint was reached in 6% of the “less than 5 mm” group, 11% of “5–9.9 mm” group, 32% of “10–14.9 mm” group and 33% in “over 15 mm” group. Aneurysms of Vertebral artery, ICA dorsal, ICA top and Basilar tip reached primary endpoint in 33%, 25%, 20% and 20%, respectively. Parameters of CFD, such as wall shear stress (WSS), pressure loss coefficient (PLc), Mass flow rate (MFR), were also analyzed.

Conclusions: Terminal type aneurysms had the tendency to recanalize after coil embolization. CFD analysis before coil embolization might be an useful tool to predict recanalization.

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Usefulness of the Motion Correction technique in the follow up of intracranial coiled aneurysm
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Purpose: To evaluate the usefulness of the Motion Correction technique in the 3D rotational angiography for following up of intracranial coiled aneurysms.

Methods: We reviewed 35 consecutive follow up digital subtraction angiographies (DSA) after coiling of intracranial aneurysms (follow up periods were 6–66 months, mean: 15.3 months). 3D rotational angiographies (3D-RA) were performed in all DSA. We compared the agreement between pre-motion correction and post-motion correction with reference standards of 3D-RA. Reference standards were made comprehensively with DSA 2D images and MRA images including TOF source images.

Results: The 3D-RA without motion correction showed 48.6% agreement with the reference standard images while the motion corrected 3D-RA showed 77.1% agreement with the reference standards. (p < 0.05, chi-square test).

Conclusion: Using motion correction appears to improve the accuracy of 3D rotational angiography in the follow up of intracranial coiled aneurysms.

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Endovascular Treatment of Residual Intracranial Aneurysms after Microsurgical Clipping: Report of 17 Cases
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Purpose: Residual or recurrence of aneurysms after microsurgical clipping is associated with a significant risk of regrowth or rupture. The incidence is reported to be 2 to 5% in the literature. We evaluated our data regarding endovascular treatment of previously operated aneurysm cases from several hospitals between 2012–2015.

Methods: The study group includes 17 patients who had previous operation for aneurysm surgery. 2 operations ended up without any clip placement whereas in 15 of the cases a clip or multiple clips were placed at or near the aneurysm neck. Six patients presented with rehemorrhage due to residual aneurysms whereas others were diagnosed on follow up angiograms. Aneurysm localizations include M1 and MCA in 7, A2-A3 junction and ACoM in 3, ICA PCoM in 4, ICA-ICA ophthalmic segment in 3 cases.
Median aneurysm size of residual aneurysms was reported to be 7 millimeter.

**Results:** Stent assisted coiling was the preferred treatment modality in 8 cases (2 Leo, 6 Leo+ baby stent). Seven patients were treated with flow diverter or flow diverter assisted coiling (5 Silk and 2 Surpass flow diverter). Two patients were treated with primary coiling. Time interval between initial open surgery and endovascular treatment was reported to be 7 months (Range 1–145 months).

**Conclusion:** Flow diverting stents might be used for residual aneurysms of the supraclinoid ICA whereas stent assisted coiling or primary coiling might be a feasible alternative distal to ICA bifurcation. Perforators near A1-ACoM junction and M1 segment limits the use of flow diverters in the treatment of residual aneurysms distal to the ICA bifurcation. Management of aneurysms after microsurgical clipping was reported at seldom. Despite the substantial risk associated with previously operated vessels, remnants might be effectively treated with endovascular measures. Endovascular route is a safe and durable treatment option for postsurgical residual aneurysms.

**Purpose:** To evaluate the potential diagnostic value and radiation dose reduction achieved from use of a novel Volume-of-interest (VOI) C-arm CT (CACT) technique for imaging of intracranial stents and flow diverters.

**Methods:** Twenty-seven patients were imaged using a VOI CACT scan following treatment with a flow diverter or stent assisted coiling. The radiation dose-area-product (DAP) was recorded for VOI scans. For comparison, the DAP from 30 previously acquired consecutive full view DynaCTs was used. Thermoluminiscence dosimetry (TLD) using 35 evenly distributed TLDs in an anthropomorphic head phantom was also performed using both a conventional full field and VOI acquisition. Three observers were presented with VOI images for assessment of potential diagnostic value.

**Results:** DAP measurements showed an exposure reduction of 85% compared to the full field acquisitions used for comparison. The TLD evaluations also showed a considerable dose reduction of 79.8% throughout the volume. For most of the evaluated cases, the observers felt that diagnostically useful information was provided by the VOI images (x̄ = 0.810). Visualization of device details such as extent of opening, positioning, wall apposition and aneurysm coverage was judged of good diagnostic quality for most cases (88.9%–92.6%).

**Conclusion:** In this study VOI CACT provided high quality diagnostic images of intracranial stents and flow diverters at a significant reduction of radiation exposure. Image content was felt to add useful information. It is a promising method to assess device status during procedures and at follow-up.

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**Intravenous three-dimensional digital subtraction angiography for the evaluation of residual aneurysm following surgical clipping**

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**Purpose:** Catheter based intra-arterial cerebral angiography remains the diagnostic tool of choice to evaluate treated aneurysms owing to the mitigation of metal artifact that limits non-invasive aneurysm obliteration. While intra-arterial angiography is a low-risk procedure, major complications may occur. We present our experience with intravenous three-dimensional digital subtraction angiography (IV 3D DSA) as a non-invasive and rapid alternative for intra-arterial catheter based angiography for the evaluation of residual aneurysm following surgical clipping.

**Methods:** 30 patients underwent IV 3D DSA following surgical clipping. Contrast was administered through at least an 18 guage antecubital intravenous line. Comparison of the reconstructed images was made to the preoperative vascular imaging and indocyanine green intraoperative videoangiography performed post-clipping. In cases where the target lesion was not well visualized, conventional angiography was performed with 3D DSA. Variables such as injection parameters, intravenous access type, reconstruction algorithm, rupture status, and cardiac output (when available) were measured.

**Results:** IV 3D DSA visualized the clipped aneurysm sufficiently well to comment on extent of aneurysm occlusion in 97% (29/30) of cases. Variables correlating with improved image quality include larger intravenous catheter size, central line catheter location, normal cardiac output, and motion correction algorithm.

**Conclusion:** IV 3D DSA is a feasible alternative to intra-arterial angiography for the detection of aneurysm residual post- clipping. The injection timing, protocol, reconstruction algorithm, catheter size, and cardiac output affected the quality of the IV 3D DSA.
The Effect of Flow Diverters on Haemodynamic Characteristics in Intracranial Aneurysms

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Purpose: Flow diverters (FD) are designed to reduce aneurysm flow. Whilst FD treatment has proven to show relative success throughout most cases, the outcome produced remains variable for certain patients, for reasons unknown. Computational fluid dynamics (CFD) has been employed as a tool to facilitate a better understanding the haemodynamic effect of deployed FD, and thereby assist in more optimised clinical decisions. This study specifically focuses on the ways to validate the accuracy of haemodynamic simulation results by using Particle image velocimetry (PIV) measurement technology.

Methods: FDs were implanted into two patient specific silicone aneurysm models; one was successful and another unsuccessful case (residual aneurysm was observed after six month follow-up). The flows inside of aneurysm before and after FDs were measured by using PIV technology. The flow measurement results were used to validate the porous medium method which introduced in previous CFD simulation1.

Results: The flow resistance forces of FD were measured by PIV at same conditions as CFD simulations. The results indicated that the resistance efficiency which we selected in our previous CFD simulation was relatively reliable.

Conclusion: In order to assure that FD treatment is successful, the flow resistant force of the FD stent must be larger than dynamic force. On the other hand, the high speed jet flow is another reason behind residual aneurysm. Thus, a method to reduce jet flow speed is of vital importance for FD design and treatment. In addition, by numerically embedding a porous medium layer to represent the FD in the parent artery, it makes possible to predict the outcome of FD treatment to aneurysm using small size of computer and short time.

Reference

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Utilization of “RAPID” CT Perfusion in Treatment of Acute Ischemic Stroke (AIS): A Community Hospital Experience in California, United States

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Introduction: In AIS patients, early recanalization and appropriate patient selection influence the clinical outcomes. “RAPID” CT/MRI perfusion technology was used in SWIFT-PRIME and EXTEND-IA trials. We report our experience utilizing RAPID at our comprehensive stroke center.

Methods & Material: RAPID imaging processing was instituted in May 2015. We are reporting data only on patients who underwent RAPID from May 16 to July 31, 2015. Utilizing Get with the Guidelines parameters, patients were divided into two groups: Group A - IV tPA Group B - Mechanical Embolectomy (MER) and/or intra-arterial thrombolysis IA. Devices used: Trevo Solitaire.

Results: RAPID: 33 positive studies.
Total Group A = 6 (18%) Group B = 5 (15%).
Group A: NIHSS: Admission: 1–11, mean 5, Discharge 0–5, mean 2.
Time: Onset to tPA 126 minutes, DTN 53 minutes.
RAPID core: < 1 cc = 5, 1.5 cc: 4, 2.7 to 113 cc: 3 Tmax > 6 seconds.
Group B: NIHSS: Admission: 4–20, mean 9, Discharge: 0–13, mean 5.
Time: Onset to MER 240 minutes, Door to MER 193 minutes.
RAPID core: < 1 cc = 2, 1.5 to 16.3 cc = 3 Tmax > 6 seconds from 2.7 to 81 cc.
TICI III = 3, TICI IIB = 1, TICI 0 = 1.

Conclusion: RAPID CT perfusion helps identify who will benefit most from MER. We used RAPID in choosing patients for IV tPA alone or ME. Tmax > 6 seconds was significantly high in patients undergoing ME than patients treated with intravenous tPA. Both groups did well clinically. Despite the small number of patients, the discharge NIHSS improved. As we gain experience with RAPID, we will develop algorithms to determine appropriate therapy. The technology is sensitive to motion artifact causing false positive results which need to be recognized. RAPID simplified and streamlined the post-processing for CT perfusion.
Multicenter Analysis of Penumbra Coil 400 System for Treatment of Wide-Neck Unruptured Intracranial Aneurysms


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Purpose: Endovascular coil embolization with adjunct devices is routinely used to treat unruptured wide-neck intracranial aneurysms. Ability to achieve desirable results without the need for adjunct devices can reduce procedure time, cost, and need for antiplatelet therapy. The Penumbra Coil 400™ system (PC400) is a new generation of 0.020" diameter platinum coils designed to enhance filling efficiency, effectiveness, and safety. Reported herein are results from a post-hoc analysis of the PC400 Aneurysm Coiling Efficiency (ACE) multicenter registry comparing coiling alone (CA) to stent-assisted coiling (SAC).

Methods: PC400 registry is a prospective study of patients with intracranial aneurysms who are treated with the PC400 System. This analysis pertains only to patients with unruptured and wide-neck aneurysms from the PC400 registry.

Results: Median (IQR) dome width in 46 aneurysms in the CA arm was 8 [6.9, 10.6] with 5.5 [4.5, 6.5] neck diameter, which are comparable to published results requiring SAC (Hetts et al., 2014; Villwock et al., 2015). The 24-hour complication rate was 0% and compared to SAC controls, CA required 49.9% less mean time (p < 0.0001). Adequate occlusion in the CA arm was achieved in 58.7% of aneurysms post-procedure, 70.6% at 6 months, and 100% at 1 year. Retreatment rate at 1 year was 0%.

Conclusion: This cohort from the ACE registry suggests that CA with the PC400 as monotherapy can provide similar acute effectiveness results when compared to SAC. This is associated with fewer procedural complications, lower costs, and a durable complete occlusion at 1 year. More patients with long-term follow up are required to confirm these findings.

References

Clinical Application of Insertion Force Sensor System for Coil Embolization of Intracranial Aneurysms

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Purpose: In an endovascular coil embolization for an intracranial aneurysm, it is important to adequately control the coil insertion force. However, mechanical stress caused by coil insertion force could only be subjectively detected by the subtle tactile feedback experienced by the interventionalist inserting the coil. The authors envisioned a system that would objectively register and quantify the coil insertion force. In this article, coil insertion force was measured in the clinical cases of unruptured intracranial aneurysm using this sensor, and actual clinical application was investigated.

Methods: The sensor consists of a hemostatic valve connected to the proximal end of a microcatheter. The sensor principle is based on an optical system. Using this, aneurysm coil insertion force could only be subjectively detected by the subtle tactile feedback experienced by the interventionalist inserting the coil. The authors envisioned a system that would objectively register and quantify the coil insertion force. In this article, coil insertion force was measured in the clinical cases of unruptured intracranial aneurysms using this sensor, and actual clinical application was investigated.

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Results: The sensor adequately recorded the coil insertion force during the actual clinical aneurysm embolizations and that reflected the usual clinical experience at hand. The presence of the sensor did not affect the procedures. In framing, insertion force was elevated according to the coil movement but did not much exceeded. In filling, the record showed a sinusoidal pattern and the force was not elevated. In finishing, insertion force tended to be elevated especially when coil did not smoothly advance into the coil mass.
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Utility of a method of preoperative planning in the intervention of unruptured cerebral aneurysms: comparative exploratory analysis in two groups of patients

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Purpose: To evaluate a method of preoperative planning for the intervention of unruptured cerebral aneurysms.

Methods: In this observational study, two groups for intervention of unruptured cerebral aneurysms were compared: twenty patients with a planning method and twenty with no specific planning method. In the group allocated to preoperative planning, a rotational cerebral angiography was performed, with consequent 3D reconstruction of images obtained by segmenting and smoothing the area of the aneurysm-related cerebral circulation; these images were the basis for hemodynamic analysis by the method of computational fluid dynamics (CFD). Finally, once geometric, anatomic and hemodynamic characteristics of the aneurysms and related circulation were defined, a silicone model was obtained using a 3D printer, in scale 1:1. With the complete information and utilizing this patient-specific silicone model, the intervention was planned and simulated for one of three methods, according to the criteria of the specialist: clipping, coiling or stenting. The results in both groups of patients (planning: yes / no) were compared with three end points: major perioperative complications, operative time and comfort of the neurosurgeon/interventionist.

Results: Although the results in terms of prevention of major perioperative complications showed that there were no statistically significant differences in the two groups, there was a significant reduction in operating time in favour of the group in which the system of preoperative planning was applied. In like manner, both neurosurgeons and interventional specialists expressed to feel themselves more comfortable during the intervention when they had applied a preoperative planning method.

Conclusion: The preoperative planning systems based on 3D images and 3D printing offer to the neurosurgeon and endovascular interventionist the opportunity to better understand their patient’s lesion, develop a strategy in advance to prevent errors and, although not necessarily reduce complications, do increase the comfort and significantly shorten the operating time.

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Bioactive versus Bare Platinum Coils for the Endovascular Treatment of Intracranial Aneurysms: Systematic Review and Meta-analysis of Randomized Clinical Trials

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Purpose: Bioactive coils have been introduced in 2002 in an attempt to improve aneurysm healing and durability of angiographic results. Evidence demonstrating superior efficacy to justify routine use of bioactive coils over bare coils is lacking. To compare periprocedural and clinical outcome after bioactive versus bare platinum coil for intracranial aneurysms.

Material and Methods: MEDLINE, EMBASE, Cochrane Library and ISI web of Knowledge CPCI-S were searched for randomized clinical trials (RCTs) comparing bioactive versus bare coils. The methodological quality was evaluated to assess bias risk. Periprocedural outcomes and mid-term outcomes were compared.

Results: Five distinct RCTs comparing bioactive (n = 1084) versus bare coils (n = 1084) were identified. Periprocedural outcome was similar for both groups. Bioactive coiling increased the rate of complete aneurysm occlusion (47% vs 40%; RR 1.17; 95% CI [1.05, 1.31]; P = 0.006) and reduced the rate of residual aneurysm neck at 10 months compared to bare coiling in the mid-term (26% vs 31%; RR 0.82; 95% CI [0.70, 0.96]; P = 0.01). There were no differences in aneurysm recurrence, aneurysm rupture, stroke, neurological death, modified Ranking Scale and reinterventions. Subgroup analysis for the three RCTs on hydrogel coils demonstrated reduction of residual aneurysms compared...
to bare coiling (25% vs 34%; RR 0.76; 95% CI [0.58, 0.99]; P = 0.04).

**Conclusion:** Bioactive coils ensure a higher rate of complete aneurysm occlusion, while reducing the rate of residual neck aneurysms compared to bare coiling in the midterm. Hydrogel coils reduce residual aneurysms compared to bare coils. Whilst there is level 1a evidence to show more complete aneurysm occlusion, longer term follow-up is needed to determine if this translates to clinical significance.

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**Surgical treatment for recurrent aneurysms after initial endovascular coil embolization**

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**Purpose:** To assess the efficacy and safety of surgical treatment for recurrent aneurysms after previous embolization, the authors retrospectively studied angiographic results, clinical results, and complications in patients treated with additional surgery.

**Materials and Methods:** Ten patients with recurrent aneurysms were treated with microsurgical treatment.

**Result:** This series included one man and six women received endovascular coiling as the first-line treatment. Tow was unruptured and eight were ruptured. The aneurysm locations were posterior communicating (n = 3), anterior communicating (n = 4), ophthalmic (n = 2), posterior inferior cerebellar (n = 1). The initial size ranged 3.0 to 21.5 mm in greatest diameter (mean, 7.7 mm), and aspect ratio was 1.2 to 3.4 (mean, 2.1). In these aneurysms, the initial coiling result was complete occlusion in six patients, neck remnants in four patients. The mechanism underlying aneurysm recurrence was coil compaction in five aneurysms, aneurysm regrowth in four aneurysms, and fundal migration in one aneurysm. The median recurrence latency was 24.1 months (0.7 to 115 months). Microsurgical clipping without coil removal were used in eight patients, trapping under bypass protection was done in two cases of posterior inferior cerebellar aneurysm and ophthalmic aneurysm. No operative morbidity was observed, and postoperative angiography revealed complete aneurysms occlusion in all cases.

**Conclusion:** The microsurgical clipping of recurrent lesions of embolized aneurysms is effective and safe when it is technically feasible. For unclippable lesions, trapping under bypass protection should be taken into consideration.

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**Endovascular Treatment Result of Intracranial Aneurysm in Young Patients**

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**Purpose:** Ruptured and unruptured intracranial aneurysms are relatively rare in young patients, and their treatment modality between surgical neck clipping and endovascular coil embolization is chosen depending on many factors. The purpose of this study is to share the authors’ experience of aneurysms in young patients and to stress the effectiveness and deny the cons of endovascular embolization in comparison to that of the more common, middle-aged patient group.

**Materials and Methods:** Medical records of all subarachnoid hemorrhage (SAH) and unruptured intracranial aneurysm (UIA) patients who underwent endovascular surgery were reviewed from 2008 to 2015 in a single center. Patients with anterior circulation aneurysms with maximum diameter less than 10 mm were selected, and different age groups were compared for procedure-related complication, recurrence, and long term outcome.

**Results:** In the young aged SAH patients, thromboembolism occurred in 4 patients (9.1%) but none showed distal flow obstruction and/or exhibited neurologic deficit. No thromboembolism occurred in the young aged UIA patients. Minor aneurysm recur was noted in 5 patients (11.4%) among the SAH group and 2 patients (8.7%) in the UIA group, whereas major recur requiring retreatment was noted in 5 (11.4%) SAH and 0 UIA patients. One patient (2.3%) in the SAH group experienced re-rupture after embolization. No young-aged UIA patients experienced aneurysm rupture after embolization.

Ten patients (22.7%) in the young-aged SAH group had hydrocephalus requiring extraventricular drainage (EVD) and/or lumbar drain but no ventriculoperitoneal shunt (VPS), while VPS was necessitated in 3 patients (6.8%). Vasospasm requiring endovascular angioplasty was noted in 7 patients (15.9%).

Concerning the long term outcome by Modified Rankin Scale (MRS), 40 patients (90.1%) had MRS below 2, which represented functional independence.

**Conclusion:** Although statistically insignificant, endovascular treatment results of young SAH and UIA patients can be said to be effective, or at least comparable with that of the typical middle-aged group in terms of complication and recurrence. It can be stressed through this study that endovascular therapy may be a reasonable treatment for young aged SAH and UIA patients.
Coil embolization of remnant or recurred aneurysm after surgical treatment

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Purpose: The aim of this study was to review the cases of coil embolization for remnant or recurred aneurysm after surgical treatment.

Materials and Methods: Between May 1999 and November 2014, 1600 cases of coil embolization were performed in two centers. 38 consecutive patients (8 men and 30 women; mean age, 58.3 years) with 38 remnant or recurred aneurysms after surgical treatment underwent coil embolization. Clinical presentation, coiling technique, angiographic and clinical outcome, and epidemiology of the group were evaluated retrospectively.

Results: At the time of surgery, 27 aneurysms initially presented with subarachnoid hemorrhage (SAH). The others were unruptured aneurysms. At the time of coil embolization, 13 aneurysms presented with SAH, 1 aneurysm with third cranial nerve palsy, and 24 aneurysms were found on follow-up imaging study. The most common location was P-com aneurysm (34.2%). The median interval between surgical treatment and coil embolization was 76.7 months. Immediate post-embolization angiography revealed 18 cases of complete occlusion, 15 cases of residual neck and 5 cases of residual sac. Procedure related event was occurred in 3 cases. In one case, that was lead to permanent morbidity. After coilng, the mean clinical follow-up period was average 35.7 months. During clinical follow-up period after coilng, major recanalization was detected in 6 cases. Rebleeding event was occurred 4 times in 3 patients.

Conclusion: Coil embolization for remnant or recurred aneurysm after clipping seems to be an effective retreatment option.

Embolization of Intracranial aneurysms with HydroFrame and Hydrosoft Coils: A single-Center Experience

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Purpose: In Hydrogel Coil, special Hydrogel is processed into a raise of wages platinum coil and is the next-generation coil which was developed for the purpose of raising an embolic ratio. Aneurysmal recanalization ratio is less 8.6% in comparison with bare platinum coil group in HELPS placed in 2011. The thing which improved a difficult point in the use of Hydro coil, is first generation, was developed as HydroFrame and Hydrosoft coil. I examine usefulness and a problem of the cerebral aneurysm embolization using these coils in our hospital.

Methods: I retrospective examined as a single Center Experience that Hydrocoil group characteristic and outcome for 40 continuation cases with using Hydro coil, Hydro Flame and Hydro soft.

I examined 40 cases that performed aneurismal embolization with using Hydro coil in all 84 cases of treatment aneurismal embolization from April, 2011 to June, 2014. Ruptured aneurysms were three cases, non-ruptured cerebral aneurysms were 37 cases. It is about half cases that was able to follow by cerebral angiogram one year after. The cases that is not finished cerebral angiogram because of less 1 year of treatment examined by the MRI and MRA.

Result: It was only 1 case at ruptured aneurysm which was recanalization with using Hydrogel coil within one year. On the other hands, Cases of only bere platinum coils, we experienced 4 aneurysmal recanalization. One was ruptured aneurysm, the other was non ruptured aneurysm. These all cases were performed re-treatment.I used hydrogel coil for additional treatment.

Conclusion: It was thought that there was the constant effectiveness in Hydrogel coil.

Is endovascular treatment of very small intracranial aneurysms (≤3 mm) associated with a high complication rate?

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Purpose: Coiling of very small (≤3 mm) aneurysms remains contentious as it is considered to be technically challenging.
and is perceived to have a high incidence of intra-procedural complications, with intra-procedural rupture rates of approximately 7.7–8.3% reported in literature (W.J. van Rooij et al., 2009; Waleed Brinjikji et al., 2010; KH Carlos Chung et al., 2013).

We report the clinical outcomes and angiographic results of 42 patients (26 ruptured and 16 unruptured) with very small intracranial aneurysms treated in a single neurosciences centre in NE England from March 2009 to May 2015.

Methods: We conducted a retrospective analysis of the clinical and angiographic results of consecutive patients with very small (≤3 mm) intracranial aneurysms, who underwent endovascular treatment in our unit between 14/03/09–18/5/15.

In this group of patients we looked at the incidence of intra-procedural complications, the use of adjunctive devices, clinical outcomes, angiographic recurrences and associated retreatment rates during follow up of up to 6 years.

Results: From March 2009 to May 2015, 44 patients with very small (≤3 mm) aneurysms were treated in our centre. In this group 42 of the 44 patients (95.4%) had endovascular treatment performed. 26 out of the 42 (61.9%) had subarachnoid haemorrhage at presentation, the remaining 16 (38.1%) were unruptured at presentation.

There was 1 intra-procedural rupture in the cohort of patients with ruptured aneurysms leading to a stroke (anterior cerebral territory infarct) with moderate residual disability. Balloon remodelling of the aneurysm was performed in this patient. No thromboembolic events (0%) were noted in this group of patients. No intra-procedural ruptures (0%) or thromboembolic events (0%) were noted in the unruptured group. The intra-procedural rupture rate in the ruptured cohort was 1/26 (3.84%). The overall intra-procedural rupture rate was 1/42 (2.38%). No other procedure related complications were noted in either group of patients.

16/41 patients had adjunctive devices used during the treatment in form of balloon remodelling in 12 (4/25 ruptured, 8/16 unruptured) and stent assistance in 4 patients (all unruptured).

In the ruptured cohort 22/26 patients (84.6%) had a favourable outcome of GOS (Glasgow outcome score) 4–5. 2 patients died and 2 are lost to follow up. In the unruptured group all patients had a good outcome with no change in the MRS score before or after procedure and at discharge. Follow up MR imaging as per the standard departmental protocol is available in 26 patients at present, and is awaited in 12 patients. 4/26 (15.38%) comprising of 2 ruptured and 2 unruptured aneurysms have very tiny neck remnants (<1 mm) which are considered insignificant and are under surveillance. The other 22 aneurysms are completely occluded. There have been no retreatments in either groups.

Conclusion: In this study, the intra-procedural rupture rate (3.84% for ruptured; 0% for unruptured cases and 2.38% overall) for very small (≤3 mm) aneurysms was significantly lower than that described in literature and similar to the rate described in the endovascular treatment of larger aneurysms. Selection of appropriate material and technique allows a good outcome in coiling of very small aneurysms in the majority of cases. Such aneurysms remain stable and rarely require a second treatment.

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Aneurysms with the Third Cranial Nerve Palsy: Long-Term Results of Intentional Sparing of Daughter Sac from Coil Packing

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Purpose: Aneurysms which cause oculomotor nerve [cranial nerve (CN) III] palsy, are frequently found with a daughter sac of the aneurysm dome. We assumed that CN III might be compressed by the daughter sac and it would be more helpful not to fill the daughter sac with coils than vice versa during endosaccular embolization for recovering from CN III palsy, because it may give a greater chance for the daughter sac to shrink by itself later (van Rooij et al., 2008). We reviewed the long-term follow up results of our experiences of such cases.

Methods: Among 16 aneurysms accompanied by CN III palsy, 12 (11 unruptured, 1 ruptured) showed a daughter sac. We tried to fill the main dome completely and spare the daughter sac from coil filling to increase the possibility of decompression. We evaluated the initial and long-term effectiveness of this concept using medical records and follow-up images.

Results: After initial embolization, all of CN III palsy caused by unruptured aneurysms (11/11) resolved completely after various periods (3–90 days) of time. No adverse effects were noted during and after the procedures except for one case of harmless coil stretching during coil filling using double microcatheter technique. One patient with ruptured aneurysm expired from lung problems after 2 months. Mean follow-up period is 49.8 months (3–96, median 75). Coil compaction was found in one aneurysm at 6 months and re-embolization was done.

Conclusion: During the coil embolization of the cerebral aneurysm causing CN III palsy, sparing the daughter sac...
from coil packing while tightly packing the main dome can be helpful in increasing the effectiveness of decompression.

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A single-center experience and a comprehensive literature review regarding blister-like aneurysms in atypical locations

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Purpose: To evaluate the treatment strategy offered and to review all cases of atypical blister-like aneurysms (BLAs) published from January 1986 to November 2014. We also conducted a review of our institution’s experience with atypical BLAs. Furthermore, we would propose a flow chart of the management for suspected BLAs.

Methods: We conducted a comprehensive literature search review of the literature on Blister-like aneurysms (BLAs) in atypical locations. Studies reporting BLAs in locations other than the dorsal ICA wall were selected. Clinical presentation, treatment modality, complications and outcomes (modified Rankin scale, mRS, for neurological outcomes, Roy scale for radiological outcomes) were extracted from each study. A review of our single institution experience with atypical BLAs was also conducted. We sought to analyze atypical BLAs topography and outcomes according to each specific treatment modality.

Results: Atypical BLAs were observed in the anterior communicating, middle cerebral, basilar, posterior cerebral, anterior cerebral and posterior inferior cerebellar arteries. Sixty-five percent of the patients were treated with surgery, 30% with an endovascular approach and 5% with a combined approach. Eighty-eight percent and 55% of the patients experienced a good outcome (mRS 0-1-2) in the endovascular and surgical group, respectively. There were two deaths in the endovascular group and two in the surgical group.

Conclusion: Endovascular treatment seems to have lowered morbidity and mortality and provided a better outcome compared to surgical approaches. Given the very small size of BLAs and their poor initial visibility, it is important to remember that they may occur in atypical sites other than the most common ICA localization.

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Stentgrafts in intracranial endovascular treatment: Pericardium covered stent (Aneugraft) or stentgrafts

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Purpose: Covered stent or stent grafts might be used in the treatment of ICA aneurysms in selected cases. Traumatic ICA pseudoaneurysm/fistula is another indication. They might be considered as an ideal alternative to parent artery occlusion for the treatment of traumatic or postsurgical carotocavernous fistula. We present our experience of stentgrafts or pericardium (Aneugraft) covered stents in intracranial endovascular treatment.

Methods: We report our stent graft and covered stent experience at two centers on 11 patients within the last 3 years. Three cavernous segment, 1 ICA dissecting aneurysm 2 carotocavernous fistula, 4 iatrogenic pseudoaneurysm, and 1 venous EVOH remnant at sinus rectus were treated with 5 Aneugraft (Itgi Medical), 8 Graftmaster (Abboth Inc.) and 2 covered stents (Jomed Inc.) were used for primary treatment. Five patients were treated at an emergency basis. Median age of the patients was 55 years.

Results: Technical success was achieved in all but 1 patient (due to access problems). Severe morbidity or mortality was not recorded in any patient. An 8 F guiding catheter plus 6 F Neuron (Penumbra Inc.) guiding chetater were used in the majority of cases for a successful delivery of Neuron 0.070 or Navien 0.072 distal access catheter. Fargomini 135 cm, Vasco 28 (Balt Inc.) and XT27 microcatheters + supportive 0.014 stiff microguidewires were used for access support. Mean follow up was 18 months. Among 4 traumatic pseudoaneurysms successful deployments were achieved in 3 cases. Among 2 traumatic carotocavernous fistula one was successfully closed however transvenous closure was performed for further treatment in the second case due to minor residual fistula. 3 cavernous aneurysms and one dissecting ophthalmic segment aneurysm were completely obliterated. In one patient, residual EVOH remnant was fixated to wall of sinus rectus with a covered stent.

Conclusion: Despite technical difficulties and access problems, pericardium covered stents and stent grafts have important use in endovascular field.
Endovascular Treatment Experience in Anterior Choroidal Artery Aneurysms

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Purpose: Aneurysms of the anterior choroidal artery (AChA) constitute 2 to 5% of all intracranial aneurysms. Clipping or endovascular treatment of AChA aneurysms might be associated with postoperative ischemic complications more than any other aneurysm site. Mortality and morbidity rates regarding AChA treatment are relatively high. We retrospectively evaluated our experience regarding endovascular treatment of AChA between 2012–2015.

Methods: We identified 31 patients with 32 aneurysms between June 2012–April 2015 were included into the study. SAH was noted in 12 patients.

Results: Primary coiling was performed in 11, stent or flow diverter assisted coiling in 5, flow diverter in 14 and stent assisted flow diverter treatment in 2 AChAs. Peroperative hypoperfusion or occlusion of AChA was noted in 5 patients and intravenous tirofiban was started. Postoperative early deterioration and follow-up angiography was necessary in another 2 patients. 6 patients were subjected to AChA related hemodynamic instability four of which presented with SAH. Four patients were treated with primary coiling and 2 with stent assisted flow diverter treatment. There was no postoperative mortality. Severe morbidity including hemiparesis and hemiplegia was noted in 1 patient due to thromemboli at the A2-A3 junction with an mRS score of 3 at 6 month follow up. AChA compromise due to FD use was not noted in the present series.

Conclusion: Relatively higher rates of complications associated with AChAs were recorded (19% procedural related morbidity). Meticulous care should be taken during primary coiling since as high as one third of patients were subjected to AChA related hemodynamic instability. Anticoagulating treatment should be started immediately at the time of clinical deterioration or angiographical evidence of AChA hypoperfusion to eliminate severe clinical morbidity. Treatment of AChAs with FD stents seems to be superior to primary coiling despite its low incidence of use in SAH.

LEO+ Baby stent use in intracranial aneurysms: Technical challenges and experience on 31 cases

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Purpose: Technological advances in the endovascular field definitely provided a more successful treatment of cerebral aneurysms. Stent-assisted coiling provides a durable and denser coil embolization compared to primary coiling of intracranial aneurysms. Recently LEO+ Baby stents were released into the market for the treatment of intracranial aneurysms. In the present report 31 cases treated with LEO+ Baby stents were discussed.

Methods: 31 cases were included into the study and aneurysms were localized in M1, MCA bifurcation, basilar tip, ACoM, A2, A2-A3 junction, ophthalmic and choroidal artery. LEO+ Baby stent were used for treatment in all cases. In 5 cases more than 1 LEO+ Baby stent was used.

Results: SAH was noted in 15 cases. Premedication with Clopidogrel and Aspirin was started 3 hours to 5 days before the procedure in all but 8 patients. Complete or near complete aneurysm obliteration was succeeded in 24 patients. Peroperative rupture of the aneurysm was noted in 3 cases and LEO+ Baby stent was used as a supportive and salvage measure for dense coil packing during the bleeding event in 2 cases. Thromboembolic events were noted at 2 patients one of which was noted during the procedure. Instent thrombosis was noted in 1 case after the procedure. The final angiographic results were evaluated on follow up.

Conclusion: Leobaby stents are low-profile woven stents and might be used as an alternative to standard stenting in distal cerebral aneurysms like MCA, ACoM and basilar tip. It might also be used as an alternative treatment for residual aneurysms of the regarding vasculature.
unpredictable. Therapeutic options include reconstructive or
deconstructive approaches, surgically or endovascularly, but
no option has been proven to be optimal. We report a case
with ruptured BBA that are treated endovascularly, and
requires re-treatment with flow-diverter stent due to the
progression of the BBA.

Methods: A 47-year-old female patient came to the emer-
gency department due to a sudden severe headache. Em-
ergency CT scan showed a subarachnoid haemorrhage,
and DSA reveals a large, irregular shaped aneurysm on
the left Internal Carotid Artery (ICA). The patient was trea-
ted first with balloon assisted coiling. 1 week later the
patient bled again, and follow-up DSA showed that the
aneurysm has become much bigger, twice the size it used
to be. After carefully evaluate the arterial anatomy, decon-
structive approach seemed to be too risky since the collat-
eral blood flow is too poor.

Results: Decision has been made to retreat the patient using
a flow-diverter stent and further coiling of the sac. The
patient was stable after that, and could go home after 2
weeks with minor neurologic deficit. Follow-up DSA after
3 months was done and the aneurysm is also stable.

Conclusion: Blood blister-like aneurysm can be very danger-
ous and difficult to treat. Among the options that we have
to up to now, Flow-diverter stent can be a reasonable one for
those with poor collateral which makes deconstructive
approach impossible.

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Removal of Foreign Particles during endovascular
Treatment of Cerebrovascular Diseases with EN
Snare system

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Purpose: A serious complication of endovascular therapy of
cerebrovascular diseases is an unintended foreign body in the
vasculature. A coil migration, retained catheter or an
attached EVOH copolymer might induce thromboembolic
events. Endovascular retrieval should be attempted at
proper situations. A rate as high as 80% was reported for
retrieval of foreign bodies in the peripheral vasculature. A
snare retrieval device is conveniently designed for endovas-
cular retrieval of foreign particles.

Methods: We identified 7 cases in a retrospective analysis of
953 endovascular treatment sequences between 2011 and
2015 and evaluated the cause, management, and outcomes
of these procedures. Foreign particles at undesired localiza-
tions were experienced on 5 AVM and 2 aneurysm treatment
sessions. Snare device was able to be utilized in 4 selected
cases. Localization of the foreign particles were ICA in 5, M1
inferior truncus in 1 and AcoM-A1 junction in 1 case. In 2
cases extruded coils were trapped between vessel wall of A1
and ICA respectively with Leoþ baby and Enterprise intra-
cranial stents.

Results: In the present series, there were 3 successful retrie-
val out of 4 trials with snare system all of which were
retained catheters. Unsuccessful trial with snare system
includes a migrating coil which was trapped to the ICA
wall with an Enterprise stent. Two EVOH polymer cast at
A2 nad M1 inferior truncus were attempted to for retrieval
with Catch mini retrieval devices one of which was success-
ful. Retained coil fragment at proximal A1 was trapped to
the vessel wall with a Leoþ baby intracranial stent.

Conclusion: Snare device including micro version should be
available at all times in an endovascular suite. Technical
success with snare device is optimum if the event is success-
fully managed during endovascular procedure.

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Endovascular Treatment of A1 Aneurysms:
Experience with 10 Cases

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Purpose: A1 aneurysms are rare and constitute less than 1%
of intracranial aneurysms. It is well known that A1 segment
aneurysms of the ACA has several technical challenges for
coil embolization due to their distinctive configurations.

Flow diverters (FD) in the last decade are reported to be
an alternative treatment to coil or stent assisted
embolization.

Methods: We identified 10 cases with A1 aneurysms who
were treated through endovascular route with 12 treatment
sessions between 2011 and 2015. Clinical and angiographi-
ocal outcomes of treating these aneurysms through endovas-
cular measures were studied.

Results: Median size of the aneurysms were 6 mm (range 2
to 12 mm). All but 2 patients presented without a bleeding
episode. 2 patients presented with residual aneurysm after
SAH, 4 with headache and the remaining 4 cases were
diagnosed incidentally. Two aneurysms were reported to be
associated with a distal fenestration of A1 and AcoM
respectively. 6 of the aneurysms two of which was a recur-
rent aneurysm after primary coils were treated with FDs(4
Silk-2 Surpass FD). Primary coiling or balloon assisted coil-
ing was performed in 6 sessions two of which were retreated
in a consecutive session with flow diverters One patient
presenting with SAH and treated with primary coiling was
lost on follow up. There were no procedural related com-
plaints. Median follow up was detected as 14 months
(Range 3–47 months). There was no neurological
deterioration, perforator related ischemic events or bleeding due to aneurysm during the follow-up period. Complete elimination of the aneurysm from the circulation was achieved in 9 cases. Fenestrations were not visualized on follow up angiograms.

**Conclusion:** A1 aneurysms are amenable to safe-efficacious endovascular treatment. Despite previous experiences with primary coiling, treatment with FDs is a safe alternative. Treatment at this segment of the ACA is feasible particularly for unruptured cases with excellent results despite critical perforators.

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Can we justify the embolization of unruptured aneurysms? – Analysis of 1,008 cases based on the historical perspective of 15 years experiences

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**Purpose:** We review our cases of unruptured aneurysms treated with endovascular embolization, and inspect its efficacy and problems as the prophylactic measures for growth and rupture of aneurysms.

**Methods:** The clinical objects are 1,008 unruptured aneurysms treated with endovascular embolization in 936 patients over 15 years in our institute and affiliated hospitals. Cases were stratified into three separate periods based on the development of devices, techniques, equipment and management: the first period (2001–2005), the second period (2006–2009) and the third period (2010–2015). Clinical results were retrospectively evaluated.

**Results:** Major treatment-related complications occurred in 54 operations including 12 perforation, 36 ischemic complications, and 4 other ones, in which 15 patients were in unfavorable outcome. The rate of complications in each period is 8.6% (20/233 aneurysms) in the 1st period, 3.8% (13/339) in the 2nd and 4.9% (21/432) in the 3rd, respectively. Treatment-related morbidity has gradually decreased (3.4%, 1.2% and 0.7%, respectively). Two aneurysms ruptured during follow-up, and 14 aneurysms required reembolization due to the marked recanalization. The rate of retreatment is significantly higher in the 1st period (8.6% (20/233 aneurysms) in the 1st period, 3.8% (13/339) in the 2nd and 4.9% (21/432) in the 3rd, respectively. Treatment-related morbidity has gradually decreased (3.4%, 1.2% and 0.7%, respectively). Two aneurysms ruptured during follow-up, and 14 aneurysms required reembolization due to the marked recanalization.

**Conclusion:** Embolization for cerebral aneurysms may be safely performed during the follow-up period. Complete elimination of the aneurysm from the circulation was achieved in 9 cases. Fenestrations were not visualized on follow up angiograms.

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Initial experience of coiling cerebral aneurysms using the new Comaneci device

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**Purpose:** The Comaneci (Rapid Medical, Israel) is a non-occlusive mesh providing support to the neck of the aneurysm during coiling.

**Methods:** Three patients were treated with the Comaneci device. Two patients had acute ruptured posterior communicating aneurysms. One patient was returning for elective treatment of a recurrent carotico-ophthalmic aneurysm.

**Results:** The Comaneci device was successfully deployed in all cases. It was collapsed and removed once successful aneurysm obliteration by coils had been achieved. Excellent occlusion of all three aneurysms was obtained. One patient developed a distal middle cerebral artery clot that was treated with intravenous aspirin. The source was uncertain as there was no thrombus within the device itself. This patient suffered minor neurological consequences.

**Conclusion:** The Comaneci device has been trialled on three patients with excellent aneurysm occlusion. In view of the single thromboembolic event, further study in a larger patient cohort is required after this preliminary report, to assess more accurately the efficacy and safety profile of this device.

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Buenos Aires experience with Barricade Coils, middle-term Follow Up

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**Purpose:** Evaluate the safety and efficacy in the treatment of intracranial aneurysms with “Barricade” coils, with middle-term DSA F-up.

**Methods:** Between June 2013 to August 2014, 41 patients (Female: 26) with 43 aneurysms underwent endovascular treatment using Barricade Coils (Complex Framing coils, Complex Finishing Coils, Helical Filling Coils and Helical-------
Blood blister like aneurysms are friable and are technically unique as they don’t possess intima and media, and are broad based with a small aspect ratio. They are pathologically and morphologically challenging to treat either by surgical or endovascular means. They are pathologically and morphologically challenging to treat either by surgical or endovascular means. They are pathologically and morphologically unique as they don’t possess intima and media, and are broad based with a small aspect ratio.

Methods: We present our initial experience of managing blister aneurysms (BA) at our institution.

Results: Twenty-six patients [Male:10, (38%, n = 26), median age: 54, range = 36–68] with aneurysmal subarachnoid hemorrhage had 26 BA. The BA location was supraclinoid ICA (23, 88%), posterior cerebral (1, 3%), vertebral (1, 3%) and basilar artery (1, 3%), and were treated with single stent (6, 23%), overlapping stents (5, 19%), stent assisted coiling (SAC) (6, 23%) and pipeline embolization device (PED) (9, 35%). There was no intra-operative rupture and in-stent thrombus that resolved with intra-arterial abciximab was noted in three patients. Three died (re-bleed in one treated with SAC; two died of SAH induced complications) and one was dependent on follow up. Two patients with vasospasm induced ischemic deficits improved on follow up (mRS 1). Overall good outcome (mRS: 0–2) was seen in 22 (84%) patients. Follow-up angiography was available in 21 (80%) patients, and revealed complete or near complete aneurysm occlusion in 15 (71.5%), incomplete obliteration in 2 (9.5%) and no change in 2 (9.5%) cases. Two cases treated with stent assisted coiling showed angiographic recurrence and were managed with repeat coiling and overlapping stent placement. All 5 patients treated with PED and angiographic follow up had complete occlusion of the aneurysm sac.

Conclusions: Barricade coils proved to be safe and effective at middle-term follow up, with a predictable behavior and stability of the cast of coils. Further studies with longer follow up are required.

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Endovascular management of blister aneurysms presenting with subarachnoid hemorrhage: single centre experience

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Purpose: Blood blister like aneurysms are friable and are technically challenging to treat either by surgical or endovascular means. They are pathologically and morphologically unique as they don’t possess intima and media, and are broad based with a small aspect ratio.

Methods: We present our initial experience of managing blister aneurysms (BA) at our institution.

Results: Twenty-six patients [Male:10, (38%, n = 26), median age: 54, range = 36–68] with aneurysmal subarachnoid hemorrhage had 26 BA. The BA location was supraclinoid ICA (23, 88%), posterior cerebral (1, 3%), vertebral (1, 3%) and basilar artery (1, 3%), and were treated with single stent (6, 23%), overlapping stents (5, 19%), stent assisted coiling (SAC) (6, 23%) and pipeline embolization device (PED) (9, 35%). There was no intra-operative rupture and in-stent thrombus that resolved with intra-arterial abciximab was noted in three patients. Three died (re-bleed in one treated with SAC; two died of SAH induced complications) and one was dependent on follow up. Two patients with vasospasm induced ischemic deficits improved on follow up (mRS 1). Overall good outcome (mRS: 0–2) was seen in 22 (84%) patients. Follow-up angiography was available in 21 (80%) patients, and revealed complete or near complete aneurysm occlusion in 15 (71.5%), incomplete obliteration in 2 (9.5%) and no change in 2 (9.5%) cases. Two cases treated with stent assisted coiling showed angiographic recurrence and were managed with repeat coiling and overlapping stent placement. All 5 patients treated with PED and angiographic follow up had complete occlusion of the aneurysm sac.

Conclusions: Barricade coils proved to be safe and effective at middle-term follow up, with a predictable behavior and stability of the cast of coils. Further studies with longer follow up are required.

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Endovascular treatment of middle cerebral artery bifurcation aneurysms

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Purpose: The middle cerebral artery (MCA) is a challenging site for endovascular treatment due to frequent occurrence of wide neck aneurysms incorporating one of the MCA trunk. We retrospectively evaluated our results in endovascular treatment (EVT) of unruptured MCA bifurcation aneurysms.

Methods: From February 2013 to June 2015, 55 consecutive patients with 59 unruptured MCA aneurysms (49 small, 10 large/giant) were treated in our institution. Demographics, aneurysm characteristics, treatment modality, intra procedural hemorrhagic and thromboembolic events, 30-day neurological events, and follow-up imaging studies were evaluated.

Results: Mean age was 53.9 years (range, 23–79 years 39 women). 52 aneurysms were treated by coiling (44 with assistance of another device), 7 with flow diverters (+/- coils or stents). Technical success rate was 100 %. Five technical complications occurred (all with stents: 1 migration, 1 extravasation, 2 suboptimal appositions, 1 deployment difficulty). Permanent morbidity occurred in 1 patient (1.8%), there was no mortality. Follow-up was available in 48 patients (87.2%). One patient died from unrelated causes. One patient had seizure and another had a delayed foreign body (hypersensitivity reaction), both were managed medically and did well. At a mean follow-up of 10 months, on imaging studies, 42 aneurysms were either stable or improved, 4 aneurysms recanalised and were retreated without adverse events.

Conclusion: With the help of the developing stent technology (such as the use of new generation cerebrovascular stents and flow diverters) we were able to treat unruptured MCA aneurysms with a higher technical success rate and a safety profile comparable to surgical treatment in experienced hands. Midterm follow-up results suggest that the treatment is durable.
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Endovascular management of blister aneurysms: Multicentre experience

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Purpose: Blister aneurysms are a rare entity. They are typically diagnosed following a subarachnoid haemorrhage and are known to behave more aggressively than saccular aneurysms. The current treatment options include surgical, endovascular or combined therapy. Treatment of blister aneurysms is complex and controversial. The difficulties arise given their fragile walls, small size and the absence of an aneurysm neck. Regrowth or rebleeding following the initial treatment is not uncommon requiring further intervention. Recent advances in endovascular devices and techniques have added further options for treatment.

Methods: Data analysis of a cohort of patients treated with endovascular therapy was conducted. Baseline characteristics collected. Clinical information, imaging findings, method of treatment and post-procedural clinical course were documented.

Results*. The number of patients treated is to be reported. The type of endovascular modality used in this cohort is to be discussed (coiling alone, stenting alone, combination of both, usage of flow-diverting devices). Rebleeding, regrowth rates and the need for further intervention will be presented. Clinical outcomes of the treated patients to be outlined.

Conclusion: Endovascular treatment for blister aneurysms is becoming increasingly useful for treating these challenging and fragile aneurysms.

*This is an ongoing series involving multiple centers; the updated results will be finalized prior to the conference.

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Stent-assisted coil embolization of intracranial aneurysms: complications in acutely ruptured versus unruptured aneurysms

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Purpose: The use of stents in the setting of SAH is controversial because of concerns about the efficacy and risk of dual antiplatelet therapy. We compare complications in stent-assisted coil embolization in patients with acutely ruptured aneurysms with complications in unruptured aneurysms.

Methods: Between February 2007 and March 2015, 45 acutely ruptured aneurysms and 47 unruptured aneurysms were treated with stent-assisted coiling. Patients with ruptured aneurysms were not pretreated with antiplatelet medication but received intravenous Aspirin during the procedure. Thrombo-embolic events and hemorrhagic complications were recorded.

Results: In ruptured aneurysms, 9 of 45 patients had thrombo-embolic complications. Four patients remained asymptomatic, 4 developed infarctions and one patient died. Five of 45 patients had an early rebleed from the treated aneurysm after 3–45 days and in 4 this rebleed was fatal. Overall procedure related complication rate in acute SAH was 22% (10 of 45, 95%CI 12–36%). In 46 patients with 47 unruptured aneurysms, thrombo-embolic complications occurred in 2. One patient remained asymptomatic; the other had an infarction in the left thalamus. Complication rate in unruptured aneurysms was 2.2 % (1 of 46, 95%CI 0.01–12%). No first time hemorrhages occurred in 46 patients with 47 aneurysms during 6 months follow-up.

Conclusion: Complication rate of stent-assisted coiling in ruptured aneurysms was 10 times as high as in unruptured aneurysms. Early rebleed accounted for most mortality. In ruptured aneurysms, alternative therapies without the need for antiplatelet medication such as surgery, balloon-assisted coiling or WEB-device should be encouraged.

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P1 ~ P2 aneurysm, occlusion or reconstruction?

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Purpose: Aneurysm(AN) on P1~P2 segment was uncommon, which mortality and morbidity rate were 5.3% and 2.6% ~ 20%. With special characters, its treatment is still challenging.

Methods: The average age of 27 patients was 44.8 (10 ~ 72)years old. 13 cases (48.2%) presented hemorrhage:5 with subarachnoid haemorrhage (SAH, 18.5%),8 (29.6%) with cerebral, ventricular or mixed hemorrhage. The distribution of AN was as follows: 14 (51.8%) on P2, 10(37%) on P1-P2, and 3 (11.2%) on P1.

Results: 24 cases were performed endovascular treatment: pure coils in 3 cases (saccular AN), reconstruction (stent + coils) in 3 cases(P1 AN), direct occlusion in others 18 patients (75%). The procedures were all successful without distinct relevant ischemic events. 2 cases (accidental find) were followed up and one patient died due to rebleeding before treatment. 12 patients were followed-up by DSA(mean 14.9 months): cure in 5 cases (41.7%), improvement in 11 cases, stabilization in 2 cases, residual recurrence in 4 early patients.

Conclusion: The symptom and architecture of P1~P2 AN was different from other intracerebral AN: more younger population, more chronic headache, less typical SAH (18.5%); more large or giant AN (59.3%), more dissecting AN (70.4%)and less saccual AN (30%). As for large, giant or
dissecting AN, occlusion or reconstruction are kept dispute. From our results, P1 AN should be reconstructed if with suitable vascular architecture for stenting, if no that, occlusion may be considered (special breeding AN) established on a adequately estimation of collateral circulation and compensation (such as posterior communicating artery). The most of P1-P2 and P2 AN can be occluded due to the extensive anastomoses between the anterior and posterior circulation. During occlusion of AN, it is note that the proximal parent artery of AN need be occluded to prevent recurrence, and as far use coils (no glue) as possible protect perforators.

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Endovascular Treatment of the Partially Thrombosed Intracranial Aneurysms
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Purpose: Partially thrombosed aneurysms (PTA) which are ruptured rarely, constitute less than 10% of all intracranial aneurysms. The aim of this retrospective study is to evaluate endovascular treatment options and final clinical and radiological results of patients having PTA located in the intracranial circulation.

Methods: During the last 8 years, 44 patients (13 female and 31 male), having age range of 5–71; mean, 48 years, with the diagnosis of PTA in the intracranial circulation underwent endovascular treatment for their aneurysms. PTA diagnosis was based on the CTA and/or MRI findings.

Results: Of the 44 aneurysms, 26 (59%) were located in the anterior and the remaining 18 (41%) in the posterior circulation. They were saccular (48%) or fusiform (52%) in shape. The presenting symptoms include symptoms of mass effect (headache, cranial nevre findings, focal neurologic deficits, seizure) in 35 patients, cerebral embolic ischemia in 7 patients, and intracranial bleeding in 2 patients. During the endovascular treatment, aneurysm and parent vessel occlusion together was achieved in 10 patients (23%) (three of them were spontaneous), while in the remaining 34 patients, parent vessel could be saved as follows; stent assisted coil embolization of the aneurysm in 10 (23%), flow diverting stent implantation alone in 15 (34%), and intra-saccular coil occlusion only in 9 (20%) patients. No extra morbidity or mortality was observed. In the follow-up period, among 4 patients having aneurysm remnant/recurrence, 3 underwent second endovascular intervention with resultant total occlusion of the aneurysm without complication. Symptoms related to mass effect improved in time in all patients.

Conclusion: PTA is a unique and rare aneurysm formation with peculiar clinical presentation. Current endovascular techniques are safe and successfull with long term stable clinical results in such type of intracranial aneurysms.

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Morphological and hemodynamic analysis of posterior communicating artery aneurysms prone to rupture: a matched case-control study
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Purpose: We evaluated the correlation between posterior communicating artery (PcomA) aneurysm rupture and morphologic and hemodynamic parameters to assess related rupture risk indices.

Methods: Six patients with PcomA aneurysms that ultimately ruptured (cases) were studied after initially being included in a prospective database including their three-dimensional (3-D) imaging before rupture. For each case, 4 incident stable unruptured aneurysms (controls) were randomly selected and matched based on clinical factors. The 3-D images from all patients were reconstructed to establish the patient-specific model. Six morphologic parameters and 3 hemodynamic parameters were measured and calculated. A conditional logistic regression analysis was used to assess the individual risk of rupture.

Results: The analysis demonstrated a larger aneurysm size (P = 0.001), higher aspect ratio (AR) (P = 0.018), ellipticity index (EI) (P < 0.001), undulation index (UI) (P = 0.005) and the percentage of the low WSS area (LSA %) (P = 0.010), a lower normalized wall shear stress (WSS) (P = 0.005) in the case group. The multivariate conditional logistic regression analysis demonstrated that only normalized WSS was significantly associated with the rupture of PcomA aneurysms (OR = 0.151; 95% CI, 0.025 to 0.914; P = 0.040).

Conclusion: Hemodynamics and morphology are closely associated with aneurysm rupture, and WSS may be a more reliable parameter characterizing the rupture status of PcomA aneurysms.
aneurysms within 6 hours of symptom affect the clinical outcomes. **Methods:** One-hundred and ninety-four patients of aneurysmal SAH had endovascular treatment between June 2007 and January 2015. According to treatment timing from symptom onset, these 194 patients were classified into three groups: group A, endovascular treatment within 6 hours (n = 57); group B, endovascular treatment in 6–24 hours (n = 95); and group C, endovascular treatment after 24 hours (n = 42). For each group, the patient demographics, modified Fisher grade, neurologic status at admission (using World Federation of Neurosurgical Societies grade), aneurysm characteristics, presence of hydrocephalus, presence of vasospasm and clinical outcomes were recorded. Clinical outcomes were measured at 6 months using modified Rankin Scale (mRS).

**Results:** There was significant higher incidence of poor outcome in group A with good WFNS grade at presentation (12 of 32, 37.5%) compared with group B (9 of 76, 11.8%) and group C (2 of 30, 6.7%) in each. Univariate analysis demonstrated that factors of clinical aggravation in patients of good WFNS grade in group A were larger amount of haemorrhage (modified Fisher grade 3 or 4, P < 0.05), posterior circulation aneurysms (P < 0.05) and presence of hydrocephalus (P < 0.05). Age, gender, surgical complications, presence of intracranial haemorrhage, and vasospasm were not statistically significant. There was no significant difference of clinical outcomes in patients of poor WFNS grade at presentation among three groups.

**Conclusion:** Clinical outcome in patients of good WFNS grade at presentation and resuscitation within 6 hours may worsen by larger amount of haemorrhage, presence of hydrocephalus and aneurysms located in posterior circulation.

**Follow-up of intracranial aneurysms treated by stent-assisted coiling: Preliminary results comparing time-of-flight MR angiography (TOF-MRA) and contrast-enhanced MR angiography (CE-MRA) with digital subtraction angiography (DSA) as gold standard**

**Purpose:** Follow-up of intracranial aneurysms treated by stent assisted coiling with MRI is complicated by imaging artifacts produced by stents additional to coils. This study compares the diagnostic accuracy of three-dimensional time-of-flight MR angiography (3D-TOF-MRA) and contrast-enhanced MRA (CE-MRA) for the evaluation of aneurysm occlusion and parent artery patency after stent assisted coiling, with digital subtraction angiography (DSA) as the gold standard.

**Methods:** Patients treated with stent-assisted coiling at the University of Ottawa between July 2006 and November 2014 followed by MRA (3D-TOF-MRA and CE-MRA) and DSA within 6 weeks period were retrospectively reviewed from a prospective single-center database. Aneurysm occlusion was assessed with full and simplified Montreal scales and parent artery patency with two-grade scales.

**Results:** There were 65 patients with 66 aneurysms included. The majority of patients were women (n = 44) with an average age of 57 years (+/-11). LVIS (n = 25), and Neuroform (n = 20) were the most frequently used stents. Intermodality agreement for aneurysm occlusion and vessel patency was higher for CE-MRA (0.85 and 0.93) than for TOF-MRA (0.86 and 0.67). CE-MRA had comparable accuracy to TOF-MRA for aneurysm remnant detection (sensitivity 75% vs 69%; specificity 88% vs 91%). Patency of the parent artery was better assessed with CE-MRA than TOF-MRA (specificity 93% vs 67%; sensitivity indeterminate for both modalities).

**Conclusions:** CE- and TOF-MRA are comparable for evaluation of aneurysm occlusion, and CE-MRA had a higher specificity for ensuring parent artery patency following treatment with stent-assisted coiling. Next steps include a sub-analysis of artefacts caused by different stent types.

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eCLIPs: A novel device for treatment of bifurcation aneurysms: Preliminary clinical and angiographic results

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**Purpose:** Intracranial aneurysms located at bifurcations remain some of the most difficult aneurysms to treat with current endovascular techniques. We present the eclips self-expanding, fully retrievable and resheathable endoluminal device specifically designed for the treatment of bifurcation aneurysms and its initial results. The device can be used as a coil assist device or as a stand-alone device. When used as a coil assist device, the device allows for post implant coiling.

**Methods:** To date 22 implants have been done. Patients harbored ruptured, unruptured, or previously unruptured/ruptured coiled aneurysms that showed recurrence. Early in the experience, giant aneurysms were also included. In descending order of locations, aneurysms were at the Basilar Tip, Carotid Terminus, Middle Cerebral Artery and Anterior cerebral artery. Aneurysms were submitted for review, to determine eclips eligibility based on aneurysm neck size, vascular accessibility and limitations of conventional means alone for obliteration of the aneurysm.
Results: In the 22 cases where the device was used so far, device navigation, delivery and orientation was well controllable. Detailed 6 month follow up data is pending at this time for all cases. Preliminary follow-up imaging has shown cases with complete aneurysm occlusion (including one patient where the device was used as a stand-alone without implanting additional coils). There was no device migration. There was no intimal hyperplasia and/or parent artery/side branch stenosis.

Conclusion: The eclip device is a novel endoluminal device for the treatment of select intracranial bifurcation aneurysms. Safety and effectiveness is being determined. A greater number of cases need to be performed to understand which bifurcation aneurysms and configurations are ideally suited for this type of treatment and which should be managed by alternative means.

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Endovascular Treatment Strategies for Posterior Communicating Artery Aneurysm according to Angiographic Characteristics

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Purpose: In cases of posterior communicating artery (PcomA) aneurysm, the relationship between complication and obstruction of PcomA has been poorly understood. We report ischemic complications related to the obstruction of PcomA and suggest the strategies of treatment according to the angiographic characteristics of PcomA and Posterior cerebral artery (PCA).

Materials and Methods: Clinical and radiological records of 166 cases of coil embolization treated for a PcomA aneurysm during 11 years were retrospectively reviewed. Twenty one patients with PcomA aneurysm who had initially undergone endovascular treatment and had been identified the occlusion of PcomA on immediate or follow-up angiography were enrolled. We classified PcomA aneurysm according to the characteristics PcomA and PCA (P1) in baseline angiography as followed; Type I was defined as PcomA aneurysm with an absent PcomA and a normal sized P1. Type II was defined as a hypoplastic PcomA and a normal sized P1. Type III was defined as a normal sized PcomA and an absent P1. Type IV was defined as a normal sized PcomA and a hypoplastic P1. Type V was a normal sized PcomA and a normal sized P1.

Results: Among all cases of PcomA obstruction, 15 cases (71.4%) were type II PcomA aneurysm, 4 cases were type IV, one case was type III and one case was type V. The ischemic events related PcomA obstruction occurred in 3 cases (type II, type III and type IV), which were included in 2 tuberothalamic infarctions (type III and type IV) and one cortical infarction in PCA territories (type II).

Conclusion: In cases of PcomA aneurysm with normal sized PcomA and hypoplastic or absent P1, the surgeon should pay special attention to the obstruction of PcomA and we believe that the size of ipsilateral P1 in baseline angiography might be important factor of ischemic complication related to the obstruction of PcomA.

References

Use of enterprise® stent in the treatment of wide neck rupture intracranial aneurysms

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Introduction: Endovascular approach has become a safe alternative for the treatment of cerebral aneurysms including different aneurysm variants, such as: wide neck, fusiform, and aneurysms in the distal segments of main arteries. Nevertheless, stent embolization of ruptured wide neck remains a challenge, since most of these patients have been referred to open surgery in the past.

Objective: Evaluate the feasibility, safety and efficacy of the Enterprise stent in the treatment of 30 patients with ruptured aneurysms from 2008 to 2014.

Materials and Method: Retrospective review of 30 patients with ruptured cerebral aneurysms treated with stent assisted embolization and prospective review of their evolution from June 2008–2014. We analyzed the anatomical features, localization, and complications years after treatment, including percentage of occlusion and recanalization.

Results: 70% were female; median age was 53 years, most frequent location was the carotid ophthalmic segment (40%), followed by posterior communicating artery (20%) and posterior circulation (15.5%). Average dome size was 7.8 mm and neck size was 5.10 mm. Following the Raymond classification at one year follow up, 90% had complete obliteration, 7% required repositioning, 1 patient had migration of the stent, 3 patients required re-embolization due to residual aneurysm, 2 presented bleeding during the procedure, 2 had hematoma at site of arterial puncture and 1 patient died.

Conclusions: Enterprise® stent use in coil embolization of challenging ruptured wide neck aneurysms is effective and safe. Complexity of treatment include: arteries with a sharp angle, with a larger diameter at aneurysm area, vasospasm close to the aneurysm, tortuosity and hydrocephalus development post bleeding. We do not recommend stent deployment in sharp angle zones or in large diameter to decrease the risk of stent migration.

Bibliography


Stent-assisted embolization of ruptured intracranial aneurysms using low profile stent system: a case series

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Introduction: Traditional stent-assisted embolization of intracranial aneurysms required delivery catheters typically larger than the coiling and balloon catheters, which are also more difficult to access distal circulation.

Purpose: We assessed the application of a low profile stent system for stent-assisted embolization of ruptured intracranial aneurysms.

Materials and Methods: We retrospectively reviewed and identified these patients over the two years from our hospital records.

Results: Twenty patients underwent stent-assisted embolization of ruptured intracranial aneurysms using a low profile stent system (LVISTM Jr. Device, Microvention; Baby Leo+, Balt). The aneurysm locations included anterior cerebral artery, middle cerebral artery, vertebral artery, and posterior cerebral artery. All aneurysms were completely occluded at the time of treatment and last radiological follow up. One patient developed intracerebral hemorrhage at a vascular territory different from the offending vessel. Two patients died as a sequelae of severe subarachnoid hemorrhage and all other patients achieved favorable neurological outcome at last follow-up (mRS 0–2).

Conclusions: Low profile stent system provided a safe and feasible way for stent-assisted embolization of ruptured intracranial aneurysms.
Stent-assisted Coil Embolization of Intracranial Aneurysms Using the Solitaire™ AB Neurovascular Remodeling Device

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Purpose: This retrospective study was to present our experience in the clinical and angiographic outcomes of patients treated with stent-assisted coil embolization using the Solitaire™ AB stents.

Methods: From March 2011 to December 2014, 50 patients harboring 55 wide-necked or complex intracranial aneurysms were consecutively enrolled. Four patients presented with an acute subarachnoid hemorrhage. Stent implantation was combined with a standard coiling procedure in 47 aneurysms; 5 of them underwent by bailout stenting and two patients treated with two aneurysms simultaneously as single stenting. Two patients were treated by temporary stenting and one patient by flow-diverting.

Results: Successful positioning of the remodeling device was obtained in all the cases. On the postprocedural angiographic results, a Raymond class 1 was obtained in 32 (58%) of the aneurysms, a Raymond class 2 in (33)% and a Raymond class 3 in 5 (9%). There were three thromboembolic complications (5.5%) and three hemorrhagic complications (5.5%). There were no procedure-related complications. Follow-up angiographic results after 1 year from the embolization were obtained in 34 of 45 (75.6%), although ten aneurysms were not yet reached the follow-up period of angiography. These results were classified as Raymond class 1 in 21 aneurysms (46.7%), class 2 in 8 (17.8%), and class 3 in 5 (11.1%). Angiographic improvement due to progressive thrombosis of the aneurysm was obtained in 5 aneurysms, but 2 aneurysms were recanalized. In-stent stenosis was found in one aneurysm but, stent migration was not seen on follow-up angiography.

Conclusions: Stent-assisted coil embolization of wide-necked or complex intracranial aneurysms was found to be safe and effective with the Solitaire™ AB stent at immediate post-embolization and after 1 year follow-up. Long-term follow-up will be required to identify the effect of the Solitaire™ AB stent on recanalization rate.

Posterior Circulation Dissecting Aneurysms: review of 97 cases from a single center

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Purpose: Review epidemiology, clinical profile & management outcome of patients with posterior circulation dissecting aneurysms.

Methods: Demographics, clinical presentation, neurological deficits at presentation, treatment modality instituted and outcome upon discharge and on follow up, during period January 2007 through April 2015 was analysed.

Results: 109 patients (M:F = 70:39, mean age = 40.8 yrs) were diagnosed with posterior circulation dissecting aneurysms on DSA accounting for 6.0% of over 1800 patients with intracranial aneurysms during the study period. Commonest location of dissecting aneurysms was posterior cerebral artery (33, ~30.2%) followed by vertebral artery (27, ~24.7%). 77 (70.6%) patients presented with subarachnoid haemorrhage, 16 with mass effect symptoms and 9 with ischemic symptoms. Remaining had headache and other nonspecific symptoms. 56 underwent endovascular treatment and 13 had surgery. 31 cases were conservatively managed. 4 are awaiting endovascular treatment. 12 patients are lost to follow up and are omitted from analysis. 26 out of 31 conservatively managed patients with available follow up, spontaneous complete thrombosis was seen in 6 (23%) while 8 (30.7%) have died. The rest 12 patients are stable. 4 out of 56 patients endovascularly treated died, while the rest are doing well. Two of 11 patients who underwent surgical treatment have died.

Conclusion: Endovascular or surgical intervention in posterior circulation dissecting aneurysms results in better outcome compared to conservative treatment. Spontaneous thrombosis is frequent but unpredictable as observed in our study with no definite angiographic indicator for such an outcome. In view of fairly significant mortality and recurrent haemorrhage in patients treated conservatively, active intervention wherever possible is justified to reduce morbidity and mortality.

The Barrel VRD Vascular Reconstruction Device for the Treatment of Wide-Neck Bifurcation Aneurysms

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Rothschild Foundation

Purpose: Complex wide-necked bifurcation aneurysms by using a single-stent and double (X and Y) stenting remain challenging. The purpose of the French Barrel VRD™
Prospective Registry was to evaluate the safety and probable benefit of the device when used to facilitate endovascular coiling of wide-neck bifurcating aneurysms.

**Methods:** Patients (all harboring unruptured aneurysms) were placed on a double anti-platelet protocol (Clopidogrel and ASA) prior to treatment. Data presented includes 12-month follow-up data. Specific variables that were evaluated in this study include: the occurrence and frequency of adverse events and unanticipated adverse device were assessed as angiographic aneurysm occlusion grade, and occlusion durability. Occlusion grade and parent vessel compromise were assessed by DSA after the procedure and at 12-month angiogram.

**Results:** Twenty patients harboring 20 bifurcation aneurysms were enrolled. One patient was enrolled, but not treated due to being a low anti-platelet responder. Aneurysm necks ranged from 3.1 to 8.0 mm (mean: 5.6) and dome/neck ratio ranged from 0.6 to 1.9 (mean: 1.2). All but 2 aneurysms were virgin unruptured aneurysms, 2 aneurysms were recurring aneurysms after previous endovascular treatment. Trans-cell microcatheter placement was obtained in all cases. Technical success was 100% (19/19). Discharge mRS was 0 for all but 1 patient (this patient was mRS 2 at admission). Four serious adverse events were deployed in 3 patients. At the end of the procedure, Raymond grade 1 occlusion was obtained in 9 cases, grade 2 in 5 cases, and grade 3 in 5 cases. To date, one-year angiographic follow-up was obtained in 5 (25.0%) patients, showing Raymond grade 1 occlusion in 3/5, grade 2 in 1/5, grade 3 in 1/5.

**Conclusion:** The main advantage of the Barrel VRD™ is to avoid the use of 2 stents in a Y-configuration for bifurcation aneurysm neck reconstruction.

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Are all PICA aneurysms dissecting in nature: review of 16 cases?

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**Purpose:** Subarachnoid haemorrhage from a ruptured posterior inferior cerebellar artery (PICA) aneurysm is uncommon with a reported incidence of between 0.5 and 5.3%.

Less common however is the incidental discovery of an aneurysm in this location. PICA aneurysms are also a heterogeneous group with many having the angiographic features of dissection and others appearing saccular. We treated a patient with a ruptured small pica aneurysm that was saccular in appearance that subsequently rebled and on follow-up angiography appeared dissecting. This prompted us to review all PICA aneurysms to determine the angiographic features that may indicate underlying dissection.

**Method:** The University of Cape Town neurovascular database was searched using the terms “PICA dissection” and “PICA aneurysm” for the 10 year period from Jan 2005 to Dec 2014. Flow related aneurysms associated with arteriovenous malformations, giant aneurysms, unbleed aneurysms, traumatic aneurysms and vertebral artery aneurysms were excluded from the analysis. Patient clinical, angiographic, treatment and outcome data was reviewed.

**Results:** 16 patients with ruptured PICA aneurysms were identified out of a total of 1346 patients (1.2%). Six were identified as saccular and 10 as having features of dissection. Fusiform and saccular shapes were considered as dissecting as long as there was associated proximal or distal vessel stenosis or dilatation. The 6 saccular aneurysms were treated by clipping in 1 case and aneurysm coiling in 5, one of the patients rebled because of underlying dissection. The 10 dissecting aneurysms were treated by coiling of the saccular component in 4 and stent coiling in 1 patient. Three patients had aneurysm trapping using NBCA or coils and 1 patient had parent vessel occlusion proximal to the aneurysm. Three patients with delayed presentation had no intervention and healing of the dissection was confirmed on repeat angiography. Overall outcomes were good for 14 patients with only one having severe disability and one mortality.

**Conclusion:** PICA dissection may have a fusiform appearance and careful assessment of PICA aneurysm angiographic morphology is required to determine if dissection is present.

**References**


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Treatment of wide-neck bifurcation aneurysms with pCONus assisted coil occlusion: procedural safety and mid-term occlusion stability

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**Purpose:** Wide neck bifurcation aneurysms (WNBA) are considered to belong to the subgroup of aneurysms with increased difficulty and risks. Balloon- and stent-remodeling
are known techniques for their treatment. pCONus is a self-expanding, retrievable, electrolytically detachable device with a proximal shaft, 4 distal petals and a nylon cross in the distal end of the shaft. The device is made to bridge the orifice of WNBA in order to allow coil occlusion. It combines elements of “waffle cone” stent deployment and the no longer available TriSpan Device. Our purpose was to evaluate the safety and efficacy of this device.

Methods: 73 consecutive patients with 75 WNBA underwent endovascular treatment using pCONus between February, 2012 and January, 2015. Target vessels included middle cerebral artery in 38 (50.7%), anterior communicating artery in 17 (22.7%), and basilar tip in 16 (21.3%). 18 patients were treated in the setting of acute subarachnoid hemorrhage (24%). The fundus had a medial diameter of 8 mm and median neck of 6 mm. Planned angiographic follow-up intervals were at 3 and 12 months then every year thereafter.

Results: Neither technical failure nor rupture was encountered. Acute thrombi formation was observed in only one patient, which resolved after administration a body weight adapted bolus dose of eptifibatide. Neither permanent neurological deficit nor death related to treatment was observed. After the initial procedure, total occlusion was achieved in 33 (44%) patients and a neck remnant was evident in 23 (31%). At the first planned follow-up angiography 59 aneurysms were eligible and of those we saw 58 (98%). 59% showed complete occlusion and 22% a small neck remnant. During the second follow-up 24 aneurysms were eligible and we saw all 24 (100%). Of these 58% had complete occlusion and 8% had a neck remnant with 33% residual filling. Evident coil compaction requiring re-treatment was observed in fourteen patients. pCONus also assisted re-coiling without difficulties. No intimal hyperplasia has been observed.

Conclusion: pCONus allows controlled coil occlusion of WNBA, both ruptured and unruptured. pCONus facilitates initial coil insertion and retreatment as well. Major complications are rare.

References
1. Moret et al., 1997.
2. Horowitz et al., 2006.
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The pConus stent to assist coil embolization of wide-neck intracranial bifurcation aneurysms: clinical study to assess safety and efficacy

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Purpose: This study aimed at observing clinical safety and efficacy of the pConus stent in stent-assisted coil embolization of wide-neck intracranial bifurcation aneurysms.

Methods: IRB approved single-center observation study in 15 patients for the endovascular treatment of wide-neck bifurcation aneurysms. After obtaining informed consent, patients were included according to the following criteria: aneurysm fundus-to-neck ratio < 2 or neck diameter > 4 mm. Primary end point of clinical safety was absence of death and absence of any symptomatic stroke (major or minor) or transient ischemic attack. Primary end point for treatment efficacy was complete angiographic occlusion according to the Raymond–Roy Occlusion Classification (RROC) immediately after the procedure and at follow-up after 6 months on magnetic resonance imaging.

Results: In 14/15 (93%) of patients (12 middle cerebral artery, 2 anterior communicating artery, 1 terminal carotid artery aneurysms) the primary end point of safety was reached; in the one remaining patient, transient ischemic attack, but no permanent deficit was observed; in 9/15 (60%), efficient occlusion (RROC1) was reached, and in 6/ 15 (40%), a residual neck remained (RROC2). Stent-assisted coil embolization was technically successful in 14/15 (93%) cases. In the one remaining patient, the angulation between the main axis of the aneurysm dome and the parent vessel was unfavourable so that Y-stent-assisted coil embolization was used.

Conclusion: Deployment of the pConus is safe and effective to assist endovascular treatment of intracranial wide-neck bifurcation aneurysms by coiling.

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Ten-year Experience in Endovascular Treatment of Ruptured Aneurysms of the Posterior Inferior Cerebellar Artery

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Purpose: The aim of this report is to present our ten-year experience in endovascular treatment of ruptured posterior inferior cerebellar artery (PICA) sacculum aneurysms and evaluation of differences in clinical presentation, in the extension of subarachnoid haemorrhage and in outcome after endovascular treatment between patients with PICA aneurysms and patients with aneurysms in different locations treated in our department.

Methods: Out of 932 patients with a ruptured intracranial aneurysm treated endovascularly in our institution in years 2004–2014 38 aneurysms were located at the posterior inferior cerebellar artery (PICA). Clinical presentation, mean aneurysm diameter and outcome of the therapy in this group were compared with the same for ruptured aneurysms in other locations. Patients discharged with favourable
outcomes were checked angiographically in the follow-up period.

**Results:** Thirty-four patients with ruptured PICA aneurysms were treated by selective endovascular coiling. Two patients with wide necked aneurysms had endovascular stents implanted. In two cases, the parent vessel was occluded due to failure to catheterize the target aneurysm. There were two cases of rupture during coil placement. Both of them concerned aneurysms smaller than 5 mm. The evaluated variables did not differ significantly between patients with ruptured aneurysms located on the PICA and patients with ruptured aneurysms in other locations, but significantly more ruptured aneurysms in the PICA group were under 6 mm in diameter. 29.4% of controlled aneurysms needed additional reembolization in the follow-up period.

**Conclusion:** Clinical presentation, extension of subarachnoid haemorrhage and outcome after endovascular treatment did not differ significantly between patients with ruptured aneurysms located on the PICA and patients with aneurysms located elsewhere intracranially. Endovascular treatment is an effective method of therapy in patients with ruptured PICA aneurysms and results are favourable, even when sacrificing of the PICA is required.

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**Preliminary experience with the PulseRider aneurysm neck reconstruction device**

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**Purpose:** The Pulserider (Pulsar Vascular) is a novel device for neck reconstruction to assist in coiling of complex wide-necked aneurysms. We present our preliminary technical experience with the device, safety data, and early follow-up.

**Methods:** Between 2014–2015 we treated four patients with this device (2 MCA, 2 A COM). We reviewed angiographic and discharge data and also reviewed patients on our multidisciplinary clinic.

**Results:** All device deployments were uneventful and coiling through the device was carried out with good packing density and maintained device stability. There were no clinical complications. Follow up catheter angiography available in two patients to date showing persistent complete occlusion.

**Conclusion:** PulseRider offers an additional option to effectively and safely manage difficult neck anatomy in our small series.

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**Endovascular Treatment of Cerebral Aneurysms Using The Woven Endobridge (WEB) Technique in A Single Centre: Preliminary Results**

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**Purpose:** The Woven EndoBridge (WEB Sequent Medical) device is a new innovative interventional technique to secure cerebral aneurysms. We reviewed our data of patients treated with the WEB device. This was part of a national database of all UK centres utilising this device.

**Methods:** Prospective data collection was carried out on all 23 patients who underwent 25 WEB treatments at our institution. Of 25 procedures, 3 were for ruptured, 1 for late late acute, and the remainder for non-ruptured aneurysms. A novel 6-point Leeds scoring system was designed to ensure accurate assessment based on the morphology of the WEB device. Follow up was assessed by MRA angiogram and clinical follow up by Modified Rankin Scale (mRS).

**Results:** From 25 selected cases, 22 (88%) patients had a successful deployment of the WEB device. Immediately post procedure 14 (64%) had satisfactory aneurysm occlusion (Leeds Score 1-3a/3), 3 (14%) had a neck remnant (Leeds Score 4) and 5 (23%) patients had an aneurysm remnant (Leeds Score 5). At >3 month follow-up 20 patients had a stable aneurysm (91%) and 2 patients (9%) a recurrent aneurysm. Of the recurrent aneurysms, one patient was readmitted with hydrocephalus and received retreatment. The other patient remains under observation. Thromboembolic events were observed in 3 patients (14%), but only 1 (5%) had clinical sequela (mRS from 0 to 1).

**Conclusion:** The WEB is a promising device for treatment of difficult wide necked bifurcation aneurysms. Our results show effective occlusion of the aneurysms with minimal complications. Longer term follow-up is required to assess durability of this novel treatment.
Endovascular Treatment of Ruptured Large or Wide-neck Basilar Tip Aneurysms Associated with Moyamoya Disease using the Stent-assisted Coil Technique

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Purpose: Angioplasty and stenting was not recommended for treating arteries affected by moyamoya disease (MMD) because of the high restenosis rate. However, there are few reports addressing the safety of stent treatment of aneurysms located on unaffected arteries in MMD patients. We report our experiences of stent-assisted coil embolization for ruptured large or wide-neck basilar tip aneurysms (BTA) associated with MMD.

Methods: A retrospective review was conducted of 5 patients with ruptured basilar tip aneurysms associated with moyamoya disease treated by stent-assisted coil from January 2010 to December 2013 in our hospital. All presented with subarachnoid haemorrhage (SAH) and the diagnosis was confirmed by digital subtraction angiography (DSA). The procedure-related complications, immediate angiographic results, clinical and angiographic follow-ups were analyzed.

Results: Successful embolization was performed without procedure-related complications in all 5 patients, of which three were treated by single stent-assisted coiling, and the others were treated by Y-configured stent technique. Immediate angiographic results showed complete occlusion in two patients, neck residual in one, and partial occlusion in two. Postoperative angiographic follow-ups were obtained in all 5 cases at a mean time of 17.6 ± 9.3 months (range 6–28 months). Follow-up angiographic examinations demonstrated total occlusion without in-stent restenosis in all cases, and all the patients reported good outcomes (mRS 0–2).

Conclusion: Endovascular embolization using stent-assisted coiling proved to be a safe and efficient treatment for ruptured large or wide-neck BTAs associated with moyamoya disease, however, the long-term safety still remains to be confirmed.

Efficiency and safety of Leo plus Baby stent use in treatment of intracranial aneurysms

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Purpose: Intracranial complex aneurysms located on distal vessels are challenging in endovascular surgery. Efforts to completely occlude all types of ruptured as well as unruptured aneurysms during single procedure lead to development of various techniques. Introduction of Leo plus Baby intracranial stents dedicated for small arteries (lumen diameter from 1.5 to 3.1 mm) is a great example of such advance. Nevertheless, rigorous follow-up is essential for every new device. The purpose of the study is to assess the efficiency and safety of stenting with Leo plus Baby in treatment of intracranial aneurysms.

Methods: Study involved 134 patients (102 female and 32 male) with the mean age of 53.8 ± 11.4 years. Presence of the unruptured/ruptured wide-neck aneurysm located on distal artery; regrowth of the aneurysm after coiling and coil migration were three including criteria for Leo plus stent þ coils implantation. Six months after primary procedures, patients were readmitted to hospital and physical examination followed by cerebral angiography was performed. The overall procedure technical and clinical success rate as well as complication rate were assessed.

Results: Stent placement was successful in 99%. The overall procedure complication rate was 9.7%. Acute or subacute in-stent thrombosis treated uneventfully with Abciximab occurred in 11 cases, stent migration in 1 case and coil migration in 1 case. Nobody died during follow – up period, hemiparesis associated with procedure was observed in one patient. Most common aneurysm localisation was middle cerebral artery (56%) and anterior communicating artery (22%).

Conclusions: Implantation of Leo plus stent is efficient method of intracranial aneurysm treatment. Associated complication rate is low and in most cases can be managed with good outcome.
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Preliminary experience in the use of a novel “asymmetrical” stent assisted technique for bifurcation aneurysms treatment

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Purpose: Stent assisted coiling in case of endovascular treatment of large neck intracranial aneurysms is a well established technique that allows coils positioning preventing protrusion of coils into the parent artery and long term recanalization. Sometimes due to angioarchitecture of the neck/vessel complex, a double stenting in “x” or “y” shaped configuration is necessary in order to achieve a satisfactory result. The availability of a close cells nitinol stent with a larger round shaped focal segment at its middle part (so called “barrel” shape, Medtronic) can overcome the need of a double stenting, making the procedure simpler and safer.

Methods: Eight patients (4 M:4 F, median age 52-yo) with eight unruptured incidental aneurysms (main diameter ranged from 9 to 25 mm) were treated between December 2014 and June 2015: 5 basilar-tip, 2 a-com, 1 p-com. Neck to parent vessel ratio was in all cases unfavourable for coiling alone. After positionning the Barrel stent, utilizing a 0’021inch microcatheter (Prowler Plus, Orion, Headway), a 0’010inch microcatheter was navigated into the aneurysmal fundus trough the stent strut for coiling.

Results: The device was released easily in all cases with the barrel at the expected neck location. In few cases there was the need to readjust the stent position pushing or pulling it, without resheating it completely. Crossing the stent was always feasible. Coils protrusion never happened, nor stent displacement during coiling or at the final stent detachment. In one case angiography and in one case MR 3-month follow-up were available.

Conclusions: In our series the use of the device was always feasible, allowing to a safe and effective stent assisted coiling without any technical or clinical complications. Of course, we need a larger series with a longer follow-up in order to better understand limits and advantages of this new technique.

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Follow up results of endovascular treatment of unruptured intradural aneurysms of the anterior part of the circle of Willis

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Purpose: Evaluation of the results of endovascular treatment of unruptured intradural aneurysms of the anterior part of the circle of Willis.

Material and Methods: Retrospective analysis of 92 patients with unruptured aneurysms of the anterior part of the circle of Willis treated at our institution in the period from 2000 to 2011; age range from 12 to 73 years. 11 patients had multiple aneurysms. Endovascular procedures included coiling alone.

Results: The following clinical outcomes have been observed: absence of neurological deficits in 87 (94.6%), permanent neurological deficits in 5 (5.4%) - Rankin scale 5 and below; intraoperative ruptures were observed in 3 patients, thromboembolism -3 patients. Complete occlusion was achieved in 70 (76.85%) cases, and was maintained in 95% of cases during follow up.(1 to 11 years) Mortality was one patient. In last years the number of complications was decreased as a result of improved technique, mandatory use of general anesthesia, as well as aggressive prophylaxis and treatment of thromboembolic complications. None of the treated patients in the follow-up period developed intracranial hemorrhage.

Conclusion: Endovascular treatment of intradural aneurysms of the anterior circle of Willis by skilled surgeons can be advised for this group of patients.

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Short-term outcome of single stenting technique for unruptured tiny aneurysms of the anterior circulation

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Purpose: To evaluate the short-term outcome of single stenting technique for unruptured tiny aneurysms of the anterior circulation.

Materials and Methods: Eleven unruptured tiny aneurysms of the anterior circulation were treated by a single stent deployed in the parent artery between January 2008 and July 2013 in Beijing Hospital. The maximum diameter of the aneurysms ranged from 2.0 to 3.0 mm, mean (2.4 ± 0.4) mm, and their dome-to-neck ratios were all ≤1.2. Their locations were clinoid segment of internal carotid artery (n = 2), posterior communicating artery origin (n = 4), anterior choroidal artery origin (n = 2) and middle cerebral artery bifurcation (n = 3). All internal carotid aneurysms were located in the medial and/or ventral wall of the internal carotid artery. The rate of aneurysm obliteration and rupture during follow-up was obtained by repeat angiography and clinic interview respectively.

Results: Sole stent placement in the parent artery was intentionally performed for nine aneurysms, while attempt of coiling after stent deployment for the other two aneurysms failed due to unsuccessful microcatherization. Ten stents were successfully deployed, of which one was used to treat two tandem lesions simultaneously. Only one aneurysm became smaller immediately postprocedure. No perioperative complications occurred. Angiographic follow-up after a mean period of (13 ± 6) months (range 8–24 months) revealed that 8 aneurysms did no change in size,
2 became smaller and only one was totally occluded. Asymptomatic in-stent stenosis of the parent artery was found in all 3 shrinking or occluded aneurysms. No aneurysm rupture was observed in the clinical follow-up.

**Conclusion:** For those unruptured, wide-necked, tiny aneurysms arising at branching sites in the anterior circulation, single stenting technique seems to be a safe alternative treatment, while the short-term rate of aneurysm occlusion is low.

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*Endovascular treatment of intracranial aneurysms with Pipeline Embolization Device (PED): clinical and angiographic long term follow up*

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**Purpose:** We present our retrospective experience with the PED since sep/2010 up to oct/2014 in intracranial aneurysms, periprocedural results and long term follow up.

**Methods:** Patients harboring large and giant wide-necked, nonsaccular, and recurrent, and small post clipping remnant and artery emerging of sac intracranial aneurysms were selected for treatment. Device conformability, time to occlusion and clinical evolution were evaluated.

**Results:** Forty-seven patients with 55 intracranial aneurysms were treated with the PED (38 female). Small n = 25 that include those with artery emerging of sac and segmental defect, large (n = 19), giant (n = 4), Fusiform/dissecting (n = 3), and 4 post clipping remnant were included. A total of 49 PEDs were in 47 procedures. Non mortality was encountered. Two patients registered procedural morbidity (stroke and vertebral dissection). In 4 cases In-neurostent PED and 2 In-Diversor PED were implanted. 3 inaccuracies were registered (6,1%) and 2 (4%) conformability defect resolved with balloon.

All patients were evaluated with Digital Subtraction Angiogram on FU (between 3 and 51 months). Three patientes presented A1 reduction, one symptomatic. 3 aneurysms partially open at long term FU (5,4%). 2 asymptomatic ophthalmic artery occlusion. Three patientes suffered visual defect: one with spontaneous reversion, one with 6 months intermittent fugax amaurosis and one with episodes related to reduction of antiplatelet treatment. All patients with mass effect symptoms improved on FU.

**Conclusion:** Endovascular reconstruction with the PED in our experience represents a safe procedure with experimented operators, and effective about rate of occlusion at long term FU with low procedural and FU morbi-mortality.

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*Initial Experience with Innovative Pericardium Covered Neurovascular Stent*

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**Purpose:** The covered stent is an option in endovascular therapy; it is specifically designed for immediate endovascular reconstruction of a segmentally diseased artery. Experience with covered stents for neurological indications is still limited. We describe our first six cases with cerebral aneurysms treated with a pericardium-covered stent (AneuGraftNx, ITGI Medical Ltd., Or Akiva, Israel) for vessel reconstruction.

**Materials & Methods:** Six patients, 4 females and 2 males, underwent treatment for giant and blister aneurysms of the internal carotid artery (ICA). Their ages were between 22 and 55 years (mean: 39). Only one patient had a subarachnoid haemorrhage. This patient also had a blister aneurysm of the ICA opthalmic segment. While three patients had aneurysms of the ICA cavernous segment, one had an aneurysm of the ICA petrous segment. The sixth had a giant aneurysm of the posterior communicating artery. One of the left ICA cavernous segment aneurysms was a recanalized one treated previously with stent-assisted coiling.

**Results:** Full blood vessel reconstruction was achieved and the aneurysms were immediately and completely excluded from the blood flow. In three patients, two AneuGraftNx stents were used. All patients were discharged without any neurological deficit. Two patients underwent follow-up angiograms (at the 3rd and 8th months), that showed no aneurysm filling and no in-stent stenosis. They were also symptom-free.

**Conclusion:** Covered neurological stents may provide an effective tool for the safe and immediate exclusion of aneurysms in the cerebral vasculature, and particularly in the treatment of wide-necked aneurysms. More clinical data is still needed on the subject.

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*Efficacy of flow diversion as treatment for anterior cerebral artery bifurcation aneurysms*

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**Purpose:** To assess clinical efficacy and safety of flow diverting stent (FDS) placement as an alternative to complex
embolization in the treatment of anterior cerebral artery (ACA) bifurcation aneurysms.

**Materials and Methods:** ACA aneurysms categorised as ‘difficult to treat’ on account of unfavourable morphology or recurrence after primary coiling and treated with FDS were identified in 23 patients from a local database retrospectively. Two interventional neuroradiologists reviewed clinical records and imaging. Aneurysms were classified according to morphology: those incorporating the A1/A2 junction bilaterally as H-shaped and those receiving supply from a dominant or unilateral A1 junction as Y-shaped. Modified Rankin Scores (mRS) were obtained by telephone at follow up using a validated test (Patel et al. 2012). Occlusion and complication rates were assessed using observational statistical analysis.

**Results:** 3 pericallosal, 6 H-shaped and 14 Y-shaped aneurysms were assessed in 23 patients (M6:F17) aged 33–70. The follow-up duration was 3–36 months. mRS was available in 19/23 patients and was 0–2 in 18/19. 16/23 (70%) aneurysms were completely occluded by 1 year. 10 were Y-shaped, 6 H-shaped and 2 pericallosal. 5/23 (22%) were partially occluded and only 2 (8%) were unchanged. In 8/23 (35%) patients, small caudate head infarct ipsilateral to the stent was demonstrated including 2/2 treated with telescoped stents. 8/8 were asymptomatic. 7/8 were Y-shaped aneurysms and 1/8 was pericallosal.

**Conclusion:** Flow diversion is an effective method for treating difficult ACA aneurysms, however there is a significant rate of small, clinically silent perforator infarcts of the caudate head. The impact of this is unclear, but the risk of this complication must be considered and discussed in the consent process. This risk could be related to aneurysm morphology and multiple stents and could potentially be reduced by patient selection and avoidance of telescoped stents where possible.

**Reference**


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**WEB-SL/SLS® Aneurysm Treatment: One-month Safety Results in WEBCAST2 Study**

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**Purpose:** WEB Flow disruption is an innovative endovascular treatment for wide-neck bifurcation aneurysms. WEBCAST1 was analyzing the safety and efficacy of WEB-DL device. WEBCAST2 is dedicated to the safety and efficacy analysis of WEB-SL and WEB-SLS device.

**Methods:** WEBCAST2 is a prospective, multicenter, European study involving 13 Interventional Neuroradiology centers. Patients with bifurcation aneurysms are included in WEBCAST2. Aneurysm locations included in WEBCAST2 are middle cerebral artery, internal carotid artery terminus, anterior communicating artery, posterior communicating artery, and basilar tip. Patients with ruptured and unruptured aneurysms are included. All adverse events are collected and will be analyzed by an independent medical monitor. Morbidity and mortality will be analyzed at 1, 6, and 12 months. Follow-up imaging will be obtained at 6 and 12 months and up to 5 years, and independently analyzed by an expert in Interventional Neuroradiology. The goal is to enroll 55 patients.

**Results:** Inclusions started in August 2014. As of May 13, 52 patients were included. The expectation is to have inclusions completed end of May or beginning of June. One-month clinical follow-up will be completed end of June. One-month safety data will be presented and analyzed in comparison with other WEB Good Clinical Practice (GCP) Data (WEBCAST1 and French Observatory that included patients treated with both WEB-DL and WEB-SL/SLS).

**Conclusion:** WEBCAST2 is an ongoing study evaluating WEB-SL/SLS aneurysm treatment. Inclusion completion is expected end of May. One-month safety data will be presented and analyzed in light of previous GCP studies (WEBCAST1 and French Observatory).

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**The LUNA™ Aneurysm Embolization System for The Treatment Of Intracranial Aneurysms. Post-Market Clinical 12-Month Follow-Up Study**

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**Purpose:** The LUNA Aneurysm Embolization System (LUNA™ AES) is an intra saccular flow disruption device. We report herein the safety and efficacy of the device as part of the LUNA™ AES PMCF study.

**Methods:** The study is ongoing (up to 36 months follow-up) and data presented includes 6 and 12-month follow-up data. The primary safety variables collected as part of the LUNA™ PMCF study are the occurrence and frequency of adverse events (AE). An independent Core Laboratory evaluated angiographic assessment of aneurysm occlusion grade, parent vessel compromise, and occlusion durability. Occlusion grade and parent vessel compromise were assessed by DSA after the procedure as well as on the 6 and 12-month angiograms.

**Results:** 63 patients were enrolled at 9 European sites. The mean age was 52.4 years (median 53 years). The majority of patients were female (84.1%). Most patients had an initial Modified Rankin Scale (mRS) of 0 (80.1%). Most aneurysms were unruptured (60/64, 93.8%) and the majority of aneurysms were Bifurcation or Terminal aneurysms (76.6%). All aneurysms were ≤10 mm (range 4–10 mm) in height with a
Flow Diversion in the Treatment of Aneurysms (FIAT): A Randomized Care Trial

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Purpose: Flow diversion is an innovative method to treat intracranial aneurysms. The Flow diversion in the treatment of Intracranial Aneurysm (FIAT) trial was designed to enable flow diversion within a clinical trial framework to study safety and efficacy.

Methods: FIAT proposed randomized allocation to flow diversion or standard management options (observation, coiling, parent vessel occlusion, or clipping), and a registry of patients deemed ineligible for standard options. The primary safety outcome was death or dependency (mRS > 2) at 3 months. The primary efficacy outcome was a composite of angiographic occlusion at 3–12 months combined with a good clinical outcome.

Results: Three sites in Canada were enrolling patients when the study was halted by the DSMC. Of 112 participating patients, 78 patients were randomized (39 in each arm), and 34 received flow diversion within a registry. Results of this randomized trial will be presented at the WFITN.

Conclusion: Randomized trials can be designed to protect patients and at the same time provide data to guide clinical practice. FIAT and other randomized studies can help delineate the role of flow diversion in the management of aneurysms.

Compaction of Flow Diverters improves occlusion of Experimental Wide-Necked Aneurysms

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Purpose: Flow diverters (FDs) are increasingly used in the treatment of wide-necked aneurysms. We hypothesized that intentional compaction during flow diverter delivery could improve aneurysm occlusion rates.

Methods: Bilateral wide-necked carotid aneurysms were created in 12 dogs. Endovascular treatment was performed one month later, using Pipeline embolization devices deployed by compaction across the neck of aneurysms (n = 12). Group 1a consisted of aneurysms treated with a single compacted FD (n = 8), while Group 1b aneurysms had two compacted FDs to cover the aneurysm ostium (n = 4). Control aneurysms consisted of similar aneurysms treated with a single device deployed without compaction (Group 3; n = 6) and untreated aneurysms (Group 4; n = 4). Angiographic results were compared at 3 months. Pathology specimens were photographed and the neointimal coverage of devices at the necks was scored using an ordinal grading system.

Results: Twenty-two of 24 aneurysms were patent at one month. Deployment with compaction was successful in 8 cases (Group 1a aneurysms). The compaction maneuver led to 5 complications, including prolapso of the device inside the aneurysm in 4 cases, rescued by deploying a second flow diverter in a telescoping fashion (forming Group 1b aneurysms); one compacted device migrated distally in the maxillary artery, leaving the aneurysm untreated. Angiographic results differed significantly between groups (P = 0.0002). Aneurysms treated with a single compacted flow diverter were more often occluded at 3 months (7/7) than aneurysms flow-diverted without compaction (2/6; P = 0.021). All aneurysms treated with 2 compacted flow diverters were occluded, while all untreated aneurysms remained patent at 3 months. There were no parent vessel stenoses.

Conclusion: Compaction of flow diverters can improve angiographic occlusion of experimental wide necked aneurysms.
Design and Enrollment Status of the WEB-Intrasaccular Therapy (WEB-IT) Study

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Purpose: The Woven Endobridge (WEB) is an intra-aneurysmal flow diverter intended for use in the endovascular embolization of intracranial, wide-necked, bifurcation aneurysms (WNBA). In the United States (US) the WEB has recently been granted an Investigational Device Exemption (IDE) for use within the WEB-IT Study. We present the design and enrollment status of the WEB-Intrasaccular Therapy (WEB-IT) study.

Methods: WEB-IT is a prospective, multicenter, single-arm interventional study designed to evaluate the safety and effectiveness of the WEB device for the treatment of ruptured and unruptured WNBA arising from the basilar apex, middle cerebral artery, internal carotid artery terminus, and anterior communicating artery complex. The primary effectiveness endpoint is complete angiographic occlusion of the targeted aneurysm at 1 year as determined by an independent core laboratory. The primary safety endpoint is the proportion of subjects with death or any major stroke within the first 30 days after treatment or major ipsilateral stroke or death due to a neurological cause from day 31 to 1 year. Both effectiveness and safety endpoints will be compared with a performance goal or Objective Performance Characteristic (OPC) derived from the available clinical literature for the treatment of WNBA. The study will be interpreted as a success if both endpoints are met. The aneurysms to be treated should be saccular in shape, have a neck size ≥4 mm or a dome-to-neck ratio <2, and a diameter of approximately 5–11 mm at screening. Ruptured patients must have a Hunt & Hess score of I or II. Patients will be followed for 5 years after the procedure.

Results: The WEB-IT trial was initiated on August 19, 2014. To date 49 of 150 subjects have been enrolled.

Conclusions: The WEB-IT trial will provide an assessment of the safety and efficacy of the WEB device for the treatment of WNBA.

Use of the Vascular Simulations' Replicator as a Physician Training Tool for the WEB-IT Clinical Study

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Purpose: The WEB is a novel intrasaccular aneurysm therapy for ruptured and unruptured intracranial wide neck bifurcation aneurysms. The WEB Intrasaccular Therapy Study (WEB-IT) is the pivotal US IDE Study to demonstrate the safety and effectiveness of the therapy for US FDA approval. WEB-IT will enroll approximately 150 patients and no roll-in cases are permitted. A significant challenge of study execution is how to efficiently and effectively train an entirely new user group (US clinical investigators) on the safe and effective use of this new technology while under a clinical trial setting.

Methods: The Replicator (Vascular Simulations, Stony Brook NY) is a new type of mechanical flow model that simulates the cardiac cycle and incorporates 3D replication of actual patient vasculature. The model allows simulated aneurysm treatment in a true angiographic environment. Training on the Replicator has been integrated as a key aspect of the multimodal WEB-IT Physician Training Program. Benefits of using the Replicator include: case planning (access set-up, WEB placement and deployment, “dry run” clinical cases with the full research team to minimize study deviations), treatment of the same or similar aneurysms as the clinical cases, a shortened learning curve, and the practice of advanced techniques and more difficult delivery options in a no risk environment. In addition, the study design will be described including study inclusion/exclusion criteria, primary safety and effectiveness endpoints, and indications for use.

Results: The WEB-IT trial was initiated on August 19, 2014. To date 49 of 150 subjects have been enrolled. Replicator based training summary is as follows:

- 19 centralized training programs.
- 26 pre case training sessions.
- 40 physicians from 21 investigational sites trained.
- Creation of 5 discrete heads.
- Replication of 41 total aneurysms.
- Specific aneurysms replicated: 16-Basilar, 5-ICAt, 16-MCA, 10-ACOM.

Conclusions: Use of the Vascular Simulations’ Replicator has proven to be an effective physician training tool for the WEB-IT Clinical Study. This program may prove to be a model for the training support required for other emerging neurovascular technology platforms.
Impact of aneurysm size on the complication rate associated with flow diverter treatment of intracranial aneurysms: A composite analysis of three large scale multicenter studies

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Purpose: Flow Diverter Treatment (FDT) of intracranial aneurysms has been reportedly associated with excellent morphological results and a varying rate of periprocedural complications. The purpose of this work was to study the incidence of complications and safety outcomes in relation to aneurysm size through a composite analysis of three large scale multicenter studies.

Methods: A total of 1221 aneurysms in 1092 patients were included from the PUFS single arm prospective trial, and the ASPIRE prospective and IntrePED retrospective registries. In PUFS and the US ASPIRE sites, the indication was restricted to wide-neck aneurysms larger than 10 mm, located on the intracranial internal carotid artery from the petrous to the superior hypophyseal segments. All aneurysms treated prior to study initiation were included in IntrePED without restrictions in anatomy, size or ruptured status. All adverse events were evaluated by an independent event adjudication committee. Complications were considered major if symptoms lasted longer than 7 days and were classified as ipsilateral ischemic stroke (IIS) or ipsilateral intracranial hemorrhage (IIH). The major complications are reported below.

Results: The incidence of IIS and IIH for the entire population was 3.7% and 2.0%, respectively. The IIS rate was 2.4%, 3.3% and 9.4% while IIH rate was 1.2%, 2.5% and 2.8% for small, large and giant aneurysms respectively. The composite incidence of morbidity defined as major IIS and major IIH was 5.7% and the rate of neurological mortality was 3.3%. The combined morbidity-neurological mortality rate was 7.1% for the entire cohort including ruptured aneurysms, and 4.4%, 7.2% and 17.0% for small, large and giant aneurysms respectively.

Conclusion: The rate of periprocedural IIS and subsequent major morbidity and neurological mortality following FDT correlates with aneurysm size. Small aneurysms were associated with better outcomes than the large and giant aneurysms.

Aneurysm recurrence or persistence post treatment using flow diverting stent due to enlargement of a hypoplastic artery

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Purpose: Hypoplasia of the A1 segment of the anterior cerebral artery or the P1 segment of the posterior cerebral artery is relatively common (up to 10%). Delayed enlargement of a hypoplastic artery after aneurysm treatment with a flow diverting stent (FDS) may lead to treatment failure.

Methods: 3 illustrative cases are presented.


Conclusion: Hypoplastic vessels may enlarge after FDS treatment leading to treatment failure.

Preliminary monocenter experience using new generation “long” flow diverter stents (FD) in dissecting aneurysms

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Purpose: Dissecting aneurysms, mainly in posterior circulation, are still a challenging issue for INR either if symptomatic or not.

Methods: In the last year we have treated several of them, but in three particular cases we have adopted the new generation “long” flow diverter stents (up to 6 cm). All of them were uruptured, 2 slightly and 1 heavily symptomatic, 2 in posterior circulation (vertebro-basilar VB), and 1 in left ICA. Follow up (CT, MRI and DSA) is 6 months for the anterior circulation, 9 and 15 for the posterior ones. One giant VB dissecting aneurysm was retreated with an additionallong FD stent.

Results: We didn’t experienced any intraprocedural complications. All parent vessels are patent and in 2 of the 3 cases the discharge was within 5 days. 2 of them are almost asymptomatic until now and able to a regular lifestyle.
The anterior circulation one is shrunk, whether the posterior ones are dimensionally unchanged. The posterior biggest one (VB) worsened symptomatology.

**Conclusion:** Long FD stents allow to treat a longer pathologic segment without too many telescopic overlaps. In our personal opinion probably an early approach to a dissecting aneurysm before becoming heavily symptomatic could promise a better outcome.

**Reference**

1. References should be in the Harvard (author, date) format within the body of the text (eg. Smith, 2000; Smith & Jones, 2005; Smith et al., 2002) and listed by lead author alphabetical order at the end of the paper.

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**Lights and shadows in our monocenter experience using p64 flow diverter stent**

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**Purpose:** As a new paradigm in endovascular treatment of cerebral aneurysms, flow diverter devices (FD) are becoming a suitable and, in selected cases, preferred alternative to traditional neuroendovascular options. We present our monocentric experience with a new generation FD stent p64 (Phenox), a braided mesh tube composed of a 64 nitinol wires, totally retrievable.

**Materials and Methods:** Between September 2013 and may 2015 we have been treating 10 patients with 10 aneurysms with the new generation p64 (Phenox). Alle the aneurysms were in the anterior circulation (5 paraofthalmic ICA, 1 fetal PCA, 2 MCA and 1 Acom). The last case, using the newest detachment system (4.0), is a recanalization of a previously ruptured and coiled anterior corioideal artery aneurysm. All the patients were checked with a 6–8 months DSA and MRI. The last patient has just a CT/MRI control and is undergoing DSA between december 2015 and january 2016.

**Results:** The mean follow up is 14.5 months regarding first 9 cases. Aneurysmal occlusion after 6 months DSA is 7/9 (77.8%). We experienced 3 technical problems in the deploying/detaching phase: in 2/3 cases a second stent was needed to obtain an adequate coverage of the neck. One of the not cured cases is a fetal PCA aneurysm. In 4 cases we observed intimal asymptomatic hyperplasia. In the last patient there were no technical problems during stent deployment and detachment, due to the new releasing system (4.0).

**Conclusion:** P64 FD is the only completely retrievable FD and the increased mesh density of the stent is in line with literature data in terms of aneurysmal occlusion. Misddeploying/detaching is a questionable point for the previous version on the market. The new releasing system seems to be more user friendly; future data are needed to confirm it.

**Reference**


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**SAFE (Safety and efficacy Analysis of Fred Embolic device in aneurysm treatment): Study design and Preliminary Results**

L Pierot, JY Gauvrit, JP Lejeune, AL Derelle, J Grabrillargues, for the and SAFE Investigators

**Purpose:** Flow diversion is now a well-established endovascular technique for the treatment of intracranial aneurysms. FRED is a dual-layer, self-expanding nickel titanium flow-diverter. SAFE is dedicated to the evaluation of safety and efficacy of the device.

**Methods:** SAFE is a prospective, multicenter, French study involving 13 Interventional Neuroradiology centers. The primary efficacy endpoint is the rate of complete aneurysm occlusion at 6 months without associated stenosis of the parent vessel. The primary safety endpoint is the rate of morbidity (mRS > 2) and mortality at 6 months. Adverse events as well as anatomical results will be independently evaluated. According to the endpoints, the target population is 85 patients.

**Results:** Inclusion and exclusion criteria will be presented. Inclusions started in July 2014. As of May 13, 61 patients were included. The expectation is to have inclusions completed end of September 2015. The data will be analyzed in light of the previous data of prospective studies evaluating flow diversion.

**Conclusion:** SAFE is an ongoing GCP (Good Clinical Practice) study aiming to evaluate safety and efficacy of FRED flow diverter in aneurysm treatment.

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**Safety and Efficacy of WEB® Aneurysm Treatment: Combined Analysis of WEBCAST and French Observatory Studies**

L Pierot, A Molyneux, J Byrne; for the WEBCAST and French Observatory Investigators

**Purpose:** WEB Flow disruption is an innovative endovascular treatment for wide-neck bifurcation aneurysms. Two prospective multicenter GCP (Good Clinical Practice) studies were conducted in Europe and inclusions were completed in February 2014 in both trials. Safety and efficacy data are analyzed.

**Methods:** Patients with wide neck bifurcation aneurysms were included in both WEBCAST and French Observatory.
An independent medical monitor independently analyzed adverse events. Follow-up imaging was obtained at 6 and 12 months in WEBCAST study and at 12 months in French Observatory. An independent expert in Interventional Neuroradiology evaluated anatomical results using the 3 grades scale: complete occlusion, neck remnant, and aneurysm remnant. In WEBCAST, the reader was also directly comparing evolution of anatomical results between 6 months and 12 months classified as improved, stable, or worsened.

**Results:** A total of 113 patients (74 females, 65.5%) with 114 aneurysms (10 ruptured, 8.8%; 99 unruptured, 88.8%; and 5 recanalized, 4.4%) were included in both studies (51 in WEBCAST and 62 in French Observatory). Fifty-nine aneurysms were located at middle cerebral artery (51.8%), 22 at anterior communicating artery (51.8%), 21 at basilar artery (18.4%), and 12 at internal carotid artery terminus (10.5%). Morbidity and mortality at one month were respectively 2.7% and 0.0%.

Twelve months imaging follow-up is now completed in both WEBCAST and French Observatory, is currently under analysis, and will be presented.

**Conclusion:** This analysis confirms the safety of WEB treatment. Efficacy data will be presented.

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**WEB endovascular treatment of wide-neck bifurcation aneurysms: long-term results in a European series**

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**Purpose:** Flow disruption with the WEB-DL device has been used safely for the treatment of wide-necked bifurcation aneurysms. The stability of aneurysm occlusion after this treatment was evaluated in short- and midterm, but not in long-term. This retrospective multicenter European study is the continuation of an already published series dealing with short-and midterm anatomical results and analyzes long-term data in patients treated with WEB-DL.

**Methods:** Twelve European neurointerventional centers initially participated to the study. In addition to data collected for the initial publication, images obtained at long-term follow-up were collected and independently analyzed by the same experienced interventional neuroradiologist.

**Results:** Out of the initial 45 patients, 26 (20 females and 6 males) aged 35 to 73 years (mean: 55.2 +/- 10.6 years; median: 55.5 years) harboring 26 aneurysms treated with the WEB-DL device had long-term follow-up (median: 27.4 months). Three out of 26 patients (11.5%) were retreated between short- and midterm follow-up and none between mid- and long-term. Long-term aneurysm occlusion in the 19 patients treated with WEB only and not retreated during follow-up was complete occlusion in 13/19 patients (68.4%) including aneurysms with opacification of the proximal recess (9/19 patients, 47.4%), neck remnant in 3/19 patients (15.8%), and aneurysm remnant in 3/19 patients (15.8%). In all patients (100.0%), aneurysm occlusion was stable between midterm and long-term follow-up.

**Conclusions:** The results suggest that WEB treatment of wide-neck bifurcation aneurysms offers long-term stable occlusion.

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**Endovascular treatment of Giant Internal Carotid artery terminus (carotid T) aneurysms using a combination of coils and flow divertors- A case series**

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**Purpose:** Giant aneurysms of ICA terminus are very rare and are associated with a poor natural history (K Fujita et al. 1988). Endovascular treatment of large and giant aneurysms with simple coiling or stent assisted coiling is associated with a recanalization rate of up to 29% (Xu Gao et al. 2010). Treatment of these aneurysms has been traditionally performed by Huntarian ligation or endovascular parent vessel occlusion with or without EC-IC bypass but both these procedures also carry significant associated risks (Drake CG et al. 1994). Flow diversion for intracranial aneurysms has evolved over the last few years as a promising alternative therapy for endovascular aneurysm occlusion. Increasingly a combination of endosaccular coiling and flow diversion is being used in the treatment of large and giant aneurysms, as there were concerns of aneurysm growth and delayed rupture when flow divertors were used in isolation to treat such cases. (Timothy Hampton et al. 2011, Thomas Mattingly et al. 2015).

We report a series of three consecutive cases of giant ICA terminus aneurysms that were successfully treated using a combination of coiling and flow diversion performed in our unit over the last year.

**Methods:** Two patients with giant R ICA terminus aneurysms and one with left giant ICA terminus aneurysm were treated using a combination of "pipeline"[COVEDIEN] stents and coils. The patients were preloaded with a combination of Aspirin and clopidogrel for a week before the procedure as per the standard departmental protocol. The procedures were performed under GA and systemic heparinisation. Bilateral femoral punctures were made with the coiling catheters and stent delivery catheters in their own separate guiding catheters within the ICA. After "jailing" the Coiling catheter in the aneurysm, the aneurysms were coiled to a moderate coil density and two telescopic pipeline stents were deployed subsequently from ipsilateral M1 to distal
ICA in all the three cases. Balloon angioplasty had to be performed in two patients to ensure the adequacy of stent opening and apposition.

**Results:** There were no procedure related complications. All three patients were discharged within 24–48 hrs after surgery. Three months MRI/MRA (both CE and TOF) and subsequent clinic follow up are available in all three patients. All patients remain well and have no deficit. The first patient has longstanding temporal lobe epilepsy which remains unchanged and is under control with anti-epileptics. In two of the patients the aneurysms have completely thrombosed and no longer filling. The stent remains patent with distal MCA filling normally. There is no evidence of distal ischaemia or infarction in the brain. There is a slight increase in the high T2 signal changes around the aneurysms but no significant mass effect or midline shift. In the third patient the patent luminal component of the aneurysm has reduced substantially in size from 2.5 cm to 9 mm but is still opacifying with contrast, which is however surrounded by dense organised thrombus. Again there is some increase in the high T2 signal around the aneurysm but no significant mass effect, midline shift and no ischaemia.

The A1 segment of ACA (anterior cerebral artery) ipsilateral to the stent has regressed in two patients and completely disappeared in the third patient with the contralateral anterior cerebral artery providing the dominant supply to the ipsilateral anterior cerebral artery territories in all three patients via the ACOM (anterior communicating artery). Asymptomatic mural enhancement was noted in one patient. There were no cases of progressive or symptomatic enlargement of the treated aneurysm in any of the patients, contrary to what has been previously described (Timothy Hampton et al. 2011, Thomas Mattingly et al. 2015).

All three patients remain under follow up with scans due in the next three months.

**Conclusion:** Treatment using a combination of flow diversion and endosaccular coiling offers a promising therapy for Giant ICA terminus aneurysms, with very good immediate and short term results in this difficult disease.

**References**


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**Surpass Flow Diverter: A real world experience derived from 200 cases**

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**Purpose:** We present angiographic and clinical results of 200 cases treated with Surpass flow diverter system for treatment of intracranial aneurysms in a multicenter retrospective study.

**Methods:** In three European neurointerventional groups, 200 patients with 217 intracranial aneurysms of the anterior and posterior circulations were treated. The primary efficacy end point was accepted as the %100 aneurysm occlusion on 6–8 month DSA. The primary safety end point was any increase in modified Rankin scale (mRS) score and neurologic death.

**Results:** Successful flow-diverter delivery was achieved in 200 patients. Clinical follow-up (median, 6 months) of 200 patients was associated with angiographic follow up in 161 cases. These showed that the primary safety end point occurred in 9 cases while primary efficacy target achieved in 88% of cases in follow up angiograms. Permanent neurologic morbidity was 3% and mortality 1.5%, respectively. No ischemic strokes at or after 30 days. There was two cases with subarachnoid hemorrhage within the first month after the procedure. New or worsening cranial nerve deficit was observed in 2 cases. The mean number of devices used per aneurysm was 0.89.

**Conclusions:** Surpass flow diverter is an effective tool in the treatment of intracranial aneurysms with an acceptable safety profile comparable with other endovascular treatment options. Angiographic results showed a higher and faster rate of intracranial aneurysm occlusion while there is a reduction in the number of the used device.
Flow Diverters in Posterior Circulation

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Purpose: We present angiographic and clinical results of cases with an aneurysm located in the posterior circulation and treated with a flow diverter system (Pipeline, Silk, Surpass).

Methods: A retrospective study was maintained of all posterior circulation aneurysms treated with flow diverting systems at 3 European neurointerventional groups during a 2 years period. The primary efficacy end point was accepted as the 100% aneurysm occlusion on 6-8 month DSA. The primary safety end point was neurologic death and any increase in modified Rankin scale (mRS) score.

Results: Sixty three posterior circulation aneurysms were treated in 61 patients. In 6 cases more than one stent was used. There was one death. Four cases had a reversible ischemic event with a hyperintense focus on DWI. There were 3 cases with permanent ischemic deficit. No aneurysm rupture or stent thrombosis. Total aneurysm occlusion was observed in 52 patients.

Conclusions: Flow diverters are effective in the treatment of the posterior circulation aneurysms. Perforator occlusion rate remains an issue in this location, however with a declining fashion. This may be due to improvements in operator’s skills and advances in the technologies in particular access material.

Initial experience of 2 mm Surpass flow diverter in Intracranial Aneurysms

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Purpose: Surpass flow diverter(SFD) is an outstanding flow diverter in the endovascular field for management of cerebral aneurysms. Vessel wall opposition is optimal and strong radial force allows its profound opening particularly in small sized vessels.

Methods: In the present study we report our 2 mm SFD experience on 6 patients within the last 2 years. 6 aneurysms include 2 A1 aneurysm, 1 M1 aneurysm, 1 MCA aneurysm and 2 ACoM aneurysms. Median aneurysm size was 10 mm (range 3 to 53 mm). All but one patient presented without a bleeding episode. Patient selection for 2 mm SFD was based on the angiographic anatomy and risk of the alternative procedures such as other FDs or stent assisted coiling.

Results: Successful flow-diverter delivery was achieved in all patients. Severe morbidity including major stroke and hemiparesis was not noted in any patient at a medium follow up of 7 months. There was one residual aneurysm and peroperative thromboembolic event in one (same) patient at 9 months of follow up. Stent thrombosis and recanalization of aneurysms at 6 month control was not noted in any of these patients. There was no procedural mortality or rebleeding from the target aneurysm.

Peculiar vessel wall opposition was provided with maneuvering stent inner and outer catheter or distal access catheter (Navien) after stent deployment. Balloon or a secondary stent assistance with Catch or Solitaire intracranial stent was performed in 3 cases. Follow-up CT, MR or conventional angiography was available in all patients.

Conclusion: Technical difficulties during SFD treatment compared to standart Surpass sizes was minimized with the release of 2 mm SFD. Clinical outcomes of the 2 mm Surpass flow diverter in the treatment of selected aneurysms show optimum results with a relatively high safety.

WEB-SL Shape Changes on Follow-Up Angiography: Is it a relevant marker of aneurysm recurrence?

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Purpose: The WEB-SL is a new design of the WEB-DL intrasaccular flow disruptor that conforms better to irregular aneurysm shape providing better neck coverage. We report our anatomical results and shape changes of the WEB-SL device.

Methods: In a series of 9 patients (10 aneurysms) at their first (3-6 months) angiographic follow-up, we evaluated the shape of the WEB-SL device and aneurysm neck on angiography and Cone Beam Computed Tomography (CBCT) when available. Aneurysm occlusion was graded based on the Web Occlusion Scale (WOS). Change of device shape was quantified by measuring the distance between the proximal and distal markers of the WEB-SL. C-arm angle, table position, bony and/or vascular landmarks were used to determine similar angiographic projections when comparing initial and follow-up studies. Measurement calibrations were based on artery diameters obtained from 3D angiography. Oversizing of the width of the WEB in relation to the width of the aneurysm was recorded and expressed as the percentage of the aneurysm’s width.

Results: Angiographic device shortening was found in 7 (70%) of aneurysms at follow-up with a median oversizing.
of 108%. Three (43%) of these aneurysms had complete occlusion (WOS A, B), two demonstrated neck recurrences, and 1 worsening and 1 stable residual neck remnant each. In 1 aneurysm, the shortening improved the device configuration due to reduction of the WEB cage bulging into the parent artery. The remaining 3 (30%) WEB-SL devices did not demonstrate significant angiographic shortening, with a median oversizing of 120%. In this group, there were 1 aneurysm demonstrating stable and two demonstrating worsened aneurysm necks.

**Conclusion:** In this small cohort, shape changes occurred frequently in WEB-SL devices and seemed to be related to the sizing of the device. The anatomical results were not related to this phenomenon on short term.

**References**


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**Investigation into Clot Retraction Forces and WEB Marker Movement**

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**Purpose:** We hypothesized that the changes in WEB marker position occurring with undersizing and seen in a small percentage of patients is the result of clot retraction/organization.

**Methods:** The impact of WEB sizing on device stability were evaluated in an in vitro compression test at −1 mm, 0 mm, and +1 mm of WEB width relative test fixture width. Static weights were sequentially placed along the WEBs axial dimension while video recording WEB movement. Videos analysis determined the distance moved under the axial load. WEB response to clot retraction was assessed in an in vitro whole blood clotting test. WEBs were undersized relative to the test tube diameter and imaged at 6, 24 and 48 hrs with fluoroscopy and 3D DSA to assess any WEB movement. Canine aneurysms were treated with WEBs and followed for 3 months. 2D and 3D angiography was performed at implantation and at 3-month follow up to assess WEB movement. Gross and microscopic analyses were performed and evaluated by an independent veterinary pathologist.

**Results:** When oversized by 1 mm in width, WEBs resisted deformation (~20% marker movement) up to 40 grams force (gf). When undersized at −1 mm in the radial dimension WEB compaction occurred with ~5 gf. Biophysical calculations estimate the clotting forces due to platelet retraction are between 0.5 and 46 gf, depending on the measurement technique. Marker band movement was seen in both the in vitro and in vivo studies with the undersized WEBs.

**Conclusion:** The lack of radial compression reduces the WEBs ability to resist a force applied along its longitudinal axis. The forces generated by clot retraction are sufficient to change marker band position. Correct sizing of the WEB using the “+1 mm width, −1 mm height” method safely resists these forces.
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Initial experience including technical details of Surpass flow diverter in Intracranial Aneurysms

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Purpose: Knowledge of flow-diversion contributed more than expected to cerebral aneurysm (CA) treatment in the last decade. Surpass flow diverter (SFD) is a relatively new flow diverter in the endovascular field for management of cerebral aneurysms.

Methods: In the present study we report our SFD experience at two centers on 85 patients within the last 2 years. 96 aneurysms were treated and 8 were previously treated residual aneurysms. 10 patients presented with acute SAH or intracerebral hematoma. Aneurysms were in posterior circulation in 8 patients. Patient selection for SFD was based on the angiographic anatomy and developing experience in the stent deployment of the corresponding author.

Results: Successful flow-diverter delivery was achieved in all but 6 patients. Of these 6 patients, other FD or stent assisted coiling was preferred for treatment. Severe morbidity including major stroke and hemiparesis was not noted in any patient at 6 months control. Mean follow-up was 7.8 months.

Technical difficulties related to our preliminary experience of SFD include difficulty in proximal access and need for a supplementary intracranial stent or FD due to incomplete coverage (FD, Leo, Neuroform, Enterprise stent or stent graft) (19 patients). Peculiar vessel wall opposition was provided with maneuvering stent inner and outer catheter or distal access catheter (Navien) after stent deployment. Balloon or a secondary stent assistance with Catch or Solitaire intracranial stent was performed (20 patients) for further inappropriate oppositions in several patients.

Follow-up CT, MR or conventional angiography was available in 78% of patients. Stent thrombosis was reported in 2 patient (2%)(both are asymptommatic).

Conclusion: Despite technical difficulties during stent deployment and challenging access problems, achievement in total occlusion was satisfactory for SFD. Clinical outcomes of the Surpass flow diverter in the treatment of intracranial aneurysms show a satisfactory results with a relatively high safety. Angiographic results showed a high rate of intracranial aneurysm occlusion.

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Vertebrobasilar junction aneurysms: Flow diverter treatment with Surpass or Silk intracranial stents is alternative to primary and stent assisted coiling

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Purpose: Vertebrobasilar junction aneurysms are quite rare. The treatment of aneurysms at the VBJ is challenging. Endovascular treatment was recently chosen as an alternative treatment in most VBJ cases. Recently flow diverter use without additional coiling or stenting was more pronounced as a satisfactory alternative to primary coiling.

Methods: We identified 7 cases with 7 VBJ during a retrospective analysis of our clinical data between 2011 and 2015. Median age of the patients was calculated as 19 years (range 11–53 years). The median size of the aneurysms was detected as 22 mm (range between 12–40 mm). One case was characterized with a basilar artery fenestration. Two patients presented with a mass effect, 2 with a bleeding episode, 1 with cranial nerve palsy and the remaining two with severe chronic headache as the primary symptom.

Results: Aneurysm occlusion was successfully performed in all cases. There was no procedural morbidity. One patient was lost 2 days after the procedure due to gastrointestinal hemorrhage and pulmonary aspiration. Median follow up was reported to be 6 months (range 4–18 months). All patients were primarily treated with flow diverter devices and stent assistance was done in 2 patients. 4 patients were treated with Surpass and 3 patients with Silk FDS. In 1 case contralateral vertebral artery was occluded with coils to the level of the PICA origin and PICA was reported as open on follow up angiograms.

Conclusion: Flow diverters might be used successfully at the vertebrobasilar junction. Use of anticoagulant and antiaggregant therapy under 18 years of age was well tolerated despite reported drawbacks. Parent artery reconstruction using a flow-diverter device is a feasible and effective technique in cases presenting with aneurysms greater in size. Contralateral VA might be trapped at V4 segment until the origin of PICA to avoid contralateral washout of the VBJ aneurysm.
Endovascular Management of Tandem Aneurysms with Silk and Surpass Flow Diverters

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Purpose: Tandem intracranial aneurysms are aneurysms located along a single vessel. Adjacent tandem aneurysms arise within the same vascular segment and endovascular management of these rare lesions was not clearly described in the literature. Tandem aneurysms particularly with increased size discrepancies pose particular challenges.

Methods: We identified 25 patients with tandem aneurysms in a retrospective review of aneurysms treated between 2011 and 2015. Median age of the patients were 49.5 years of age. Aneurysms were reported to be ophthalmic segment in 11, communicating segment in 4, transitional in 5, petrous in 2, ICA bifurcation in 2 and MCA in 1 cases. Median size of the primary aneurysm of tandem aneurysms was 6 mm and secondary aneurysms were 3.5 mm respectively.

Results: Fifteen patients were treated with Silk flow diverter and remaining ten patients were treated by Surpass flow diverter. One patient treated with Surpas flow diverter + Integrity coronary stent was found to be parent artery occlusion on follow up angiogram. Follow-up was available in 23 patients with a median of 6 months. Complete occlusion of both aneurysms was obtained in twenty out of 23 (86%) aneurysms. Two patients were reported to have residual neck filling at the last follow-up. Apart from stent thrombosis in one patient, peri and post-procedural complications include 2 visual deterioration, 1 mild hemiparesis, 1 minor thromboembolic event.

Conclusion: Flow diverter stents are feasible treatment options in tandem intracranial aneurysms. Treatment with FDs is particularly useful if the secondary aneurysm is relatively small in size due to difficulty in coiling Surpass and Silk FDs are particularly within a single session of treatment sequence.
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Poster Display

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Outcome of Subarachnoid Hemorrhage in our Hospital
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Purpose: In 2012 UCAS JAPAN was announced, its data have a large impact. We reports and study cases of subarachnoid hemorrhage which treated in our hospital from April 1st 2013.

Method: From April 1st to October 20th in 2013, 11 subarachnoid hemorrhage patients which surgical treatment was done in our hospital. Brain angiography was done for all patients. We treated 11 aneurysms, and chose the best treatment for its aneurysms. Gender was 2 men, 9 women. Average age was 65.5 years old. The average size of the aneurysm was 5.4 mm. 7 cases was under 5 mm. WFNS grade 1 is 5 cases, 2 was 2 cases, 3 was 1 case, 4 was 2 cases, and 5 was 1 case. Aneurysm of the anterior circulation was selected clipping, and coil embolization was performed for aneurysm of the posterior circulation.

Result: A com aneurysm, IC aneurysm, and aneurysm of the posterior circulation was selected clipping, and coil embolization was performed for aneurysm of the posterior circulation.

Conclusion: We have reported on such treatment and its result in subarachnoid hemorrhage in our hospital.

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Follow-Up Duration of Unruptured Intracranial Aneurysms
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Purpose: Natural rate of aneurysm rupture remains controversial, especially for small aneurysms. Centres frequently choose to follow rather than treat aneurysms <7 mm. We aim to study the safety of observation in patients with small UIAs followed in Saskatchewan, and determine the optimal duration of follow-up for small aneurysms.

Methods: We conducted a retrospective review of all patients presenting between July 2008 and February 2015 with unruptured aneurysms. Aneurysm characteristics recorded included size, location, presentation, and follow-up imaging. Multiple aneurysms in a single patient were considered independently.

Results: Of the 203 UIAs <7 mm, 25 were treated, while mean follow-up time was 12.3 months for followed aneurysms, with two incidences of rupture. Of the 88 UIAs ≥ 7 mm, 42 (48%) were treated. Mean follow-up time for followed aneurysms was 8.2 months, and there was one incidence of rupture during follow-up. Overall, follow-up duration for ruptured aneurysms was significantly longer than the mean follow-up duration.

Conclusion: Treatment decision paradigms used in our centre showed low rates of rupture in untreated aneurysms less than <7 mm. Rupture in our cohort of patients occurred at a longer duration of follow-up than has been previously reported, suggesting that a longer follow-up may be necessary to confirm stability of the aneurysm.

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Endovascular Treatment of Ophthalmic Artery Aneurysms: Assessing Balloon Test Occlusion and Preservation of Vision in Coil Embolization

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Purpose: ICA–ophthalmic artery aneurysms have unique configurations corresponding to relative risks of ophthalmologic morbidity. Presented herein are clinical and radiologic outcomes of coil embolization in ophthalmic artery aneurysms.

Materials and Methods: From January 2003 to September 2013, endovascular coiling was performed in 43 consecutive patients with ophthalmic artery aneurysms, each classified by the degree to which the ophthalmic artery was incorporated by the aneurysm and the contiguity between the ophthalmic artery entry and parent ICA. Clinical and radiologic outcomes of this approach were investigated,
including the technical aspects of treatment and the efficacy of balloon test occlusion.

**Results:** Among 14 patients (32.6%, all ophthalmic artery types) undergoing balloon test occlusion before endovascular coiling, patent collaterals between the external carotid artery and ophthalmic artery were demonstrated in 12 (85.7%) and complete compromise of the ophthalmic artery (without affecting vision) occurred in 4 patients during coiling. Steam-shaped S-configured (67.9%) or straight microcatheters (17.8%) facilitated aneurysm selection in most of the superiorly directed ophthalmic artery aneurysms (n = 28), and steam-shaped pigtail microcatheters (85.7%) were useful in medially directed aneurysms (n = 14). Balloon protection (n = 22) was generally used to facilitate coiling, or a stent (n = 9) was alternatively deployed. Satisfactory aneurysm occlusion was achieved through coil embolization in 37 lesions (86.1%). During follow-up of 35 patients (mean interval, 12.9 ± 9.4 months), only 1 instance (2.9%) of major recanalization was observed.

**Conclusion:** If one tailors technical strategies, ophthalmic artery aneurysms are amenable to safe and effective endovascular coil embolization, which tends to be stable in follow-up. Balloon test occlusion may be helpful in devising treatment strategies to preserve vision when coiling ophthalmic artery aneurysms (especially those incorporating an ophthalmic artery origin) is done.

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**Different Approaches in Reconstructive Endovascular Treatment of Large and Giant Intracranial Aneurysms**

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**Purpose:** To estimate effectiveness of endovascular treatment of large and giant intracranial aneurysms using stent-assisted coiling and flow-diverting stenting.

**Methods:** 237 patient with 244 large and giant intracranial aneurysms, were operated. There were 61 men and 176 women aged from 18 to 77 years. Share of giant aneurysms was 59%.

Aneurysms demonstrated ICH at 13% of pts, in 55% cases they had pseudo-tumorous current. 204 aneurysms were localized on ICA, 40 – in vertebro-basilar basin. 92 aneurysms kept thrombotic mass. In 207 cases it is used Pipeline (PED), in 37 – stent-assisting coiling (SAC). Medication support included 75 mg of Plavix or 90 mg Ticagrelor and 100 mg of aspirin within 3 days before and 6 months after operation.

**Results:** Technical success has been reached in 95% of aneurysms. In early postoperative period morbidity/mortality has made 2.7%/3.3 % in cases with using PED and 2.7%/2.7 % in cases with using SAC thereafter. Long-term results were evaluated at 63% of pts within 4 to 50 months after operation. Total and subtotal aneurysms occlusion was detected at 85% of cases. Disappearance of clinical symptoms is noted in 39% of cases. Morbidity/mortality has made 4.9%/2.5% in PED group and 10.7%/3.5% in SAC group conformably.

**Conclusion:** PED is very effective device for remodeling parent artery lumen in cases of large and giant intracranial aneurysms. SAC technics can be recommended in cases of aneurysm with diverticulums, bifurcation aneurysms and ruptured aneurysms in acute period of SAH.

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**Aneurysm Coil Embolization Using 1.5 F Marathon® Catheter**

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**Purpose:** Marathon® catheter (Covidien, CA, USA) is a flow directed microcatheter designed mainly for delivering liquid embolic agent to brain AVMs and dural AVFs. The authors report their clinical experience of aneurysmal embolization using Marathon® catheter and asses the usefulness of this method.

**Methods:** 10 patients with intracranial aneurysms underwent coil embolization using Marathon catheter in our institutions. In all cases, ED extrassoft® coils (Kaneka, Osaka, Japan) were used as embolic agents.

**Results:** All embolization procedures were successfully accomplished and satisfactory occlusion was achieved without any new neurological symptom in all cases. Marathon® catheter not only showed superior navigability and operability during treatment of distally located small aneurysms, but showed lower reluctance in crossing stent struts.

**Conclusion:** Aneurysm coil embolization using Marathon® catheter is feasible, and has a certain role especially in treating small aneurysms which is located distally, beyond tortuous vessels or those needs trans-cell access.

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**Spontaneous Resolution of Unruptured Fusiform Aneurysm on Middle Cerebral Artery by Taking Antiplatelet Agent Only**

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**Purpose:** Little is known about the etiology and clinical course of fusiform compared with saccular aneurysms in middle cerebral artery. We report a case of unruptured
fusiform aneurysm on M2 portion of right middle cerebral artery, which was spontaneously resolved after conservative treatment by taking antiplatelet agent for one year.

**Summary of case:** 51-year old female had visited to outpatient department of neurosurgery in our hospital due to recurrent left arm weakness. Neurologic examination showed no definite focal neurologic deficit and brain image revealed no remarkable acute intracranial lesion. However, conventional cerebral angiography showed fusiform dilatation on M2 portion of right middle cerebral artery, superior trunk, without visible double lumen or Pearl & String sign. She had taken dual antiplatelet agents, aspirin 100 mg and clopidogrel 75 mg per day, for one month and, after that, the single agent only, aspirin 100 mg per day. Magnetic resonance angiogram, one year after, showed a complete spontaneous resolution of MCA fusiform aneurysm. 

**Conclusion:** We report a case of spontaneously resolved unruptured fusiform aneurysm on middle cerebral artery by conservative treatment only.

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**Endovascular Treatment of Ruptured Vertebral Artery Dissecting Aneurysms**

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**Purpose:** Neuroendovascular therapy is emerged as first-line therapy for ruptured vertebral artery dissecting aneurysms (VADAs), but the location of VADA relative to the posterior inferior cerebellar artery (PICA) and development of the PICA affect the treatment strategy.

**Method:** We studied 21 patients (16 men, 5 women, mean age, 54.7 years) with ruptured VADAs, treated between 1999 and 2014 at three hospitals.

**Results:** 16 patients underwent internal endovascular trapping, 4 patients underwent proximal endovascular occlusion, and one underwent distal endovascular occlusion in the acute stage and internal endovascular trapping four days later due to reruptured VADA. The location of ADA relative to the ipsilateral PICA were proximal to PICA (pP), PICA involved (Pi), distal to PICA (dP), and no PICA (nP) in 2, 5, 10, and 4 patients, respectively. The developments and locations of PICA were bilateral anterior inferior cerebellar artery (AICA)-PICA, ipsilateral AICA-PICA, extradural, and intradural in 1, 3, 2, and 15 patients, respectively. The number of favorable outcome (modified Rankin Scale, mRS 0 to 2) on discharge was 13 (61.9%).

**Conclusions:** Neuroendovascular therapy for VADAs using internal endovascular trapping is proper treatment, except in the Pi type. Treatment of the Pi type is controversial. Poor grade subarachnoid hemorrhage and postoperative medul- lary infarction are associated with unfavorable outcome.
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Microembolic Signal Monitoring and the Prediction of Thromboembolic Events Following Coil Embolization of Unruptured Intracranial Aneurysms: Diffusion-weighted Imaging Correlation

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Purpose: Microembolic signal (MES) monitoring with transcranial Doppler ultrasonography (TCD) may allow for early prediction of thromboembolisms following endovascular coiling of unruptured intracranial aneurysms (UIAs). However, the method has not gained widespread use and may benefit from correlation with diffusion-weighted imaging (DWI) of acute ischemic lesions after coiling. This purpose was to evaluate the relationship between MESs and DWI-positive lesions more precisely.

Methods: We conducted a prospective study on 45 consecutive patients. TCD was performed over the artery that is dependent on the site of aneurysm. Consequently, 38 patients were available to detect MESs immediately (MES-1) and 24 h (MES-2) after coiling for UIAs. We also checked DWI 1 day after the coiling and analyzed correlations between the TCD and DWI findings.

Results: MES-1 and MES-2 were positive in 25 (65.7%) and 14 (36.8%) patients, respectively. DWI-positive lesions were seen in 20 (52.6%) patients, and only 1 (2.6%) patient was asymptomatic. MES-1 and MES-2 were strongly correlated with the number of DWI-positive lesions (Spearman’s correlation coefficient = 0.79 and 0.70, P < 0.01 and P < 0.01, respectively). Additionally, there was a significant correlation between MES-1 and MES-2 (Spearman’s correlation coefficient = 0.70).

Conclusion: Based upon the significant correlation between MES and DWI findings, MES may have a role for early detection of ischemic complications after coiling of UIAs.

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Do Contrast-Fill Patterns Immediately After Coil Embolization of Small Saccular Aneurysms Impact Long-Term Results?

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Purpose: It is generally accepted that filling of a saccular aneurysm with contrast immediately after coil embolization predisposes to later recanalization. However, not all such scenarios evolve similarly over time. We investigated outcomes of small (< 7 mm) aneurysms with contrast-filled sacs immediately after coil embolization, evaluating the impact of pattern and degree of filling on subsequent recanalization.

Methods: Between January, 2008 and December, 2010, 186 small (<7 mm) saccular aneurysms that retained contrast after coil embolization accrued for this study. Lesions were categorized by pattern (eccentric vs concentric) and degree of filling on working projections. Clinical and morphologic factors were also analyzed to assess impact on subsequent recanalization. Morphologic outcomes at 6 months or more were assessed.

Results: In 93.5% (174/186) of aneurysms with visible contrast retention, complete occlusion was evident on follow-up imaging studies at 6 months. Multiple logistic regression analysis indicated that eccentric (vs concentric) contrast filling carried greater risk of subsequent recanalization (p = 0.020). Stent placement and progressive occlusion were also linked, falling short of statistical significance (p = 0.089). Of 166 progressively occluded aneurysms followed for >12 months (mean, 30.8 ± 7.3 months), 158 (95.2%) exhibited stable occlusion.

Conclusion: Small (<7 mm) aneurysms that retain contrast immediately after coil embolization are more likely to become completely occluded over time through progressive thrombosis. However, an eccentric fill pattern may predispose to recanalization.
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Effect of Stenting on Progressive Thrombosis of Small Unruptured Saccular Intracranial Aneurysms Incompletely Occluded Directly After Coil Embolization: A Propensity-Score Analysis

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Purpose: The rate of incomplete occlusion in intracranial aneurysms, despite every effort, is still approximately 10%. Increasingly, self-expanding stents have been used to intensify packing density and divert flow. Nevertheless, the effect of protective stenting on progressive thrombosis of small and incompletely occluded unruptured intracranial aneurysms (UIAs) ≤10 mm in size remains unclear due to confounding factors related to stent deployment probability. In this setting, we examined the effect of stenting on progressive thrombosis using a propensity score-matched case-controlled analysis.

Methods: A total of 715 small UIAs consecutively treated by coiling between 2008 and 2010 were eligible for study. Time-of-flight magnetic resonance angiography and/or catheter angiography were used to estimate extent of saccular occlusion after coil embolization. Complete occlusion at 6 months postembolization of a sac filled with contrast immediately after coil constituted progressive thrombosis. A propensity score-matched analysis was conducted, based on probability of stent deployment.

Results: Ultimately, 206 (28.8%) small UIAs showed incomplete saccular occlusion directly after coiling. Of these, 182 (88.3%) displayed progressive thrombosis at 6 months. Aneurysm size (p < 0.01), neck size (p < 0.01), and embolization attempt (p < 0.01) differed significantly for stented and non-stented lesions, but incidence of progressive thrombosis did not differ (p = 0.78) between groups. After 1:1 propensity-score matching, however, the rate of complete occlusion in stented subjects (97.5%) surpassed that of non-stented counterparts (OR = 9.75; p = 0.01).

Conclusion: Small UIAs incompletely occluded after coiling showed a complete occlusion rate of 88.3% at 6 months postembolization. Stent deployment seems to promote complete occlusion in such lesions by progressive thrombosis.

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Triple Microcatheter Use in Endovascular Treatment of Wide-Necked Intracranial Aneurysms: Single Center Experience

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Purpose: Dual microcatheter technique is common practice in coil embolization of wide-necked aneurysm, owing to unique safety and efficacy benefits. Still, technical limitations of some complex configurations may necessitate additional microcatheters to bolster coil stability, compact coil packing, or protective effect. Described herein is a triple microcatheter technique for endovascular management of wide-necked intracranial aneurysms.

Methods: Data accruing prospectively between January, 2006 and October, 2014 on simultaneously executed triple microcatheter coil embolization procedures done in 38 saccular aneurysms were reviewed. Clinical and morphologic outcomes were assessed, with emphasis on technical aspects of treatment.

Results: Triple microcatheter technique was successfully applied in all 38 saccular aneurysms, involving posterior communicating artery (n = 13), middle cerebral artery (n = 10), basilar tip (n = 7), anterior cerebral artery (n = 5), or internal carotid artery (n = 3). Stent protection was added in four patients and balloon remodeling in one. Dual microcatheters (n = 24) were usually deployed for coil delivery within sacs of aneurysms, adding another microcatheter for protection. Otherwise, triple microcatheters were deployed expressly for coil delivery (n = 11) or coils were delivered via single microcatheter, with dual microcatheters deployed for protection (n = 3). Successful aneurysm occlusion was achieved in 89.5%, with no procedure-related morbidity or mortality. At final follow-up (mean interval, 30.2 ± 22.7 months), stable aneurysm occlusion was sustained in 72.2% (28/36).

Conclusion: Outcomes of this limited study suggest that a triple microcatheter technique may be an effective and safe therapeutic option in wide-necked aneurysms, using technical strategies tailored to complex angio-anatomic configurations.

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Multicenter Analysis of Radiation Exposure in Large and Giant Aneurysms with the Penumbra Coil 400 System: A Comparison


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Purpose: Endovascular coil embolization is highly effective and is routinely used to treat cerebral aneurysms. From recent literature, there is an increased concern regarding radiation exposure from these types of medical procedures. The Penumbra Coil 400™ system (PC400) is a new generation of 0.020” diameter coils designed to enhance filling efficiency, effectiveness, and safety. Reported herein are outcomes from a post-hoc analysis of the PC400 Aneurysm Coiling Efficiency multicenter registry comparing the Pipeline embolization device and conventional coils in a recent published article (Colby et al., 2014) to coiling in large and giant proximal aneurysms (≥10 mm). 

Methods: The PC400 registry is a prospective study of patients with intracranial aneurysms who are treated with the PC400 System. Patients with cerebral aneurysms ≥10 mm were included in this analysis.

Results: 100% of Pipeline and conventional coils aneurysms were located in the ICA (N = 37 and N = 18, respectively), while PC400 registry had 59.2% in the ICA (N = 98). Mean age in PC400 registry was 63.5 ± 13.3 vs. Pipeline’s 60.0 ± 2.1 (p = 0.0135) and conventional coils’ 62.2 ± 1.9 (p = 0.3628). Mean aneurysm size (mm) was greater in PC400 registry than Pipeline (15.0 ± 6.7 vs. 13.5 ± 0.6, p = 0.0306) and similar to conventional coils (15.0 ± 6.7 vs. 14.9 ± 1.5, p = 0.8960). Total mean fluoroscopy time (min) was significantly lower for PC400 registry than both Pipeline (48.5 ± 32.8 vs. 56.1 ± 5.0, p = 0.0305) and conventional coils (48.5 ± 32.8 vs. 85.9 ± 11.9, p < 0.0001). The PC400 cohort had a 43.5% reduction in time compared with conventional coils.

Conclusion: Analysis of treatment of large and giant proximal aneurysms displayed significant reduction in fluoroscopy time in the PC400 cohort even with a greater aneurysm size. This demonstrates that coil embolization with the larger diameter PC 400 may have promise in requiring less radiation exposure.

Reference

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Rescue Mechanical Thrombectomy Using a Retriever Stent for Thromboembolism During Coil Embolization of Ruptured Cerebral Aneurysms

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Purpose: In patients with subarachnoid hemorrhage, intraoperative thromboembolism during coil embolization of ruptured cerebral aneurysms is major concern, which is reported as 3% to 10%. Especially in the case of totally occlusive arterial thrombi, the role of intra-arterial fibrinolytic agent is limited. The authors report the experience and outcome of stent retriever in patient with totally occluded arterial thrombi during coil embolization.

Methods: Between January 2013 and December 2014, 91 patients with intracranial ruptured aneurysm were treated by using endovascular coil embolization. Among the 91 patients, arterial occlusion caused by thromboembolic event occurred in 7 patients (7.7%). In these patients, mechanical thrombectomy by using stent retriever (Solitaire AB stent, Covidien, Irvine, California) with or without adjuvant administration of intra-arterial fibrinolytic agent was performed. We respectively reviewed the angiographic and clinical outcomes of the rescue treatment with stent retriever.

Results: Complete recanalization was achieved in 6 cases (85.7%) and partial recanalization in 1 case (14.3%). Whereas 5 patients were asymptomatic after thrombolysis by stent retriever, 1 patient suffered from postprocedural bleeding, and cerebral infarction occurred in the remaining 1 patient.

Conclusion: Mechanical thrombectomy with stent retriever may be considered as rescue treatment for the patients with totally occlusive arterial thrombi, as well as the patients...
who experienced failure from intra-arterial fibrinolytic agent. Attention should be paid for the prevention of fatal cerebral hemorrhage after procedure.

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Effects of Smaller Finalising Coils (Less Than 2 Mm in Diameter) on Preventing Recurrence After Embolisation of Small Cerebral Aneurysm

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Purpose: Smaller coils which are less than 2 mm in diameter has been used at the final stage of embolisation to achieve better aneurysm occlusion immediately. But good angiographic occlusion does not always guarantee the long-term stability of the aneurysms. We compared follow up results of aneurysms finalised with less than 2 mm coils to non-finalised aneurysms to evaluate the effects of these small coils on permanent occlusion of the small aneurysms.

Materials and Methods: Medical records and angiographic images of 92 aneurysms, located at anterior circulation, their occlusion procedures started with 3 mm to 6 mm frame coil, were analysed retrospectively. Mean age was 56.1 year and male to female ratio was 1:2.5. Forty-nine aneurysms were ruptured (53.3%). Aneurysm were divided into three groups, ‘Finalised’ which consists of 54 aneurysms treated with 2 mm or less diameter coils at the last stage of the procedure, ‘Not Finalised’ twenty aneurysms, only coiled with 3 mm to 6 mm diameter coils, and eighteen ‘Hydrosoft’ group treated with hydrogel coated coils regardless of finalising coil usage. The degree of the aneurysm occlusion were initially evaluated 6 months after the procedure and thereafter 1 year interval with magnetic resonance angiography. Seventy-two aneurysms (78.3%) were followed more than 6 months and the mean follow up interval was 26.6 months.

Results: In not finalised group, complete occlusion rate immediately after the procedure was 15% (3 of 20, mean packing density 22.3%). Among 17 aneurysms which have follow-up images, 16 aneurysms (94.1%) achieved satisfactory occlusion and only 1 aneurysm (5.9%) was retreated due to recurrence. Finalised aneurysms achieved 66.3% initial complete occlusion rate (25 of 54, mean packing density 21.9%) and 89.6% (43 of 48) satisfactory occlusion rate on follow-up. Four aneurysms (8.3%) were recurred in finalised group. Aneurysms treated with Hydrosoft coils achieved 5.6% (only 1 of 18, mean packing density 28.2%) immediate complete occlusion rate and 73.3% (11 of 15) on follow up. Three aneurysms (20%) were recurred in Hydrosoft group. There was no permanent neurological deficit nor death.

Conclusion: By finalising small aneurysms with less than 2 mm diameter coils, we could achieve higher immediate complete occlusion rate. But the long-term results did not match with initial degree of the occlusion. With not finalising technique, we achieved better satisfactory occlusion and less recurrence after coil embolisation of the small aneurysms.

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A Modified Canine Side-Wall Aneurysm Model Designed for Testing of Intra-Luminal and Intra-Saccular Flow Diverters

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Purpose: Our goal was to create a canine aneurysm model suitable for use in testing of intra-saccular and intra-luminal flow diverters.

Methods: All procedures were performed under an institutional approved protocol. Vein patch aneurysms were created as has been previously described in detail for construction of terminal aneurysms except the vein patch was offset to the side of the bifurcation formed by anastomosis of the proximal RCCA with the junction of the connected distal LCCA and RCCA.

Results: 24 aneurysms were created with the size ranging between 5 and 12 mm. in the greatest dimension. Over a period of 5.5 weeks between aneurysm creation and angiographic evaluation 2 partial thrombosis occurred. Angiography done at 30fps revealed a distinct flow jet entering the left side of the aneurysm pouch (the side closest to the proximal RCCA). Flow in these aneurysms was intermediate between the sluggish flow typical of sidewall aneurysms and the hyperdynamic flow seen in the bifurcation and terminal aneurysm models. The anatomy of this aneurysm closely resembles that of a side-wall type aneurysm occurring just distal to a major bifurcation.

Conclusion: The modified side-wall model has more robust flow than does that of the conventional model. It better mimics human aneurysms typically treated with flow diverters than does the conventional canine side wall aneurysm model. Additional modifications can be made with this model to simulate various asymmetric aneurysm configurations.

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Patient-Specific Velocity and Flow Profiles of Intracranial Arteries

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Purpose: Computational Fluid Dynamics (CFD) is commonly used in studies to determine hemodynamic risk factors of intracranial aneurysm rupture. Most of these studies use generalized inflow profiles obtained from healthy volunteers as boundary conditions. However, there are large variations in arterial flow profiles between patients and between anatomical locations. The aim of this study was to generate location-specific velocity and flow parameters of aneurysmal parent arteries with the potential to use in CFD studies.

Methods: For 94 patients (62 male; mean age 55.2) with a total of 103 aneurysms (61 ruptured), we collected velocity information in aneurysmal parent arteries for a full cardiac cycle using 2D PC-MRI. Velocity profiles were collected for the middle cerebral artery (n = 30), anterior communicating artery (n = 26), internal carotid artery (n = 19), posterior communicating artery (n = 11), basilar artery (n = 10), anterior cerebral artery (n = 6), and vertebral artery (n = 1). The maximum and mean velocity and the maximum and mean flow were determined and compared for each of the 15 artery combinations.

Results: Both the velocity and flow parameters showed significant differences between some of the different parent artery locations. For example, the median value of the maximum basilar artery velocities (74, range:38–87 cm/s) was significantly lower compared with the middle cerebral artery (97, range:50–150 cm/s). Both flow parameters showed significant differences in 10 of the 15 combinations. In 4 of the 15 and 6 of the 15 combinations, a significant difference was found for the mean and maximum velocity, respectively.

Conclusion: There are large variations in intracranial arterial flow profiles both per location as well as per patient. Our study underscores the need for using patient specific inflow profiles in CFD. When this information is not available, location specific inflow profiles can be used for more realistic CFD simulations.

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The Influence of Vessel Straightening After Stent Placement on Hemodynamics in Sidewall Intracranial Aneurysms

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Purpose: Neurovascular stent assisted coil embolization is frequently used for the treatment of wide necked aneurysms. These stents may have substantial effects on the vascular geometry and therefore also on intra-aneurysmal hemodynamics. This may promote thrombus formation in the aneurysm sac and reduce recurrence rates. In this study, we quantified straightening of the parent artery and the accompanying hemodynamic changes after stent placement.

Methods: From 6 patients with 6 sidewall aneurysms, 3D vascular models were created from 3DRA (n = 11) and MRA (n = 1) imaging data before and after treatment. The aneurysm morphology and parent vessel radii were assumed to be identical in the before and after treatment models. To quantify straightening of the parent vessel, the tortuosity (ratio between the artery length and the distance between both end points) was calculated. Computational fluid dynamics was used to simulate intra-aneurysmal hemodynamics. Flow patterns were characterized by two experienced neuroradiologists in consensus. Furthermore, the velocity magnitude, wall shear stress, and oscillatory shear index were calculated.

Results: For 2 cases, in which the stent was partially located in the extra-dural space, tortuosity and flow patterns remained unchanged. In the remaining 4 cases, tortuosity decreased with a mean of 56% and flow patterns changed in 3 cases.

Conclusion: Vessel straightening of the parent artery is likely to occur after stent placement in extra-dural arteries, resulting in alteration of flow patterns in some cases. However, hemodynamic changes vary and the changes in parent artery tortuosity are hard to predict. A larger population is needed to confirm these findings and to relate induced changes with recurrence rates.
The Relation Between Aneurysmal Inflow and Early Recurrence in Coiled Intracranial Aneurysms
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Purpose: Coil embolization is an established technique for treatment of intracranial aneurysms. Recurrence occurs in 20% of coiled aneurysms due to coil compaction or enlargement of a remnant. Little is known about the relation of hemodynamics with early recurrence of coiled intracranial aneurysms.

Methods: 19 patients with 19 early aneurysm recurrences were identified in our database of 270 patients. Hemodynamics of untreated aneurysms were simulated using computational fluid dynamics to determine the location of the inflow jet. Overlap of the entire inflow jet and its core (highest 20 percentile inflow velocity) with the area of recurrence at the aneurysm neck was assessed.

Results: In 14 out of 19 cases (74%) the location of the core of the jet agreed with the area of recurrence. In 16 out 19 cases (84%), the area of the whole inflow jet overlapped with the area of recurrence.

Conclusion: In most aneurysms, there is a strong agreement between the pre-treatment aneurysmal inflow location and the position of early recurrence. However, this strong relation was not found in all recurrent aneurysms. This study suggests that hemodynamics may have an important role in aneurysm recurrence, but that more aspects should be taken into account to accurately predict location and prevalence of recurrence.

Endovascular Treatment of Persistent Hypoglossal Artery Aneurysm
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Purpose: Persistent hypoglossal artery is a rare vascular anomaly. The persistent hypoglossal artery (PHA) is the second most common carotid-vertebrobasilar artery anastomosis and its reported prevalence is 0.02%-0.10%. There were seldom reports regarding endovascular treatment of PHA aneurysm in the literature. The present case is the first PHA aneurysm treated with Surpass flow diverter.

Methods: 51- year-old men was admitted to emergency wards with loss of consciousness. CT revealed severe subarachnoid hemorrhage. There were no positive neurological sign on admission.

Angiograms showed communication between the right internal carotid and basilar arteries through an anomalous vessel penetrating the hypoglossal canal. Three-dimensional reconstructions showed an optimal visualization of the PHA aneurysm’s neck and measurement of the sac. Aneurysm size was calculated as 4.5×5 mm.

Results: The patient was successfully treated with primary coil embolization. Residual neck filling was noted on 10 months follow up angiograms and a Surpass flow diverter 3x20mm was deployed at the aneurysmatic segment. On 18 months follow-up angiograms the aneurysm was completely eliminated from the circulation.

Conclusion: PHA is a rare vascular anomaly that might be associated with other vascular disorders such as aneurysms and atherosclerotic diseases. In the present report, endovascular treatment with flow diverter treatment and opotimum result was achieved with good clinical outcome on 18 months of follow up. To our knowledge; this is the first reported case of PHA aneurysm reported to be treated with intracranial flow diverter.

True Posterior Communicating Artery Aneurysms: Report of 2 Seldom Cases Treated with Primary Coiling and Silk Flow Diverter
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Purpose: True posterior communicating artery (PCoM) aneurysms are rare in which the aneurysm arises only from the PCOM rather than the junction of the ICA or PCOM. Most of the previous reports featured microsurgical clipping rather than endovascular measures. True PCoM aneurysms might also be associated with ipsilateral ICA occlusion. PCOM must be followed posteriorly to visualise the aneurysm neck for microsurgical clipping though visualisation might be associated with periprocedural complications due to temporal lobe retraction particularly in cases presenting with rupture.

Methods: The present report featured 2 female cases 52 and 79 years old respectively. The former presented with rupture whereas severe headache was the symptom in the latter case. Patient presenting with SAH was featuring a trilublated aneurysm close to P1 segment with a 5.5x4 mm in size and primary coiling was preferred for treatment. Second case was a 79-year-old female presenting with severe
headache featuring an aneurysm with a size of 5x5.5 mm and Silk flow diverter covering the aneurysmal segment was preferred treatment modality.

**Results:** Follow up was reported to be 38 and 14 months respectively. There was no mortality or morbidity in any of the patients. Aneurysms were completely eliminated from the circulation in both patients. No periprocedural or late complication was encountered in any of the cases.

**Conclusion:** Primary endovascular treatment of true PCoM aneurysms is feasible and safe alternative to microsurgical clipping. Primary coiling or treatment with flow diverter stents are available options.

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**The endovascular treatment of the cerebral aneurysms with FRED – flow diverter – the experience on 21 patients**

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**Purpose:** The analysis of the cerebral aneurysms treatment with FRED (flow diverter) in the period 20 August 2013 – 1 March 2015.

**Methods:** 21 patients with 24 aneurysms. We covered with FRED 23 aneurysms – in 2 patients we covered 2 aneurysms with only 1 stent, and for 1 aneurysm we used coils.

**The aneurysms**

- 6 aneurysms were ruptured (1 cavernous segment aneurysm, 1 anterior choroidal artery origin aneurysm, 1 bazilar tip artery aneurysm, 1 MCA bifurcation aneurysm, 2 posterior communicating artery origin aneurysms)
- 18 aneurysms non-ruptured.

**Localisation of the aneurysms**

- ICA cavernous segment – 7 aneurysms
- ICA ophtalmic segment – 5 aneurysms
- ICA posterior communicating artery origin – 2 aneurysms
- MCA bifurcation – 1 aneurysm
- Anterior communicating artery – 1 aneurysm
- Bazilar tip bifurcation – 1 aneurysm

**Results:**

- 20 aneurysms – total occlusion – 1 year (87%)
- 2 aneurysms – got smaller – 1 year (9%)
- 1 aneurysm – unchanged – 1 year (4%)
- 19 patients – follow-up at 1 year (90.5%)
- 1 aneurysm ruptured 6 weeks after stent implantation (20 mm. diameter aneurysm – no coils inside)
- 3 cases – in stent moderate stenosis but without clinical symptoms at 8 weeks, solved at 1 year
- 2 FREDs needed balloon inflation for proper wall apposition (in very tortuous vessels)
- 1 stent occlusion (patient stopped the antiplatelets therapy after 4 weeks)

**Conclusion:** FRED is efficient (high rate occlusion at 1 year).

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**Endovascular Treatment of Intracranial Infectious Aneurysms**

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**Purpose:** Intracranial infectious aneurysms (IIA) are rare infectious neurovascular lesions, which account for 1-5% of all intracranial aneurysms. They are most often seen during bacterial endocarditis although they can be caused by fungal infections as well.

**Methods:** From 2000 to 2014, 13 patients (6 women, 7 men) with 15 mycotic aneurysms (13 were ruptured, 2 were unruptured) were treated by endovascular approach in our institution. The age of patients ranged from 5 to 68 year with a mean age of 41.6. Data of all patients were carefully and retrospectively reviewed including radiological studies and clinical records.

**Results:** All patients were treated immediately with endovascular approach after the confirmation and/or suspicion of IIA. In all but one occasions, aneurysms were located in distal cerebral circulation, while one aneurysm was located in cavernous part of the internal carotid artery which was due to the local invasion of cavernous sinus fungal infection. Detachable coil was used as an embolization material in 10 of 15 aneurysms, liquid embolic agent in 3 patients, and detachable balloon in one patient, while the last aneurysm was occluded spontaneously. Occlusion of parent vessel together with aneurysm was performed in 14 (including spontaneous occlusion) aneurysms, while intrasaccular coil embolization could be done in one patient. MRI and MRA follow-up was performed at least one occasion in all cases which revealed stable results. We did not encounter any extra morbidity after embolization, and we had no mortality in the follow-up.

**Conclusion:** Endovascular occlusion of parent vessel together with aneurysm appears to be the good management strategy in most cases in case of intracranial infectious aneurysm.

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**Mid-Term Experiences with the PulseRider**

**G Gal**

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**Purpose:** To report our experience with a recently developed adjunctive device for the endovascular treatment of bifurcational wide neck aneurysms.

**Methods:** Between May 2014 and May 2015, 12 wide-necked aneurysms, in 12 patients were treated with coils and the PulseRider® (Pulsar Vascular, San Jose, CA, USA), serving as
a scaffold, placed at the aneurysm neck. Five aneurysms were located at the MCA bifurcation, five at the ACom, and two at the BA-tip. All aneurysms were considered “difficult to treat” lesions, two of them previously treated with coils, one with coils and WEB, and one surgically clipped. Five aneurysms were ruptured, one of them treated in the acute phase. All elective patients were premedicated with platelet inhibitors. The device was introduced through a 0.021" microcatheter and deployed at the neck of the aneurysms. A 0.017" microcatheter was navigated through the PulseRider® into the aneurysm, which was subsequently occluded with coils. Following completion of the coil packing, the device was electrically detached.

Results: In all cases the device could be navigated to and deployed at the target site. Crossing the device with a 2nd microcather for coil placement was possible in all cases, allowing for successful and complete aneurysm occlusion. No complications occurred during the procedures. All elective patients were discharged on the 2nd day after the treatment. Follow up examination with MRA in two patients showed permanent, total occlusion of the aneurysms. The rest await follow up angiograms.

Conclusion: The PulseRider® is a promising new device that can easily be deployed through a low profile (6 F) guiding catheter. It expands the neurointerventional armamentarium for “difficult to treat” cerebral aneurysms that would otherwise require double stenting or flow diverter. The lesser amount of intraluminal metal may allow for its future use in acutely ruptured cases.

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Preliminary Experience with Pconus for the Treatment of Wide Neck Bifurcation Aneurysms in 10 Patients
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Purpose: The pCONus Bifurcation Aneurysm Implant is an intraluminal device intended to assist coiling in the treatment of complex and wide neck intracranial bifurcation aneurysms. We report our preliminary experience with pCONus devices.

Methods: Ten patients with ten wide-neck aneurysms (3 recently ruptured) were treated with pCONus assisted coiling. Seven aneurysms were located in the anterior circulation (3 aCom and 4 MCA) and three in the posterior circulation (basilar artery). pCONus device was preferred to other techniques due to its secure anchoring and optimal placement mainly related to its precise deployment and complete recoverability.

Primary end points were complete aneurysm occlusion and clinical safety considered as absence of death, of major or minor stroke.

Results: In 7 patients complete occlusion was achieved, in 3 a residual neck remnant was observed. Clinical safety was obtained in all patients as no ischaemic complications were observed. Neurologic status remained unchanged at follow-up. Angiographic controls at 6 months were obtained in 7 patients with no significant modifications of aneurysms filling.

No intimal hyperplasia was observed.

Conclusion: The use pCONus Bifurcation Aneurysm Implant system has confirmed to be safe and very effective, with a precise deployment control that allows the facilitates and extends the possibility of endovascular treatment of complex and wide neck intracranial bifurcation aneurysms.

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Double Microcatheter Technique for Coiling of Wide-Neck Aneurysm
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Purpose: To study effectiveness and problematic of using double microcatheter for coiling of a wide-neck aneurysm.

Methods: Serial case report.

Result: With double microcatheter technique, coil can be stabilized in desired position. Advantage of this technique: it is simple and easy. While drawback of this technique is the stiffness of the coil that not yet detached sometime make difficult to get a tight filling.

Conclusion: Double microcatheter technique is feasible and helpful for coiling of wide neck aneurysm.

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Effect of Modeled Arterial Configuration on the CFD Predictions of Cerebral Aneurysm Hemodynamics
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Purpose: Transient patient specific CFD simulations were conducted to investigate the effect of modeled arterial configuration on the predictions of cerebral aneurysm hemodynamics with an emphasis on wall shear stress and oscillatory shear index. The arterial configuration considered in a CFD model contributes significantly to the time required to perform the computations, especially in transient models.

Methods: The CFD model adopted two non-Newtonian blood viscosity model; namely power-law and Carreau models, in addition to Newtonian viscosity model.

Results: The findings suggest that the viscosity model affect the model sensitivity to the length of parent and child arteries considered in the model.

Conclusion: The reduction of modeled arterial configuration may reduce the required computational time significantly. However, it may result in mispredictions of arterial hemodynamics. The use of non-Newtonian viscosity models increases the CFD model sensitivity to geometrical configurations. Therefore extensive patient specific simulations are required to define optimal arterial configuration for the CFD to become effective in cerebral aneurysm management.

References

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Creating a Visualization Model of Filling Coil Insertion in Aneurysm
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Purpose: There are many kind of filling coil but detailed behavior is not clear, because of the coil of the past is placing in the aneurysm. The purpose of this study is observing some filling coils behavior in the aneurysm model.

Methods: We place the microcatheter in the center of the silicon aneurysm model (diameter 8 mm / neck 1.5 mm) and place three helical nylon coils (55 cm, VER 15%). Next we place seven kind of filling coils (Target 360 soft, CASHMERE, Galaxy Xtrasoft, Axium, COSMOS, ED COIL ExtraSoft, ED COIL ∞ ExtraSoft) and observe the behavior. We analyze size, position, form and reproducibility.

Results: Each coils have the characteristic behavior. In the same secondary coil roller, some coils have the different size. Target and Axium tend to become large size. ED COIL tend to become small size. ED COIL ∞ is placed different form in each practice. The primary coil roller is smaller, tend to place in the depths.

Conclusion: In this experiment, each coils have different behavior in the same conditions. This result may allow to choice suitable coil in various situation.

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The Efficacy of Embolization Using Double Catheter Technique for Ruptured Very-Broad Aneurysms
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Purpose: We used double catheter technique (DCT) for very-broad-neck ruptured aneurysms for which balloon neck plasty technique is inappropriate. We analyzed our clinical result and discussed the adequacy of our strategy which was
to avoid stent assisted technique in acute phase of subarachnoid hemorrhage.

Methods: Fifteen patients with 15 aneurysms underwent embolization with DCT between 2008 and 2013. The most frequent locations were IC-PC and BA tip. The mean size of aneurysms in maximum diameter was 10.8 (3–24) mm. The mean dome-neck ratio was 1.1 (0.65–1.4). We studied the occlusion grade, perioperative complication, mRS at 90 days and recurrence in follow-up.

Results: At initial treatment, 7 aneurysms resulted in complete occlusion or neck remnant. Although the remaining 8 aneurysms were recognized slow body filling, re-bleeding was not found. In 2 cases, asymptomatic infarction due to coiling was found. The ratio of mRS 0–2 was 88% and 29% among the patients with Hunt & Hess grade 2–3 and 4–5. Among 3 basilar aneurysms, recurrence was found and 2 aneurysms were retreated with stent-assisted coiling resulted in 1 further recanalization.

Conclusion: The embolization with DCT for ruptured very-broad-neck aneurysms was effective and safe. Although stent-assisted coiling for recurrent aneurysm in chronic stage was effective, the large thrombosed aneurysm need parent vessel occlusion or the application of flow-diverting stent.

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Tactic and Pitfall of Residual or Recurrent Cerebral Aneurysm

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Purpose: Among previously treated aneurysm, surgical clipping has 4% possibility of remant aneurysm and has 0.38–0.79% possibility of rebleeding from remnant aneurysm per year. Coiling has 60–90% possibility of total or near total occlusion rate, but has 2.9% possibility of rebleeding from remnant aneurysm. Several studies were done such as CARAT(cerebral aneurysm rerupture after treatment) study, ISAT study.

Materials and Methods: In total, 13 patients, with residual or recurrent aneurysm after treatment between January 1996 and June 2013 were included. We retrospectively evaluated the medical records, radiologic findings.

Result: Total 13 patient, male were 5 and female were 8. Ruptured aneurysms were 11 (clip 4, coil 7) and unruptured aneurysms were 2 (clip 1, coil 1). Residual or recurrent aneurysms after surgical clipping were 5 of 1868 (0.2%) and same after coiling were 8 of 222 (3.6%). Location of recurrent aneurysm after clipping included the following: A-com (n = 2), P-com (n = 2), MCA (n = 1) and same of after coil included the following: A-com (n = 4), P-com (n = 2), ICA (n = 2).

Conclusion: Previously treated aneurysms need to follow up imaging because of recurrence and rebleeding. A-com aneurysms and endovascular group have higher frequency of recurrence. Embolization could be safe, effective option with low morbidity and mortality, but it leaves a doubt of long term durability. Open microsurgery is the definitive treatment, but it is a heavy burden to neurosurgeons.

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Clinical Implication of Fenestration in Patients with Anterior Communicating Artery Aneurysm Treated with Coil Embolization

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Purpose: The purpose of this study was to evaluate morphologic factors associated with rupture in anterior communicating artery (AcomA) aneurysms and to investigate the clinical implication of AcomA fenestration as a risk factor for aneurysm rupture.

Methods: The clinical and radiologic findings of 255 patients with AcomA aneurysms treated with coil embolization between January 2005 and March 2014 were retrospectively reviewed. We performed univariate and multivariate analyses to evaluate the associations between morphologic variables and rupture status.

Results: The number of patients with AcomA fenestration was 17 out of 255 (6.6%). There were no statistically significant differences between the fenestration group and nonfenestration group in clinical and morphologic characteristics. Multivariate logistic regression tests showed that superior direction of aneurysm dome (OR 2.8, \( p = 0.018 \)), presence of a daughter sac (OR 6.6, \( p < 0.001 \)), high aspect ratio (OR 2.6, \( p < 0.001 \)), size greater than 7 mm (OR 2.9, \( p = 0.021 \)), and AcomA fenestration (OR 3.5, \( p = 0.043 \)) were significantly associated with AcomA aneurysm rupture.

Conclusions: The results of this study demonstrated that a fenestrated AcomA is associated with risk of aneurysm rupture. Therefore, AcomA fenestration should be considered as an important morphologic risk factor for rupture, along with other known risk factors such as the direction of aneurysm dome, a daughter sac, high aspect ratio, and size.

References

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Hemodynamic and Geometric Characteristics as Predictors for the Rupture of Cerebral Aneurysms: Case-Control Study in Two Groups of Patients with Ruptured and Stable Unruptured Lesions
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Purpose: To identify hemodynamic and geometric characteristics that predict the rupture of cerebral aneurysms, comparing two groups of patients: ruptured (cases) versus unruptured stable lesions with at least one year of follow-up (control)

Methods: In this observational case-control study, two groups of patients with cerebral aneurysms were compared: 35 patients with a ruptured aneurysm and 35 patients with an unruptured lesion; the control group had at least one year of follow-up after diagnosis in order to define the lesion as stable. In both groups the hemodynamic analysis of the lesions was performed by the method of computational fluid dynamics. At the same time, a total of fifteen geometric variables were analysed: max aneurysm size, max depth & width, aneurysm volume, aneurysm surface area, average neck diameter, undulation index, presence of blebs, height to width ratio, ellipticity index, non-sphericity index, aspect ratio, size ratio, volume to ostium ratio, bottleneck factor, aneurysm inflow-angle. To identify independent predictive variables for rupture, a multivariable logistic regression model was constructed, including the following information: demographic, genetic background, comorbidities (hypertension), smoking, and hemodynamic and geometric features.

Results: Two hemodynamic (mean wall shear stress and oscillatory shear index) and three geometric variables (max aneurysm size, aspect ratio and aneurysm inflow-angle) were identified as independent variables that predicted the rupture of cerebral aneurysms.

Conclusion: The study of hemodynamic and geometric features in unruptured cerebral aneurysms may yield valuable information to assess the risk of rupture, and thus to select patients for intervention or follow-up with more solid criteria.

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Quantification of Velocity Changes in Patient-Specific 3D-Printed Replicas of Cerebral Aneurysms after Flow Diverter Placement by 3D Phase Contrast MR
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Purpose: To quantify intra-aneurysmal blood velocity changes after flow diverter (FD) placement in cerebral aneurysms by employing 3D-printed models and 3D phase contrast magnetic resonance imaging (3D pcMRI).

Methods: Based on retrospectively collected 3D digital subtraction angiographic (DSA) image data (Siemens AX), 3D models of five cerebral aneurysms were printed in polylactic acid (PLA, Makerbot Inc.). Models were attached to a continuous flow loop before and after covering the aneurysm ostium by a Pipeline FD device. Velocity components inside the aneurysm model with and without FD were calculated using full 3D velocity information obtained from the MRI image data.

Results: No MRI image artifacts were created by the Pipeline FD device. Blood velocities inside the aneurysm decreased for all cases (p < 0.03) and varied based on aneurysm and parent artery geometry from 13 to 50% (mean: 23%, range without FD: 28–52 cm/sec, range with FD: 16–43 cm/sec).

Conclusion: Patient-specific 3D-printed replicas of cerebral aneurysms were successfully used ex-vivo to quantify reduction in intra-aneurysmal blood velocities after FD placement. Decrease in velocities varied and depended on the geometry of the aneurysm and parent artery segment.

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When the Working Angle at Cerebral Aneurysm Embolization Decided by 3D-RA is Beyond the Limits of C-Arm Range of Motion
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Purpose: Proper working angle results in excellent embolization at neuroendovascular therapy of cerebral aneurysms. Analysis of 3D rotational angiography (3D-RA) makes it easy and proper to decide the working angle.
However, sometimes the working angle decided by 3D-RA is beyond the limits of C-arm range of motion. We examined the difference between the limits of C-arm range of motion decided by workstation of 3D-RA theoretically and practically.

**Methods:** The limits of C-arm range of motion was plotted theoretically (decided by workstation) and practically from LAO 130° to RAO 130° and from cranial 90° to caudal 90°. DSA machine was Axiom Artis dFA (Siemens), 3D-RA data was analyzed by LEONARD workstation with software syngo XWP version VA71C (old type) and syngo XWP version VB13F (new type).

**Results:** Region(1) within the limits of C-arm range of motion both theoretically and practically Region(2) within the limits of C-arm range of motion theoretically but beyond the limits practically. Region(3) within the limits of C-arm range of motion both theoretically and practically. Region(4) beyond the limits of C-arm range of motion both theoretically and practically. In cases of Region(1)(3), embolization is possible at the working angle decided by workstation. In cases of Region(2)(4), change of head position (chin up, chin down or head tilt) makes the working angle within the limits of C-arm range of motion practically. The new software makes the difference between the limits of C-arm range of motion theoretically and practically small.

**Conclusion:** When the working angle at cerebral aneurysm embolization decided by 3D-RA is beyond the limits of C-arm range of motion, change of the head position makes the working angle within the limits of C-arm range of motion practically.

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**Endovascular Coil Embolization of Intracranial Aneurysms with a Branch Arising from the Sac**

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**Background and Purpose:** Because of a remarkable advance in technology and technique of endovascular coiling, a cerebral aneurysm with a branch incorporated into the sac can be safely treated. The purpose of this study is to review the feasibility, techniques, and clinical and angiographic outcomes of coil embolizations in this category.

**Materials and Methods:** Since 2011, 32 patients with saccular cerebral aneurysms presented with subarachnoid hemorrhage (SAH) were treated endovascularly. 8 patients were male and 24 patients were female. Median age was 65.5 years (range 36–88). 6 patients were classified as grade 5 according to Hunt and Hess grade. The modified Rankin Scale (mRS) was used to assess functional outcomes after treatment of at discharge.

**Results:** Procedure related morbidity and mortality rates were observed in 4 patients (19%) during or after the procedure. Procedure-related morbidity and mortality rates were 4.8% and 0%, respectively. Sixteen of the 17 patients had favorable outcome (modified Rankin Scale 0–2). Three recurrent aneurysms (16.6%) were observed during follow-up period exclusively in ruptured ICA-posterior communicating artery cases, and were treated endovascularly at 12–22 months.

**Conclusions:** By using the current techniques of endovascular treatment, cerebral aneurysms with a branch arising from the sac can be safely treated by coiling. However, risks and benefits should be carefully considered in the decision to treat aneurysm of this category especially for ICA-posterior communication artery aneurysms.

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**Functional Outcomes of Endovascular Coiling of Ruptured Cerebral Aneurysms**

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**Purpose:** Since the publication of international subarachnoid aneurysm trial, endovascular coiling has been accepted as the first line treatment for ruptured cerebral aneurysms. We retrospectively reviewed and evaluated the functional outcomes of our experience.

**Methods:** Since 2011, 32 patients with saccular cerebral aneurysms presented with subarachnoid hemorrhage (SAH) were treated endovascularly. 8 patients were male and 24 patients were female. Median age was 65.5 years (range 36–88). 6 patients were classified as grade 5 according to Hunt and Hess grade. The modified Rankin Scale (mRS) was used to assess functional outcomes after treatment of at discharge.

**Results:** Procedure related morbidity was observed in a patient (3.1%). 25 patients (75.8%) had a good outcome. When we excluded a patient who had preictal mRS greater than 2 and 6 patients presented with grade 5 SAH, 24 of 25 patients (96%) had a good outcome. On the other hands, all the patients with grade 5 SAH were dependent or dead. Delayed cerebral ischemia was observed in 3 patients, and shunt-dependent hydrocephalus was observed in 2 patients.

**Conclusion:** Our data suggest that the prognosis after endovascular treatment of ruptured cerebral aneurysms has been improving. However, the prognosis of patients with grade 5 SAH remains poor.

Endovascular Coil Embolization of Intracranial Aneurysms with a Branch Arising from the Sac

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**Results:** Procedure related morbidity was observed in a patient (3.1%). 25 patients (75.8%) had a good outcome. When we excluded a patient who had preictal mRS greater than 2 and 6 patients presented with grade 5 SAH, 24 of 25 patients (96%) had a good outcome. On the other hands, all the patients with grade 5 SAH were dependent or dead. Delayed cerebral ischemia was observed in 3 patients, and shunt-dependent hydrocephalus was observed in 2 patients.

**Conclusion:** Our data suggest that the prognosis after endovascular treatment of ruptured cerebral aneurysms has been improving. However, the prognosis of patients with grade 5 SAH remains poor.
Successful Endovascular Treatment of a Dissecting Aneurysm of Vertebral Artery Associated with Double Origin of the Posterior Inferior Cerebellar Artery: Case Report

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Background: Double origin of the PICA (DOPICA) were rarely reported in the literature, and reported incidence of DOPICA was 1.45% (Lesley, Rajab, and Case, 2007). In contrast, a high concurrence rate of DOPICA and vertebral artery dissecting aneurysm (VADA) has been reported (Koh et al., 2007) (Koh et al., 2012).

Clinical presentation: A 61-year-old woman presented with vomiting and diplopia with preceding headache. Magnetic Resonance Imaging (MRI) showed fresh infarction of left lateral medulla and a VADA of left vertebral artery (VA). The next day, she had transient loss of consciousness and MRI depicted subarachnoid hemorrhage.

Technique and intervention: Four-vessel digital subtraction angiography showed a posterior inferior cerebellar artery (PICA) arising both intracranially and extracranially from the left vertebral artery. Although the dissecting lesion involved V3 and V4 portion, it did not involve extracranially originating PICA. Internal trapping of V3 and V4 portion was chosen and performed safely, because the extracranial channel was expected to supply the PICA territory.

Conclusion: Early endovascular intervention should be considered in the treatment dissecting aneurysm of vertebral artery associated with double origin of the posterior inferior cerebellar artery for patients with relatively long lesions even in unruptured cases.

Referee

Endovascular Treatment for Superior Cerebellar Artery Aneurysms: Morphological Features, Technique, and Outcome

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Purpose: Superior cerebellar artery (SCA) aneurysms have distinctive morphologic configurations and vascular origins. Herein, we have analyzed the angioarchitectural characteristics of SCA aneurysms and outcomes achieved through endovascular treatment.

Materials and Methods: Data accruing prospectively from January, 2002 to September, 2013 yielded 53 SCA aneurysms in 53 patients. Each lesion was classified as either basilar artery (BA), BA–SCA, or SCA type, according to the nature of incorporated vasculature. Clinical and morphologic outcomes were assessed, with emphasis on technical aspects of treatment.

Results: Angles formed by SCA and posterior cerebral artery were obtuse (124.8 ± 29.1°) on sides ipsilateral to aneurysms, differing significantly from contralateral counterparts (44.8 ± 22.0°) (p < 0.001). The most common type of aneurysm was BA–SCA (54.7 %), followed by SCA (28.3 %) and BA (17.0 %), and BA type aneurysms were the largest in size. Steam-shaped S-configured microcatheters (n = 19, 67.9 %) facilitated aneurysm selection for approach via contralateral vertebral artery (n = 28), whereas pre-shaped 45/90/J microcatheters (n = 21, 84.0 %) primarily were used for ipsilateral vertebral artery approach (n = 25). Single-microcatheter technique (52.8 %) was most often applied, followed by single-microcatheter (34.0 %), stent-assisted (9.4 %), and microcatheter-protection techniques (3.8 %). Aneurysmal occlusion was satisfactorily achieved in 45 lesions (82.1 %), with no procedure-related morbidity and mortality. In follow-up monitoring of 46 patients for a mean period of 25.8 ± 24.4 months, only a single instance of major recanalization (2.2 %) occurred.

Conclusion: Coil embolization of SCA aneurysms is a safe and effective treatment modality, enabling individualized procedural strategies to accommodate distinctive angioanatomic configurations.
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Transradial Approach for Intracranial Aneurysm Embolization

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Purpose: To describe our experience with the transradial approach for coil embolization with or without stent assisted.

Materials and Methods: The clinical and imaging characteristics as well as periprocedural outcomes of patients treated for unruptured or ruptured intracranial aneurysm via the transradial approach were analyzed retrospectively. Between January 2008 and May 2013, ten patients with intracranial aneurysm (BA, n = 2, SCA, n = 2, PCA, n = 2, ICA, n = 2 and MCAB, n = 2) were treated via the transradial approach because of tortuous brachiocephalic and vertebral origin anatomy or bovine left common carotid artery.

Results: Simple coiling was two cases and other 8 cases (80%) are stent assisted coil embolization. Modified Raymond grade I results are 7 cases (70%), grade II are 3 cases. There were no procedure complications such as intracranial hemorrhage or ischemic stroke.

Conclusion: The transradial approach is an alternative method for coil embolization of intracranial aneurysms to the femoral approach for unfavorable access route.

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Endovascular Treatment of Ruptured Anterior Inferior Cerebellar Artery Pseudoaneurysm Mimicking Non-Aneurysmal Subarachnoid Hemorrhage

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Purpose: Subarachnoid hemorrhage (SAH) is usually caused by a ruptured intracranial aneurysm. However, in some patients, no source of hemorrhage might be detected despite repeated digital subtraction angiography (DSA). We report for the endovascular treatment is found in the case of anterior inferior cerebellar artery (AICA) pseudoaneurysm after repeated DAS.

Methods: A 74-year-old man presented with severe headache, drowsy mentality. Brain computed tomography revealed non-aneurysmal subarachnoid hemorrhage (SAH). DSA also revealed negative findings. After one week, DAS performed and found AICA pseudoaneurysm. Unfortunately, rebleeding was done after 2 hours to 2nd DSA.

Results: We tried endovascular treatment. Our plan was offending AICA occlusion by coil. Because we didn’t select AICA, we only selected AICA proximal area. So, we deployed helical coil into AICA partially, then remained coil in basilar artery was stented by Enterprise stent. And we performed decompressive suboccipital craniectomy but the patient was expired.

Conclusion: In our case, we should be highly suspicious of patients with a nonaneurysmal SAH. In order to reduce the morbidity and mortality resulting from a misdiagnosis, repeat DSA is necessary, and exclusion of an aneurysm is important.

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Telescopic Stenting as a Rescue Technique for Stent Displacement During the Endovascular Treatment of Intracranial Aneurysms – Case Series

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Purpose: Flow diverters, self-expanding braided stents deployed across an aneurysm neck have wide applications. However giant, wide-necked and fusiform aneurysm represent a challenge to interventional neuroradiologists. We report our experience in telescopic stenting as a rescue technique for stent displacement during the endovascular treatment of intracranial aneurysms.

Methods: Between January 2013 and May 2015, 263 consecutive patients with intracranial aneurysms underwent endovascular treatment in our institution. 68 of 263 (26%) patients were treated with stents. After initially successful stent deployment in 4 patients we observed delayed (several minutes) stent dislodgement into the aneurysm. Location of aneurysm was as follows: ICA – 2, ACA – 1, basilar artery – 1.

Results: In 2 patients with dislodgement of the distal tip of the stent (ICA location both) we recatheterized the lumen of the displaced stent and the distal part of the parent artery and then successfully put second stent to reconstruct the artery. In case of giant basilar fusiform aneurysm it was proximal stent tip displacement, we deployed second stent from the first to the proximal segment of the parent artery. In case of giant partially thrombosed distal ACA aneurysm we observed delayed disjunction of initially telescopi
deployed 2 stents, and third stent was used to reconstruct the artery.

**Conclusion:** Stent foreshortening may cause its dislodgement into the aneurysm. Maximize stent landing zone length may reduce the incidence of stent dislodgement. Telescopic stenting can be used successfully to reconstruct the artery.

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**Selection of Guiding System for Aneurysmal Coil Embolization**

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**Purpose:** Appropriate selection of guiding system is important to achieve successful coil embolization. We need to deliver guiding system to more distal part of the vessel and get strong support by guiding catheter, to obtain good handling with device. And we need the guiding catheter with large lumen to use several devices at once. We retrospectively investigated the selection of guiding catheter in patients who had previously undergone coil embolization.

**Methods:** Retrospective analysis was conducted for consecutive 95 patients who received coil embolization between May 2013 and May 2015 at our institutions. Type of guiding system, location of aneurysms and the technique for coil embolization were analyzed.

**Results:** 6Fr guiding catheters were selected in 20 patients (21%), 7Fr guiding catheters in 35 patients (37%) and 8Fr guiding catheters in 40 patients (42%). In all of 40 patients who underwent coil embolization with 8Fr guiding catheter, triple coaxial systems constructed with 6Fr intermediate catheter and 8Fr guiding catheter were selected. Most of the aneurysms located in MCA, Acom or ACA distal were treated with 8Fr triple coaxial system, aneurysms located in ICA with 7Fr guiding catheter and aneurysms located posterior circulation with 6Fr guiding catheter. Simple technique tended to be selected for coil embolization with 8Fr triple coaxial system. 85% of the cases with 8Fr triple coaxial systems were able to achieve beyond petrous ICA access. There was no complication related guiding catheter.

**Conclusion:** Simple technique with 8Fr triple coaxial system was used in most of the aneurysms located in distal part of the artery to achieve better microcatheter handling. Appropriate selection of guiding system might contributes to safe and successful coil embolization.

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**Follow-up Study of Intracranial Fusiform Aneurysms in the Vertebrobasilar Arteries**

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**Purpose:** Intracranial fusiform aneurysms in vertebrobasilar arteries (FAVBAs) are often detected incidentally by medical check-up with magnetic resonance imaging. FAVBAs are considered to be dissecting aneurysms in chronic stage which have not been diagnosed at onset. Although endovascular treatment is reported to be safe and effective for FAVBAs, their natural history is not well known. We report the follow-up data of FAVBAs and discuss their treatment strategy.

**Methods:** The clinical data of 83 patients (47 men, 36 women; mean age, 59 (35–82) years), who were incidentally diagnosed FAVBA (72 patients) or who had FAVBA derived from symptomatic unruptured vertebrobasilar dissection more than a year after onset (11 patients), were retrospectively analysed.

**Results:** Aneurysms were located in the basilar artery in 2 cases and in the vertebral artery in 75 cases. In other 6 cases, aneurysms extended from the vertebral artery to the basilar artery. With a mean follow-up of 41 months, enlargement of FAVBAs was occurred in 9 patients. Among them, three patients became symptomatic; rupture of aneurysm in 1, brainstem infarction in 1, brainstem symptom due to compression by aneurysm in 1. Significant risk factors for enlargement of FAVBAs were involvement of the basilar artery and the size of aneurysm.

**Conclusion:** Although Intracranial fusiform aneurysms in the vertebral artery have a good natural history, those involving the basilar artery tend to enlarge and become symptomatic. Observation is recommended for FAVBAs when they are stable.
Phase study investigating the utility of ROTEM Delta® and Multiplate® guided management of anti-coagulation and anti-platelet therapy in adult patients undergoing interventional neuroradiological procedures for management of cerebral aneurysm.

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Purpose: Interventional neuroradiological (NR) management of cerebral aneurysms carries the risk of thromboembolic and haemorrhagic complications, to which significant morbidity and mortality is attributed. As part of our three phase study investigating the utility of ROTEM Delta®, ROTEM Platelet® and Multiplate® guided management of anti-coagulation and anti-platelet therapy in adult patients undergoing interventional NR procedures for management of cerebral aneurysm, we conducted a retrospective audit of experience at our centre.

Methods: The electronic medical records of all patients admitted to the Gold Coast University Hospital Intensive Care Unit following subarachnoid haemorrhage (SAH) or elective interventional NR or neurosurgical clipping of cerebral aneurysms between January 2011 and December 2014 were retrieved. Primary outcomes of interest were death, and thromboembolic and haemorrhagic events during hospital admission.

Results: One hundred and fifty-two patients underwent interventional NR procedures for cerebral aneurysms. This consisted of 92 (60.5%) elective cases and 60 (39.5%) emergency cases following SAH. The overall mortality rate was 5.9%, the rate of thromboembolic and haemorrhagic events was 11.2% and 7.2% respectively. For elective cases the mortality rate was 2.2%, the rate of thromboembolic and haemorrhagic events was 5.4% and 3.3% respectively. For emergency cases the mortality rate was 11.7%, thromboembolic and haemorrhagic event rates were 20% and 13.3% respectively. Intra-procedural complications occurred in 6.6% of the entire cohort; 4.3% of elective cases and 10% of emergency cases. Median length of follow-up was 448 days, with 91.6% of the entire cohort followed up. At follow up, 64.1% of patients had no neurological deficits, 29% had mild non-specific deficits and 6.9% had significant disability. Interventional NR represents the primary treatment modality for management of cerebral aneurysms at our centre. During the study period 9 patients underwent open neurosurgical clipping of cerebral aneurysms. These 9 patients were all elective and no patients with SAH underwent open neurosurgical intervention.

Conclusion: Management of cerebral aneurysms, particularly following rupture, is associated with significant risks of thromboembolic and haemorrhagic complications, which carry significant morbidity and mortality. The data from the cohort presented above forms the basis of the study design for subsequent phases. Phase 2 aims to identify patients at increased risk of complications using ROTEM Delta®, ROTEM Platelet® and Multiplate® devices.

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Vascular and Hemodynamic Change in Endovascular Treatment for Ruptured Aneurysm with Coexistence of Severe Angiographic Vasospasm

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Purpose: In severe vasospasm, various situations could be happened unlike non-spasmotic phase. We would like to report cases that experienced unforeseen circumstances in treatment for ruptured aneurysm with coexistence of severe vasospasm.

Methods: Three patients with subarachnoid haemorrhage (SAH) and severe vasospasm were treated with endovascular coiling.

Results: In two patients, non dominant ACA was not visualized and dominant ACA was severe narrowed. When the microcatheter was advanced near to aneurysm through parent ACA, blood flow arrest was occurred in total ACA territory. One of two patients, we quickly selected aneurysm, made frame using 2 coils and immediately, withdrew the microcatheter in proximal ACA. After waiting for few minutes, the ACA was more dilated and, when advanced in A2 segment, partial blood flow was observed in ACA territory. One of two patients, we quickly selected aneurysm, made frame using 2 coils and immediately, withdrew the microcatheter in proximal ACA.. After waiting for few minute, reselection and additional coiling was performed in several times. In this way, such as advance-withdrawal tip, aneurysm was obliterated and the blood flow was well maintained. In the other patient, Advance-withdrawal tip could not performed because proximal portion of A2 segment was curved, which made tension and jumping of microcatheter. Microcatheter was withdrawn to ICA and waited. Angiogram after few minutes, the ACA was more dilated and, when advanced in A2 segment, partial blood flow was observed in ACA territory. Aneurysm was obliterated and the blood flow was maintained. Vasospasm was slightly improved without angioplasty. In last patient, coiling was tried in A-com aneurysm. During coiling, contra-lateral ACA frequently was not visualized.

Conclusion: In final angiogram, the aneurysm seemed to be near totally obliterated. After two weeks, the vasospasm was improved but recanalization was occurred in previous coiled
aneurysm. Although aneurysm seemed to be occluded completely on vasospasm period, early recanalization was happened between few days. In severe vasospasm period, the unfavorable influence on blood flow caused by intravascular device, effect of catheterization to spasmotic vessel and the possibility of early recanalization should be considered.

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Endovascular Treatment for Symptomatic Vertebral Artery Dissecting Aneurysms

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Purpose: Vertebral artery dissecting aneurysms (VADA) are challenging disorders for neurosurgeons. Authors retrospectively evaluated our experience using endovascular techniques to treat these aneurysms.

Methods: Between July 2008 and December 2014, we treated 17 patients with dissecting aneurysms of the intracranial vertebral artery. Among them thirteen patients underwent endovascular treatment. Seven patients presented with subarachnoid hemorrhage from the ruptured aneurysm, another five presented with symptoms of abrupt severe headache and the other one with ischemia. The endovascular modalities were the following: 1) internal trapping (n = 7), 2) stent with coil (n = 2), 3) stent alone (n = 2), and 4) coil alone (n = 2).

Results: There were no procedural complications following endovascular treatment. Clinical outcomes were favorable in 11 patients (84.6%). Initial neurological status was the main factor for the clinical outcome. No re-hemorrhages were observed in these patients during follow-up.

Conclusion: Endovascular treatment, which includes several techniques, might be safe and effective strategy for patients with VADAs and can be the first choice for most patients. Risk can be managed by using appropriate endovascular techniques according to aneurysm location, configuration, and relationship with the posterior inferior cerebellar artery.

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Protection Effect of Intentional Only Daughter Sac Coil Embolization of Complex Ruptured Cerebral Aneurysms(2 Years Long Term Follow Up)

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Purpose: Protection effect of coil embolization of ruptured cerebral aneurysms has been well known against rebleeding, but whether only partial dome coiling of ruptured cerebral protects against rebleeding has been not as well known except only a few cases reports.

Methods: In the two cases, We had tried intentionally coiling in the only daughter sac of ruptured aneurysms. These two cases could be not done surgical clipping because of restrictively medical condition.

Results: In the all of cases, complete embolization of only daughter sac were done without procedural complications like aneurysmal rupture. We had performed regular fluoroscopy and magnetic resonance angiographic image follow-up during 2 years. First case, minimal coil compaction happened but an intra-aneurysmal blood inflow didn’t occur. Second case, any sort of change didn’t occur.

Conclusion: Proper use of a treatment strategy of intentional partial dome protection for complex aneurysms that are not favorable for clipping or primary complete coiling may prevent acute rebleeding and produce favorable clinical outcomes.

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Therapeutic Strategies of Unruptured Intracranial Aneurysms Associated with Cranioceleular Artery Stenosis

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Purpose: To the therapeutic strategies of unruptured intracranial aneurysms associated with cranioceleular artery stenosis.

Methods: The data of 72 patients diagnosed as UIAs associated with stenosis of carotid artery or vertebrobasilar artery by DSA examination were reviewed retrospectively. The parent arteries of UIAs were found stenosis with 37 patients. 35 patients had non-parent arteries stenosis including 5 patients with anterior communicating aneurysms. Aneurysm clipping and coiling, artery stenosis stenting, CEA, medical treatment and observation were chosen respectively count on the evaluation with each patient. All the patients underwent follow-up with DSA or MRA images.

Result: 11 of 37 UIAs patients with parent artery stenosis were performed procedures for UIAs or artery stenosis: 5 underwent simultaneous procedures for both aneurysm and stenosis, 4 only for aneurysm and 2 just for stenosis. Among 27 of 35 UIAs patients with non-parent artery stenosis: 11 underwent simultaneous procedures for both aneurysm and stenosis, 10 only for aneurysm and 6 just for stenosis. The other 34 patients received medical treatment or observation. The angiography during follow-up showed no in-stent restenosis and aneurysms recanalization.

Conclusion: The evaluation on each patient, including clinic information, images and hemodynamic factors, is important before intevention. Positive procedures should be
performed on high risk UIAs. Consecutive follow-up is essential for all patients.

360 Hemodynamic Analyses of Large Intracranial Aneurysms
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Purpose: To simulate the computational hemodynamics of large intracranial aneurysms and analyze the hemodynamics of three types of large intracranial aneurysms.

Methods: A total of 64 patient-specific models of large intracranial aneurysms were constructed with the data of DSA (digital subtraction angiography). According to the location of outflow vessel, plane of main vortex and impact zone, large intracranial aneurysms were classified into type A (outflow vessel in the plane of main vortex), type B1(outflow vessel out of plane of main vortex, impact zone at the lateral wall of aneurysm) and type B2(outflow vessel out of plane of main vortex, impact zone at the dome of aneurysm). Blood flow was assumed to be laminar and incompressible and blood Newtonian fluid. The time-dependent pulsatile boundary condition was deployed at inlet. CFD ICEM and Fluent software packages were used to simulate the computational hemodynamics of three types of large intracranial aneurysms.

Results: The distributions of hemodynamic variables during the cardiac cycle were analyzed for wall shear stress, velocity and streamlines. The velocity ratio (ratio of aneurysmal flow velocity to parent artery flow velocity) of type A, B1 and B2 was 0.186 ± 0.019, 0.706 ± 0.077 and 0.208 ± 0.041 respectively. The wall shear stress ratio (ratio of aneurysmal wall shear stress to parent artery wall shear stress) of types A, B1 and B2 was 0.081 ± 0.029, 1.019 ± 0.139 and 0.103 ± 0.031 respectively. The flow velocity and wall shear stress were the highest in type B1 group followed by those in type B2 group and the lowest in type A group.

Conclusion: As reflected by the location of impact zone, the location of outflow vessel and inflow -angle can influence the level of blood flow in aneurysm sac.

361 Comparison of Packing Density of New Generation Coils to Last Generation Coils in Treating Cerebral Aneurysms
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Purpose: To report the comparison of the packing density of new generation coils to last generation coils in treating cerebral aneurysms.

Methods: New generation coils (Target coils, Stryker, USA) were launched in our hospital since September 2013. Before that, we used mostly Matrix coils (Stryker, USA) for the treatment of cerebral aneurysms. Retrospectively, we selected 24 patients (27 aneurysms) using Target coils and 23 patients (23 aneurysms) using Matrix coils with age and sex matching in order to compare their effect in packing density. In both group, they consisted with 7 ruptured aneurysms, and 10 were treated with stent-assisted coiling.

Results: The aneurysm size in the Target group and Matrix group were 3.1–18.81 mm and 3.0–10.3 mm the volume were 7.71–309.46 mm ³ (mean = 66.52) and 7.65–2967 mm ³ (mean = 312.65), the packing density were 20.48–78.86% (mean = 40%) and 12.93–94.82% (mean = 21.0%) respectively. Complete obliteration of aneurysm (Raymond grade 1) in immediate post-procedural angiogram were shown in 21 aneurysms and 27 aneurysms. No complication noted in both groups. In the clinical and imaging follow-up (mean = 4.4 months and 15.1 months), recurrent aneurysms found in 4 and 7 (include 2 residual aneurysms) in Target and Matrix coil treated group respectively.

Conclusion: New generation coils have a trend of better packing density and might have the better obliteration rate as compare to the last generation coils.

362 Experience of Intracranial Aneurysms Treatment with LVIS and LVIS Jr.: Clinical and Angiographic Short Term Follow Up
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Purpose: We present our experience with coils stent assisted with neurostents LVIS and LVIS Jr. of intracranial aneurysms, periprocedural results and short term follow up.

Methods: Descriptive and Retrospective analysis of reports of endovascular treatment of intracranial wide neck unruptured aneurysms withs coils assisted with neurostents LVIS and LVIS Jr. Type of device, reason of its implant, size of aneurysms, conformability, clinical and angiographic at short term FU.

Results: Twenty-seven patients (21 female) were registered. Small n = 23 (85%) and large n = 4 (15%) aneurysms. In 25 cases as a planned procedure and two cases devices were implanted as a rescue that include one through a Scepter balón during remodelling technique. Initial conformability was successful in 22 (81, 4%), in 4 cases conformability defect resolved with balloon (3 LVIS). One device removed due to unwanted safe position. One callosal haemorrhage was registered related to microguire with transient
morbidity and mRS 4 at 6 months (4%). 22 patients were controlled with DSA with 20 total occlusion (91%).

**Conclusión**

Endovascular reconstruction with LVIS and LVIS Jr with coils for small and large aneurysm in our experience represents a safe procedure and effective about rate of occlusion at short term FU with low procedural morbi-mortality.

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**Unruptured Aneurysms Treatment: Procedural Morbi-Mortality at Single Neurological Center (FLENI) in Buenos Aires**

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**Purpose:** Unruptured aneurysms are those diagnosed incidentally, symptomatic related to mass effect, or those found in relationship to another one ruptured. We present the morbi-mortality results of endovascular treatment of unruptured aneurysms at a single neurological center in Buenos Aires.

**Methods:** Retrospective analysis of reports of endovascular treatment of unruptured aneurysms since August 2009 to April 2015: clinical presentation, size, techniques applied and morbi-mortality procedural results.

**Results:** 215 therapeutic procedures were analyzed for the treatment of 233 aneurysms. 207 (88.8%) were pure incidental, 23 related to mass effect symptoms and 3 were unruptured aneurysms in patients with prior HSA of another one. About size: Small n = 178 (76.3%), large n = 47 (20.1%), giant n = 7 (3%) and one dissecting. Techniques include coils alone 53 (24.6%), coils stent assisted 66 (30.6%), coils bálon assisted 35 (16.2%), endovascular flow diverters 59 (27.4%) and 2 endosaccular flow diverters. Procedures were performed in a biplane equipment, under general anesthesia in all cases and immediate post operative care in a neurological ICU. Non mortality was registered. Overall procedural morbidity was 4.1% and was divided in neurological (1.8%): 3 bleeding, 1 ischemic and no-neurological: retroperitoneal haematoma n = 3, one femoral arterio-venous fistula and 1 femoral pseudoaneurysm (2.3%).

**Conclusion:** Endovascular treatment of unruptured aneurysms in our experience represents a safe procedure with experimented operators, high resolution equipment and specific neurological ICU, with low percent of complications most of them in patientes under double antiplatelet treatment.

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**Flow Diverters: A Curative Endovascular Treatment for Ruptured Intracranial Blood Blister Aneurysms**

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**Purpose:** Data on durability and success rate of Pipeline Embolization Device (PED) as a new emerging endovascular device in treatment of Ruptured blood blister aneurysms is limited. We report our with ruptured blood outcomes of three patients angiographic and clinical treatment using endovascular reconstructive underwent blister aneurysms who pipeline flow diverters.

**Methods:** Five cases of blood blister aneurysms presented with SAH to Department of Neuroradiology, Sri Ramachandra Medical College and Research Institute, Chennai were treated with flow diverter stent device during year of 2013-2014. Data, including demographics, aneurysm location and features, clinical presentation, complications, results, and follow-up information, for up to 6 months is presented.

**Results:** Five patients (4 females and 1 male, aged between 40–60 yrs) who presented with SAH were diagnosed to have blood blister aneurysm involving basilar trunk (2), cavernous ICA (1), ACOM complex (1), Azygous ACA (1) were treated with Pipeline Embolization Device. The median time to treatment was 7–10 days from rupture in 4 patients and three months in 1 patient. All patients GCS at the time of admission was 15/15 and number of flow diverter devices used was one in each patient. Intra/post procedure period was uneventful without any evidence of stent stenosis/rerupture/ICH/death. The follow up period ranges from 3 to 6 months. Patients remained asymptomatic during the follow up period. The overall occlusion rate of blood blister aneurysm treated with flow diverter stent is 100% signifying flow diverter stent being the ideal choice of treatment for a ruptured blood blister aneurysm with patients condition taking in to consideration.

**Conclusion:** Flow diverting devices for the management of ruptured blood blister aneurysms offer a safer and more ideal solution with low morbidity-mortality, high angiographic complete occlusion rates. Since, treatment by surgical means predisposes high chance of morbidity and mortality. Long term efficacy of flow diverting device is yet to be established.
An Outcome After Saccular Packing for Ruptured Blood-Blister Like Aneurysm

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Purpose: Most of the blood blister-like aneurysms (BBAs) are found at the anterior wall of internal carotid artery (ICA), so this is considered as one of the dissecting aneurysms. Until now, we treated ruptured BBAs that were determined to be treatable with coil embolization. We re-searched the outcome of these BBA cases retrospectively.

Methods: We analyzed our prospectively maintained database to identify patients from January 2000 to April 2014 in Nagoya University and the related institutes. During the period, 15 patients were treated for ruptured BBA with coil embolization. The mean age was 48 years, 2 patients were male. All of the aneurysms were located in the anterior wall of ICA. Only 1 aneurysm was excluded from the enrollment because it was too difficult to perform coil embolization and we changed the strategy to perform internal trapping of the parent artery.

Results: The Hunt and Kosnik Grade 2–3 was 8 cases (57%), Grade 4–5 was 6 cases (43%). We treated 2 cases (14%) at the acute phase, 6 cases (43%) at subacute and 6 cases at chronic phase respectively. Balloon-assisted technique was used in 7 cases as an adjunctive technique, simple technique in 5 cases, and stent-assisted technique in 2 cases. The intraoperative rupture was occurred in only 1 case (7%) for complication associated with the procedure, no ischemic complication was observed. Rebleeding during the follow-up period was not observed. Meanwhile, the recurrence was observed in 6 cases (43%), all of which were re-treated. The interval from the initial treatment to re-treatment was average 63 days (28–148 days). These re-retreatments were observed in 2 cases, we performed internal trapping in one case of which. Complications associated with re-treatment and re-bleeding after embolizations in all cases was not observed. For clinical results, the 12 cases (86%) had good prognosis (GR), the 2 case (14%) had poor prognosis (MD + SD + D).

Conclusion: We think that coil embolization can be an option of treatment for the ruptured blood blister-like aneurysm that is considered to be treatable morphologically, though it requires a close post-operative follow-up to monitor the recurrence.

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Aneurysmal Neck Plasty in Broad-Necked Aneurysms with a Unilateral Partial Stent Reconstruction: Half-Bridge Stenting Method

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Purpose: Here we describe a novel technique named “Half-bridge stenting method”, in which the aneurysmal neck was partially covered by a single stent before coiling with a microcatheter through the open side.

Technique: Two cases of broad-necked terminal-type aneurysm and one of broad-necked lateral wall-type aneurysm were treated. The stents were deployed from a unilateral branch or distal parent artery to the aneurysmal neck with a trumpet-like. All aneurysms were satisfactorily embolized with coils.

Conclusions: This technique can be used to smoothly insert coils into the aneurysms without restriction of the microcatheter by the stents. Furthermore, additional stenting and coiling also can be performed in case of retreatment.

Preliminary Clinical Experience with Pipeline Embolization for Unruptured Large or Giant Intracranial Aneurysms in Japanese Patients

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Purpose: The Pipeline embolization device is the first and only flow diversion device to be approved by the Japanese Ministry of Health, Labour and Welfare, the approval for which was received in April 2015. Prior to that, we performed clinical trials with the approval of our hospital’s ethics committee and written informed consent from all of the patients. The purpose of this study is to evaluate the safety and efficacy of pipeline embolization for large or giant unruptured intracranial aneurysms (UIAs) in Japanese patients.

Methods: A retrospective review of the medical records, outpatient charts, and operative records was performed.

Results: Six patients (4 female, 2 male) with a mean age of 61.8 years (range 48–72) underwent pipeline embolization for large or giant UIAs. Among those, 3 patients had symptoms due to the mass effect. The mean aneurysm size was 19.5 mm with the mean neck size of 9.4 mm. The locations of the aneurysms were the C4 segment of the internal carotid artery in 2 patients, C3 in 2, and C2 in 2. All the patients had an uneventful postoperative course with no clinical complications. The 6-month follow-up catheter angiogram showed complete aneurysm occlusion in all the patients except 1, in whom the angiogram showed persistent filling of a tiny aneurysm. All the patients reported significant relief of their symptoms.

Conclusions: The results of this preliminary clinical experience indicate that pipeline embolization is safe and effective for large or giant UIAs in Japanese patients.
Conclusion: Transradial approach showed the safety and efficacy in endovascular treatment of brain aneurysm and can be applied as the safer alternative to transfemoral approach.

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Preliminary Experience with Surpass/Streamline Flow Diverter Stent for Unruptured Intracranial Aneurysms Treatment in 9 Patients
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Purpose: The use of Flow Diverter stents have emerged for the endovascular treatment of difficult-to-treat or otherwise untreatable cerebral aneurysms. We report our preliminary experience with Surpass/Streamline devices.

Methods: Between February 2014 and March 2015 13 aneurysms were treated utilizing the Surpass/Streamline stent in 9 patients (female/male, 8/1; age range, 46–67 years; mean age, 56 years).

Primary end points for clinical safety were the absence of death, of major or minor stroke, and absence of transient ischaemic attack.

Primary end point for treatment efficacy was complete occlusion at 3 and 6 months follow-up according to the O’Kelly Marotta grading scale (OKM).

Results: None of the patients died and in none of them ischaemic procedure-related complications were observed. Immediate post-treatment angiography demonstrated reduced flow into all aneurysms.

In all but one patient complete aneurysm occlusion was observed at 3 months CT follow-up; in the other patient, with giant aneurysm treated with coiling also, DSA control was performed at 6 months has shown an angiographic filling grade of C1 according to the OKM.

In all the patients collateral arteries were covered with FD and all were patent at the 3 and 6 months follow-up.

Conclusion: The use of Surpass/Streamline flow-diverter stent has confirmed to be safe and very effective, with a particularly precise deployment control. The ability of the Surpass Streamline to be recaptured after partial deployment and its increased navigability have raised the Surpass stent features.

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The Interim Result of Pipeline Flow Divertor in a Single Centre
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Purpose: Flow diverters are increasingly used in the endovascular treatment of intracranial aneurysms. Our aim was to determine obliteration, recurrences and complication rates following Pipeline embolization device (PED) placement for intracranial aneurysm treatment and their associated risk factors.

Methods: We retrospectively evaluated all patients with intracranial aneurysms treated with the PED between Oct 2008 and Nov 2014 in our institution. Neurologic complications included spontaneous rupture, intracranial hemorrhage, thromboembolism and 30-day mortality. Treatment outcome included aneurysm obliteration rates in 6 months, 1 year and 2 year respectively. Statistical analysis was performed by SPSS version 16 by Fisher Exact test with p value < 0.05 indicating statistical significance.

Results: 60 consecutive patients with pipeline embolization device performed were identified during the study period with mean age of 56.1 years (34–84) and a mean follow-up time of 31.6 ± 21.2 months. 51.7% (31/60) were female, 48.3% (29/60) were male. 60% (36/60) were non-ruptured aneurysms while 40% (24/60) were ruptured cases. 81.7% (49/60), 6.7% (4/60), 11.7% (7/60) of cases were due to aneurysms, dissection and dissecting aneurysms respectively. 71.1% (43/60) were treated with pipeline alone while 28.3% (17/60) were treated with pipeline-assisted coiling. 78.3% (47/60) of aneurysms were located along anterior circulation while 21.7% (13/60) were along posterior circulation. The aneurysms treated had a mean size of 6.69 ± 6.06 mm (2–31), with a mean aspect ratio of 1.40 ± 0.84. 78.3% (47/60) were saccular aneurysms while the remaining ones were fusiform. 19.2% were giant aneurysms >10 mm. 6.7% (4/60) were complicated with thromboembolism during procedure and immediate recanalization was achieved with chemical treatment in 3 of them and both mechanical and chemical treatment in 1 of them. 1 patient suffered from intracranial hemorrhage due to clopidogrel overdose. 25% cases noted spasm during procedure and were treated with chemical angioplasty. 30-day mortality was 3.3% (2/60) and rebleeding rate was 1.6%. Obliteration rates in 6 months, 1 year and 2 year were 55%, 70% and 70% respectively. There was no aneurysm progression or recurrence after pipeline placement noted. Aneurysms along posterior circulation had statistically significant association with higher recurrence rate (p = 0.005) after PED placement.

Conclusion: PED placement is a reasonably safe and effective treatment for intracranial aneurysms especially those with unfavorable morphologic features, such as wide neck, large size, and fusiform morphology.
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Treatment of Bleeding Dissecting Aneurysms – Cases Illustration
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Purpose: Acute dissecting aneurysms are prone to rebleed. Surgical reconstruction is difficult and sometimes ends up in disasters due to the poor anatomical integrity of artery wall. Proximal occlusion of parent artery after testing balloon occlusion and flow reversal has been tried before. The failure to occlude the diseased segment may lead to rerupture of the aneurysm. Embolization occlusion of the aneurysm together with the parent artery provides the definitive treatment to protect from rebleeding albeit the risk of distal territory ischemia. With the availability of flow divertor, this offers a chance to tackle the problem with a reconstructive strategy. There is some success in using flow divertor to treat vertebral basilar dissecting aneurysms and anterior circulation dissecting aneurysms as well. The use of antiplatelet has to take into consideration the rebleeding risk and stent-related thromboembolic risk.

Case 1
A 38-yr-old lady found collapse in bus, was taken to the Emergency Department, suffering from seizure. CT scan showed acute subarachnoid hemorrhage and intraventricular hemorrhage. CT angiogram showed 5 mm aneurysmal dilatation of distal left VA, compatible with ruptured dissecting aneurysm. In view of dominance of left VA, pipeline flow divertor was placed in L VA the following day. She recovered well after the vasospasm was over. Control CTA showed patent L VA and AICA-PICA artery.

Case 2
A 60-yr-old lady was taken to Emergency Department after collapse. She regained semi-consciousness on arrival. CT scan showed acute subarachnoid hemorrhage. CT angiogram showed some irregularity of supraclinoid right ICA. DSA revealed a mild focal dilatation of right ICA. Early CTA on D3 showed progression of the diseased segment. Pipeline flow divertor was placed across the focal dissection on D4. However, it was complicated by acute stent thrombosis which was recanalized by iv and ia abciximab. She suffered diffuse cerebral vasospasm. Control DSA showed further progression of the dissection and a second Pipeline flow divertor was placed inside the first one. Control CTA showed healed R ICA dissection.

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Comparison of Enterprise with Neuroform Stent-Assisted Coil Embolization of Unruptured Wide Neck Aneurysms in Internal Carotid Artery: a Single Center Study
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Purpose: The Enterprise and Neuroform stents are the most well used two self-expandable stents in stent-assisted coil embolization (SACE). Comparative knowledge about technical feasibility, peri-and post procedural complications as well as follow-up data is limited in using these two different stents in treating distal internal carotid artery (ICA) aneurysm under SACE. differed stent design would yield difference results. Comparisons of technical and complications of deploying two different stent designs in performing SACE of distal ICA aneurysm were done.

Methods: We enrolled 237 patients with 244 aneurysms: 82 cases with an open-cell stent (Neuroform) and 164 cases with a close-cell stent (Enterprise), starting from January 2005 and June 2014. A single stent was placed in ICA segment, including carotid siphon, unruptured aneurysm with clinical and image follow-up s were done within 30 days, one-year and above 1 year after the embolization Stent-assisted coil embolization using more than one stent, stent deployment only and patients with no record of at least 1 year of image and clinical data were excluded. Baseline characteristics, peri-and post procedural (one year and over one year) complications were compared.

Results: Baseline characteirstics of open cell (Neuroform) and close cell (Enterprise) groups showed no difference. Peri-procedural complication events were frequent in Enterprise group. (27% vs. 12%, p = 0.013). Asymptomatic diffusion positive lesions were much higher in close cell group. (24% vs. 11%, p = 0.017) Within the peri-procedural complication There were no significant difference in delayed infarction, in-stent stenosis, hemorrhagic complications and recanalization in either group in 1-year and over 1-year follow-up. However, the Enterprise stent group had a tendency of delayed infarction and in-stent stenosis after 1 year of deployment.

Conclusion: There were significantly lower peri-procedural event and complication recurrence after 1 year of procedure in Neuroform. One the basis of the finding, Neuroform stent could be preferred when considering stent-assisted coil embolization of aneurysm in internal carotid artery.

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Relationship Between MR-DWI-Positive Lesions and Symptomatic Ischemic Complications After Coiling of Ruptured Intracranial Aneurysms

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Purpose: The aims of this study were to evaluate the risk factors for developing symptomatic ischemic complication (SIC, transient ischemic attack or stroke) and microembolism detected as Magnetic resonance diffusion-weighted imaging positive (DWI positive) lesions in coiling of ruptured intracranial aneurysms. Plus, relationship between each factor and modified Rankin Scale (mRS) after 3 month was studied.

Methods: From March 2010 and to March 2013, forty two subarachnoid hemorrhage patients with ruptured intracranial aneurysm underwent both coiling and postoperative Magnetic resonance diffusion-weighted imaging (MR-DWI). The incidence and risk factors for SIC and DWI positive were retrospectively analyzed. The relationships between 3-month mRS and DWI positive or SIC were also analyzed.

Result: The incidence of DWI positive was 50%. There is no big difference from incidence of unruptured aneurysm (54.5%). The incidence of SIC was 9.5% (4/42). Patients aged older than 65 years have a tendency for SIC (p=0.011). Patients with SIC appeared unfavorable 3 month mRS (mRS 3~6, p=0.032).

Conclusion: Conclusion – When endovascular surgeon tries coil embolization to ruptured intracranial aneurysm, should try to reduce the occurrence of SIC, particularly in patients older than 65 years old.

References

**Purpose:** Several patients have experienced the recurrence after coiling or clipping of aneurysms. Practical application of computational fluid dynamic (CFD) analysis was limited due to complexity in long processing time. Therefore, we attempted to identify hemodynamic factors related to the recurrence of treated intracranial aneurysm by using recently developed test version.

**Methods:** Six patients with recurred aneurysm were identified in our database for further CFD analysis. The patient-specific recurred aneurysm models were reconstructed from 3D digital subtraction angiographic images acquired during follow-up. The virtual models of occluded aneurysms were generated by manually removing the recurred aneurysm from the parent artery. CFD analysis was performed using an integrated CFD research platform (Siemens Healthcare GmbH) for pre-processing and simulation. For each aneurysm case, the CFD results from recurred and virtually occluded aneurysm model were visualized in Paraview 3.0 (Kitware, Sandia National Labs and CSimSoft) and compared in a side-by-side view. Two experienced observers independently reviewed and compared the hemodynamic features (WSS, pressure, velocity) of two datasets in each patient.

**Results:** We obtained complete set of data in 6 patients. It took 20 minutes in obtaining whole data sets for the successfully applicable cases. Slightly increased WSS and pressure and no significant change of velocity were identified near the neck of the recurred aneurysm. The Cohen’s kappa values were 1.00, 0.71 and 0.33 for WSS, pressure and velocity.

**Conclusion:** The preliminary CFD analysis with a new test version indicated that slightly increased WSS and pressure could be observed near the neck of the recurred aneurysm in relatively short processing time. Application of such results warrants further study in a larger patient population.

**Preoperative Three-Dimensional Angiographic Evaluation of Middle Cerebral Artery Trunk Aneurysms: Successful Demonstration of the Close Relationship between the Early Frontal Cortical Branches and Lateral Lenticulostrate Arteries**

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**Purpose:** Understanding the anatomic relationship between the aneurysm, branching vessels, and the lenticulostrate arteries (LSAs) is important for the treatment planning of a patient with the middle cerebral artery (MCA) trunk aneurysm. We aimed to demonstrate the branching-vessel anatomy related to the MCA trunk aneurysm using three-dimensional (3D) angiography.

**Methods:** We retrospectively reviewed 3D angiographic findings of 64 cases of MCA trunk aneurysm using 3D workstation with various post-processing conditions. We classified the aneurysms into 4 groups (early frontal cortical branch (EFCB) aneurysm, early temporal cortical branch (ETCB) aneurysm, LSA aneurysm, non-branching aneurysm) and analyzed the relationship between the branching vessels and the LSAs.

**Results:** There were 30 EFCB aneurysms, 25 ETCB aneurysms, seven LSA aneurysms and two non-branching aneurysms. Twenty-six (86%) of the 30 EFCB aneurysms, in contrast to none of the 25 ETCB aneurysms, were associated with the LSAs, and shared common origins.

**Conclusion:** With 3D angiography, we were able to classify the MCA trunk aneurysms and identify clinically important anatomic relationship between the aneurysm and branching vessels including the LSAs. EFCB aneurysms showed a close relationship with the LSAs, in contrast to the ETCB aneurysms, pre-treatment identification of the origin of LSAs is important to obviate any perforator injury in EFCB aneurysms.
and symptomatic parent artery stenosis was present in 1 case.  

Conclusion: TFD was safe to use in this series. The occlusion rate was higher with respect to the previous reports using the non-tapered version. TFD may be preferred especially for aneurysms in the paraophthalmic region.

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The Role of Closed Cell Stents in the Treatment of Blood Blister-Like Aneurysms: A Brazilian Single Center Experience

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Purpose: Blood blister-like aneurysms (BBAs) are arterial lesions from non-branching sites, located mainly on the ophthalmic internal carotid artery (ICA), and with uncertain behavior. Our goal is to describe the experience of a single center of Brazil, especially with closed cell (not flow diverters) stents, in the management of these lesions.

Methods: We performed a retrospective analysis from medical records of 12 consecutive patients diagnosed with BBAs and undergoing treatment between December/09 and July/14 in our service. Four patients were treated with flow diverter stents (FDS), seven patients with some closed cell stent, and one with stent-assisted coiling (after frustrated attempt to clipping). The main parameters analyzed were aneurysms site, time from bleeding to the treatment, rebleeding, and occlusion rate at 3 and 6 months.

Results: In our series, there was a predominance of female patients (75%) and the average age was 48.7 years. The main localization of the aneurysms was the supraclinoid internal carotid artery (83.3%). The average time between bleeding and treatment was 11.3 days. We observed a low rebleeding rate, compared to the literature (16.7%). The occlusion rate at 3 months in the cases treated with closed cell stents was 85.7%, the same observed in patients treated with FDS.

Conclusions: In our series the use of closed-cell stents proved to be safe and effective, with occlusion rates similar to those with FDS. In locations with a high density of perforating vessels (as basilar and middle cerebral arteries), closed cell stents appear as a safer alternative to the use of FDS.

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Tips and Tricks Using the Surpass Flow Diverter (SFD): Giant Aneurysm with Complex Carotid Accesses

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Purpose: The new generation endo-luminal device SFD was developed as other flow diverter devices (FDD) to reconstruct parent artery and exclude cerebral aneurysm. Until present the median maximum diameter (MMD) of this vascular pathology treated by the SFD according to the literature is 7.2 mm. We present our prospective clinical and angiographic single-center experience in giant aneurysm with a MMD of 20.4 mm and complex access treated by the FDS, considering technical tips to succeed during procedures.

Materials: Twenty-six (26) patients with a range of complex giant ruptured and un-ruptured aneurysms and complex accesses were treated between May 2014 and May 2015 with the SFD. Clinical and angiographic follow-up were performed at 1 and 3 months. Data were prospectively collected mainly centered in the different materials, techniques and anatomical consideration to improve procedures safety considering this is the only over the wire FDS available in the market.

Results: Twenty-six PATIENTS (26) (mean age, 65 years; range, 32–84), harboring 7 ruptured and 19 unruptured aneurysms were treated at our center. All patients were treated with a single device. Successful delivery of the device was achieved in all patients. In this central population of giant aneurysm no major peri-procedural morbidity or mortality was observed. During follow-up, no patient experienced transient or permanent neurological deficit. Nine patients had neurological symptoms related to their aneurysm and 7 showed improvement of these symptoms during follow-up (mainly ocular nerve palsy). At 3-month follow-up, 25 of 26 aneurysms showed a complete occlusion. In all cases tri-axial system was used, characterized by a 7 Fr carotid sheath, an intermediary catheter (DAC) an a micro-catheter after replaced by a 14 or 16 inches 300 cm length guide-wire. In 11 cases intra-cerebral balloon was anchored in the medial cerebral artery to rectified guide-wire loops. In 9 cases it was necessary to advance the DAC into intracranial internal carotid artery to perform the delivery.

Conclusions: SFD stents showed high safety and efficacy profile as a new generation FDD in treatment of giant and complex intracranial aneurysms even with challenging carotid access.

References


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Flow Diverter Devices in Ruptured Intracranial Aneurysms: A Single Center Experience

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Purpose: In this single center series, we retrospectively evaluate the effectiveness and the mid-term follow-up of ruptured aneurysms treated by implantation of flow diverter device.

Methods: We retrospectively reviewed 15 patients (11 F 4 M) with subarachnoid hemorrhage due to a ruptured intracranial aneurysm which were treated with flow diverter device. Of fifteen ruptured aneurysm, eight were blood blister-like aneurysm and the remaining seven were dissecting/fusiform. Average time between subarachnoid hemorrhage and the treatment was 3,7 days. Intra/peri-procedural morbidity and mortality was recorded. Clinical follow-up and angiographic follow-up were carried between 6 and 12 month from the procedure.

Results: None of the ruptured aneurysm rebleed after the endovascular treatment. Overall mortality was 13% (2/15); two patients died after few days because of complications of the SAH. Overall morbidity was 6%; one patient experienced an intraparenchymal bleeding during the positioning of an external ventricular drainage. During the endovascular procedure, 3 adverse events without clinical sequelae occurred. Angiographic follow-up shows a complete occlusion of the aneurysm in 10 of 13 surviving patients; one patient shows a remnant of the aneurysm, one patient was retreated due to an enlargement of the aneurysm, one patient was lost at the mid-term follow-up.

Conclusion: Flow diverter device can be utilized as last choice in patient with ruptured aneurysm, like blood blister-like and dissecting type, in which conventional neurosurgical or endovascular treatments can be challenging.

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Tasmanian Experience with Aneurysms

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Purpose: In the era where imaging is increasingly identifying smaller aneurysms due to its improving quality, the results of ISUIA are coming into question. In the face of the recommendation that small (<7 mm) aneurysms have a low rupture rate we analysed the Tasmanian population for size and location of intracranial aneurysms.

Methods: 4 years of retrospective data was collected for all aneurysms treated at the Royal Hobart Hospital, the only centre for neurosurgery in Tasmania (population around 500,000). During the period all cases, encompassing both ruptured and non-ruptured aneurysms treated both surgically and endovascularly were included. Data was collected on rupture, grade, aneurysm size and location and method of treatment.

Results: 175 cases were identified during the time period investigated. 103 (59%) cases were incidental/unruptured aneurysms. >90% of the ruptured aneurysms were in the anterior circulation. Two thirds of posterior circulation aneurysms were incidental findings. 65% of the ruptured anterior circulation aneurysms were less than 7 mm. The mean size of anterior ruptured aneurysms was 6.36 (±4.48) mm. The mean size of posterior ruptured aneurysms was 8.08 (±3.93) mm. In the unruptured categories, the mean for anterior and posterior aneurysms was 5.5 (±3.60) mm and 5.61 (±2.61) mm respectively. There was only 1 in each of the following categories: large ruptured, large unruptured, giant ruptured, giant unruptured aneurysms.

Conclusion: The remote geography of Tasmania allows a unique population analysis of intracranial aneurysms. While the natural history of unruptured aneurysms remains incomplete, it appears the paradigms of ISUIA need to be carefully considered.

References


Purpose: Endovascular treatment of wide neck brain aneurysms can be very challenging, particularly wide-neck bifurcation intracranial aneurysms. WEB is an intrasaccular flow disruption device, placed within the aneurysm pouch, creating a flow stasis with subsequent thrombosis. The first double layer version of the WEB devices presented some troubles in its feasibility with a not negligible rate of recurrence. We report our experience with both versions, double layer and single layer, of the WEB device.

Methods: Since June 2012, 14 patients with 14 brain unruptured aneurysms were treated at our institution using WEB devices. The former 2/14 aneurysms were treated using the double layer version of the WEB device. The latter 12/14 ones were treated with the new single-layer version. All treated aneurysms were unruptured. Seven out of 14 aneurysms were located at MCA bifurcation (6 small; 1 large recurrent aneurysm, already treated twice with coiling), 2/14 at Acomm bifurcation (1 small, 1 medium), 4/14 at intracranial carotid bifurcation (2 medium, 2 small), 1/10 basilar tip (small). Follow-up was performed by MRI at one month and single layer, of the WEB device.

Results: All treatments were performed without any procedural and post-procedural complication. Follow-up showed recurrence in 1/14 aneurysm. This case, successfully retreated with p-Conus device, will be discussed. It referred to the first case in our experience and, as previously mentioned, it was performed with a double layer WEB device.

Conclusions: According to our preliminary experience, despite some troubles during first treatment, WEB endovascular device revealed safe and feasible. Feasibility improved using single layer device that looked softer and more reliable than the stiffer double layer one. To obtain optimal results, the importance of initial measurements has to be stressed.
Conclusion: Our clinical experience in the treatment of complex cerebral aneurysms with flow diverting stent (Pipeline) has shown to be effective with a low morbidity and no significant permanent neurological complication. Patients with complex aneurysms which are not candidates for regular stent and coil embolization can benefit in a safe and effective way with treatment of flow diverting stent (Pipeline).

References

Flow Diverter Treatment for Recurrence After Stent Assisted Coil Embolization of Intracranial Aneurysms

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Purpose: To show efficacy and safety of Flow Diverter (FD) treatment for recurrence after stent assisted coil embolization of intracranial aneurysms (AN).

Methods: Since 2008, we introduced neck bridge stent assisted coil embolization (SACE) for wide neck intracranial ANs. We experienced about 2.5% recurrence of 450 SACE and mainly repeat endovascular treatment is effective. We introduced FD for 3 cases of recurrence after second treatment of recurrent intracranial ANs, treated with SACE.

Results: All 5 cases treated with Surpass Flowdiverting Stent. One is ruptured vertebral dissecting AN, Second is unruptured ICA AN, treated with SACE followed by SAH. Third is unruptured ICA AN, treated with SACE and has rapidly recurrence. All 3 cases were successfully treated with FD without any complication and additional recurrence.

Conclusion: FD treatment is one of choice for recurrence after SACE.

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Technical Aspects and Clinical and Radiographical Results of Endovascular Coiling of Aneurysm with a Brunch Arising From the Sac

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Purpose: Aneurysms with a branch arising from the sac have been thought to be contraindication for endovascular embolization. In such cases, there is major risk of occluding the branch during the procedure, and consequently, incomplete aneurysm occlusion increase. The purpose of this study is to evaluate the techniques and long-term clinical and radiographic outcomes of coiling for aneurysms with branch arising from the sac.

Methods: Sixty patients with 60 aneurysms with a branch arising from the sac (28 ruptured, 32 unruptured) were retrospectively reviewed and evaluated. There were 49 women and 11 men (mean age, 65.1 years). Location of the aneurysms were the anterior cerebral artery in 2 (3.3%), the middle cerebral artery in 10 (16.7%), the anterior choroidal artery in 10 (16.7%), posterior communicating artery in 21 (35%), ophthalmic artery in 2 (3.3%), basilar artery-superior cerebellar artery in 9 (15%), vertebral artery-posterior inferior cerebellar artery in 6 (10%). Twenty-six procedures were performed by using a single catheter; 20, by double catheter; 9, by balloon remodeling; 2, by stent assisted; and 3, by balloon and double catheter techniques.

Results: Periprocedural complications occurred in 2 cases, including 2 thromboembolic events (incorporated branch occlusion and embolic infarction). Forty-eight of the 60 aneurysms were followed-up more than 6 months after embolization, of which 39 showed stable or improved occlusion; 5, minor recurrence; and 4, major recurrence. Major recurrence is found more often in large, IC-PC aneurysm.

Conclusion: The double catheter technique was very useful to preserve a branch arising from sac, and 3D complex shape coils, especially inner direction coils were effective for a framing coil. Coiling of aneurysms with a branch arising from the sac could be performed safely with acceptable clinical and radiographic outcomes.

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During Waffle Cone Technique in Management of Wide Neck Aneurysm, Stent Migration into Cerebral Aneurysm

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**Purpose:** Stent-assisted coil embolization (SACE) is a common method to manage intracranial wide-neck aneurysm. Using waffle cone technique, a stent must be successfully deployed into the parent artery to cross the aneurysm neck. Sometimes, we meet unexpected complications. We describe the complication case that during waffle cone technique in management of wide neck basilar tip aneurysm, stent migration into aneurysmal sac.

**Methods:** A 40-year-old woman presented with severe headache, drowsy mentality. Brain computed tomography revealed all cisternal subarachnoid hemorrhage (SAH). DSA revealed giant basilar tip aneurysm. We determined to treat by waffle cone technique in endovascular treatment.

**Results:** During the waffle cone technique using Enterprise stent, there was stent migration into aneurysmal sac. But, fortunately we noticed early. Then, we deployed coils aneurysmal sac and in stent portion into sac. The procedure. That procedure has ended satisfactorily.

**Conclusion:** It is sometimes meet the complication of intra-procedural distal stent migration. In waffle cone technique, there is required special attention this is because the risk of rupture. If the rest of the treatment as soon recognized because it is not particularly difficult, always requires careful attention.

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**Experiences of Using HydroGel Coil in Small Aneurysms: Procedural Safety, Treatment Efficacy and Tips for Complete Occlusion**

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**Purpose:** In most endovascular therapy centers, ordinary pure platinum coils have been used for intra-cerebral aneurysmal endovascular therapy. To prevent a recurrence after the therapy, recently we use a HydroGel-frame coil called Hydro-Frame as the first coil of the embolization for intra-cerebral aneurysms of more than 5 mm size. In addition to that, after the improvement of detaching system called Advanced Detach System, we are able to use this Hydro-frame coil for aneurysms of less than 4 mm size. This presentation discusses some advantages and problems of this HydroGel Coil from our experiences.

**Methods:** I would like to present a few cases of neuroendovascular therapy with HydroGel Coil, and consider the effectiveness and diversity of them.

eg. 56 y/o female with un-ruptured IC-PC AN of 4 mm, 62 y/o female with Acom AN of 3.21 mm × 2.26 mm, and 74 y/o female with SAH case due to ruptured Acom aneurysm.

**Conclusion:** The HydroGel Coil with new detaching system is able to be smoothly delivered and detached immediately with good performance, therefore it will effectively provide easy-to-perform endovascular operations for various sizes of intra-cerebral aneurysms.

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**Comparison of Efficacy of Assisted Coiling Techniques in Endovascular Treatment of Cerebral Aneurysms of Anterior Circulation**

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**Methods:** 687 patients underwent endovascular treatment for cerebral aneurysms in our department since 01.2011 to 12.2014. In 579 (84.4%) of them, the aneurysms were located in anterior circulation.

**Results:** Since 01.2011 to 12.2013 n = 409 patients were treated; n = 146 (36.7%) operated using assisting techniques: The first group n = 68 /146 (46.6%) - balloon assistance, the second group n = 66 /146 (45.2%) - stent assistance, the third group n = 12 /146 (8.2%) - both techniques simultaneously. Comparison of long-term outcomes in all groups revealed significant decrease of recanalization rates in second and third groups. According to that, stent-assisted and combined technique became the preferred treatment strategy in our department.

Since 01.2014 to 12.2014 n = 170 patients were operated. In n = 87 (49.5%) of them, assisting techniques were used: n = 24 /170 (33.3%) - balloon assistance, n = 42 (50.0%) - stent assistance, n = 14 (16.7%) - combined technique. Analysis of short-term results demonstrates remarkable switch of the spectrum of performed procedures towards utilization of stent-assisted and combined techniques.

**Conclusion:** Both balloon- and stent-assistance are useful for treatment of wide-necked cerebral aneurysms. Balloon-assistance allows more dense packing of coils inside the aneurysm, while stent creates the frame for future endothelium growth over the ostium of the aneurysm, which significantly decrease the recanalization rates from the report.

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**Direct Puncture of Vertebral Artery Pseudoaneurysm for Parent Artery Occlusion in Patient with Neurofibromatosis Type 1**

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**Purpose:** Pseudoaneurysms of the cervical part of vertebral artery (VA) are uncommon lesions that may be induced by trauma, dissection, or rarely infection or even neurofibromatosis. Endovascular treatment is becoming a method of choice in such cases.

**Case Report**
A 47-year-old woman presented to the emergency room with acute onset of headache, vomiting and neck pain.
The clinical history revealed a neurofibromatosis type 1 but with no previous problems affecting neck or extremities. On physical examination there was a pulsatile mass in the left posterior suboccipital region. Neurologic examination showed a mild weakness of the right upper extremity and intact cranial nerves. Diagnostic imaging showed a large pseudo-aneurysm in V3 segment with surrounding hemathoma that compressed spinal cord. Since it was a ruptured aneurysm, we decided to do the parent artery occlusion. Attempt to catheterize the distal part of left VA failed, so just proximal part occlusion with coils was performed. Patient improved clinically, but after few days subocipital mass started to grow again due to retrograde filling of the aneurysm and string fistulous flow into cervical veins.

A decision was made to perform a direct percutaneous puncture of pseudoaneurysm and occlude parent artery. Under US guidance Seldinger needle has been placed into the aneurysm sack pointing to the distal ostium of aneurysm. Distal part of left VA was catheterised and occluded with GDC coils. Three month follow up arteriogram revealed occluded V 4 segment, thrombosed pseudoaneurysm and normal flow in to basilar artery. All symptoms improved and hemathoma diminished.

Conclusion: Direct percutaneous puncture and embolization has been practiced in treatment of variety of head and neck diseases, including tumors and arteriovenous malformations. To our knowledge, however, a direct percutaneous puncture of aneurysm and subsequent parent artery occlusion of vertebral artery has not been reported and published until now.

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Complete Spontaneous Thrombosis of an Unruptured Anterior Communicating Artery Aneurysm After Partial Clipping

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Purpose: Complete spontaneous thrombosis of saccular aneurysms is a rare event that can be discovered incidentally.

Summary of Case
In this case report, the author described a woman who has an unruptured anterior communicating artery (AcoA) aneurysm incidentally in MR angiography. Cerebral angiography revealed a bilobulated saccular aneurysm at AcoA. She received operation with clip ligation but partial clipping was done. After 4 years, she visited to our hospital for follow-up. We performed conventional angiography and found complete obliteration of residual aneurysm suspected to spontaneous thrombosis. Aneurysm shape is very important feature which is narrow, long neck of the aneurysm. Also, systemic condition was affected such as hypotension, anti-fibrinolytic agent, and thrombogenic potential of non-ionic contrast media.

Conclusion: Recanalization of spontaneously thrombosed aneurysm due to combine clot organization and clot retraction can occur. Repeat follow-up imaging study is very important.

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Transvenous Stenting of Sigmoid Venous Varix for Treatment of Pulsatile Tinnitus

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Purpose: To present a new application of stenting in the treatment of venous disease. To review a case of pulsatile tinnitus and discuss its treatment and outcome utilizing modern stenting technology.

Methods: We present a case of a patient treated by transvenous stenting for the treatment of a venous varix or diverticulum in the sigmoid sinus and describe the technique as well as outcome of the case. To this date, intracranial angioplasty and stent deployment has been used in the treatment of dural arteriovenous fistulas and multiple reports have been described in the literature (Levrier et al 2006, Liebig et al 2005, Malek et al 1999, Murphy et al 2000).

Results: We will review the technique of these treatments and discuss intracranial transvenous treatments of other venous pathologies within the neural axis.

Conclusion: We present the case of a patient with pulsatile tinnitus related to a dural venous varix successfully treated with transvenous stenting and will review other described applications of transvenous stenting in the literature.

References
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Low Recanalization Rate in PCONus Assisted Coiling

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Purpose: Here we report our experience of follow-up for intracranial aneurysm treated by stent assisted coiling, using the pCONus device.

Methods: From May 2013 to May 2015 we treated 10 patients (range of age 33–69 years) with intracranial aneurysms (1 at the basilar top, 3 at A1-A2 bifurcation, 6 at M1-M2 bifurcation) using the pCONus device and coils. 5 patients have 5 unruptured aneurysms; the other 5 patients had SAH (Sub-Arachnoid Haemorrhage) and they were treated from 15 hours to 15 days after the bleeding. Antiplatelet therapy followed the procedure. 9 of 10 patients underwent follow-up, as usual in our department, doing Contrast Enhanced MR-angiography (CEMRA) at 6 months and Digital Subtraction Angiography (DSA) at 1 year.

Results: At the follow-up, in all cases, we observed the stent and the vessels patency and the exclusion of the aneurysms; only in 1 case we decided to leave a basal remnant to preserve a branch arising from the neck of the aneurysm, and the remnant did not increase till now.

Conclusion: Complex aneurysms often require complex assisted coilings technique with one or more balloons or stents, increasing the procedural risks; in selected case, with favourable geometry of the vessels, the pCONus stent alone improves the coiling creating something like a “barrier” to migration or protrusion of coils during the procedure, even if wide necked aneurysms; it makes possible a stable cast of coils. This may be the answer to this very good outcome at follow-up for this short series of patients; the follow-up will go on, so these are just preliminary data.

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Embolization of Intracranial Aneurysm Performed by Carotid Puncture and Hemostatic Closure of the Puncture Site in the Carotid Artery

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Purpose: We would like to report embolization of intracranial carotid aneurysm by puncture of the common carotid artery in the neck, and hemostasis in the puncture site after the procedure.

Summary of case: A patient post heart transplantation with residual aortic dissection in the thoracic descending aorta, abdominal aorta and left common iliac artery has a left supraclinoid internal carotid aneurysm. Femoral approach cannot be performed safely without damage to the aorta because of presence of residual dissection. Embolization was performed under general anesthesia. We punctured the left common carotid artery in the lower neck in proper location and direction so that the catheter can enter the internal carotid artery without difficult. We placed a 5-French short sheath at the puncture site. A 5-French guiding catheter was placed in the high cervical internal carotid artery. After implanted an Enterprise stent, coiling was performed by a microcather selectively placed inside the aneurysm. One of the difficulty is how to do hemostasis after removing the catheter and sheath in this patient who was under dual antiplatelet pre-medication and heparinization during the procedure. An Angio-seal vascular closure device was used for hemostasis. Before using it, we injected sterile saline in the soft tissue of neck to increase thickness of neck to ensure the entire collagen of the Angio-seal device was placed inside the soft tissue of neck without protruding outside of the skin. At the end of the procedure, hemostasis was achieved without problem using Angio-seal device and described technique.

Conclusion: Embolization of intracranial aneurysm can be performed by carotid puncture and hemostasis can be successfully achieved after the embolization.

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A Case of Subarachnoid Hemorrhage from De Novo Anterior Communicating Aneurysm: Analysis by CFD Technology

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Purpose: Several reports described relationship between de novo aneurysms and hemodynamic change after mechanical injury on parent artery by clipping for the initial aneurysm. However CFD analysis of de novo aneurysm developed very close to initial ruptured aneurysm performed coil embolization is rare.

Methods: We report a 42-year-old male with subarachnoid hemorrhage caused by ruptured anterior communicating aneurysm that performed coil embolization by simple technique. Four years later, he developed second subarachnoid hemorrhage caused by ruptured de novo aneurysm located on another site of anterior communicating artery. We performed coil embolization for his ruptured second aneurysm, but it was re-ruptured again after three weeks later. Digital subtraction angiography demonstrated the aneurysm had coil compaction, so the aneurysm was clipped consecutively.
Results: We examined the features on vessel site of de novo aneurysm occurred and rupture point of the aneurysm using computational fluid dynamics (CFD) technology. CFD results compared before and after initial coil embolization suggested that de novo aneurysm’s orifice had high WSS vector variant degree consistently. And the results also showed that the flow pattern on a rupture point of de novo aneurysm on a cardiac cycle had changed characteristically.

Conclusion: Results of CFD analysis demonstrated that the site of having high WSS vector variant degree which reflects hemodynamic instability had tendency to develop a de novo aneurysm. CFD technology has possibility to detect de novo aneurysms, and in cases with obvious changes in the CFD factors after not only clipping but also coiling, long term follow up was strongly recommended.

Analysis of Perioperative Complication Risks Associated with Stent-Assisted Coil Embolization

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Purpose: This study was conducted to clarify risk factors of perioperative complications associated with stent-assisted coil embolization.

Methods: We retrospectively reviewed all cases of cerebral aneurysms treated with coiling at our neuro-endovascular team’s affiliated hospitals between October 2010 and November 2014. Totally 398 cases consisting of 241 unruptured (stent usage: 34.4%) and 157 ruptured cases (stent usage: 15.3%) were reviewed. Patient outcomes were assessed with the occurrence of procedure-related complications during 30 days following coiling, including transient ischemic and asymptomatic hemorrhagic events, and in-stent thrombosis if counter-measures needed. Multiple regression analysis was performed by using the following factors as independent variables; Sex, Age, Aneurysm location (middle cerebral artery or not), Hospitals (full time or part time), Rupture or not, Stent used or not.

Results: Perioperative complications were observed by 13.1% in cases with stent assistance, and 5.2% without stent assistance. Multiple regression analysis revealed that stent-assistance was significantly associated with perioperative complications (p = 0.0073). Morbi-mortality rates were 1.03% with stent assistance and 0.78% without stent assistance, showing no statistically significant difference.

Conclusion: Results of CFD analysis demonstrated that the site of having high WSS vector variant degree which reflects hemodynamic instability had tendency to develop a de novo aneurysm. CFD technology has possibility to detect de novo aneurysms, and in cases with obvious changes in the CFD factors after not only clipping but also coiling, long term follow up was strongly recommended.

Presentation withdrawn

Cavernous ICA Aneurysms: Unpredicted Results of Endovascular Treatment in Siriraj Hospital

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Purpose: 2–9% of intracranial aneurysms is cavernous ICA (Internal carotid artery) aneurysm or CIA. Nowadays, natural history of cavernous sinus is still unpredictable. However, many institutions have reports about benign natural history of these type of aneurysms, or low risk of complication. The treatment may be not necessary. The purpose of this study is to evaluate final result of example cases of CIA.

Methods: Four cases of CIA, from total 636 aneurysms in 497 patients between 1997–2013 at Siriraj Hospital, Bangkok, Thailand were retrospectively reviewed. The results of each CIA cases were described.

Results: 2/4 cases had spontaneous resolution of CIA but parent ICA was occluded in one of the case but another case the ICA was preserved during follow up. One case presented with incomplete right third cranial nerve palsy with findings of CIA in the first MRI but there is no evidence of aneurysm in cerebral angiogram. Annual MRI follow up shows progressive enlargement of the aneurysm with stable in symptom. The last case presented with left ptosis. We decided to use flow-divertor, however, the aneurysm still increase in size even there was evidence of complete thrombosis in the aneurysm.

Conclusion: Most of our CIA showed benign result without serious complication. But sometimes the result end up with enlargement of the lesion even treatment or not. The natural history of the CIA is still misery and large series of CIA should be done to make sure which is the best management for them.
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Dynamic Morphological Change of Cavernous Internal Carotid Artery Aneurysmal Vasculopathy: is it Predictable?

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Purpose: Unruptured cavernous internal carotid artery aneurysm (CIA) was accounted for 2–9% of intracranial aneurysms. Its natural history is still unpredictable. The purpose of this study is to evaluate the outcome of CIA after the aneurysmal sac was obliterated.

Methods: From total 636 aneurysms in 497 patients between 1997–2013 at Siriraj Hospital, Bangkok, Thailand, there were 42 CIA with mean size about 13.75 mm. A retrospective review of 4 CIA who had aneurysmal sac obliteration was performed.

Result: Of 4 patients, there were two females, with means age at 66.5 year-old (ranging from 41 to 78) All presented with compressive effect to cranial nerve. Three of four had partially thrombosis on first imaging. Among 3 patients who had spontaneous obliteration of the aneurysmal sac, 1 had ICA occlusion, 1 had progressive enlargement of the thrombus even no residual aneurysmal sac. The other one patient who had flow diverter, had both recanalization of the aneurysmal sac and progressive enlarged thrombus. Symptoms resolved in two patients, whereas persistent symptoms in the others.

Conclusion: Obliteration of an aneurysmal lumen in CIA does not always mean cessation of the ongoing process, and the symptom may not resolved. Thus endoluminal reconstruction of a CIA is a decision-making challenge, particularly in patient with unruptured status.

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Ruptured Intracranial Vertebral Artery Dissecting Aneurysms: an Evaluation of Prognostic Factors of Treatment Outcome

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Purpose: Intracranial spontaneous vertebral artery (VA) dissecting aneurysms could present with haemorrhage or thromboembolic events. In patients who presented with haemorrhage carried a risk of recurrent bleeding about 70% and mortality rate about 8.3%. Even no standard recommendation for treatment of dissecting VA aneurysms, but simple endovascular procedure with parent vessel occlusion have shown results of good treatment outcome. Reconstructive techniques such as stent-assisted coiling embolization have been also effective, particularly, in the parent vessel that might not be sacrificed. The purpose of this paper is to analyse the prognostic factors of good treatment outcome in patients with ruptured intracranial VA dissecting aneurysms.

Methods: A total of 26 patients with VA dissecting aneurysms who were treated at Siriraj hospital, during 2008 to 2014 were retrospective reviewed. Parent VA sacrificed was the initial treatment option, if it was possible, for the ruptured aneurysms. Endovascular reconstructive treatment was indicated in ipsilateral dominant VA or PICA involvement. Favourable outcome was determined by using a modified Rankin score (mRS = 0–2). Statistical significance was taken as P-value < 0.05.

Results: There were 17 patients who had aneurysmal ruptured, 53% were female, with the mean age of 52.7 years. Parent VA sacrifice and VA reconstruction were each equal at 41% whereas conservative treatment at 18%. The good clinical outcome was found at 61.1%. The mortality rate was 17.6%. The favourable outcome were associated with initial Hunt and Hess grading (65%), mild GCS (65%) and the total occlusion of aneurysms after treatment (65%).

Conclusion: The good prognostic factors in patients with ruptured intracranial VA dissecting aneurysms were initial Hunt and Hess grading, mild GCS and total occlusion of aneurysms after treatment. We recommend endovascular parent vessel sacrifice to be the first option for treatment ruptured vertebral artery dissecting aneurysm.

References


399 Presentation withdrawn

**Clinical Results of Endovascular Trapping for Consecutive 11 Patients with Ruptured Vertebral Artery Dissecting Aneurysms Involved Posterior Inferior Cerebellar Artery**

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**Purpose:** In endovascular trapping for ruptured vertebral artery dissecting aneurysm (rVADA) involved posterior inferior cerebellar artery (PICA), were either partial trapping or the sacrifice of PICA acceptable? We hereby report the clinical results of treatment that made use of the endovascular trapping with or without the sacrifice of PICA.

**Methods:** We totally experienced 61 cases of rVADA from 2000 to 2014. 11 cases of the PICA involved type were treated by endovascular trapping with coils with or without the sacrifice of PICA. All patients received full dose heparin against thromboembolic events during procedures only, and the effect was neutralize naturally.

**Results:** Patient’s background: mean age = 49.3, Male: female = 8:3, Hunt & Kosnik grade: 3 in 2, 5 in 3, 2 in 4, 1 in 5. All procedure was carried out within 24 hours after onset, and divided into 4 in proximal parent artery occlusion, 3 in partial trapping, and 4 in complete trapping. No external decompression was necessary for the cerebellar infarction. In ischemic complication, distal embolic events and brainstem infarction broke out 2 and 3 cases, respectively. At 6 months after embolization, modified Rankin scale for their outcome was 8 cases in 0 to 2, 1 case in 3 and 2 cases in 6. No rebleeding event and angiographical recurrence happened in 9 cases of alive. The H&K grade of subarachnoid hemorrhage on admission was poor (4 and 5) in 2 cases of dead.

**Conclusion:** The endovascular trapping could be acceptable treatment for rVADA involved PICA.

400 **Endovascular Treatment for Failed Surgical Procedure of Blood Blister-Like Aneurysm: A Report of Two Cases**

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**Purpose:** Blood blister-like aneurysm (BBA) of the internal carotid artery (ICA) is a rare but clinically important cause of subarachnoid hemorrhage (SAH), which accounts for 0.5% of incidences of ruptured intracranial aneurysms. They arise from non-branching sites on the supraclinoid ICA and are suspected to originate from a dissection. The purpose of the report is to describe our experience of endovascular treatment of two cases of surgical failed blood blister-like aneurysm (BBA) of the internal carotid artery (ICA).

**Methods:** A 46-year-old and a 32-year-old male patient presented with subarachnoid hemorrhage (SAH). Cerebral angiography study revealed a BBA from supraclinoid ICA. Surgical clipping were then applied but aneurysm recurrence at the initial clipping site were detected in both cases.

**Results:** Endovascular treatment by coiling and stent-within-a-stent method was then applied. Follow-up angiography studies showed successful occlusion of the aneurysms without complication.

**Conclusion:** Endovascular treatment may be a salvageable option for BBA, especially when surgical treatment has failed.

401 **Rebleeding From Cerebral Aneurysms During 3DCT Angiography**

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**Purpose:** Computed tomographic angiography (CTA) is commonly used for the non-invasive detection of cerebrovascular lesions responsible for subarachnoid hemorrhage, but rebleeding may occur during this procedure (Hondny, 2003; Yasui, 1996). We investigated imaging findings and related factors in patients who experienced rebleeding during CTA in our hospital.

**Materials and Methods:** Participants comprised 112 patients who underwent CTA for ruptured cerebral aneurysm in our
hospital between January 2009 and December 2012. CTA was performed using a 64-row detector system.

Results: Rebleeding occurred during CTA in 5 of 112 patients, representing a rebleeding rate of 4.5%. Mean time from initial onset of hemorrhage to CTA was shorter in patients with rebleeding (median, 95 minutes) than in patients without rebleeding (median, 228 minutes). Patients with rebleeding showed either: a) spiral or wave-shaped hemorrhage into the cistern in which the aneurysm was located; or b) tear-drop-shaped hemorrhage within the hematoma. Patients with rebleeding were all grade 5 according to the World Federation of Neurological Surgeons (WFNS) and underwent CTA within 3 h of onset.

Conclusion: CTA offers excellent performance for the diagnosis of cerebral aneurysm, but rebleeding rate was 4.5% in hyperacute stage in this study.

References

A Method to Measure the Hydraulic Resistance of FD Stents

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Purpose: The working mechanism of a FD (flow diverter) stent is to provide a hydraulic resistance between the parent artery and the aneurysm sac, thereby slowing the intra-aneurysmal flow leading to intra-aneurysmal thrombosis. Different parameters, such as porosity and pore density have been used to characterize individual devices. While the impact of these geometrical features is debatable, the most relevant parameter of a FD is its hydraulic resistance. The purpose of the paper is to present a measurement rig and a method to determine the hydraulic resistance of various types of FD-s as a function of the flow rate. Its importance is double: it provides a measure to compare the performance of various products and it provides input data to simulate stents using a porous layer.

Methods: The measurement fluid is water. The device consists of two tanks. The upper one provides the hydrostatic pressure. The stent is placed under water in the lower one to avoid bubble formation on the stent surface. The stent is placed into a small tube whose side contains a hole. The inlet in the tube is symmetrical from both sides, the outlet is placed into a small tube whose side contains a hole. The flow rate is measured by metering.

Results: The dependence of the hydraulic resistance is quadratic, indicating that two parameters are needed for its
description. These parameters are obtained by curve fitting on measurement points. By inserting two stents into each other, there is a random factor how the struts are located relative to each other. Repeating the procedure many times, the average resistance will be roughly twice that of one stent. The effect of the second stent on slowing the intraaneurysmal flow is much less than that of the first one.

Conclusion: We provided a rig description and a method to determine the hydraulic resistance of FD stents.

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Endovascular Treatment of Ruptured Internal Carotid Artery Aneurysms by SAC Technique

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Purpose: To evaluate the safety and efficacy of stent-assisted coiling in treatment of ruptured internal carotid aneurysms.

Methods: 58 consecutive ruptured ICA aneurysms were treated by stent-assisted coiling between November 2003 and April 2011 with average size 7.86 mm. Average follow-up time was 4.9 years.

Results: Intraoperative rupture occurred in 2 aneurysms. 30-days mortality was 1.7%. Immediate complete occlusion and occlusion with residual neck was achieved in 87.9. mRS 0–2, 3 and 4–6 was achieved in 49, 4 and 5 cases respectively.

Conclusion: The stent-assisted coiling provides high rates of accurate occlusion in endovascular treatment of ruptured ICA aneurysms. Stent-assisted coiling of ruptured carotid aneurysms can be performed with acceptable complication rate.

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Comparison of the Tubridge Flow Diverter and Conventional Stents in Large and Giant Aneurysms: Safety and Efficacy Based on a Propensity Score-Matched Analysis

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Purpose: The Tubridge flow diverter (FD) is a novel device aimed at reconstructing the parent artery and occluding an aneurysm. We performed a propensity score-matched analysis to compare the safety and efficacy between the Tubridge FD and conventional stents.

Methods: A database review was conducted to identify patients with large and giant unruptured aneurysms (≥10 mm) treated with the Tubridge FD or conventional stents. Demographic and aneurysmal data, complications, angiographic and clinic outcomes were collected. A propensity score, representing the probability of using the Tubridge FD, was generated for each aneurysm using the relevant patient's and aneurysmal variables. Angiographic results, complications, and clinical outcomes were compared following propensity score adjustment.

Results: After matching of the propensity score, 45 aneurysms treated with the Tubridge FD and 45 treated with conventional stents were matched. The Tubridge cohort had a significantly (P = 0.0002) higher complete occlusion rate at the 6-month follow-up (68.6%) than the conventional stent cohort (24.3%). The Tubridge cohort more frequently achieved improvement (P < .0001) and had a much lower recurrence rate (P = 0.0001). The rate of peri-procedural complications was similar (P = 1), as was the proportion of patients who attained a favorable outcome (mRS ≤ 2) at discharge (P = 1) and at the 6-month follow-up (P = 1).

Conclusion: The Tubridge FD provided a remarkably higher complete occlusion rate than conventional stents, with comparable morbidity and clinical outcomes. Our findings provide reliable evidence to demonstrate that the Tubridge FD could be a preferred treatment option for large and giant unruptured aneurysms.

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Endovascular Stenting for Blood Blister-Like Aneurysms: Report of 42 Cases

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Purpose: To evaluate the safety and efficacy of stent assisted coiling and determine the effect of the overlapping stents in the treatment of BBAs.

Methods: A retrospective review of the aneurysm database identified 42 patients carrying BBAs treated by stent assisted coiling in our institution from November, 2004 to August, 2014. The clinical characteristics, and angiographic results were reviewed.

Results: Endovascular stenting with/without coiling was applied in 42 BBAs, including single stent in 22, double stents in 9, and triple stents or more in 11 cases. Over the strut technique was applied in 8 cases (successful rate 50%), and jailing or semi-jailing technique (successful rate 100%) was used in 34 cases. The jailing or semi-jailing technique provide higher successful rate than the over the strut technique (P = 0.001). The clinical follow-ups at 36.4 months (on average) was 0–2 in 32 cases (78.0%) and 3–6 in 9 cases (22.0%), with a mortality of 12.2%. Angiographic follow-ups in 38 BBAs revealed total occlusion in 22 cases (57.9%), improvement in 2 cases (5.3%), and recanalization in 14 cases (36.8).
Conclusions: It’s feasible to treat ICA BBAs with endovascular stent assisted coiling. Jailring or semi-jailing technique is helpful to increase the successful rate. Overlapping stents provide better angiographic and clinical results.

Endovascular Treatment for Saccular Aneurysms of the Early Cortical Branch of the Middle Cerebral Artery

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Purpose: Saccular aneurysms located at the early cortical branch of the middle cerebral artery (MCA) are uncommon, and endovascular treatment (EVT) for them is not well documented. We performed this study to evaluate the feasibility, safety, and efficacy of EVT for early cortical branch aneurysms of the middle cerebral artery.

Methods: From July 2011 to June 2014, 34 consecutive patients harbouring 35 early cortical branch aneurysms were treated at our institution via endovascular approach. The clinical and angiographic results were retrospectively evaluated.

Results: Treatments were successful in all cases, including coiling alone in 18 patients, balloon-assisted coiling in 2, and stent-assisted coiling in 15. Immediate angiograms showed total occlusion in 8 patients, neck remnant in 5 and partial occlusion in 22. Two (5.7%) procedure-related complications occurred, including early aneurysm rebleeding in one patient and acute stent thrombosis in the other one. Three (8.5%) patients suffered from postoperative complications including one early cortical branch obliteration, one late stent thrombosis and one delayed aneurysm rebleeding. Twenty-three of 23 patients underwent follow-up cerebral angiography at intervals ranging from 3 to 14 months (mean, 5.7 months). The result showed 17/23 (73.9%) aneurysms were completely occluded, 2/23 (13%) were stable or improved, and others were partially recanalized. The clinical follow-up (mean, 7.6 months) of all survived patients demonstrated no neurologic deterioration or rebleeding.

Conclusion: Our preliminary experience demonstrates that EVT for the early cortical branch aneurysms is feasible and safe. However, more adequate follow-up is required to evaluate its long-term results.

Endovascular Treatment of Middle Cerebral Artery Aneurysm with the LVIS Junior Stent

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Purpose: Middle cerebral artery (MCA) aneurysms often occur in small parent vessels and are incorporated with the orifice of acute-angled efferent branch vessels. Endovascular treatment for these aneurysms remains technically challenging. This study aimed to assess the clinical safety and efficacy of the Low-profile Visualized Intraluminal Support Junior (LVIS Jr) stent for embolization of MCA aneurysms.

Methods: Eighteen intracranial aneurysms, including 13 unruptured and 5 ruptured aneurysms, were treated with LVIS Jr stent-assisted coil embolization. The clinical data and technical results are presented.

Results: A total of 18 stents were successfully delivered to the target aneurysms, and the technical success rate was 100%. There was complete occlusion in 8 (44.4%) of 18 cases, neck remnants in 7 (38.9%) cases, and partial occlusion in 3 (16.7%) cases. In-stent thrombosis occurred in 1 case, and the symptoms disappeared after transvenous tirofiban injection. The modified Rankin Scale score at discharge was 0 in 14 patients, 1 in 3 patients, and 2 in 1 patient.

Conclusions: The LVIS Jr stent provided excellent trackability and deliverability and is safe and effective for the treatment of wide-necked MCA aneurysms with tortuous and smaller parent vessels.

Endovascular Treatment of Ruptured Wide-Neck Anterior Communicating Artery Aneurysms - Treatment and Short- and Mid-Term Results in 164 Cases

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Purpose: We aimed to assess the safety and efficacy of endovascular treatment for ruptured wide-neck anterior communicating artery aneurysms (AcomAAs) and determine predictors of treatment results.

Methods: A total of 164 patients (M:F = 69:95; median age, 55 years) with 164 ruptured wide-neck AcomAAs were treated by endovascular method between January 2011 and June 2013 at our institution. Treatment and predictors of complete embolization, perioperative adverse events, recanalization, and unfavourable outcome were analysed, respectively.
Results: A total of 69 aneurysms were treated by stent-assisted coiling, and the remaining 95 ones were managed by only coiling. Perioperative complications occurred in 21 (12.8%) patients, including 9 haemorrhagic and 12 ischemic complications. The available median durations of angiographic (n = 131) and clinical (n = 164) follow-ups were 11 months (range, 6–40months) and 18months (range, 1 days-40months), respectively. Aneurysms bleb formation and posterior dome orientation were independent predictors of perioperative haemorrhagic complications. A total of 10 cases occurred angiographic recanalization, which was affected by stent implantation (p = 0.0099) and the immediate angiographic results (p = 0.0003), and progressive thrombosis and in-stent occlusion were not detected on follow-up angiograms. 90.24% (148/164) patients had favourable outcomes (the modified Rankin Scale score [mRS], 0–2), and unfavourable Hunt-Hess scale (odds ratio [OR] = 75.826; 95% confidence interval [CI], 17.903–321.147; p < 0.0001) was the only independent predictor of unfavourable outcomes in the treated AcomAAs.

Conclusion: Without the increase of stent-related perioperative complications, stent-assisted coiling for ruptured wide-neck AcomAAs was more efficient than single coiling in decreasing recurrence. Unfavourable Hunt-Hess scale was the only independent predictor of unfavourable outcomes in the treated AcomAAs.

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Endovascular Treatment of Wide-Neck Anterior Communicating Artery Aneurysms Using the LVIS Junior Stent

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Purpose: We performed this retrospective study to assess the clinical safety and efficacy of the low-profile visualized intraluminal support junior (LVIS Jr.; MicroVention Inc., Aliso Viejo, CA, USA) stent placement in anterior communicating artery (ACA) aneurysms. ACA aneurysms are one of the most common intracranial aneurysms. Stent placement is particularly difficult due to the complexity of the vascular anatomy and the small vessels of the ACA complex.

Methods: From November 2013 and June 2014, LVIS Jr. stent-assisted coiling was performed in 11 patients with 12 wide-neck ACA aneurysms. Patient demographics, morphologic features of the aneurysm, clinical results and follow-up results were presented.

Results: Successful deployment of the LVIS Jr. stent in the targeted artery was achieved in all patients. Complete occlusion was achieved in seven patients, neck remnant in three, and partial occlusion in two. The angiographic follow-up of nine patients (mean 4.4 months) showed that all aneurysms remained stable or improved. There was no in-stent stenosis, recurrence or retreatment. The modified Rankin scale score at discharge was 0 in eight patients and one in three patients.

Conclusions: The LVIS Jr. stent provided excellent trackability and deliverability and is safe and effective for the treatment of wide-necked ACA aneurysms. Further follow-up is needed to assess the long-term efficacy of LVIS Jr. stent placement in ACA.

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Predictors of Recurrence After Stent-assisted Coil Embolization of Paraclinoid Aneurysms

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Purpose: Stent-assisted coil embolization has been increasingly used to treat paraclinoid aneurysms. The study was aimed to evaluate safety and efficacy of stent-assisted coil embolization for paraclinoid aneurysms and explore the factors influencing the long-term outcomes.

Methods: Under an institutional review board approved protocol, the clinical and angiographic data of 129 paraclinoid aneurysms in 120 patients (Male:Female = 36:84; median age, 52 years; range, 21–84) treated by stent-assisted coil embolization were reviewed retrospectively. Clinical status, aneurysmal morphology, treatment strategy and results were analyzed using Chi-square tests in the univariate analysis and further analyzed using backward stepwise logistic regression.

Results: The univariate analysis indicated significance between the groups regarding hypertension, ruptured aneurysms, size, wide neck and immediate treatment results (P < 0.05). Multivariate logistic regression analysis found that ruptured aneurysms (odds ratio [OR] = 5.893, 95% confidence interval [CI], 1.512–23.054; p = 0.011), larger size (OR = 2.339; 95%CI, 1.148–4.781; p = 0.020) and hypertension (OR = 6.143; 95%CI, 1.560–24.183; p = 0.009) might be predictors of recurrence.

Conclusion: Stent-assisted coil embolization of paraclinoid aneurysm has a risk of recurrence. Ruptured aneurysms, larger size and hypertension may be the risk factors for recurrence.
Risk Factors and Regression Models for Prediction of Posterior Communicating Artery Aneurysm Rupture

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Purpose: Morphology and hemodynamics are believed to play an important role in rupture of intracranial aneurysms. We aimed to determine the independent risk factors of aneurysm rupture by focusing on only posterior communicating artery (PCoA) aneurysms and build regression models for rupture risk assessment of PCoA aneurysms.

Methods: In 129 PCoA aneurysms (85 ruptured, 44 unruptured), clinical, morphological and hemodynamic characteristics were compared between the ruptured and unruptured groups. Multivariate logistic regression analysis was performed to determine the independent predictors for the rupture status of PCoA aneurysms and build logistic regression models based on morphology, hemodynamics and both of them. Then morphological and hemodynamic features of another 28 consecutive aneurysms were measured and applied in the previous regression models. The model performances at predicting rupture statuses at different cut-off were measured and compared against anecdotal metrics (aneurysm size > 7 mm, aspect ratio > 1.6 and size ratio > 2.0).

Results: In univariate analysis, the size of aneurysm dome, aspect ratio (AR), size ratio (SR), dome-to-neck ratio (DN), inflow angle (IA), normalized wall shear stress (NWSS) and percentage of low WSS area (LSA) were significant parameters (P < 0.05). In multivariate logistic regression analysis, 3 different logistic regression models were built. Size and IA were demonstrated to be the independently significant factor in the morphology model, whereas NWSS was the only independently significant parameters in the hemodynamics model. IA and LSA were retained in the combined model. For the test cohort of 28 PCoA aneurysms, the combined model showed relatively higher sensitivity (0.79) and specificity (0.78) simultaneously at a cutoff score of 50% than the other 2 models and anecdotal metrics.

Conclusion: Hemodynamics and morphology were important in discriminating rupture status of PCoA aneurysms and the models could potentially assist in clinical decision-making for unruptured PCoA aneurysms.

Ruptured Intracranial Aneurysm Endovascular Treatment (RIAEVT) Risk Score: A Predictive Modelling Study for Individual Elderly Patients

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Purpose: Endovascular treatment (EVT) entails a higher risk of complication in elderly patients with ruptured intracranial aneurysms (RIAs). Our aim was to develop and validate a complication risk score for individual elderly patients about to undergo EVT.

Methods: Retrospectively collected data, including clinical, lesion, and procedure-related characteristics of consecutive elderly patients with RIA who had undergone EVT within a period of 10 years, were used to develop a complication predictive score by performing a multivariable logistic regression analysis. The complications included intraprocedural rupture, ischemic stroke, recurrent subarachnoid hemorrhage (SAH), and distant intraparenchymal hemorrhage within 30 days after EVT. The score was validated internally with bootstrapping techniques.

Results: Five hundred and twenty elderly patients who underwent EVT were enrolled. At 30 days, the procedure-related complication rate was 13.08%. Six risk factors, namely hypertension, Hunt-Hess score, Fisher score, wide-necked aneurysm, a bleb on the aneurysm sac, and tiny aneurysm were independently associated with procedure-related complications. The RIAEVT score model was developed based on these six variables and predicted the risk of complications at a sensitivity of 63.22% and specificity of 84.79%.

Conclusions: Our study indicated that hypertension, high Hunt-Hess score, high Fisher score, wide-necked aneurysm, a bleb on the aneurysm sac, and tiny aneurysm were independently associated with procedure-related complications. In combination with these risk factors, the RIAEVT risk score can be a useful tool in the prediction of EVT-related complications but needs to be validated in prospective cohorts from various centers before it can be recommended for application.

Ruptured Intracranial Aneurysms in Elderly Patients: Risk Analysis of Endovascular Treatment Complications

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Purpose: To retrospectively evaluate the periprocedure complications from endovascular treatment (EVT) for ruptured intracranial aneurysms (RIAs) in elderly patients and to
explore preliminarily which factors are associated with complications.

**Methods:** Retrospectively collected data included clinical, lesions and procedural related characteristics of 520 consecutive RIAs elderly patients underwent EVT over a period of 10 years in a single center were used to evaluate the peri-procedure complications and preliminarily risk factors with multivariable logistic regression analysis. The periprocedure complications including death, intraprocedural rupture, ischemic stroke, recurrent SAH and distant intraparenchymal hemorrhage after EVT. All patients included underwent independent neurological evaluation before and after the procedure and at 30 days.

**Results:** We reported 12 cases (2.31%) of intraprocedural rupture, 35 cases (6.73%) of ischemic stroke, 16 cases (3.08%) of recurrent SAH, and 5 cases (0.96%) of distant intraparenchymal hemorrhage. The overall complication rate at 30 days after EVT was 13.08%. Multivariable logistic regression analysis revealed that hypertension, high GCS score, high Hunt-Hess score, size ratio, aneurysm shape irregular and timing of coiling after rupture less than 72 hours were independent risk factors of periprocedure death. With a bleb on the aneurysm sac and large aneurysm size were independent risk factors of intraprocedural rupture. Ventricle hematocoele, high Hunt-Hess score and with a bleb on the aneurysm sac were independent risk factors of recurrent SAH. Past cerebral infarction history, high Fisher scale score and tiny aneurysm size were independent risk factors of distant intraparenchymal hemorrhage. Hypertension, high Hunt-Hess score, high Fisher scale score, wide-necked aneurysm, aspect ratio and with a bleb on the aneurysm sac were independent risk factors of ischemic stroke after EVT.

**Conclusion:** Cerebrovascular complications from EVT for RIAs are diverse. The clinical grade including Hunt-Hess score, Fisher scale score and some important morphological characteristics are associated with these complications.

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**Stent Assisted Coiling for the Treatment of 211 Acutely Ruptured Wide-Necked Intracranial Aneurysms: A Single Center 11-Year Experience**

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**Purpose:** To evaluate the safety, angiographic and clinical outcome of stent assisted coiling (SAC) for acutely ruptured wide-necked intracranial aneurysms treated in a single center over an 11 year period.

**Methods:** Under an IRB approved protocol, we retrospectively reviewed the angiographic and clinical data of 211 patients (52 male, 159 female; median, 56 years; range, 31–83 years) with acutely ruptured wide-necked intracranial aneurysms (neck >4 mm and/or dome to neck ratio ≤2) treated by SAC from September 2000 to December 2011. Baseline characteristics, procedure-related complications, angiographic follow-up results and clinical outcome were analyzed statistically. A Mann-Whitney U test was performed for non-normally distributed continuous variables. A Pearson’s chi-square or Fisher’s exact test was performed for categorical variables. Univariate analysis and Logistic regression analysis were performed to determine the association of procedure-related complications and clinical outcome with potential risk factors.

**Results:** Procedure-related complications occurred in 30 patients (14.2%). They were more common in AComA (26.7%, 12/45) and MCA-bifurcation (40%, 4/10) aneurysms than in aneurysms at other locations (9.0%, 14/156). Clinical outcome (median, 33 months) was good in 175 patients (82.9%) with a MRS of ≤2. Older age (p = 0.013, OR value = 1.054) and higher Hunt-Hess grade (p < 0.001, OR value = 15.876) were independent risk factors for unfavorable outcome. 152 of 190 (80%) survived patients underwent angiographic follow-up at least once (median, 12 months). The complete occlusion rate improved from immediate 45.5% to 75.7% at follow-up (115/152).

**Conclusion:** Angiographic and clinical outcomes in our series were comparable to those reported using coiling alone or balloon assisted coiling techniques. SAC for the treatment of acutely ruptured MCA-bifurcation and AcomA aneurysms was associated with a significantly higher incidence of complications than was the case for treatment of aneurysms at other locations.

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**Stent Assisted Coiling Versus Non Stent Assisted Coiling for Intracranial Aneurysms: A Systematic Review and Meta-Analysis**

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**Purpose:** Endovascular embolization has become an effective and important way for treating intracranial aneurysms and parent artery reconstruction is becoming the consensus of interventional doctors. We systematically reviewed the literature which compares the treatment of stent assisted coiling and non stent assisted coiling, a meta-analysis was done to compare the safety and efficacy of these two kinds of schemes. This may help to provide basis for physicians to choose a better way to treat intracranial aneurysms and improve patients’ outcome. This may provide evidence for physicians when making clinical decisions to treat intracranial aneurysms and improve patients’ outcome.

**Methods:** According to the methods and guidelines for Meta analysis, searching PubMed, Embase, Medline and Cochrane Controlled Trials Register database, we reviewed
all the documents about the comparison of stent assisted coiling and non stent assisted coiling. Extracting dates about complication rate, ischemic stroke rate, hemorrhagic stroke rate, immediate occlusion rate, cure rate at follow up, progressive occlusion rate and recurrence rate from the literature and then the meta-analysis was done. 

**Results:** 15 papers including 1 RCT and 14 observational studies were selected. No statistical differences were found in immediate occlusion rate (OR = 1.06; 95% CI, 0.75–1.50), complication rate (OR = 1.28; 95% CI, 0.98–1.66), ischemic stroke rate (OR = 1.59; 95% CI, 0.94–2.69; P = 0.08) and hemorrhagic stroke rate (OR = 1.20; 95% CI, 0.59–2.45). However, comparing with non stent assisted coiling, stent assisted coiling has an advantage in cure rate at follow up (OR = 1.95; 95% CI, 1.22–3.11), progressive occlusion rate (OR = 2.86; 95% CI, 1.85–3.90) and recurrence rate (OR = 0.42; 95% CI, 0.31–0.56).

**Conclusion:** In cure rate at follow up and recurrence rate, stent assisted coiling is superior to non stent assisted coiling. No statistical differences were found in the safety of the two methods.

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**Stepwise Stent Deployment Technique for Tandem Intracranial Aneurysms: A Review of 26 Cases**

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**Purpose:** We performed this study to report our experience using a stepwise stent deployment technique for the treatment of tandem intracranial aneurysms.

**Methods:** Patients with intracranial tandem aneurysms that were treated with a stepwise stent deployment technique between May 2009 and December 2014 were retrospectively reviewed.

**Results:** Twenty-six patients with 52 tandem aneurysms were identified (11 men, 15 women), with a mean age of 55.3 years (range, 17–82 years). Subarachnoid haemorrhage was confirmed in 13 patients using computed tomography at onset. Complete occlusion was achieved in 23 of the aneurysms (44.2%) after the procedure, neck remnant in 10 (19.2%), and aneurysm remnant in 19 (36.5%). The perioperative complications included in-stent thrombosis in one case and vasospasm in two cases, none of which left a permanent neurological deficit. The modified Rankin Scale (mRS) score at discharge was 0–2 in 25 cases and 3 in one case. The follow-up angiograms available for 19 patients showed complete occlusion in 38 aneurysms, improved in 4, and stable in 4. All of the patients had mRS scores of 0–1 during the clinical follow-up period.

**Conclusions:** The stepwise stent deployment technique is feasible and helpful in the treatment of intracranial tandem aneurysms.

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**Stromal Cell-Derived Factor 1α Dynamically Mediates Saccular Aneurysm Remodelling in Rabbits**

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**Purpose:** The factors which attract those stem or progenitor cells to injury site become the key point of facilitating aneurysm repair. Stromal-cell-derived factor 1α (SDF-1α) plays an essential role in angiogenesis and aneurysm wall inflammation. However, the dynamic expression profile and role of SDF-1α in aneurysm wall remodelling remains unknown. Here, we investigated the expression profile of SDF-1α during the remodelling process in induced saccular aneurysm in rabbits using porcine elastase.

**Methods:** Saccular aneurysms were induced in thirty New Zealand White rabbits. The aneurysms were harvested on day 1, 3, 7, 14 and 21. Blood sample were collected to investigate the serum SDF-1α level at different time points before model establishment and postoperatively on day 1, 3, 7, 14 and 21. The endothelial cells lying on the inner surface of aneurysm sac were observed with scanning electron microscopy on different time points. After the procedure, SDF-1α expression level was examined with immunohistochemistry, Western blot and real-time PCR. In vitro, expression of adhesion molecular on endothelial progenitor cells was examined after given SDF-1α stimulation. Migration assay were also investigated using endothelial progenitor cells after given SDF-1α with different concentration gradient.

**Results:** All aneurysm models were successfully established in New Zealand White rabbits. Aneurysms were harvested on day 1, 3, 7, 14 and 21. Aneurysm sacs were substantially filled with thrombosis 3 days after model induction and were subsequently remodeled, accompanied by progressive thrombosis degradation and intima re-endothelialization. Serum SDF-1α levels increased in a bimodal fashion during the 21 days post-operation. Immunohistochemistry, western blot and real-time PCR analyses showed that SDF-1α expression was increased in the local aneurysm wall and reached a maximum on day 14. Vascular endothelial (VE)-cadherin was up-regulated after stimulation with SDF-1α and endothelial progenitor cell migration was enhanced by SDF-1α.

**Conclusion:** SDF-1α dynamically mediates aneurysm wall remodelling and may facilitate aneurysm maturation by up-regulating VE-cadherin expression and promoting the migration of endothelial progenitor cells to the site of injury. SDF-1α expression levels in peripheral blood and local aneurysm wall were associated with the status of aneurysm wall inflammation and intra-aneurysmal thrombus.
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Treatment of Ruptured Vertebral Artery Dissecting Aneurysms Distal to the Posterior Inferior Cerebellar Artery: Stenting or Trapping?

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Purpose: The treatment of ruptured vertebral artery dissecting aneurysms (VADAs) continues to be controversial. Our aim was to evaluate the safety, efficacy, and long-term outcomes of internal trapping and stent-assisted coiling (SAC) for ruptured VADAs distal to the posterior inferior cerebellar artery (supra-PICA VADAs), which is the most common subset.

Methods: A retrospective review was conducted of 39 consecutive ruptured supra-PICA VADAs treated with internal trapping (n = 20) or with SAC (n = 19) at our institution. The clinical and angiographic data were retrospectively compared.

Results: The immediate total occlusion rate of the VADAs was 80% in the trapping group, which improved to 88.9% at the follow-ups (45 months on average). Unwanted occlusions of the posterior inferior cerebellar artery (PICA) were detected in 3 trapped cases. Incomplete obliteration of the VADA or unwanted occlusions of the PICA were detected primarily in the VADAs closest to the PICA. In the stenting group, the immediate total occlusion rate was 47.4%, which improved to 100% at the follow-ups (39 months on average). The immediate total occlusion rate of the VADAs was higher in the trapping group (p < 0.05), but the later total occlusion was slightly higher in the stenting group (p > 0.05).

Conclusions: Our preliminary results showed that internal trapping and stent-assisted coiling are both technically feasible for treating ruptured supra-PICA VADAs. Although not statistically significant, procedural related complications occurred more frequently in the trapping group. When the VADAs are close to the PICA, we suggest that the lesions should be treated using SAC.

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Fenestration of Vertebro-Basilar Artery with a Complex Intracranial Aneurysm

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Vertebro-basilar artery fenestration is an uncommon congenital variant, which has been associated with saccular aneurysm. There are rare reports of aneurysm in children who have vertebro-basilar artery fenestration. We present a case of an 8-year-old girl who suffered with a sudden headache. Computed tomography revealed subarachnoid hemorrhage and acute hydrocephalus. The following magnetic resonance imaging showed an abnormal signal in the vertebro-basilar artery, which we confirmed on digital subtraction angiography to be a complex aneurysm. The girl recovered without any complications after the endovascular treatment with coils by double microcatheter technique. Based on the literature review, the etiology of the fenestration, aneurysm morphology and the treatment strategy are discussed. (CASE REPORT)

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The Clinical Features and Endovascular Treatment of Moyamoya Disease with Intracranial Aneurysms

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Purpose: To explore the clinical manifestation, neuroimaging characteristics and endovascular treatment for intracranial aneurysms associated with Moyamoya disease.

Methods: The clinical data of 7 cases with moyamoya associated with intracranial aneurysm confirmed by cerebral digital subtraction angiography (DSA), and treated with embolization were retrospectively analyzed, involved clinical manifestation, neuro-imaging characteristics and curative effect.

Results: 5 cases had aneurysms showed subarachnoid hemorrhage. 2 cases showed intracerebral hemorrhage and flooding into ventricular. 5 cases belonged to the major artery type and 2 peripheral artery type. All cases were treated by endovascular embolization. All of 7 patients achieved good curative effects and excellent clinical outcomes.

Conclusion: Moyamoya disease associated with intracranial aneurysm may result in different types of clinical manifestation and imaging characteristics, endovascular treatment is feasible for aneurysms associated with Moyamoya disease.

2 – Antiplatelets/Anticoagulation

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Ibuprofen Inhibits ASA: A Potentially Fatal Interaction

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Vertebro-basilar artery fenestration is an uncommon congenital variant, which has been associated with saccular aneurysm. There are rare reports of aneurysm in children who have vertebro-basilar artery fenestration. We present a case of an 8-year-old girl who suffered with a sudden headache. Computed tomography revealed subarachnoid hemorrhage and acute hydrocephalus. The following magnetic resonance imaging showed an abnormal signal in the vertebro-basilar artery, which we confirmed on digital subtraction angiography to be a complex aneurysm. The girl recovered without any complications after the endovascular treatment with coils by double microcatheter technique. Based on the literature review, the etiology of the fenestration, aneurysm morphology and the treatment strategy are discussed. (CASE REPORT)
Purpose: Ibuprofen, a nonsteroidal anti-inflammatory drug, has been used to prevent inflammatory reactions and related aneurysm rupture due to excessive thrombus formation after flow diversion of large and giant aneurysms. Ibuprofen, however, interferes with the platelet function inhibition effect of acetylsalicylic acid (ASA).

Methods: A 53-year-old patient presented with an incidental aneurysm of the proximal basilar artery (fundus 24 mm, neck 13 mm). On April 15th the patient underwent a ventricular shunt operation. On April 17th the patient was loaded with 500 mg ASA IV and 180 mg ticagrelor PO. During the procedure on the same day, 500 mg ASA IV and 15.8 mg epifibatide IV were added. Five coils were inserted inside the aneurysm sac. An Enterprise2 stent (4/39) and two p64 flow diverters (4/24) were deployed in the basilar artery without difficulty. The postprocedural medication included 100 mg ASA, 2x 90 mg ticagrelor, 2x 3,000 U certoparin sodium, 3x 4 mg dexamethasone and 1x 400 mg ibuprofen daily.

Results: The patient was discharged home asymptomatic on April 20th after dual platelet inhibition was confirmed (Multiplate). On April 24th, the patient lost consciousness and was transferred to us. The family confirmed that all medications had been taken. Multiplate showed platelet inhibition from ticagrelor and no ASA effect. MRI and DSA confirmed acute in-stent thrombosis. Despite rapid and successful aspiration thrombectomy of the basilar artery the patient died due to brainstem infarction. Ibuprofen was detected in urine and blood.

Conclusion: Ibuprofen can significantly inhibit ASA. Patients who need dual platelet function inhibition (e.g., following intracranial stent or flow diverter treatment) must not receive ibuprofen. In case of doubt, response testing using Multiplate or VerifyNow is recommended.

Reference

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Association Between Carotid Artery Stenosis and the Ratio of Serum Eicosapentaenoic / Arachidonic Acid
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Purpose: This study aimed to investigate the association between carotid artery stenosis and the ratio of eicosapentaenoic / arachidonic acid (EPA/A).

Methods: We retrospectively reviewed records of 68 patients who underwent carotid artery stenting between November 2005 and March 2015 in our hospital. Of 68 cases, symptomatic 37 cases (54.4%) and asymptomatic 31 cases were (45.6%) included. Cases were classified as L group (0.55), M group (0.55–1.05) and H group (>1.05).

Results: The mean EPA/AA ratio was lower in symptomatic cases (0.50) than asymptomatic cases (0.66), and 65% were L group in symptomatic cases whereas 52% in asymptomatic cases. In addition, 67% of vulnerable plaque imaging was seen in L group. For perioperative results of carotid stenting, all 5 cases of DWI-positive and 1 case with neurological complication were in L group and never seen in H group. The mean EPA/AA of restenosis cases showed 0.48, and 2 of 3 cases were L group, and never seen in H group, too.

Conclusion: The EPA/AA ratio relates to histological features of atherosclerosis of carotid artery, and EPA medication may reduce complications of carotid stenting and may prevent restenosis.
425 Presentation withdrawn

Prevalence and Risk Factors for Increased Platelet Reactivity after Carotid Artery Stenting

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Purpose: Increased platelet reactivity after carotid artery stenting (CAS) may cause thromboembolic complications. This study aimed to investigate the incidence of and determine the factors related to increased platelet reactivity after CAS.

Materials and Methods: Between October 2013 and December 2014, all patients admitted with a diagnosis of internal carotid artery stenosis and treated with CAS at the Department of Neurosurgery, Gifu University Hospital were investigated prospectively. Patients received preprocedural antiplatelet therapy comprising some combination of aspirin (100 mg/day), clopidogrel (75 mg/day), and/or cilostazol (200 mg/day) for a minimum of 7 days. Adenosine diphosphate (ADP)- and collagen-induced platelet aggregation were measured before and 4 days after CAS. Changes in platelet reactivity were evaluated as changes in the categorized platelet reactivity grade based on the effective-dose 50%. Clinical characteristics of patients with and without increased platelet reactivity were compared.

Results: Among 39 consecutive patients who underwent CAS, 19 (49%) exhibited increased platelet reactivity. In the univariate analysis, a significantly larger number of patients in the activated group presented with diabetes mellitus (DM) when compared with the non-activated group (14/19, 74% vs. 3/20, 15%; \( p < 0.001 \)). The level of glycated hemoglobin (HbA1c) was also significantly higher in the activated group than in the non-activated group (6.6 ± 0.7 mg/dl vs. 5.9 ± 0.7 mg/dl; \( p = 0.011 \)). Furthermore, high-intensity signal (HIS) was significantly more frequently observed on time-of-flight (TOF)-MR angiography (MRA) evaluations of patients in the activated group (10/19; 53%) relative to the non-activated group (4/20; 20%; \( p = 0.002 \)). DM (odds ratio [OR], 17.1; 95% confidence interval [CI], 2.4–120.4; \( p = 0.004 \)) and carotid artery plaques exhibiting HIS on TOF-MRA (OR, 1.9–311.8; \( p = 0.014 \)) were independently associated with increased platelet reactivity in a multivariate analysis.

Conclusion: Increased platelet reactivity occurred in nearly half of patients subjected to CAS, and was independently associated with DM and carotid artery plaques exhibiting HIS on TOF-MRA.

426 Preliminary Experience of Tirofiban Infusion in Coil Embolization of Ruptured Intracranial Aneurysms

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Purpose: Thromboembolic complications are the most commonly reported complications during endovascular treatment of intracranial aneurysms with coils. There have been some reports on the use of intraarterial tirofiban in ruptured aneurysms. We report our experience with intravenous tirofiban infusion in patients who have received coil embolization for intracranial aneurysms.

Methods: Between December 2008 and November 2014, we retrospectively reviewed 249 ruptured intracranial aneurysms that treated with coiling at our institutions. 28 patients harboring 31 ruptured intracranial aneurysms underwent intravenous tirofiban infusion during and after coil embolization procedure. Intraarterial tirofiban infusion through a microcatheter was also performed to resolve thrombus formation in 26 patients during the procedure.

Results: 26 aneurysms (83.9%) were located in the anterior circulation. The mean size of aneurysms was 6.0 mm. 26 aneurysms were saccular and 13 aneurysms treated with stent-assisted coiling. Antiplatelet premedication was administered in only three cases before procedure and thrombus formation during procedure was detected in 24 cases. Two intracranial hemorrhagic complication (increase in the amount of hematoma) occurred during a follow up period. In addition, two systemic hemorrhagic complication was also found.

Conclusion: Intravenous tirofiban as a monotherapy or in addition to intraarterial tirofiban seem to be safe during and after coil embolization in patients with ruptured intracranial aneurysms.

3 AVM

427 Endovascular Treatment of Spinal Sulcal Artery Pseudoaneurysm as a Rare Complication of Epidural Anesthesia

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Purpose: Pseudoaneurysm of spinal arteries is a rare pathology, usually occurring as a complication of spinal intervention. Symptoms are mainly caused by edema of
spinal cord due to congestion in draining veins. Topical neurological symptoms correlate with the location of lesion, typically dysesthesia and paresis to plegia and alternatively conus medullaris or cauda equina syndromes. **Methods:** A 26-yo patient with familial adenomatous polyposis after subtotal colectomy in general and spinal anesthesia who developed lower limbs dysesthesia and progressive paraparesis and cauda equina syndrome has been referred to our department for further investigation. MRI of thoracic and lumbar spine showed spinal cord edema from Th12 to L1 with suspected spinal AV malformation. DSA clearly demonstrated pseudoaneurysm of sulcal artery of spine fed by Adamkiewicz artery originating from left Th12 intercostal artery. First attempt to catheterize the lesion using Si-10 microcatheter was unsuccessful due to sharp angle from anterior spinal artery to sulcal artery, therefore Magic 1.2 F microcatheter with Hybrid007D and Hybrid008D microguide-wires were used to cross over the angle. Pseudoaneurysm was occluded with one Balf Flow Coil 2.5/20. **Results:** Successful complete exclusion of pseudoaneurysm was achieved. Edema together with dysesthesia and paraparesis regressed, patient could walk unaided, with significant neurological restoration. **Conclusion:** Pseudoaneurysm of spinal artery is a rare iatrogenic complication, to our best knowledge, we could not find any yet reported similar case of sulcal artery pseudoaneurysm. We suggest that embolization with Balf Flow Coils is a safe and efficient endovascular procedure in treatment of such vascular lesions.

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**Acute Cerebral Haemorrhage with Arteriovenous Malformation (AVM): Role of Angiographic – CT (Dynacta)**

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**Purpose:** In patients with hematoma associated with arteriovenous malformations (AVMs), it is critical to evaluate the angio-architecture of the malformation and determine the relationship of a peri or intranidal aneurysm to the hematoma. **Methods:** Combined angiography/CT suite that uses flat-panel detector (FD) technology provides with higher-resolution angiography and CT-like images (Angiographic-CT). We retrospectively reviewed cases of cerebral hematoma due to ruptured AVM in whom Angiographic CT was done. **Results:** Ten patients [median age: 43 years (12–75); male 6 (60%) ] were evaluated with the technique. The AVM nidus measured ≤3 cms in seven (70%, n = 10) and 4 cms in one patient. DSA images revealed possible peri/intranidal aneurysm in eight patients. Angiographic CT examination revealed projection of aneurysm sac into the hematoma cavity thereby confirming the presence of a ruptured intra/ perinidal aneurysm in seven patients. Suspected intranidal aneurysm on DSA was identified as venous loop on AngioCT in one patient. In another case with feeding artery and venous aneurysm, it confirmed that the arterial aneurysm was the ruptured one by its relationship to the hematoma. In seven patients, the aneurysm and part of AVM were embolized in acute stage and was followed with radiosurgery or surgery for the residual AVM. Two patients were directly operated upon with excision of aneurysm, AVM and hematoma. One patient awaits treatment. During surgery the Angio-CT images were useful to localize the AVM in relationship to the hematoma. In one patient with very small AVM, the Angiographic-CT images were used for neuronavigation during surgery. AngioCT also helps planning the surgical approach. **Conclusion:** Angiographic-CT with intra-arterial injection is a useful adjunct to cerebral angiography in evaluating patients with cerebral hematoma due to ruptured AVMs. It is more accurate than DSA to localize and confirm intra/ perinidal aneurysms, delineating relationship of hematoma and AVM and for image guidance during surgery.

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**Onyx™ Embolization of Cerebral AVM Using Scepter™ Balloon Catheter**

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**Purpose:** Onyx™ embolization of cerebral AVM is useful, especially for using “Plug and Push method”. However, during this method, sometimes the tip of the catheter is embedded into the plug, and it is difficult to retrieve the non-detachable catheter (such as Marathon™ catherer). Using Scepter™ balloon catheter (Scepter™) is very easy to push Onyx™ without any backflow and it is like “Plug and Push method”. And after the injection of Onyx™, Scepter™ is very easy to retrieve. We present our experiences of Onyx™ embolization of cerebral AVM using Scepter™ and show its usefulness. **Methods:** We have experienced 4 cases (6 sessions) of Onyx™ embolization of cerebral AVM using Scepter™. They were 3 males and 1 female, and mean age was 48.8 years old. All AVM were located in cerebrum and 3 cases were ruptured. Spezter & Martin grade were III in 2 cases and IV in 2 cases. Under general anesthesia, through a 6 or 7 french sized guiding catheter, Scepter™ was navigated...
into appropriate feeding artery as near as possible to the nidus using 0.014 microguidewire. And after inflation of the balloon, Onyx™ was injected into the nidus as much as possible.

Results: Within 6 sessions, 2 feeders were embolized in 2 sessions, and 1 feeder was embolized in 4 sessions. Scepter™ was retrieved easily after embolization in all cases. After embolization, one case was complete occlusion, 2 cases were 90% occlusion, but one case was less than 50% occlusion. As a complication, one case occurred intracerebral hemorrhage a day after embolization. Modified Rankin Score 30days after treatment were 0 in 3 cases and 2 in 1 case.

Conclusion: Onyx™ embolization of cerebral AVM using Scepter™ is easy for “Plug and Push method”, and useful for the treatment of AVM.

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Improved Cerebrovascular Reserve After Embolization of Ruptured Cerebral Proliferative Angiopathy

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Purpose: Cerebral proliferative angiopathy is a rare and peculiar type of cerebral vascular malformation characterized by diffuse network with normal brain tissue intermingled, multiple nondominant arterial feeders, relatively small draining veins, angiographic capillary angioectasia and vascular proliferation. It should be separated from cerebral AVMs in angioarchitecture, nature history, clinical presentation.

Materials and Methods: In our case, we present a 61-year-old male stuporous patient who suffered headache with left side weakness and his brain radiographic images showed characteristics of ruptured cerebral proliferative angiopathy. We treated him through endovascular method.

Result: After treatment of embolization, brain SPECT showed improvement of cerebrovascular reserve on perilesional area. And previous stroke like symptom was disappeared.

Conclusion: There are many consideration points of endovascular treatment of cerebral proliferative angiopathy. And therapeutic strategy of neurointervention should be done carefully.

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Pre-Existing, Incidental and Hemorrhagic Avms in Pregnancy and Postpartum: Gestational Age, Morbidity and Mortality, Management and Risk for Fetus

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Objective: The aim of this study was to review maternal and fetal outcomes of pregnancies who present with AVMs according to the pathology and gestational age.

Methods: A literature review was performed and analyzed 65 cases of verified AVM during pregnancy previously reported in the literature in English.

Results: Sixty-five cases of pregnancy-associated AVM were identified. The patient age ranged from 16–45 years, mean 28 years. There were 16 cases (24.6%) with pre-existing AVMs and 2 (3.1%) were incidental. There were 54 cases (83.1%) of AVM ruptured during pregnancy and postpartum, 6 cases (11.1%) were in the first trimester, 24(44.4%) were in the 2nd, 22(40.7%) were in the 3rd trimester and 2(3.7%) was postpartum. Unfavorable clinical outcome (mRS ≥ 2) was identified in 20 cases (30.8%) and abortion occurred in 10 cases (15.4%). There were 3 maternal deaths, giving a case mortality rate of 4.6%. Fifty-three fetus was born via cesarean section in 42 cases and vaginal delivery in 10 cases, 48 were good health, 3 were temporally intubated, 1 was macrosomia and 1 was died. In univariate analysis, AVM hemorrhage presentation were significantly associated with a maternal poor outcome (modified Rankin Scale ≥2) (p = 0.030), however, not significantly associated with fetus risk (p = 0.864). Gestation age was not significantly associated with maternal poor outcome (p = 0.875) and fetus risk (p = 0.790).

Conclusion: AVM hemorrhage presentation was significantly associated with a maternal poor outcome, however, not significantly associated with fetus risk. Gestation age was not significantly associated with maternal poor outcome and fetus risk.
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Endovascular Embolization of Brainstem Arteriovenous Malformation

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Purpose: Brainstem Arteriovenous malformation (BSAVM) is not common, and it represents about 2.5% of brain AVM. BSAVM is still challenging even with modern microsurgical, endovascular and radiosurgical techniques and tools because of high risk of deterioration due to hemorrhage and infarction. There are only a few cases of patients with BSAVM, and adequate treatment strategies are yet to be elucidated, especially about endovascular management of BSAVM. We report a case with endovascular embolization of BSAVM. The relevant literature is also discussed.

Methods: This 54-year-old male presented with a history of severe headache, nausea followed by deep drowsy consciousness and general weakness. Computed tomography (CT) scan showed a hyperdense lesion in the ventral pontine region. CT angiogram demonstrated abnormal vascular structure around superior cerebellar artery (SCA) and anterior inferior cerebellar artery (AICA) on the right side.

Results: Cerebral angiography showed arterial supply from right AICA and multiple small branches of the basilar artery. Venous drainage was to the sagittal sinus.

Conclusion: After Onyx embolization, residual small feeding arteries and venous drainage were seen on angiogram, but main component of the AVM was suggested to be eliminated.

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Cerebral Proliferative Angiopathy, Rare and Recent Discovered Clinical Entity: Case Series of a Single Health Care Center in the Amazon, Brazil

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Purpose: Describe the retrospectively determined cases of Cerebral Proliferative Angiopathy (CPA) in a health care center.

Methods: Retrospective analysis of the hospital's brain arteriovenous malformation databank of 570 cases since 2004. CPA was determined based on the definitions proposed recently (Lasjaunias et al., 2008). The patients' clinical and hospital charts were reviewed. In addition, vascular specialists, whom classified the cases based on the architectural nature, consulted the cerebral angiogram and magnetic resonance imaging.

Results: Nine patients with CPA were identified, representing 1.57% of all vascular malformations in our center. We have identified a high prevalence of CPA in young adults (mean age 24), besides a male predominance (77.8%; n = 7). Seizures was the most common symptom (n = 6); only one case presented a hemorrhagic event and three cases showed stroke-like symptoms. None of the patients was managed through endovascular procedure. Only one patient was sent to the operating room for a ventriculoperitoneal shunt; due to the possibility of the hemorrhagic event to narrow the fourth ventricle. No patient died due to CPA and all procedures were uneventful with no complications due to procedure.

Conclusion: Neurosurgeons and interventional neuroradiologists need to understand the conservative medical management of this recent described cerebral vascular entity. Moreover, be reminded that, despite, the known “benign” evolution, CPA can present complications that require aggressive medical care. At last, we affirm that stroke-like events can be present as a main symptom, the light for treatment will not discovered until this time.

Reference

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Developmental Venous Anomaly (Dva) could be Related to Cerebral Proliferative Angiopathy?

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Purpose: Abnormal venous drainage patterns, such as developmental venous anomalies (DVAs), are frequently related to neighbouring vascular malformations. Although the clinical relevance of DVAs remains controversial, increasing attention has been focused on the possible importance of venous outflow disturbance and venous
hypertension in DVAs for the appearance of other malformations, like cerebral proliferative angiopathy (CPA). Our purpose is describe a case where we observed a direct relationship between DVA and CPA.

Methods: We report a case of a 12 years old boy with long-standing complaints of right sided hypoesthesia and seizures, whose brain angiogram had findings compatible with a DVA draining a vascular malformation with cerebral proliferative angiopathy features.

Results: Our patient, since childhood, had complaints of right sided hypoesthesia and seizures. After neurologic evaluation (where a Magnetic Resonance showed a DVA in the left post-central cortex), he was referred to our service.

Conclusion: A cerebral angiography was performed and reveals a tangle of small vessels in the transition of arterial and capillary phase, without early venous drainage, but draining into a DVA located along the left post-central cortex. As well as some theories already described, we believe that our case is an example that some degree of compromise in venous drainage, due to DVA, leads to a process of angiogenesis and vascular malformations development.

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Wyburn Mason Syndrome: A Report about an Incomplete Metameric Capillary Malformation

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Purpose: Wyburn-Mason syndrome (WMS), also known as Bonnet-Dechaume-Blanc syndrome or retinoencephalofacial angiomatosis, is a rare condition. It is considered one of the nonhereditary congenital phakomatoses and is characterized by vascular malformations (arteriovenous and capillary mostly) that affect the retina, visual pathways, midbrain, and facial structures. It usually is unilateral and often is asymptomatic. Our aim is describe a case where the WMS presents incompletely.

Methods: We report a case of a 32 years old woman with long-standing complaints (from the childhood) of right visual commitment, whose brain angiogram had findings compatible with a capillary malformation affecting the optic pathway.

Results: Our patient, since childhood, had complaints of right visual disturbances, which gradually evolved into complete loss. After ophthalmologic evaluation (ophthalmoscopy examination reveals multiple dilated vascular channels over the right retina suggestive of retinal vascular malformation), it was referred to the holding of a cerebral angiography.

Conclusion: Cerebral angiography reveals a tangle of small vessels in the transition of arterial and capillary phase, without early venous drainage, following the path of the right optic way, starting in the retina, through nerve, chiasm and optic tract. Features were in keeping with Wyburn-Mason syndrome (WMS). Because it is only capillary, and because there is already complete loss of vision, the treatment of our patient was conservative.

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Spontaneous Thrombosis of Brain Arteriovenous Malformation after Partial Endovascular Embolization

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Introduction: Spontaneous thrombosis of brain arteriovenous malformation (BAVM) rarely occurs. Frequency of spontaneous BAVM occlusion after partial endovascular embolization is not known and few case reports were published.

Objective: To demonstrate a case of spontaneous BAVM occlusion after partial endovascular embolization.

Case presentation: A 60-year-old male patient who had presented with generalize tonic clonic seizure (GTC) for 30 years. CT scan of brain was performed and showed right frontal brain AVM with partially thrombosed venous ectasia. Cerebral angiography was done which presented moderate-sized BAVM at right frontal lobe, Spetzler Martin was grade III. Two branches of transarterial embolization were done using mixtures of NBCA/Lipiodol. Control angiogram showed 30% flow reduction of BAVM. Five months after embolization, cerebral angiogram confirmed complete obliteration of the BAVM.

Conclusion: Most of spontaneous thrombosis of BAVMs after partial embolization are small size. However, this event can occur in moderate or large size of the BAVM likes our case.
Bilateral Segmental Agenesis of the ICA with Vascular Re-Routing Through a Trans-Sellar Intercavernous Anastomotic Artery, a Persistent Trigeminal Artery and a Hypertrophied Ascending Pharyngeal Artery

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Purpose: To describe a case of bilateral congenital agenesis of the ICA with collateral support via a rare trans-sellar intercavernous anastomotic artery, the origin of which remains elusive in the literature. We discuss the embryogenesis of the ICA (Lasjaunias, 1980), the patterns of collateral support in ICA agenesis (Lie, 1968) and the theory behind the vascular re-routing which occurs when a particular segment of the ICA fail to form, as well as the clinical relevance of these anomalies.

Methods: A 39-year-old woman presented with a symptomatic small left parietal cortical infarct, which was later ascribed to an ASD diagnosed on echocardiography, MRI/MRA, cerebral DSA, and cone-beam CT with intra-arterial contrast demonstrated agenesis of the right ICA from its origin and continuation of the right CCA as a hypertrophied ascending pharyngeal artery, which penetrated through the tympanic canal entering the intrapetrous carotid canal and reconstituting the ICA via anastomoses with the caroticotympanic artery. The left ICA was also absent from its origin to the cavernous segment, with a trans-sellar anastomotic artery providing right to left flow between the cavernous ICAs, and a right paramedian artery connecting the upper basilar trunk (at the expected origin of a PTGA) directly to the intercavernous artery, a persistent right dorsal ophthalmic artery and small extradural aneurysms.

Conclusion: Agenesis of the ICA is a rare congenital anomaly, with an incidence of less than 0.01%. Approximately 100 cases are reported in the literature (a small proportion of which are bilateral) and the trans-sellar intercavernous anastomosis seen here is reported in less than one fifth of these cases (Given et al., 2001). Furthermore an inter-cavernous collateral artery and a contralateral persistent trigeminal artery have not previously been described in a single patient (Quint et al., 1989), which may lend weight to one of the two main theories on the origin of this unusual vessel.

References
Bilateral Infra-Optic Origin of Anterior Cerebral Arteries- A Rare Variant: Its Embryogenesis and Clinical Significance

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Purpose: Phylogenetically, the anterior cerebral artery is amongst the oldest vessels of the telencephalon. Its early connection with choroidal vasculature and primary role as a rostral internal carotid artery trunk, leads to many important variations with considerable clinical significance (e.g. cerebral aneurysm and perforator AVM supply). Of importance is the fact that this anomaly is associated with intracranial aneurysms and approximately 44% of patients with this variation will have an anterior communicating artery aneurysm (Chakraborty S et al., 2006)

Although anatomical variations of the anterior cerebral artery are common, bilateral infra-optic course of the anterior cerebral artery is extremely rare with less than 5 cases described in literature. (Ji C et al., 2010)

Methods: We describe a case of bilateral infra-optic origin of the anterior cerebral arteries associated with a posterior communicating artery aneurysm that was admitted to our unit. We also present a hypothesis of the embryogenesis of this rare anatomical variant and its clinical significance.

Results: A 54 year old female patient was transferred to our institution with sudden onset severe occipital headache and collapse. The initial CT brain scan demonstrated subarachnoid haemorrhage.

Subsequent CT angiography revealed an aneurysm of the left posterior communicating artery which was suspected to be the cause of the subarachnoid haemorrhage.

This study also demonstrated the anomalous origin of the right anterior cerebral artery.

Conclusion: Subsequent catheter angiography revealed bilateral infra-optic origins of the anterior cerebral arteries and a left posterior communicating artery aneurysm. The posterior communicating artery aneurysm was embolised and the patient made a good clinical recovery.

References

Anomalous Origin of the Posterior Inferior Cerebellar Artery (PICA) from the Cervical Internal Carotid Artery: A Kind of Carotid-Basilar Anastomosis?

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Purpose: Anastomotic vessels between the carotid and vertebrobasilar systems exist during embryonic development. The one that persists most frequently in adults is the persistent trigeminal artery, occurring with an incidence about 0.5% in cerebral angiograms. Unlike those arteries that have a direct communication with the basilar artery, there are case reports in the literature of direct anastomosis between the intracranial internal carotid artery and the cerebellar arteries, without the interposition of the basilar artery. These arteries are considered persistent trigeminal artery variants. Our goal, therefore, is to describe a case where we observe a posterior inferior cerebellar artery (PICA) originating from the cervical internal carotid artery under an embryological analysis.

Methods: We report a case of a 36 years-old woman with chronic complaints of headache, with not well-defined characteristics, which underwent a vascular study that showed, as an incidental finding, the left PICA originated from the left cervical internal carotid artery.

Results: Because of a chronic condition of headache, our patient underwent a study of magnetic resonance imaging (MRI) with angio (MRA), whose only finding was a cerebellar arterial branch originated from the left cervical internal carotid artery (ICA).

Conclusion: Subsequent catheter angiography revealed bilateral infra-optic origins of the anterior cerebral arteries and a left posterior communicating artery aneurysm. The posterior communicating artery aneurysm was embolised and the patient made a good clinical recovery.

References
Purpose: Anterior cerebral artery (ACA) complex has indisputable functional, neurological and neurosurgical significance. The purpose of this study is to describe some of the features, variations of this artery and its angiographic correlation.

Methods: We retrospectively reviewed 300 digital subtraction angiography (Phillips Allura™ and Allura Clarity™) from patients without pathology. Then gross anatomy, patterns of origin, its course, branches and the variability of the ACA complex was studied with special emphasis in A-1 segments, A-2 and anterior communicating artery (AcoA).

Results: ACA arise from the carotid bifurcation, in its first portion it passes through the carotid cistern, it runs horizontal and anterior direction. It has a lower caliber 1–4 mm (2.6 mm) in its origin in regard to the Middle cerebral artery (MCA) in 70% of the cases, equal 24% and higher 6% (especially in A-1 contralateral hypoplasia). The A-1 segments varied in length from 7.2 to 18.0 mm. A difference in diameter between the right and left A-1 was found in 62% and hypoplasia in 10%. The average diameter of the ACoA was 1.2 mm, one AcoA in 60%, double en 30%. ACA Aycgos 3%. The A-2 segment describes an anterior and superior shape curve, in relation with the corpus callosum.

Conclusion: The precise knowledge of the anatomic variation in this vascular complex is essential to a correct analysis, interpretation and therapeutic planning, both interventional neuro-radiology and neurosurgical.

5 – Critical Care

Emergency Balloon Embolization for a Traumatic Carotid-Cavernous Fistula Presenting with Hemorrhagic Venous Infarction: A Case Report

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Purpose: To demonstrate an emergency endovascular treatment for traumatic carotid-cavernous fistula with hemorrhagic complication using gold-valve balloon.

Methods: A 42-year-old male presented with progressive chemosis and proptosis of the right eye for 2 months. He had a history of motor cycle accident with severe head injury before his symptoms occurred about 2 weeks. He met the physician and underwent MRI / MRA of the brain demonstrated an arterialization of enlarged bilateral cavernous sinuses and bilateral superior ophthalmic veins, indicating traumatic carotid-cavernous fistula. Cortical venous reflux to the right cerebral and cerebellar hemispheres was seen without definite brain signal change. However, he was not given any treatment.

Results: Then approximately 3 weeks later, he developed generalized seizure and acute left hemiparesis. CT of the brain showed a large acute intraparenchymal hematoma at the right fronto-parieto-temporal lobe. He was referred to our hospital and then, emergency digital subtraction angiogram was done which confirmed a traumatic carotid-cavernous fistula in the right side with aggressive reflux to the right sphenoparietal sinus, right uncal vein and right superior petrosal sinus which connected to the right right cerebral and cerebellar cortical veins. Furthermore, other refluxes to bilateral superior ophthalmic veins and bilateral inferior petrosal veins were visualized. In the meantime, transarterial embolization was done under local anesthesia using one gold-valve balloon with successful closure of the fistula. Total procedural time including diagnostic angiogram & treatment was less than 45 minutes.

Conclusion: Balloon embolization is an easy, rapid and effective emergency treatment for a traumatic carotid-cavernous fistula with hemorrhagic venous infarction.

Eagle Syndrome Presented with Neurological Symptoms

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Purpose: Eagle syndrome characterized by the long styloid process accompanied by the styloid ligament calcification. Most symptomatic cases have craniofacial and cervicofacial regions pain. Clinical findings related to the lower cranial nerves compression have also been reported. Another way of symptomatology is the carotid artery compression. Eagle syndrome with neurologic symptoms has been reported rarely.

Methods: Four cases, aged 22–68 years, admitted to hospital with different neurological symptoms were reviewed retrospectively.

Results: Case 1
32 –year-old male patients presented with headache and ataxia. Craniocervical angio CT and MRI revealed bilateral long styloid process, right transverse-sigmoid sinus thrombosis related to the right jugular vein compression by the styloid process. The patient managed with long term anticoagulation.
Case 2
22-year-old man presented with papilledema and headache. Angio CT revealed hypoplastic right transverse sinus and compressed left internal jugular vein between the C2 transverses process and calcified styloid ligament. The patient was prescribed antiedema medications.
Case 3
39 –year-old presented with recurrent aphasia and right hemiparesia. Angio CT revealed bilateral long styloid process and left cervical internal carotid artery loop caused by the abnormal left styloid process. And a result of
compliance of the left ICA developed ischemia in parietal region. The abnormal styloid process was resected surgically.

Case 4

69-year-old male patient presented with recurrent TIA related to the right cerebral hemisphere. Angio CT revealed abnormally long right styloid process compressing the right ICA accompanied by the fusiform aneurysmal dilatation of the artery. The patient was managed by the life long antagoagant treatment.

Conclusion: Eagle syndrome may be presented with neurological symptoms. It would be kept in mind in differential diagnosis in case of neurological symptoms without any objective etiological factors.


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Purpose: The purpose of this case study is to demonstrate the clinical efficacy of contralateral carotid angioplasty with stenting (CAS) for acute stroke due to ipsilateral iatrogenic traumatic thrombotic aneurysm of the cervical internal carotid artery (ICA) to the patient who diagnosed skull base infection.

Methods: 78 year old male patient underwent left mastoidectomy for chronic otitis media at otorhinolaryngology department. 3 months after the operation, patient complained continuous left side headache and ear discharge, so check up the temporal computed tomogram (CT) and neck angio CT. The 15.2x11.1 mm sized thrombotic pseudo-aneurysm on petrous segment of the left ICA and severe stenosis of right carotid bulb was seen on CT scan. So transfer to neurosurgery department for treatment of developing acute stroke due to thrombogenesis by pseudo-aneurysm and contralateral ICA stenosis. Trans-femoral carotid angiography and contralateral angioplasty with stenting for developing acute stroke due to iatrogenic traumatic thrombotic pseudo-aneurysm was done. After stenting, left ICA was automatically occluded and right ICA supplied contralateral ICA territory.

Results: 2 months after contralateral CAS, although there are no neurologic change, patient complained continuous left eye ball pain and ear discharge. So after check up the orbit CT and Brian MRI (magnetic resonance image) enhance, he diagnosed severe skull base infection and uveitis. Although adequate antibiotics therapy, patient expired due to severe skull base infection with progressed systemic infection.

Conclusion: Although right ICA blood flow increased and supplied left ICA territory via anterior communicating artery, skull base infection and uveitis was aggravated due to interrupted blood supply of left distal ICA territory. Meticulous attention is required to the contralateral CAS with thrombotic pseudo-aneurysm occlusion of the ipsilateral ICA on severe skull base infection patient.

6 – DAVF

Spontaneous Angiographic Changes in Venous Drainage Patterns Related to Symptom Changes in Patients with Untreated Cavernous Sinus Dural Arteriovenous Fistula

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Purpose: We aimed to evaluate the relationship between symptom changes and angiographic changes in untreated cavernous sinus dural arteriovenous fistula (CSDAVF), with a focus on venous drainage patterns

Method: The clinical and radiologic features of 34 untreated CSDAVF patients were retrospectively reviewed. We classified venous drainage patterns as Type I (only antegrade drainage), Type II (combined antegrade drainage and venous reflux), Type III (venous reflux without antegrade drainage), and Type IV (stasis or occlusion of venous reflux). Symptom changes were categorized as improvement, aggravation of initial symptom, and pattern change.

Results: Twenty-one patients (61.7%) showed symptom changes during the follow-up period (median, 12; range, 3–151 months). In the symptom improvement group (n = 10), all patients with follow-up angiography showed spontaneous occlusion. In the symptom aggravation group (n = 4), new venous reflux developed in two (Type I to Type II) and spontaneous occlusion occurred in two (Type III to spontaneous occlusion). In the pattern change group (n = 7), two showed new venous reflux (Type I to Type II) and five showed stasis or occlusion of an engorged ophthalmic vein (Type II or III to Type IV). Angiographic regression was observed in all Type III and IV, while cortical venous reflux (CVR) developed in one Type I patient.

Conclusion: Symptom changes correlated with chronic angiographic changes. Without treatment, most CSDAVFs behaved benignly with a low incidence of CVR. Therefore, close observation is possible in CSDAVFs with tolerable symptoms, no CVR, and no antegrade drainage despite aggravation or fluctuation in symptoms.

Christophe Cognard et al., 1995
Dae Chul Suh et al., 2005
Dong Joon Kim et al., 2010
Hiro Kiyosue et al., 2008
Signal Intensity Mimicking Dural Arteriovenous Fistula in Dural Sinuses on Time-Of-Flight Magnetic Resonance Angiography: Changes Caused by Head Elevation

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Purpose: The presence of a flow-related signal in the normal dural sinus on time-of flight (TOF) magnetic resonance angiography (MRA) is common. The aim of this study was to identify changes in signal intensity in the dural sinus caused by changes in patient position.

Materials and Methods: We performed TOF MRA of the cerebral region in supine/head elevation in 64 patients who showed abnormal flow-related signals in the dural sinuses. Flow related signal intensity of the dural sinuses was analyzed.

Results: Flow-related signal was seen in 113 sites (64 patients), specifically in the sigmoid, inferior petrosal, and cavernous sinuses in 65 sites (70.3%; 23 bilateral, 19 left, 3 right), 43 sites (67.2%; 19 bilateral, 20 left, 4 right), and 25 sites (39.1%; 7 bilateral, 13 left, 5 right), respectively. Following head elevation, flow-related signal changes were observed in cavernous, inferior petrosal, and sigmoid sinuses in 105(105/113, 92.9%) sites: there was loss of signal (60/113, 53.1%), or decrease (13/113, 11.5%), mixed decrease (30/113, 26.5%), increase (2/113, 1.8%), or no change (8/113, 7.1%) of intensity.

Conclusions: Flow-related signal of dural sinuses on TOF MRA was affected by head elevation in 92.9% of the sites. Head elevation could be used to differentiate between pathologic and physiologic states.

References

Anterior Ethmoidal Durals Arteriovenous Fistulae (Davf): Radiologic Iconography and Treatment by Endovascular Approach through the Ophthalmic Artery

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CHRJ Jean Minjoz

Purpose: To review the radiologic findings (at Computed Tomography, Magnetic Resonance and Angiography) of anterior ethmoidal dural arteriovenous fistulae (DAVF), a rare intracranial lesion associated with a high risk of intracranial hemorrhage, where a prompt diagnosis and treatment may improve prognosis.

To report the feasibility of endovascular treatment with Onyx, with an approach through the ophthalmic artery, for these high risk lesions that are usually treated by surgery.

Methods: Anterior ethmoidal DAVF are rare intracranial lesions associated with a reported hemorrhage rates ranged from 62 to 91%. We present the radiologic findings in our series of 4 patients with anterior ethmoidal DAVF in median and paramedian localization: three were unexpected findings, one patient presented with a frontal intraparenchymal haematoma.

Results: The prompt diagnosis was suspected at magnetic resonance and computed tomography imaging and confirmed by a cerebral angiography. A procedure of endovascular embolization was considered feasible.

In two cases the endovascular embolization with Onyx was successfully performed through the ophthalmic artery. One patient died for cardiac failure and one patient did not consent to the treatment. A middle (6 months) and a long (1 year) term follow up was performed in treated patients and no residual fistula was observed.

Conclusion: A prompt diagnosis and a following endovascular treatment may improve prognosis of the anterior ethmoidal DAVF, a rare intracranial lesion associated with a high risk of intracranial hemorrhage.
Selective Percutaneous Coil + Squid Embolization of a Recurrent Carotico cavernous Fistula under DSA + Ultrasonographic Guidance

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Purpose: Carotico cavernous fistulas are usually encountered after trauma. Detachable intracranial balloons as well as covered stents and coiling were the most common procedures reported in the literature. Transvenous or transarterial routes might be preferred depending on the availability of the access. However treatment poses a particular challenge when both arterial and venous access including ECA were unavailable.

Methods: A 60 year old patient was treated for carotico cavernous fistula due to previous head trauma. The patient was treated transarterially through bilateral ECA injections. Vascularization through left ICA supraclinoid segment through capillaries were not treated at this session. Follow up angiograms on 6 months of follow-up featured a dilated superior ophthalmic vein with marked dilatation at the cavernous sinus. Nevertheless transvenous access to the fistula was unavailable.

Results: Percutaneous selective puncture of the superior ophthalmic vein was performed with the needle of pediatric 4 F introducer sheath (Terumo Inc, Japan). Puncture was performed on venous routemap of SOV under lateral projection of DSA and Toshiba Applio ultrasonography was utilized for AP sonographic visualization of SOV. After introducing the needle through SOV a preshaped Hybrid double angled microguidewire was introduced through the needle. The microguidewire was introduced to the cavernous sinus and an Excelsior SL10 microcatheter (Stryker Inc.) was introduced over it through the skin to the cavernous sinus. Nevertheless transvenous access to the cavernous sinus was also showed in two cases. One patient’s symptom disappeared with spontaneous closure after diagnostic angiography, but it relapsed one week later. All patients were cured with endovascular shunt occlusion. No periprocedural complication was occurred. There were no recurrences during a mean follow-up period of 29.3 months.

Conclusion: Middle meningeal arteriovenous fistulas were induced not only by head trauma, but also by craniotomy and idiopathic. Endovascular treatment was less invasive and effective. It is also important to investigate the etiology and the mechanism of middle meningeal arteriovenous fistulas.

Endovascular Management of Middle Meningeal Arteriovenous Fistula

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Purpose: Middle meningeal arteriovenous fistulas are rare. The purpose of this study was to evaluate the clinical and radiological features and the treatment outcomes of middle meningeal arteriovenous fistulas.

Methods: Six patients (mean age 46.5 years; 3 men, 3 women) diagnosed with middle meningeal arteriovenous fistula between 1996 and 2013 in our institution were included. We reviewed their medical records, retrospectively.

Results: The clinical presentation was tinnitus without intracranial hematoma in four cases, and epidural hematoma and subarachnoid hemorrhage in two cases. There were the histories of head trauma in two cases. One case was post-craniotomy for ruptured aneurysm, and the remaining three cases were idiopathic. Tinnitus appeared just after head injury in trauma patients, and epidural hematoma was revealed three days after craniotomy. All patients were diagnosed with conventional angiography. The main feeder was middle meningeal artery in all cases, and the meningeal branches of ophthalmic artery also supplied in two cases. The main drainage route was pterygoid plexus in four cases, superior sagittal sinus in one case, and both in one case. The drainage into cavernous sinus was also showed in two cases. One patient’s symptom disappeared with spontaneous closure after diagnostic angiography, but it relapsed one week later. All patients were cured with endovascular shunt occlusion. No periprocedural complication was occurred. There were no recurrences during a mean follow-up period of 29.3 months.

Conclusion: Middle meningeal arteriovenous fistulas were induced not only by head trauma, but also by craniotomy and idiopathic. Endovascular treatment was less invasive and effective. It is also important to investigate the etiology and the mechanism of middle meningeal arteriovenous fistulas.
**Methods:** Thirty-two cases without any lesions affecting cavernous or ACC were examined by using fat-suppressed, contrast-enhanced, 3D fast-gradient-echo sequences. Two radiologists evaluated the anatomy of IPCV in the 64 sides (32 patients) on a workstation. 

**Results:** IPCV were identified in all cases. IPCV originated from postero-inferior wall of CS in 49, medio-inferior wall in one, carotid canal venous plexus in 14 sides. IPCV terminated at ACC in 63 sides and the inferior petrosal sinus (IPS) in one side. IPCV was connected with ipsilateral upper part of IPS in 2, middle part in 36, and lower part in 8. Other connections, including basilar plexus, contralateral IPCV, and anterior condylar vein, were identified in 3, 2, and one respectively. 

**Conclusion:** IPCV can communicate not only with IPS but various surrounding venous structures. The information about the anatomical variation can be essential for the transvenous approach in case with CS and ACC lesions.

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**A Case of Convexity Dural Arteriovenous Fistula Causing Intracerebral Hemorrhage**

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Dural arteriovenous fistulas (dAVFs) are abnormal arteriovenous connections within the dura mater and convexity dAVFs involving diploic venous systems have been rarely reported (Shim et al., 2011). We report a rare case of convexity dural arteriovenous fistula causing intracerebral hemorrhage. She presented with transient left leg paralysis. Magnetic resonance imaging of the brain didn't demonstrate any signs of acute cerebral infarction or hemorrhage. On the fourth day after initial symptom, she became comatose and showed left hemiparesis. Computed tomography revealed intracerebral hemorrhage in the right parietal lobe. Digital subtraction angiography revealed a dAVF within the right temporoparietal bone along right middle meningeal artery grooves. The fistula was fed by frontal branch of right middle meningeal artery and dural branches of right internal maxillary artery and drained into diploic vein finally reaching superior sagittal sinus with cortical vein reflux. Emergency transarterial embolization was performed with NBCA and the shunt flow disappeared. The postoperative course was uneventful and her level of consciousness was gradually improved. Diploic vein is rarely confirmed in digital subtraction angiography, but is revealed under abnormal state, such as dAVFs or trauma (Inui et al., 2012). Since diploic veins have connections to intracranial dural sinuses and play a role for maintaining cerebral venous perfusion (Gonzalez et al., 2009), dAVFs involving diploic veins, might cause intracerebral hemorrhage. We report a rare case of convexity dAVFs associated with the diploic vein which was successfully treated with transarterial NBCA embolization. For curative treatment, the angiographic architecture must be analyzed carefully.

**References**


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**Onyx Embolization of Dural Arteriovenous Fistulas with Cortical Venous Drainage**

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**Purpose:** We assessed the efficacy of onyx embolization of dural arteriovenous fistulas (DAVF).

**Methods:** We performed onyx embolization for 5 patients with DAVF which was difficult to apply transvenous approach. The location of DAVF is transvers-sigmoid sinus among 4 patients and superior sagittal sinus among 1 patient. In all patients, onyx was injected trans-arterially.

**Results:** In all cases, affected sinus was filled with onyx and total occlusion was achieved. In 1 case, the fixed microcatheter by onyx was ruptured during the removal. But there were no neurological worsening after onyx injection.

**Conclusion:** Onyx embolization of dural arteriovenous fistulas with cortical venous drainage was safe and effective.

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**Contralateral Venous Approach with Sinus Angioplasty for Treatment of Transverse-Sigmoid Dural Arteriovenous Fistula with Cortical Reflux**

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**Purpose:** Endovascular treatment options for dural arteriovenous fistula (DAVF) involving the transverse-sigmoid sinus include transvenous and transarterial embolization. However, in certain conditions such as venous stenosis or venous occlusion, transvenous embolization can be difficult to achieve. We report two cases of DAVF treated by...
transvenous embolization with balloon angioplasty via contralateral venous approach.

**Methods:** Case 1: A 62-year-old male patient with a history of dural venous sinus thrombosis refractory to anticoagulant therapy presented with acute onset of nausea and hemiparesis. Magnetic resonance imaging (MRI) revealed dilated cortical veins and cerebral edema. Angiography showed DAF with occlusion of ipsilateral transverse-sigmoid sinus and severe stenosis of contralateral transverse sinus. Case 2: A 57-year-old female patient presented with generalized seizure and deteriorated mental status. MRI and angiography showed DAVF of the left transverse-sigmoid sinus and the proximal segment of the right transverse sinus occlusion with massive cortical reflux.

**Results:** Endovascular approaches were attempted via the contralateral venous route. Mechanical dilatation or recanalization of the contralateral transverse sinus was achieved by balloon angioplasty. Subsequently, the microcatheter was advanced into the fistulous point at left transverse-sigmoid region through right transverse sinus. Embolization of the fistula was then accomplished by filling with coils. Angiograms after endovascular treatment showed restoration of antegrade venous drainage as well as complete occlusion of the fistulous shunting. The patients were discharged with improving neurological symptoms and signs.

**Conclusion:** In selected patients with serious intracranial hypertension due to massive cortical reflux, the treatment options should be considered not only to obliterate the fistula but also to restore a normal cerebral venous drainage. Contralateral venous approach with sinus angioplasty can be a viable option for management of DAVF.

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**Onyx Embolization for Aggressive-type Isolated Dural Arteriovenous Fistula using the Double-lumen Balloon Catheter**

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**Purpose:** This study aimed to compare the results of transarterial Onyx embolization using a dual-lumen balloon catheter with those using non-balloon catheter for aggressive-type (Borden type, 2 or 3) isolated dural arteriovenous fistula (ai-DAVF).

**Materials and Methods:** A total of 29 patients (mean age, 52 years; M:F = 20:9) underwent transarterial Onyx embolization for ai-DAVF using a dual-lumen balloon or non-balloon catheters between November 2007 and November 2014. Since introduction of the dual lumen balloon catheter, it has been exclusively used for Onyx embolization of ai-DAVF. We compared balloon catheter group (n = 15) with historical non-balloon catheter group (n = 14) in treatment-related complication, angiographic outcome, total procedural and Onyx injection times, and the number of feeders embolized.

**Results:** The balloon group showed complete occlusion of ai-DAVF in 13 and near complete in 2 patients, while the non-balloon group showed complete occlusion in 5, near complete in 5, and incomplete in 4 patients. (p < 0.05) Treatment-related complications occurred in 2 patients; cranial nerve palsy in 1 patient (6.7%) of the balloon group and Onyx migration to middle cerebral artery in 1 patient (7.1%) of the non-balloon group, respectively. The median number
of feeders needed to be embolized was 1 (range, 1–3) in the balloon and 2 (range, 1–4) in the non-balloon group, respectively. \((p < 0.05)\) The mean total procedural time was 62 minutes \(\pm 32\) minutes in the balloon and 171 minutes \(\pm 88\) minutes in the non-balloon group. \((p < 0.05)\) The mean Onyx injection time was 10 minutes \(\pm 6\) minutes in the balloon and 49 minutes \(\pm 32\) minutes in the non-balloon group. \((p < 0.05)\)

**Conclusion:** The utilization of the dual-lumen balloon catheter for Onyx embolization of ai-DAVF seemed to significantly increase immediate complete occlusion rate and to significantly decrease both total procedural and Onyx injection times and the number of feeders needed to be embolized.

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**456** Presentation withdrawn

**Traumatic Carotid Cavernous Fistula with a Connection between the Supraclinoid Internal Carotid Artery and Cavernous Sinus via a Pseudoaneurysm Presenting with Delayed Life-Threatening Epistaxis**

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**Purpose:** To the best of our knowledge, this is the first case of a traumatic carotid cavernous fistula (CCF) with a connection between the supraclinoid internal carotid artery (ICA) and cavernous sinus (CS) via a pseudoaneurysm, presenting with delayed life-threatening epistaxis.

**Methods:** A patient with a history of basal skull fracture due to blunt head trauma eight months previously was referred to our emergency room for massive epistaxis.

**Results:** Cerebral angiography demonstrated a high-flow CCF with a connection between the supraclinoid portion of left ICA and CS via a pseudoaneurysm, suggesting the life-threatening epistaxis had been caused by high-flow shunting, through the gap created by the basal skull fracture.

**Conclusion:** After complete obliteration of the pseudoaneurysm arising from the supraclinoid ICA by stent-assisted coil embolization, the CCF was no longer evident and epistaxis ceased.

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**Venous Congestion of the Brain Stem in CCF and Hypoglossal Canal DAVF Mimicking Arterial Infarction in MRI; the Abandoned Venous Anatomy**

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**Purpose:** The objectives of two case reports are emphasis of venous anatomy & related MRI abnormalities occurred in case of arteriovenous fistulae & venous drainages

**Methods:** Imaging of patients who diagnosed of carotid cavernous fistula (CCF) & hypoglossal canal DAVF were analyzed including follow up imaging.

**Results:** A woman who diagnosis of left CCF underwent MRI. The MRI reviewed hypersignal T2W with restricted DWI at the right cerebral peduncle. She was free of neurological deficit, specifically, hemiparesis. Her angiogram revealed venous reflux via the left uncal vein toward the right peduncular vein. Another patient had two shunts, left cavernous and hypoglossal DAVFs. The MRI showed restricted DWI at left sided pons. The venous reflux around the brain stem was demonstrated in angiogram. These two patients had provisional diagnosis of arteriovenous shunt with brain stem arterial infarction. The shunts were successfully obliterated, endovascularly. Six months follow up MRI, the brains returned to normal state.

**Conclusion:** The knowledge of venous anatomy is crucial to explain the abnormality of arteriovenous shunt. The discordance of MRI abnormality and symptoms of the arteriovenous shunt patient should raise suspicion of venous congestion/infarction rather than co- incidental abnormality e.g. acute arterial infarction.

**References**


Transvenous Injection of N-Butyl 2-Cyanoacrylate to Obliterate the Pathologic Cavernous Sinus as a Salvage Technique for Incompletely Obliterated Complex Cavernous Sinus Dural Arteriovenous Fistula after Transvenous Coil Embolization

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Purpose: We present a case of transvenous injection of n-butyl 2-cyanoacrylate (NBCA) to obliterate the pathologic cavernous sinus as a salvage technique for incompletely obliterated complex cavernous sinus dural arteriovenous fistula (CsdAVF) after transvenous coil embolization.

Methods: A 60-year-old female patient with exophthalmos, chemosis of the right eye and diplopia secondary to right third nerve palsy visited an ophthalmologic clinic. Diagnostic cerebral angiogram demonstrated a Barrow type D of complex CsdAVF, and it was completely obliterated by using coils, NBCA and Onyx via transvenous approach. Especially, after transvenous coil embolization of the pathologic cavernous sinus (CS), follow-up angiography revealed residual shunt could not be negligible. Hence, transvenous injection of NBCA was done to obliterate residual shunts recruited into CS.

Results: During injection of NBCA, it was continuously infiltrated into coiled pathologic CS as a one column to proximal segment of SOV, and refluxed into distal segment of multiple fine feeders. We achieved complete obliteration of the complex CsdAVF without periprocedural complications.

Conclusion: Transvenous injection of NBCA could be considered as a feasible option for obliteration of pathologic CS in a case of incompletely obliterated complex CsdAVF after transvenous coil embolization. Because it is a challenging technique with significant potential risks, however, transvenous injection of NBCA should be limited to specific cases.

Treatment of AVM/DAVF with Perimedullary Drainage

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Purpose: Report the diagnosis and treatment of 4 patients of intracranial AVM/DAVF with perimedullary drainage.

Methods: In last 3 years, we experienced 4 patients diagnosed to have intracranial AVM (n=1) or DAVF (n=3) with perimedullary venous drainage. They aged 57 to 81 years old and 3 of them were female. Two patients presented mainly with tetraplegia, one with subacute loss of consciousness, and one with frequent dizziness. All of them have abnormal bright T2 signal and enhancement on MR examination. Perimedullary flow void were found on only 2 patients. CTA are major tool for treatment planning except for the AVM case. The lesion of AVM case located in the right parieto-occipital lobe with straight sinus occlusion. Two of the DAVF cases were at the posterior cavernous –tentorium junction, and one at the sigmoid sinus.

Results: The 4 patients were treatment by endovascular management. Coiling along were used in 2 patients, onyx alone in one patient, and mixed coil and onyx in the remaining one. Two of them have good recovery while the remaining 2 have moderate disability in long-term follow-up.

Conclusion: The vascular lesion with perimedullary drainage mainly presented myelopathy but the main lesion may be far away. They can be managed by endovascular treatment but the outcome is depending on the initial clinical status.

Clinical Aggressive Cavernous Sinus Dural Arteriovenous Fistula: Angio-Architecture Analysis and Embolization by Various Approaches

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Purpose: Most cavernous sinus dural arteriovenous fistulas (CSDAVF) presented with benign neuro-ophthalmic symptoms. CSDAVF manifest with clinically aggressive neurologic symptoms deficits is rare. The purpose of this study is to analyze the angio-architectures of clinically aggressive CSDAVF and to report our experiences of embolization.

Materials and Methods: In the past 10 years, a total of 118 CSDAVF had been managed by embolization. From these databases, eight patients (6.8%) were found to have clinically aggressive CSDAVF. There were 6 women and 2 men, age ranged from 58 to 79 years (mean: 69). We retrospectively analyzed the angio-architecture of clinically aggressive CSDAVF, and angiographic as well clinical outcomes of embolization.

Results: The causes of clinical aggressive of CSDAVF were constraint fistula drainage of CSDAVF because of occlusion of inferior petrous sinus (IPS) with fistula flow reflux to veins of brainstem (n=6) leading to non-hemorrhagic brainstem ischemia/ edema, while 2 fistula flow reflux to cortical vein leading to intracerebral hemorrhages. Transvenous embolization via occlusive IPS to fistula was achieved in 1, five underwent trans-orbital access, while trans-arterial embolization was performed in 2. Total fistula occlusion was achieved in all 7 patients. All patients had gradually total (n=7) or partial (n=1) resolution of their symptoms within
6 months. One patient had limb weakness because of inadvertent pial embolization. Mean clinical follow-up period was 16 months.

Conclusions: Clinically aggressive CSDAVFs always associated with occlusion of IPS with leptomeningeal reflux. Most present with brainstem ischemia, followed by hemorrhagic or non-hemorrhagic stroke in cerebrum. Embolization by various accesses is a feasible and safe method to manage these clinically aggressive CSDAVFs.

Dural Arteriovenous Fistula Spontaneous Closure and Resurgence: Possible Mecanisms and Literature Review

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Purpose: Our goal is describe a case about spontaneous regression and resurgence of a Dural Arteriovenous Fistula (DAVF), analyzing the possible mechanisms based on a literature review.

Methods: We report a case of a 53 years old woman with long-standing complaints of right pulsatile tinnitus who was diagnosed with a DAVF of the right sigmoid sinus, which later showed spontaneous closure and subsequent recanalization through the same sinus.

Results: The patient underwent a cerebral angiography that revealed a DAVF in the wall of the right sigmoid sinus, fed by branches of the right middle meningeal, occipital and posterior auricular arteries. By decision of the patient, it was decided not to carry out any treatment. 8 years later, a new angiography was performed, and to our surprise, it was not observed the fistula, but only irregularities in the wall of the sigmoid sinus and reduction in its caliber, findings compatible with venous thrombosis. Months later, she presents, one more time, complaints of pulsatile tinnitus. This time, we observed the reappearance of the DAVF at the same topography, however, associated with isolation of the right sigmoid sinus, exclusively draining the fistula, and no more normal brain.

Conclusion: The relationship between DAVF and venous thrombosis is extremely close and cause – effect. The secondary hypertension due to venous thrombosis can open dural communications pre – existing, in the same way that the arterialization of the sinus can lead to endothelial injury and thrombosis. The evolution in the case that we have described would be an example of these hypotheses.

Selective Transvenous Embolization Combined with Balloon Sinoplasty for the Treatment of Intracranial Dural Arteriovenous Fistulas with Sinus Occlusion

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Purpose: Transvenous sinus packing with coils has been widely accepted as a curative treatment method for the dural arteriovenous fistulas (DAVF) with sinus occlusion. Some technical reports including luminal angioplasty or stent placement have been described to reconstruct the antegrade venous drainage. In addition, recent anatomical considerations describing about parasinus have enabled us to achieve selective embolization of shunted venous pouch. We report the technical results in 5 cases of DAVFs with sinus occlusion which were treated by selective transvenous embolization combined with balloon sinoplasty (STVEBS).

Methods: Five consecutive patients undergone STVEBS between March 2009 and March 2015 in our institution were retrospectively reviewed. There were five male, aged 68 to 83 years old. Three patients had a DAVF at transverse sinus with ipsilateral sigmoid sinus or jugular vein occlusion. One patient had concurrent DAVF at right sigmoid sinus and left transverse sinus with left trans-sigmoid sinus occlusion and previous history of right jugular vein ligation. The other one had an isolated DAVF at superior sagittal sinus.

Results: In three of the five cases, the fistula was completely obliterated by selective embolization and antegrade sinus flow was successfully reconstructed by sinoplasty. The other 2 patients showed recanalization of DAVFs at the occluded sinus with reopening of the sinus after balloon angioplasty. They were subsequently treated by sinus packing. In all 5 patients, angiography showed complete obliteration of the DAVF. No complication occurred and clinical symptoms had improved. No recurrence was observed in all patients during 3 to 75 months follow-up periods, and reconstructed sinus was patent in all 3 patients who was undergone STVEBS successfully at the last follow-up.

Conclusion: STVEBS can obliterate the DAVFs with reestablish antegrade sinus flow, and would be an effective and safe treatment method for the cases of DAVFs with sinus occlusion.
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Reversible Cognitive Impairment with Bilateral Thalamic Lesions Resulting from Dural Arteriovenous Fistula

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Introduction: Intracranial dural arteriovenous fistula (DAVF) is a rare cause of bilateral thalamic lesions and cognitive impairment.

Objective: To demonstrate an interesting case of DAVF at occipital dura with associated reversible thalamic dementia.

Case presentation: A 51-year-old man presented with a one-month history of lethargy and memory impairment. The cranial computer tomography (CT) and magnetic resonance images (MRI) showed bilateral thalamic lesions with associated enhancement. Initially cerebral venous thrombosis was considered and the patient received anticoagulants, which did not improve the symptoms. Repeated brain MRI and MRA suspected a tentorial DAVF. Cerebral angiography demonstrated DAVF in the right occipital dura which supplied by right middle meningeal artery (MMA) and dural branches from right vertebral artery. The DAVF was retrogradely drained into the cortical veins of right occipital lobe, the vein of Galen, internal cerebral veins and basal veins of Rosenthal, bilaterally. Endovascular embolization via transarterial approach was done. After embolization, his clinical symptoms were gradual improved and turned to baseline. Normalization of the imaging findings was also observed.

Conclusion: We report this case to emphasize an importance of accurate diagnosis and proper management of DAVF with thalamic dementia. Cognitive impairment caused by venous hypertension in bilateral thalami associated with DAVF is very rare and difficult to diagnosis however it may be reversible after timely treatment.

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Concomitant Origin of the Anterior Spinal Artery from the Feeder of the Spinal Dural Arteriovenous Fistula (SDAVF)

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Purpose: Concomitant origin of the anterior spinal artery (ASA) or the posterior spinal artery (PSA) from the feeder of SDAVF is rare but sometimes occurs. We report management of the SDAVF in such cases.

Methods: We reviewed 63 patients with SDAVF in our database since 1993. Angiographic findings of the segmental artery including lesion level were reviewed. Feeder origin was evaluated whether ASA or PSA was concomitantly originated. Treatment modality (surgery vs. embolization) and outcome was evaluated. Technical outcome was evaluated as complete, partial or no obliteration. Clinical outcome during follow-up period was evaluated as aggravated, stationary or improved.

Results: Nine patients had the concomitant origin of the ASA or PSA with the feeder. There were 2 cervical, 5 thoracic, 2 lumbar levels. Concomitant origin the feeder was identified with ASA (n = 7) and PSA (n = 2). Embolization was performed in 4 and op in 5 patients. Embolization resulted in complete obliteration of the lesion in 3 and partial obliteration in 1 with improvement of symptom. Final patient outcome was assessed as having improved state in 3 embolization and 4 surgery and stationary in 1 embolization and 1 surgery during 2–148 months.

Conclusion: Embolization may not be impossible and can be tried in selected cases even though operation is recommended in patients with SDAVF when there is concomitant origin of the feeder with ASA or PSA. We will discuss the technical point and risk in embolization.

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Analysis of Intracranial Dural Arteriovenous Fistulas in Northern Thailand: A Preliminary Study

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Purpose: To analyse natural history, angioarchitecture, management and treatment outcomes of intracranial dural arteriovenous fistula in our institute.

Materials: A retrospectively reviewed 61 patients with intracranial dural arteriovenous fistulas (DAVF) presented at our institute between June 2010 and October 2014. The clinical presentations, presumable causes, imaging findings and treatment outcome were reviewed.

Results: The mean age of the study population was 50.4 years with a female predominant. The majority of cases (77%) presented with benign symptoms. DAVF at the sigmoid sinus and anterior cranial fossa were found to present with malignant clinical presentation (P < 0.05). A benign clinical manifestation was found with statistical significant (P < 0.001) in the location of the cavernous sinus. Cortical venous reflux (CVR) was found in all cases presented with aggressive manifestation (P < 0.001) and no CVR was present when there was no venous outflow restriction (P < 0.001). Conservative management and symptomatic treatment in patients with tolerable benign symptoms and absence of CVR showed an improved clinical outcome in about 82%. All of the patients underwent embolization had improved clinical outcome.

Conclusion: DAVF commonly occurs in middle to late adulthood with a variable clinical manifestations mostly
associated to the shunt location. Shunt location, CVR and venous outflow restriction were shown to be related with aggressive manifestation. Endovascular embolization was the mainstay therapeutic method with high rate of good outcomes. In the absence of CVR and tolerable benign symptoms, conservative management with symptomatic treatment could be done.

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ONYX results in higher chances of complete embolization of Intracranial Dural arteriovenous fistulae versus nBCA and coils
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Purpose: Background and Purpose: Intracranial Dural arteriovenous fistulae (DAVF) with cortical venous drainage have a significant morbidity and mortality. Complete closure of these lesions is necessary to reduce these risks. This study retrospectively compares the outcomes of all the local endovascular embolization of DAVFs from 1998 to 2015. We propose that Onyx embolization resulted in fewer complications, similar procedure time and a higher chance of complete obliteration with no need for post-embolization surgery for the DAVF than other embolization methods.

Methods: 117 patients with endovascular embolization for intracranial vascular malformations from 1998 to 2015 were retrospectively reviewed. Patients with arteriovenous malformations or carotid cavernous fistulas were excluded. 27 patients had DAVFs which were treated with embolization during this time period. Inclusion criteria was patients that had DAVFs which were treated with embolization and had imaging on our archiving system. 23 patients met this criteria. Onyx cases were defined with intention to treat principle—any time Onyx was used, it was defined as Onyx case. 11 cases were treated with Onyx embolization, 9 cases were treated with nBCA (N-Butyl Cyanoacrylate) and 3 cases were treated with coils. Successful closure rates, complications and procedure time were compared between the various embolization treatment types.

Results: Post embolization surgery was required for only 2 out of 11 patients treated with ONYX, 7 out of 9 patients treated with nBCA and 1 out of 3 patients treated with coils. The chances of not requiring post embolization surgery with Onyx (81.8%) was significantly higher (p=0.008) than nBCA.
(22.22%). Although the complication rate with onyx (9.1%) was lower compared with that of nBCA (22.22%), it failed to reach statistical significance because of small sample size. Procedural time was not significantly different between Onyx (mean of 267 mins) and nBCA (mean 288 mins) (p=0.59). The odds ratio of a DAVF being treated with only ONYX and then requiring no follow up surgery was 15.75.

Conclusion: Over a 17 year period, our institution finds Onyx superior in completely obliterating DAVFs to nBCA. It was also found to be as safe and as fast as nBCA, as DAVF embolization with nBCA needed multiple catheterizations and multiple injections.

7 – Difficult Cases

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Increasing Role of Professional Neurovascular Communities on Facebook for Fast and Effective Second Opinion

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By now Facebook counts more than 1.5Bn users worldwide. Professional groups are becoming more and more actual for the last three years. The “Vascular Neurosurgery” is a closed professional group, counting more than 4000 vascular neurosurgeons and interventional neuroradiologists worldwide, among them leading specialists of the US, EU, Japan, China, Russia, India etc. Some patients requires second opinion for the best tactics. Tens of my own cases were published inside this closed group, and each time I received fast and very effective reply, often accompanied by references to the evidence based data. In all published for discussion cases good outcome, or best of possible, achieved. Here I present challenging cases of intracranial aneurysms, strokes, AVMs, SAH and vasospasm, published in Vascular Neurosurgery group and examples of discussion cases good outcome. Discussion cases good outcome, or best of possible, achieved. Here I present challenging cases of intracranial aneurysms, strokes, AVMs, SAH and vasospasm, published in Vascular Neurosurgery group and examples of discussion cases, accompanied by results of the treatment and follow up. Online real time discussion of the challenging cases in professional communities may be very helpful and fast. This type of professional communication can get a highly rated second opinion without borders and delays.
Aronov M1

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Radial Access for Complex Aortic Arch Anatomy in Endovascular Treatment of Intracranial Aneurysms

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Purpose: As we work in a high flow Neuroradiological and Cardiological Interventional center, in selective challenging cases of complex aortic arch and supraaortic branches anatomy, we have started using radial access as a valid and useful alternative for intracranial neuroendovascular treatment.

Methods: In 2014, we have adopted this strategy for 3 patients with ruptured basilar side wall and apex aneurysms, after unefective attempts from traditional femoral access. In all cases we have been using triaxial access to deploy a flow diverter stent and, as intermediate catheter, 5 Max Ace, Penumbra. In one case, a giant basilar apex aneurysm, we also coiled the sac with jailing technique. In all cases 6 months DSA and MRI follow up demonstrated complete occlusion of the aneurysms.

Results: We didn’t experienced any periprocedural complication, all radial and vertebral arteries are patent. All aneurysms are apparently cured.

Conclusion: In our experience radial access itself hasn’t shown any addititional challenges, but instead has allowed us to reach safely and quickly the target lesion obtaining an optimal endovascular result and outcome.

Reference
1. References should be in the Harvard (author, date) format within the body of the text (eg. Smith, 2000; Smith & Jones, 2005; Smith et al., 2002) and listed by lead author alphabetical order at the end of the paper.

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Safety and Efficacy of Staged Endovascular Treatment of Neonatal Vein of Galen Aneurysmal Malformations: A Case Series

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Purpose: Controversies surround the safety and efficacy of early endovascular management of Vein of Galen aneurysmal malformations (VGAMs) in the neonatal subgroup of paediatric population. Herein, we present our experience in the management of a series of neonatal VGAMs and the resultant outcome.

Methods: A retrospective review of prospectively maintained paediatric neurology and neurological surgery database was performed to identify cases with prenatal or neonatal VGAM diagnosis. Demographic data, clinical presentation, cross-sectional imaging including digital subtraction angiography (DSA) studies for obtaining angioarchitecture and hemodynamic characteristics of the lesions, treatment process, follow-up imaging, and clinical course were reviewed.
Results: Four neonatal cases of VGAMs (2 F/2 M) were identified. Review of the MR and DSA images revealed large type IV VGAMs causing high-flow arteriovenous shunts resulting in venous hypertension and impaired intracranial circulation in all cases. VGAM-induced clinical complications following delivery included: moderate to severe pulmonary hypertension, respiratory distress, and cardiac failure in all cases. In 3 cases that underwent endovascular embolization, 2 cases were diagnosed prenatally while VGAM was detected in one case during the diagnostic investigation for severe cardiac failure and intestinal ischemia. Multisession endovascular embolization was performed using ethylene vinyl alcohol copolymer and detachable coils starting in the first week of life without any procedural complication. Endovascular management resulted in significant improvement in intracranial circulation in follow-up DSA studies. Clinical complications were resolved dramatically and all 3 cases achieved appropriate growth and met all developmental milestones. One conservatively managed VGAM case was diagnosed prenatally; however, MR investigation in the first day post-delivery demonstrated extensive cortical ischemia which led to respiratory failure and death on the fifth day of life.

Conclusion: Prenatal diagnosis and early endovascular embolization of high-grade VGAMs in neonates plays a pivotal role in achieving favourable long-term outcome in this subgroup of paediatric patients.

References

Flow Diversion Device in the Treatment of Complex and Difficult Intracranial Aneurysms – Case Presentation

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Purpose: The treatment of intracranial aneurysms has evolved from surgical clip ligation to endovascular therapy. The endovascular treatment has progressed from bare coiling to stent-assisted and balloon-assisted coiling. Nonetheless, the downside of coil embolization is its inability to completely and permanently occlude complex aneurysms. With the advent of flow diverter device, these complex aneurysms can be potentially treated. In this poster, we demonstrate different types of complex aneurysms, which can be potentially treated by using the flow diversion devices. In addition, encountered and potential complications are discussed.

Methods: The armamentarium for endovascular treatment of intracranial aneurysms includes bare coiling, balloon-assisted coiling, stent-assisted coiling, parent artery occlusion, intra-aneurysmal cage and flow diverter. These are briefly discussed with diagrammatic illustrations. The concept of flow diversion is elucidated. Flow diverters induce disruption of flow near the aneurysm neck, and induce thrombosis into the aneurysmal sac while preserving physiological flow in the parent vessel and adjacent branches. Besides, asymmetrical growth of neointimal layer on the inner surface of flow diverter reflects local differences in wall shear stress. Flow diversion devices have been used extensively in the treatment of may types of complex aneurysms with good outcome. Twelve cases of different types of complex aneurysms, which were treated with flow diverters in our institution, were demonstrated.

Results: These treated complex aneurysms include giant fusiform basilar aneurysms, giant thrombosed aneurysms, blister like aneurysms, intracranial dissections, difficult ruptured berry aneurysms, bifurcation aneurysms, recurrent/remnant aneurysms, wide neck lateral aneurysms. Encountered and potential complications are illustrated, such as in-stent/in-device thrombosis, intraprocedural vessel rupture/perforation, perianeurysmal edema, distant infarction, delayed hemorrhage, side branch occlusion, and perforator occlusion.

Conclusion: Treatment of complex aneurysms is challenging, because of high rate of recurrence and regrowth. This problem has been largely solved with the advent of flow diversion device.

Endovascular Treatment of Vertebra-Vertebral Arteriovenous Fitula with Hydrogel Coils: Two Case Reports

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Purpose: High flow spontaneous Vertebro-vertebral arteriovenous fistula (VVAVF) is rare disease. In Japan, it is approved only coils as embolic material for VVAVFs. VVAVFs had sometimes high flow shunt so it is difficult for complete obliteration. We treated 2 case of VVAVF with bare platinum coils and hydrogel coils. One case, we occluded vertebral artery (VA), another case, we occluded fistula and vein without VA.
Methods: Case 1, 45 y.o. male, VAVF caused by rt.V3 segment aneurysm rupture. He also have celiac artery aneurysms and left renal aneurysms. We think he is Segmental arterial mediolysis. Lt.VA diameter is similar to rt.VA. We occluded Aneurysm and rt.VA with large volume coils and hydrogel coils via transarteral approach.

Results: Case 2, 62 y.o. male, VAVF in rt.V3 segment. We navigated micro catheter venous site via fistula and balloon catheter to arteries site. We got complete occlusion venous outlet and fistula by coils, preserved rt.VA by balloon catheter. We got complete obliteration with hydrogel coils.

Conclusion: VAVF was treated by detachable balloon, NBCA, ONYX and coils in past report. Coils alone treatment sometimes did not get complete obliteration. Combination of bare coils and hydrogel coils could be considered well tolerated treatment.

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Use of a New Covered Stent for Emergency Bleeding Cases in INR

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Purpose: Complications of invasive neurological procedures require a bail-out device in case of emergency situations. We describe a complex case involving a life-threatening bleeding treated by a neurological pericardium-covered stent graft (AneugraftNx, ITGI Medical Ltd., Or Akiva, Israel) for immediate reconstruction of the blood vessel.

Methods: A 59 year old male underwent transsphenoidal surgery for pituitary prolactinoma. A major bleeding episode occurred due to surgical damage of the internal carotid artery (ICA). A 8 F Guiding Sheath (Destination, Terumo) was placed in the left ICA. Angiogram showed a 1 mm pseudo-aneurysm at the siphon segment. Since a tolerance test failed to demonstrate collateral blood supply, we decided to use a covered stent. A 5F intermediate catheter (DAQ, Stryker Neurovascular) was coaxially placed at the petrous segment of the ICA and a 4 x 18 mm pericardium covered stent (AneugraftNx, ITGI Medical) was deployed to exclude the lesion and stop the bleeding.

Results: The procedure was uneventful, with no signs of rebleeding. The next day MR follow up demonstrated patency of the left ICA; the patient did not experience new bleeding.

Conclusions: Neurological Covered stents may be an efficient and effective treatment in emergency procedures and demonstrates high deliverability with successful deployment to target lesion.
Endovascular Treatment in Ruptured Middle Cerebral Artery Dissection Focus on Arterial Continuity Preservation

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Purpose: Rupture of spontaneous dissecting aneurysm of middle cerebral artery (MCA) is rare and the etiology remain obscure although the risk of rebleeding is greater than saccular aneurysm. Until now, most of reports about a treatment of dissecting rupture of anterior circulation are about surgical trapping or wrapping. Here, we report a case of MCA dissecting rupture treated with endovascular procedure.

Case report: 22-year-old female presented sudden stuporous mental change following severe headache and left side hemiparesis. CT showed a diffusion subarachnoid hemorrhage (SAH) and diffusion MR showed diffusion restriction at right putamen and internal capsule. There was no definite vascular abnormal finding except mild irregularity of right MCA (M1) on initial digital subtraction angiography (DSA). However, dissecting aneurysm was reported on 6-hour follow up DSA. We performed stent assisted coil embolization was done and double stent was applied for the effect of flow diversion. There was small remnant area of dissecting aneurysm, it was disappeared at 60-day and 12 – month follow up DSA.

Conclusion: We report a successful treatment about SAH due to rupture of spontaneous MCA dissection with endovascular technique. Flow diversion using stent assisted coil embolization is a good therapeutic option preserving arterial continuity.

References

Treatment of a Direct Carotid Cavernous Fistula with a Flow Diverter Stent and Coils: A Case Report

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Purpose: Direct carotid-cavernous fistulas (CCF) are high-flow shunts between the internal carotid artery (in its intracavernous portion) and the cavernous sinus adjacent, whose clinical manifestations are due to congestion of ophthalmic veins. These lesions are highly related to trauma but can be spontaneous, especially in the presence of intracavernous aneurysms. Our goal is to describe a case of spontaneous CCF secondary to rupture of an intracavernous aneurysm and treated with coils, glue and a flow diverter stent (FDS).

Methods: We report a case of a 52 years old woman with acute complaints of diplopia and right ocular symptoms, whose brain angiogram had findings compatible with a direct CCF secondary to rupture of a left intracavernous aneurysm.

Results: Our patient came to our emergency department with reports of sudden onset of binocular diplopia, and right chemosis and proptosis. The patient denied any history of trauma. Physical examination showed a ophthalmoparesis on the right. Raised the suspicion of a CCF, was held local auscultation that revealed a mild murmur. Confirmed the engorgement of the right ophthalmic vein, the patient was referred for performing a cerebral angiography, which showed a ruptured intracavernous aneurysm in the left internal carotid artery, measuring 24 x 13 x 8 mm and associated with a high flow CCF with drainage to the contralateral cavernous sinus by the intercavernous sinus.

Conclusion: Because the aneurysm association, we chose to occlude the fistula (we used coils and glue) and after, deploy a FDS aimed at reconstruction of the vessel, with good clinical and angiographic results.


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Purpose: To describe the successful treatment of spontaneous direct high flow carotid-cavernous sinus fistulas (dCOFs) with the Surpass high mesh flow Diverter.
Materials: 10 (ten) patients with slow flow dCOFs were identified and treated endovascularly in our center between January 2012 and May 2015. Three (3) of them due to the slow flow behavior, considering the potential risk of navigating the carotid tear (under 1 mm) and the high clinical presentation mode were decided to be treated by a high mesh high mesh flow diverter device (Surpass). In all cases retino-fluoresceinography before and after was practice. All data including clinical improvement, time to heal and potential complications were recorded.

Results: All patients treated by this reconstructive technique had immediate angiographic and clinical successful outcome. The flow diverter was deployed with no complications in all cases and once heparin reversion and angiographic control, no residual fistula was observed. Clinical improvement (mainly of ptaloplegia) was observed in the first 24 hours. Average of 9 (nine) days were necessary to get total clinical recovery. On follow-up, all patients presented total clinical symptom resolution.

Conclusions: In slow flow dCOFs with high potential risks due to angiographic finding high mesh flow diverter deployment is an useful tool for the trans-arterial treatment.

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Endovascular Options for Rapidly Recurrent Fusiform Aneurysm

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Recurrence of intracranial aneurysms following microsurgical clipping is rare (1–2%). Most cases involve prolonged periods between clipping and recurrence. However recurrence does complicate treatment options. Repeat microsurgical approaches can be difficult due to adhesions and fibrosis, and readjustment of clips can cause significant blood vessel injury in the process. The armoury of endovascular options for primary treatment of intracranial aneurysms can also be applied to this problem. We present the case of a ruptured left A1 aneurysm that was microsurgically clipped and had recurrence within 1 month. The recurrence was associated with re-rupture. After consideration of all treatment options there ensued a successful and complete endovascular coiling. In addition a literature review outlines other available endovascular options and the rates and time periods of intracranial aneurysm recurrences.

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8 – Innovations in Neuro Interventions

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**Significant Radiation Dose Reduction in Cerebral Angiography Using a New Imaging Acquisition and Processing Platform – A Phantom Study**

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**Purpose:** The new Philips Allura Clarity upgrade allows X-ray reduction during image acquisition by automatic motion compensation, temporal and spatial noise reduction and image enhancement. Our aim was to quantify the radiation dose reduction achieved after installation of the Philips Allura Clarity platform compared to the Philips Allura Xper platform.

**Methods:** Polymethylmethacrylate (PMMA) phantoms of 4 different thickness (15, 18, 20 and 23 cm) were used to simulate patient head attenuation. A direct dosimeter was used to measure Air kerma rates (AKR) during fluoroscopy and cerebral digital subtraction angiography (DSA) on the Philips Allura Xper platform, and then again after the Philips Allura Clarity upgrade. The measurements conformed to the International Electrotechnical Commission (IEC) standards i.e. no table top, X-ray beam focus to PMMA entrance distance of 62.5 cm, source to image distance of 105 cm and dosimeter placement at the PMMA entrance.

**Results:** The pre and post Philips Allura Clarity upgrade fluoroscopy AKRs for 15, 18, 20 and 23 cm phantoms were 0.09 to 0.08, 0.15 to 0.12, 0.20 to 0.19, 0.32 to 0.23 mGy/s respectively. Mean dose reduction was 17% (range 9–30%). In DSA the pre and post upgrade AKRs for 15, 18, 20 and 23 cm phantoms were 3.08 to 0.23, 6.04 to 0.58, 9.57 to 0.89, 14.68 to 1.74 mGy/frame respectively. Mean dose reduction was 90% (range 88–92%).

**Conclusion:** This study confirms significant radiation dose reduction, particularly during DSA, after installation of the Philips AlluraClarity imaging platform.

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**Comparison of Radiation Dose in Diagnostic and Interventional Neuro-Angiography Before and After Installation of an Image Noise and Dose Reduction System – Philips Allura Clarity**

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**Purpose:** To compare patients’ dose of diagnostic and interventional neuro-angiography in matched cases before and after installation of a dose reduction system.

**Methods:** Radiation doses of 131 diagnostic and 75 interventional neuro-angiography cases before installation of Philips Clarity were compared with the same number of cases after installation matched to the number of 3D Digital Subtraction Angiography (DSA) acquisitions and the number of Xper CTs performed for each case. The dose was mainly dependent on the number of 2D DSA frames and screening time. Radiation dose was measured in centi-Gy per cm² and time in minutes.

**Results:** In the diagnostic cohort, there was the same 68% reduction in the average dose per patient and the average dose per 2D DSA frame, despite a 32% increase in screening time after Clarity. In the intervention cohort, the reduction was 54% and 65% respectively, with a 1% increase in screening time after upgrade. Image quality was at least equal, if not better after Clarity.

Before Clarity, the median dose for diagnostic cases was 14,045.1 with the range of 2,302.2 to 42,607.7 and after Clarity, the median dose was 4,356.4 with the range of 1,005.0 to 31,875.1. In the intervention cohort, before Clarity, the median dose was 24,598.0 with a range of 4,158.5 to 108,037.4. After upgrade the median dose was 10,007.3 with a range of 2,833.8 to 53,729.2.

**Conclusion:** The Philips Allura Clarity can reduce average patient dose by 68% in diagnostic and
54% in interventional cases with at least equal image quality.

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High Resolational MR Imaging for the Diagnosis of Intracranial Arterial Dissection

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Purpose: Intracranial arterial dissection has risk of rupture and ischemia simultaneously. Early diagnosis is required and prompt treatment is also required, if needed. Although it is not a rare disease especially vertebro-basilar territory, neurological diagnosis is difficult. We performed high resolational MR (magnetic resonance) imaging for intracranial dissection to successfully visualize dissection.

Methods: In cases who were suspicious dissection, VISTA (Volume Isotropic TSE Acquisition) BB (Black Blood) scan was added. The MR equipment was Achieva 1.5T HP Nova Dual (Philips Medical Systems, Best, The Netherlands). FOV (Field of view) was 180 mm x 180 mm x 36 mm. Reconstructed voxel size was 0.8 x 0.8 x 0.8 mm. REST (regional saturation technique) slab was added at the proximal side of FOV. Acquired images were observed by MPR (multi-planner reformation) viewer. In early cases, the results were confirmed with catheter angiography.

Results: In some of the cases, dilatation of the artery, wall thickening, mural thrombi or intimal flaps were visualized. In initial a few cases, intimal flaps were visualized with VISTA BB and confirmed by DSA. In some cases, high signal intensity mural thrombus disappeared in long term follow (two or more years). On the other hand, prolonged T1 high signal lesion also were observed, which might be plaque formation. T1 weighted images were better to show vessel wall. T2 WI were more effective to detect dilatation. It took 4 minutes 45 seconds for T1 acquisition and 3 min 52 sec for T2.

Conclusion: High resolational MR imaging for the vessel wall is beneficial for the diagnosis of intracranial arterial dissections.

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Visualization of Flow in Embolized Aneurysms by Superimposed MR

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Purpose: For coil embolization of brain aneurysms, follow up imaging is important. In cases of recurrence or neck remnant, the location of residual blood flow MR (magnetic resonance) angiography is an effective, however, it is not always effective to visualize the coil mass or the shape of aneurysm. Superimposing MR angiography to high resolational T2 WI (weighted image), we tried to show the location of residual flow in embolized aneurysms.

Methods: In cases after coil embolization for aneurysms, high resolational MRA and 3D (three dimensional) T2 WI were added for routine MR study. The MR equipment was Achieva 1.5T HP Nova Dual (Philips Medical Systems, Best, The Netherlands). High resolational TOF (Time-of-flight) MRA was taken at the resolution of 0.25 x 0.25 x 0.25 mm. 3D T2 WI was taken by VISTA (Volume Isotropic TSE Acquisition) BB (Black Blood) scan. VISTA was acquired at 0.8 x 0.8 x 0.8 mm and reconstructed to 0.25 x 0.25 x 0.8. Both of TOF MRA and VISTA data were transfered to Osirix (an image processing application for Mac OS X dedicated to DICOM images). Then, VISTA BB T2 WI and TOF MRA were superimposed.

Results: Residual flow in the aneurysm could be well visualized. Concave deformity of coil, flow at the neck or at the spaces among coils were detected. Well packed aneurysm were difficult to detect on MRA, on the other hand, such lesion could be easily to detect on VISTA scan.

Conclusion: Superimpose high resolational T2 WI upon MRA was effective to show hte location of flow in embolized aneurysms.

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Patient Radiation Dose Reduction in Diagnostic and Interventional Procedures for Intracranial Aneurysms by Low Dose Angiography Protocol

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Purpose: To describe effect of low dose angiography protocol on reduction of patient radiation dose in diagnostic and interventional procedures for intracranial aneurysms.

Methods: Retrospective analysis of radiation dose area product (DAP) in Gy-cm² and air kerma (AK) in Gy for 1046
Conclusion: Application of low dose angiography protocol significantly decreases DAP and AK in both diagnostic and therapeutic procedures in patients with intracranial aneurysm.

Reference

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Cone-Beam CT Angiography in Visualizing Stent and Coils for Aneurysm Treatment
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Purpose: Developments in high-resolution cone-beam computational tomographic (CBCT) angiography have enabled visualization of both the neurovascular stents and host arteries in great detail. However, in the management of broad-based and fusiform intracranial large aneurysms, accurate stent assessment at the level of the coils was limited due to beam hardening artifacts.

Methods: A 64-year-old woman presenting with subarachnoid hemorrhage was confirmed to harbor a ruptured basilar artery large fusiform aneurysm by conventional angiography. Using a single calibrated flat-panel biplanar DSA system (Artis Q BA Twin; Siemens, Erlangen, Germany), the aneurysm was treated with a self-expanding intracranial Enterprise stent (Cordis, Miami Lakes, Florida) and subsequent aneurysm embolization with platinum microcoils.

Results: Enterprise stent and platinum coils were reconstructed as follows.

1. CBCT angiography was performed after stenting ("image A": including bone + vessel + stent)
2. CBCT angiography was performed after coiling ("image B": including bone + vessel + coil)

3. The "image A" and "image B" were superimposed based on the skull using a dedicated workstation (Leonardo; Siemens).

Conclusion: Based on the above process, the fusion image was created using visualized stent images before and after coiling. Thin section maximum intensity projections were used to obtain "in-stent" views and cross-sectional views of the stent lumen. For postprocessing, the images were viewed in volume-rendered technique (VRT), as multiplanar reconstructions or MIPs.

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A Prospective Parallel Study Correlating Computational Flow Parameters with Aneurysm Occlusion after Flow Diverter Treatment
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Purpose: Flow diverters are gaining popularity in the treatment of unruptured cerebral aneurysms. The underlying hemodynamic factors that determine treatment outcome are not well understood. We investigated the hemodynamic effect of flow diverter in a prospective cohort using computational fluid dynamics and report the parameters that may predict to flow diverter outcome.

Methods: All patients who underwent elective flow diverter surgery for intracranial aneurysm from September 2012 to December 2014 were prospectively recruited. The preoperative angiogram was converted to computational geometric three-dimensional aneurysm model and a virtual flow diverter deployed to analyze the hemodynamics change by an engineering team blinded to the clinical outcome, using a verified computational simulation technique (Tsang et al., 2015). The patients were followed up clinically and radiologically after flow diverter treatment, and successful treatment was defined as complete occlusion of aneurysm at 6 months. The hemodynamics profiles of those aneurysms that were successfully treated were compared with failure cases to identify outcome-predicting flow parameters.

Results: 13 patients with anterior circulation aneurysms treated with flow diverters were recruited. 10 were treatment success with complete aneurysm occlusion at 6 months, 3 were treatment failures. All aneurysms demonstrated increase in turnover time after flow diverter, but treatment success group showed significantly greater increase in turnover time after stenting compared with treatment failures (383% vs 225%, p = 0.042), reflecting the higher degree of stasis within the aneurysm. The degree of energy loss was reduced in the treatment success group, but increased in treatment failures (-2.2% vs +2.3%, p = 0.026). The patient's age, aneurysm volume, change in
velocity and flow rate, and wall shear stress did not differentiate flow diverter success from failures.

**Conclusion:** Computational fluid dynamics in aneurysms treated with flow diverters correlated with clinical outcome. The change in turnover time and energy loss profile after stenting appears to predict flow diverter treatment success.

**Reference**


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**Usefulness of Arterial Spin Labelling with MRI during Carotid-Artery Stenting**

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**Purpose:** Arterial spin labelling (ASL) is a useful modality of cerebral-perfusion analysis, but no reports are available that ASL can be a modality during carotid-artery stenting (CAS). We report the ASL analysis during CAS, comparing with SPECT.

**Methods:** In 2014, 52 consecutive cases performed CAS were registered. Some of the patients were excluded because of the incomplete study with any reasons. All of the registered cases were performed with ASL and IMP-SPECT. Age, sex, Powers’ stage, and the periprocedural changes of the cerebral perfusion status were analysed. On SPECT, periprocedural regional CBF (rCBF) ratio, which was compared with contralateral side, was calculated. On ASL, ASL perfusion was performed as continuous ASL with 3D FSE in 3 T MRI.

**Results:** 20 cases were registered. The average was 75.9 years old (60–90), 18 cases were in male, and 2 were in female. All cases were uneventful during CAS. Powers’ stage were 14 in stage 0, 5 in stage I, and 1 in stage II. No cases were involved in hyperperfusion syndrome. The rCBF changes during CAS were +1.8% increase in stage 0, +2.6% in stage I, and +5.8% in stage II. The changes of ASL were +0.7% in stage 0, +1.7% in stage I, and +3.8% in stage II.

It is very important revealing the cerebral perfusion status during CAS because the detection of the high-risk of hyperperfusion syndrome. However, it cannot be done because of the side effect of contrast medium or acetazolamide. ASL needs no tracers, but the metal artefact was the problem during CAS. 3D FSE enables minimizing the metal effect, which leads to the similar perfusion results compared with SPECT.

**Conclusion:** In our small study, ASL perfusion can be a good candidate analysing the cerebral perfusion status during CAS, in spite of its metal artefacts.

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**9 – Intracranial Stenosis**

**Angioplasty of Basilar and Intracranial Vertebral Arteries in 45 Consecutive Patients with Atherosclerotic Stenosis**

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**Purpose:** Symptomatic intracranial atheromatous disease is a severe condition, especially when located in the intracranial vertebral or basilar arteries. Although the negative results of recent trials, angioplasty is still performed in cases of recurrent symptoms. We performed a retrospective study of the last 15 years analyzing the outcomes of angioplasty in the treatment of this pathology.

**Methods:** Between January 2000 and April 2015, the Departments of Interventional Neuroradiology of Beneficência Portuguesa Hospital and Albert Einstein Hospital, São Paulo-Brazil performed 92 endovascular procedures for the treatment of intracranial arterial atherosclerosis stenosis in 90 patients. Forty-five of these procedures were to treat vertebrobasilar stenotic atheromatous disease. All patients were treated by stenting angioplasty using balloon-expandable stent. The mean age of the patients was 67 years (range, 44 – 84), 10 women and 35 men.

**Results:** Most patients were male (35), 25 had stenosis of the basilar artery. We have obtained satisfactory angiographic results in 95% of the patients. Complications were observed in 25% (12) of the patients, 5 presented ischemia related to perforator branches related at the site of angioplasty, 4 of them had thrombosis of the stent and 3 had hemorrhagic complications. In our series, we had 3 (5%) deaths, 2 of them related with bleeding and one with massive thrombosis.

**Conclusion:** The vertebrobasilar atherosclerotic stenosis is a serious condition and percutaneous angioplasty is an option for cases with recurrent symptoms, even with aggressive medical treatment, but with a high rate of morbidity and mortality.

**References**


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Endovascular Treatment of Pseudotumor Cerebri with Concurrent Venous Sinus Stenting and Intracranial Pressure Monitoring: A Technical Note

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Purpose: Increasing evidence supports dural venous sinus stenosis as the pathoetiology of pseudotumor cerebri (PTC) in a subset of affected patients.

Methods: We present our technique for the evaluation and endovascular treatment of PTC with associated stenosis of a dural venous sinus.

Results: A 27 year-old female with medically refractory PTC presented with two months of worsening headaches and vision. An intracranial pressure (ICP) monitor was placed three days prior to the stenting procedure, which demonstrated persistently elevated ICPs in the 30 to 40 cmH2O range. Diagnostic cerebral angiography confirmed flow-limiting stenoses of the bilateral transverse sinuses (TS). We elected to treat the patient with venous sinus stenting (VSS) of the dominant left TS. The right common femoral vein was cannulated with a triaxial system, consisting of 12 F, 10 F, and 7 F Flexor Raabe guiding sheaths, in order create an adequate microcatheter support construct. Venous pressure measurements were taken through a Renegade High Flow microcatheter. The mean venous pressure was 33 mmHg in the proximal transverse sinus and 13 mmHg in the sigmoid sinus, yielding a pressure gradient of 20 mmHg. A Protégé 10x40 mm stent was deployed across the stenosis in the left transverse sinus. Following stent deployment, the pressure gradient was reduced from 20 to 3 mm Hg. The ICP remained 36 cmH2O after stenting, but decreased to 12 cmH2O on the night following the procedure. The patient had an uneventful postoperative course. At six week follow-up, the patient had no headaches and improved visual fields on ophthalmologic examination.

Conclusion: Patients with medically refractory PTC and a physiologically significant pressure gradient across a dural venous sinus stenosis can be effectively treated with VSS. We demonstrate that VSS not only treats the clinical symptoms of PTC, but also provides immediate relief of intracranial hypertension.

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Rapid Resolution of Bilateral Abducens Nerve Palsies in a Patient with Pseudotumor Cerebri after Treatment with Venous Sinus Stenting

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Purpose: Pseudotumor cerebri (PTC) clinically manifests with symptoms of intracranial hypertension, including unilateral or bilateral abducens nerve palsy (ANP). Venous sinus stenting (VSS) has emerged as an effective treatment for PTC patients with stenosis of a major dural venous sinus and a concomitant physiologically significant pressure gradient. Although many of the common symptoms of PTC have been reported to resolve after VSS, the course of ANP recovery is unknown.

Methods: We report a case of a PTC patient with bilateral abducens nerve palsies which rapidly resolved after VSS.

Results: A 24 year-old female presented with left transverse sinus (TS) stenosis and a congenitally diminutive right TS was diagnosed with PTC. Ophthalmologic examination showed bilateral ANPs. We elected to treat the patient with VSS with concurrent ICP monitoring. After VSS, the pressure gradient across the left TS decreased from 28 mmHg to 3 mmHg, and the ICP decreased from 37 cmH2O to 14 cmH2O. Additionally, the patient’s bilateral ANPs completely resolved eight hours after VSS.

Conclusion: VSS not only confers immediate relief from intracranial hypertension, but can also rapidly resolve bilateral ANPs in some cases. However, the pathophysiological basis of ANP in relation to ICP remains incompletely understood, and thus warrants further analysis.
References


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Venous Sinus Stenting for the Management of Idiopathic Intracranial Hypertension: A Systematic Review

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Purpose: Idiopathic intracranial hypertension (IIH) may result in a chronic debilitating disease and blindness in select cases if left untreated. Common treatment options are often associated with periprocedural complications and inadequate disease control. Dural venous sinus stenosis with a physiologic venous pressure gradient has been identified as a potential etiology in a number of IIH patients. Intracranial venous sinus stenting (VSS) has emerged as a potential treatment alternative, but the overall outcomes remain unclear.

Materials and Methods: A systematic review was carried out to identify studies employing VSS for IIH. Studies were reviewed for patient complications, neurological outcomes, and radiographic results.

Results: From 2002 to 2014, 17 studies comprising 185 patients who underwent 221 VSS procedures were reported. Patients had a mean age, BMI, and opening pressure on lumbar puncture of 34.6 years, 33.4 kg/m², and 35.7 cmH₂O, respectively. One hundred sixty-one (87.0%) were women. The mean pre-stent pressure gradient was 20.1 mmHg, with a mean post-stent gradient of 4.4 mmHg. Complications occurred in 10 patients (5.4%), but were major in only 3 (1.6%). At a mean clinical follow-up of 22 months, clinical improvement was noted in 130 of 166 patients with headaches (78.3%), 52 of 56 patients with tinnitus (92.9%), 84 of 89 patients with papilledema (94.4%), and 64 of 74 patients with visual symptoms (86.5%). At a mean radiographic follow-up of 15.2 months, in-stent stenosis was noted in six patients (3.4%), but only one required retreatment. Stent-adjacent stenosis was more common, occurring in 19 patients (11.4%) and necessitating treatment in 10 patients (6.0%).

Conclusion: In IIH patients with venous sinus stenosis and a physiologic pressure gradient, VSS appears to be a safe and effective therapeutic option. Further studies are necessary to determine the long-term outcomes of VSS and the optimal management of medically refractory IIH.

References


But its long-term effect remains to be evaluated by further large samples, long-term follow-up studies.

References


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Subacute Stent Thrombosis in Basilar Artery Stenting: Case Report

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Objective: Symptomatic basilar artery stenosis is a highly morbidity disease process. Treatment options are limited. Percutaneous angioplasty is associated with a significant complication rate. We report a case of subacute stent thrombosis in basilar artery stenting.

Clinical Presentation: A 63-year-old man admission our hospital due to vertebrobasilar stroke. Magnetic resonance angiography revealed severe proximal basilar artery stenosis. We successfully treated with a coronary stent and perioperative antplatelet medications without incident. Poststenting angiography demonstrated a normal-caliber artery with patent perforators. After 7 days from stenting, the patient presented with mental deterioration. CT-angiogram showed occlusion of basilar artery. We treated intraarterial thrombolysis with urokinase and coronary balloon. Post procedural angiography revealed recanalization of occluded basilar artery.

Conclusion: Basilar artery stenting can lead to subacute thrombosis, even in patients who are treated standarized antplatelet therapy. Such complications have been described for patients after coronary artery stenting, but to our knowledge, no one has reported on a comparable number of cases of intraarterial stenting procedures. In research about subacute stent thrombosis in the intracranial circulation would be a thorough analysis of platelet function in search of non-responders to antplatelet therapy before stenting. This might help to find the patients who are at risk for stent thrombosis and to prevent this life threatening complication.

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Endovascular Treatment for Intracranial Stenosis

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Purpose: Cerebral atherosclerosis is responsible for about 30% of cases of ischemic stroke. These ischemic events are mostly resulting from cerebral embolism due to change in the atherosclerotic plaque biology.

Methods: Retrospective analysis of 1,358 consecutive patients with atherosclerotic stenosis in the service of Neurosurgery, undergoing angioplasty with stent, 87 patients with intracranial stenosis were selected from November 2005 to May 2015, observing the variables: age, sex, presenting symptoms, degree and location of the stenosis, events and associated complications.

Results: Male (55.4%), mean age 62.4 years (18–78). 80% of patients were symptomatic at diagnosis, and 57.5% of those had ischemic stroke, transient ischemic 26.8% and 15.7% persistent dizziness. The vessels of the posterior circulation are responsible for stenosis in 49 cases (56.3%) and 38 (43.6%) in the posterior circulation. In the posterior circulation dominance in basilar artery (22 cases), vertebrobasilar (20 cases), posterior cerebral (7 cases). In the anterior circulation dominance of the middle cerebral artery (14 cases), petrous segment of the internal carotid artery (13 cases), supraclinoid segment (10 cases), anterior cerebral (1 case). Eighty percent of patients with critical stenosis (>90%). The mortality rate was 9%, artery rupture in 1 case, stent occlusion in 1 case.

Conclusion: The endovascular treatment for intracranial stenosis is constituting a safe and effective treatment for ischemic stroke, with low morbidity and mortality rate.

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Intracranial Endovascular Stent Implantation of Middle Cerebral Artery Stenoses

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Purpose: Intracranial stent-assisted angioplasty is an emerging treatment modality for intracranial atherosclerotic stenosis. There are many reports that stent-assisted angioplasty is useful and safe. However, stent placement in MCA still remains as a challenge due to the risk of vascular dissection, elastic recoil, vasospasm stenosis.

The purpose of this study is to evaluate the initial success rate of the stent-assisted angioplasty for reducing the risk of second attack stroke in MCA stenosis.

Methods: 39 lesions of 35 patients were included in this study from March 2004 to September 2015. All patients had symptoms of acute cerebral infarction with stenoses
in MCA (more than 50%). The locations of the stent implantation were all in M1 segment in MCA.

**Results:** The stent implantation was successful in 34 patients (87.1%). We had one case of microselection failure due to the tortuosity of the target vessel. There was one case (2.56%) of MCA rupture during the procedure and the patient expired after 1 week. There was no periprocedural thromboembolism in our study.

**Conclusion:** In our study, initial success rate of MCA stenoses stent implantation was 87.1%. Stent implantation in MCA stenosis is technically feasible and has relatively low rate of periprocedural complication. Long-term follow up study is necessary.

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**Prevalence of Venous Sinus Stenosis in Pseudotumor Cerebri (PTC) Using Digital Subtraction Angiography (DSA)**

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**Objectives:** To Study the prevalence of intracranial venous stenosis in Pseudotumor cerebri patients.

**Patients and methods:** Thirty patients diagnosed as PTC according to Dandy criteria. All underwent general and neurological assessment. Radiological assessment included CT scan brain +/- MRI brain without contrast, MRV. All underwent digital subtraction cerebral angiography (DSA) (venous phase) to confirm the validity of filling gaps seen at the level of MRV.

**Results:** MRV brain showed that 24 patients (80%) showed filling gaps. Digital subtraction cerebral angiography (venous phase) showed 9 patients (30%) had stenosis in their dural sinuses. MRV showed to be a good screening tool since it had 100% sensitivity and negative predictive value. However, since it has a moderate specificity (62%) with a positive predictive value (PPV) of only 35%, then lesions detected should be confirmed with digital subtraction cerebral angiography (venous phase) particularly those involving the transverse and sigmoid sinus.

**Conclusion:** Venous sinus stenosis is the etiology of PTC in 30% of cases using digital subtraction angiography (venous phase).

**Keywords:** Pseudotumor cerebri, venous sinus stenosis, headache, MRV, Digital subtraction angiography (venous phase).

**References**


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**Evaluation of Stenosis at Transverse Sinus by Intravascular Ultrasound**

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**Background and Purpose:** Intravascular ultrasound (IVUS) and its virtual histology are commonly used in carotid artery stenting to evaluate stenosis and histology of plaque. We report two cases of transverse sinus stenoses, in which the stenoses were evaluated by IVUS and its virtual histology.

**Case description:** First case was a 27-year-old male presenting with visual impairment. Intracranial pressure was elevated owing to the stenosis at the transverse sinus. We
performed IVUS and deployed a stent at the stenosis, and his symptom was improved. Second case was a 51-year-old male presenting with tinnitus. An angiogram revealed an arteriovenous fistula with stenosis at the left transverse sinus. We performed the feeder embolization. After feeder embolization, the pressure gradient across the stenosis was improved. In both cases, IVUS was performed without any difficulties and complications. IVUS visualized the cross section of severe narrowing of the sinus. Virtual histology suggested fibro-fatty changes at the stenosis in both cases.

**Conclusion:** We could evaluate and visualize the sinus stenosis by IVUS. In both cases, virtual histology showed fibro-fatty changes at the stenosis. To the best of our knowledge, this is the first report to demonstrate feasibility of virtual histology for sinus stenosis by IVUS.

**References**


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**Successful Intracranial Vertebral Artery Stenting for at Least 6-Month-Old Chronic Long Complete Occlusion with a Reverse Flow Technique**

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**Purpose:** A 74-year-old man experienced cerebral infarcts (CI) three times over 6 months. First, he experienced left cerebellar infarct, second, right posterior lobe infarct, and third, right cerebellar infarct. Cerebral angiography demonstrated left intracranial vertebral artery (VA) complete occlusion longer than 6 cm and right extracranial VA complete occlusion as fist CI occurred, and these findings had not changed over 6 months. The patient had received antiplatelet of aspirin, clopidogrel or cilostazol and several atherosclerotic risk factors had been treated. However, CIs recurred two times in the posterior cerebral circulation. We attempted to open at least 6-month-old left intracranial VA long occlusion.

Antegrade flow of the extracranial left VA was blocked with the balloon-guide catheter (7Fr Optimo) and reverse flow from the basilar artery (BA) to the left VA was produced during procedures. Under left VA proximal flow blockade and reverse flow, we performed intracranial balloon angioplasty and stenting of the left intracranial VA occlusion.

**Materials and Methods:** The long complete occlusion of the left intracranial VA was successfully opened with the Shiden (2.0x20mm) and Coyote (2.5x30mm) balloons and subsequent Wingspan stents deployment. Reverse flow was documented just after complete recanalization. No complications occurred and no stroke has occurred again.

**Results:** The intracranial reverse flow technique coupled with proximal flow blockade was very useful for safe recanalization of chronic long intracranial complete occlusion.

**References**


Purpose: Report the long-term outcome of 52 severe intracranial atherosclerotic stenosis (ICAS) treated at this health care center since 2006.

Methods: A retrospective chart analysis of 52 patients with intracranial atherosclerotic stenosis submitted for an endovascular procedure, out of which, four presented with two different lesions treated with angioplasty and stenting. All the lesions in this study presented with stenosis rates higher than 70% and approximately one third of these were higher than 95%.

Results: All cases were managed endovascularly. A male predominance (94.2%) was noticed and a peak incidence at the age of 72 (44–81). All patients were symptomatic, except for one. Ischemic and vertebrobasilar insufficiency were the most common clinical presentations. 75% of the patients underwent angioplasty without a stent, due to individual anatomic variability. The stent placement succeeded in all patients. Two cases needed re-operation, because they were at first handled with simple angioplasty and posteriorly, in a month, with a stent. Complications were rare (0.76%): hemorrhagic stroke (n = 2), stent thrombosis (n = 1) and deceased post-procedure (n = 1). In general, they presented a clinical good outcome through an 18-months follow-up; in this period, one patient died due to severe clinical systemic disease.

Conclusion: Severe intracranial atherosclerotic stenosis carries a high and proved risk of stroke of 8 to 22% per year if under conservative therapy (Kim et al., 2014). Emergent intracranial angioplasty with or without stenting is safe and feasible and yields a high rate of revascularization and favorable outcome in patients with hyper-acute stroke and underlying ICAS. Despite the low rates of complications, the indication of this procedure to treat ICAS needs to be prudent. Our case series emphasizes, that this elective procedure possess an existing, notwithstanding minimal risk, for a future stroke episode. This may affect in the full re-establishment and life quality of the patients.

Reference

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Symptomatic Intracranial Atherosclerotic Stenosis: Is There Still Place for Endovascular Approach? A Systematic Review

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Purpose: Evaluate the morbidity and mortality in patients with symptomatic intracranial arterial stenosis undergoing aggressive medical therapy versus endovascular treatment.

Methods: This systematic review ranged clinical trials published from 2000 until 2015 that purposed to analyze the management of symptomatic intracranial arterial stenosis: primarily to compare the aggressive medical therapy versus endovascular treatment. The search was done in EMBASE, MEDLINE, LILACS and COCHRANE. Search terms included “intracranial stenosis”, “symptomatic intracranial stenosis”, “intracranial stenosis therapy”, “intracranial stenosis treatment”, “intracranial atherosclerotic disease”, and “angioplasty and stent intracranial stenosis”. Studies were selected according to Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines (Moher et al., 2009) and required to provide a comprehensive description of primary treatment with outcomes. Our search was restricted to clinical trials and studies in the English language.

Results: Primary results listed 12 studies; three (Chimowitz et al., 2011, Mohammadian et al., 2012, Zaidat et al., 2015) of these were included in the systematic review for mentioning clearly the specifications of the intervention group and the control group in a same study. Clinical trials carried out to date suggest that aggressive medical therapy has a lower incidence of death and stroke compared to endovascular treatment, however this showed good results when properly indicated.

Conclusion: Currently there are not enough studies in the literature to establish the superiority of a therapeutic modality over another, suggesting the need for more studies comparing those treatment modalities.

References
The Evaluation of In-Stent Restenosis after Intracranial Stenting: Qualitative and Quantitative Approach by Using a Cranial Phantom with 320-Row MDCT Angiography

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Purpose: MDCT angiography (MDCTA) has been conveniently used to evaluate in-stent restenosis (ISR) after stenting. However, recent reports suggested unsatisfactory results of qualitative analysis for intracranial ISR using MDCTA, because of poor image resolution, especially less than 3 mm-sized stent, and stent’s marker artifact (SMA). We want to propose the optimal scan parameters and quantitative analysis for an effective approach to ISR after intracranial stenting (ICS).

Methods: We scanned a cranial anthropomorphic phantom, in which inserted a 3 mm-Wingspan stent with a 50% stenotic segment at the MCA, with various voltages (80 ~ 135 kVp) and tube currents (50 ~ 600 mAs) by 320-row MDCT (Aquilion One; Toshiba, Japan). We applied available reconstruction algorithms such as FBP and Adaptive Iterative Dose Reduction (AIDR-3D: strong [STR], standard [STD] options). Degree of ISR or SMA was assessed using a 3-point qualitative grading scale. MIP with 5 mm-thickness and MPR along the stent longitudinal axis were obtained for quantitative analysis. Quantitative evaluation of ISR was done by HU measurements of intrastent stenotic (lower HU) & nonstenotic segments (higher HU), followed by calculation of contrast-to-noise ratio (CNR).

Results: The poor intraobserver agreement for qualitative visual grading for ISR analysis (weighted = 0.47) was again verified. The SMA was decreased more than 100kVp/200mAs. In quantitative analysis for ISR, a 100 kVp/600 mAs/STD showed highest CNR. However, 100 kVp/450mAs/STD (effective dose: 3.2mSv) was optimal condition in terms of stability of CT machine, lowering radiation, and homogeneity of HU. The cut-off HU ratio for the suggestion of ISR was 0.7091 (95 % CI, 0.7106 to 0.706; p = 0.047).

Conclusion: The optimal parameter for quantitative evaluation for ISR of ICS with less than 3 mm-sized stent by using 320-row MDCTA was 100 kVp/450 mAs/STD. Our alternative quantitative analysis of MDCTA may be helpful tool for practical screening for intracranial ISR.

Self-Expanding Stent for the Treatment of Complex Symptomatic Intracranial Atherosclerotic Stenosis: Complications Analysis

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Purpose: We evaluate the safety of endovascular revascularization for intracranial symptomatic atherosclerotic stenosis with self-expanding stent in basilar artery.

Methods: We retrospectively analyzed the data of 51 patients since November, 2007 to January, 2013 who accepted treatment with gateway balloon angioplasty and self-expanding stents implantation, including 37 wingspan stents, 8 enterprise stents, 5 solitaire stents and 1 neuroform stent. We evaluate the effect of clinical manifestations, imaging features and incidence of periprocedure complications.

Results: The technical success rate was 100%. The mean degree of stenosis decreased from (73.1 ± 11.5)% to (25.0 ± 15.3)% following treatment. 4 patients (7.8%) had ischemic complications including slurred speech and limb weakness. The magnetic resonance imaging prompted infarctions of pons, and these maybe the result of perforator infarctions. Two of them improved and symptoms disappeared with active periprocedure treatment, and the others remained functional impairments to some extent. The incidence of perforator infarction at upper segment and middle-lower segment of basilar artery was 22.2% and 4.8%. Because of the deficient number of cases, there was no statistically significant difference (χ2 = 3.115, P < 0.05).

Conclusion: Intracranial angioplasty and self-expanding stenting can be performed for the treatment of basilar artery stenosis with a relative safety. But perforator infarction was of major concern, especially for stenosis at the upper segment.

Solitaire Stents for the Treatment of Complex Symptomatic Intracranial Stenosis after Antithrombotic Failure: Safety and Efficacy Evaluation

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Purpose: To evaluate the feasibility, safety and efficacy of Solitaire stent placement after balloon angioplasty for treatment of complex symptomatic intracranial atherosclerotic stenosis (ICAS).
Methods: We retrospectively reviewed the clinical data from 44 patients who underwent Solitaire stent placement for complex symptomatic ICAS at our department between November 2010 and March 2014, with focus on the clinical factors, lesion characteristics, treatment results and periprocedural complications. We also summarized the early outcomes and imaging findings during the follow-up period.

Results: Overall, the technical success rate was 100% (44/44). The post-stenting residual stenosis ranged from 0% to 40% (mean, 15.00 ± 12.94%). The overall 30-day rate of procedure-related complications was 9.09% (4/44). The incidence of recurrent ischemic events related to the territory artery was 4.55% during mean 25.5 months clinical follow-up. Five patients (11.36%) developed ISR during mean 9.3 months angiographic follow-up.

Conclusion: This is the first case series study of ICAS treated by Solitaire stent placement. Deployment of a Solitaire stent with balloon angioplasty in the treatment of complex severe intracranial stenosis appears safe and effective, with a high technical success rate, relatively low periprocedural complication rate and favorable outcome during follow-up.

10 – New Techniques

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Jugular Vein Occlusion with Rare Associated Diseases: How Implicates Endovascular Management Strategies; Two Case Reports

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Purpose: Jugular vein occlusion is an uncommon condition associated with neurovascular disease and may affect clinical presentation and treatment.

Methods: The authors present how jugular vein occlusion implicates treatment strategies in two patients. The patient in Case 1 was a 31 year-old lady who presented with neck mass, bilateral exophthalmos, and pulsatile tinnitus.

Results: Angiography demonstrated AVM at right supraclavicular area with right jugular vein occlusion causing retrograde intracranial venous reflux and exophthalmos. The patient’s symptoms completely relieved after combined endovascular and surgical treatment. Embolization was scheduled later for treatment of minimal residual AVM in the next stage.

Conclusion: The patient in Case 2 was 47 year-old lady who presented with chronic progressive headache and behavioral change for 6 months. Angiography demonstrated aggressive type dural AVF at left transverse sigmoid sinus with left jugular vein occlusion. Balloon assisted Onyx embolization under direct left jugular vein approach was performed and completely cure the AVF. The authors describe different treatment techniques for this condition.

Reference


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Endovascular Combined Approach for Subtotal Carotid Artery Stenosis with Acute Embolic Infarction

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Carotid artery stenosis is an important cause of stroke. Carotid artery stenting (CAS) has emerged as an alternative to carotid endarterectomy. Several new devices were subsequently introduced as different options for cerebral embolic protection. Current data support the use of embolic protection devices for CAS. Proximal balloon occlusion is an alternative to filter protection, which, by occluding the external and common carotid artery (CCA), induces reversed flow in the target vessel before the lesion is crossed and stented. Despite the advantages of a low crossing profile and the ability to aspirated debris of all size, there are many drawbacks in using balloon occlusion of the distal ICA an embolic protection strategy. Internal carotid artery (ICA) occlusion is not tolerated by a minority of patients because of an inadequate Circle of Willis. Also, the balloon may damage and/or dissect the carotid wall. It may inadvertently and gradually deflate during the procedure, with resulting incomplete ICA protection. Finally, angiographic runs cannot be performed while the balloon is inflated, which limits the interventionist’s ability to confirm proper stent positioning before deployment. Filter devices also have potential disadvantages. They have larger crossing profiles than deflated balloons, which may complicate navigation across very severely stenotic, unstable, and tortuous lesions. A new combined technique that was developed to overcome this obstacle involves direct access to the CCA through an MERCI balloon guiding catheter; the CCA is occlude with a balloon guide catheter, usually 8 or 9Fr, and the FilterWire EZ filter (Boston Scientific, Natick, MA) pass the stenotic lesion under flow arrested condition. We describe a case series of combined approach technique for a subtotal carotid artery occlusion.

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Contrast -Enhanced Angiographic Cone -Beam Computed Tomography without Quantitative Contrast Dilution

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Purpose: Contrast-enhanced cone-beam computed tomography (CBCT) has been introduced and accepted as a useful technique to evaluate delicate vascular anatomy and neurovascular stents. Current protocol for CBCT requires quantitative dilution of contrast medium to obtain adequate quality images. Here we introduce simple methods to obtain contrast-enhanced CBCT without quantitative contrast dilution.

Methods: A simple experiment was performed to estimate the change in flow rate in the internal carotid artery during the procedure. Transcranial doppler (TCD) was used to evaluate the velocity change before and after catheterization and fluid infusion. In addition, 0.3 cc/sec (n = 3) and 0.2 cc/sec (n = 7) contrast infusions were injected and followed by saline flushes using a 300 mmHg pressure bag to evaluate neurovascular stent and host arteries.

Results: Flow velocities changed -15% ± 6.8% and +17% ± 5.5% from baseline during catheterization and guiding catheter flushing with a 300 mmHg pressure bag, respectively. Evaluation of the stents and vascular structure was feasible using this technique in all patients. Quality assessment showed that the 0.2 cc/sec contrast infusion protocol was better for evaluating the stent and host artery.

Conclusion: Contrast-enhanced CBCT can be performed without quantitative contrast dilution. Adequate contrast dilution can be achieved with a small saline flush and normal blood flow. The body must be divided into four sections (except for case reports).

Reference

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Easy Advancement of Large-Profile Microcatheter (Excelsior XT27™) by Parallel Use of Two Microguidewires for Neuroform Stent Delivery

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Purpose: Due to its relatively large profile of the microcatheter for a stent delivery, navigating the microcatheter could be challenging in some situation. We could overcome the difficulty by parallel use of two microguidewires through the stent-delivery microcatheter.

Methods: For the last 5 months, 16 patients with wide-necked bifurcation aneurysms (8 basilar tip, 4 Acom origin, 3 MCA, and 1 SCA origin) were treated with Neuroform stent-assisted coiling. A 300-cm 0.014-in microguidewire (Transend) was placed into the target branch by exchange technique followed by a 0.027-in microcatheter (Excelsior XT27) insertion. When there was any resistance, we inserted another microguidewire (Traxcess 14) along with the already placed microguidewire in parallel fashion to facilitate the microcatheter advancement. We analyzed the incidence and pattern of microguidewire delivery difficulty and success rate of the ‘parallel-wire technique’.

Results: Navigation difficulty occurred in 31.3% (5/16). All of them were due to the bump-like transition of the aneurysm neck and parent artery branch interfering passage of the microcatheter tip. We could advance the microcatheter successfully by applying parallel-wire technique in all the 5 cases. Neuroform stents were placed through the microcatheters in 4 and the microcatheter was used as a neck-protection device in 1. There was no procedure-related problem.

Conclusion: Simply by using another microguidewire together with pre-existing microguidewire in parallel fashion, the Neuroform stent-delivery microcatheter could easily be navigated into the target location in case of any advancement difficulty.

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Relay Balloon Technique for Recanalization of Acute Symptomatic Proximal ICA Occlusion

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Purpose: Endovascular recanalization of acute symptomatic occlusion of the internal carotid artery (ICA) due to underlying atherosclerotic stenosis could be technically challenging especially when there is no enough landing zone for a balloon-guiding catheter (BGC) at the bulb portion. The purpose of this study is to present the ‘relay-balloon technique’ devised for complete flow arrest until the end of the recanalization, and analyze its safety and effectiveness.

Methods: Endovascular recanalization with the ‘relay-balloon technique’ was attempted in ten consecutive patients with acute symptomatic proximal ICA occlusions from February 2013 to February 2015. The distal CCA was occluded with a BGC during balloon dilatation with an angioplasty catheter (APC) for the underlying proximal ICA stenosis. And then the inflated APC was repositioned a little upward assuring flow arrest so that the BGC could be repositioned into the bulb portion for further ICA flow arrest and aspiration of the he occluded ICA after removing the deflated APC. After full recanalization of the ICA and any combined distal embolic lesion, proximal ICA was stented while the BGC was removed. We analyzed technical success rate and early clinical and angiographic outcomes.
Results: Successful revascularization was achieved in all patients (thrombolysis in cerebral infarction [TICI] 2a/b and 3). Procedure-related complications occurred in one patient (Hemorrhagic transformation) who recovered successfully. The mean NIHSS score at discharge was 3.55 (range 0–18). The mean modified Rankin Scale score at 3 months was 1 ± 1.67 (range 0–6).

Conclusion: Relay balloon technique can be safely and effectively applied for the endovascular revascularization of acute symptomatic proximal ICA occlusion.

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Clinical Observation of Anticoagulation and Endovascular Mechanical Thrombectomy with Solitaire AB Stents in the Treatment of Cerebral Venous Sinus Thrombosis

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1The First Affiliated Hospital Of Zhengzhou University

Purpose: To present the clinical outcomes of National Institutes of Health Stroke Scale (NIHSS) and visual analog scale (VAS) response after patients treated for cerebral venous sinus thrombosis with endovascular mechanical thrombectomy compared to patients treated with anticoagulation (control).

Materials and Methods: 42 patients were diagnosed as cerebral venous sinus thrombosis by clinical MRI, and MRV examination. They were divided into anticoagulation therapy group (group A, n=22) and mechanical thrombectomy group (group B, n=20). Heparin 100 mg/24h was infused intravenously during the first 3 days, and after that warfarin was administered orally for half a year in patients of group A; Mechanical thrombectomy with stents were performed and anticoagulant therapy was continued for 6 months in patients of group B. The present symptom (headache) of the patients was scored by VAS at the different time points before and 3 days, 3, 6 and 12 months after the treatment. The neurological function of the patients at the different time points before and after the treatment were evaluated by NIHSS.

Results: The VAS scores was 6.4 ± 1.7 three days after the treatment in group A, and it was 3.2 ± 1.2 in group B; the VAS score was 4.2 ± 1.1 three months after the treatment in group A, and it was 2.0 ± 1.3 in group B. There were significant differences between the two groups (P < 0.05). The NIHSS scores were 14.8 ± 2.1, 10.2 ± 1.3, 9.7 ± 1.8, and 7.1 ± 1.2 respectively at3 day, 3, 6, and 12 months after the treatment in group A, and they were 9.0 ± 0.6, 7.1 ± 1.4, 5.9 ± 2.1, and 5.3 ± 2.2 in group B. There were significant differences between the two groups at the same time point (P < 0.05).

Conclusion: There was a significantly better improving and neurological function in patients treat with endovascular mechanical thrombectomy compared to controls.

Reference


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Mechanical Thrombectomy with Solitaire AB Stents in Combination with Thrombolysis for Treatment of Intracranial Venous Sinus Thrombosis

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1The first affiliated hospital of Zhengzhou University

Purpose: To retrospectively determine the safety and effectiveness of mechanical thrombectomy for intracranial dural sinus thrombosis with Solitaire AB stents.

Materials and Methods: This is a retrospective analysis of consecutives 12 patients with intracranial dural sinus thrombosis who treated with mechanical thrombectomy by using Solitaire AB stents between January 2013 and October 2014. The patients were followed up for 3 to 12 months after the procedure.

Results: Fourteen Solitaire AB stents were used. The procedure was completed in all patients without complications. At the same time, 2 patients performed catheter-directed thrombolysis with urokinase 300 000 to 700 000 U. The post-operative symptoms in all the 12 patients were improved significantly. Glasgow coma scale scores at admission: 1 case was 3, 1 was 12, and 10 were 15. Glasgow coma scale scores at discharge: 11 cases were 5, and 1 was 4. Statistically significant difference between Glasgow coma scale scores admission and discharge was indentified (P < 0.05). The patients were followed up for 3 to 12 months, 1 were followed up by telephone, 1 were followed up at the outpatient department, 6 were followed up with MRV, 4 were followed up with DSA, and none had recurrence.

Conclusion: Using Solitaire AB stents for intracranial venous sinus mechanical thrombectomy may significantly improve the clinical symptoms of patients. Single-center experience has shown that no obvious complications occurred.

Reference

Easy Advancement of Large-Profile Microcatheter (Excelsior XT27™) by Parallel Use of Two Microguidewires for Neuroform Stent Delivery

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Purpose: Due to its relatively large profile of the microcatheter for a stent delivery, navigating the microcatheter could be challenging, especially in wide-necked bifurcation aneurysms such as basilar tip lesion. We could overcome the difficulty by parallel use of two microguidewires through the stent-delivery microcatheter.

Methods: Between December 2014 to April 2015, 16 patients with a wide-necked bifurcation aneurysms (8 basilar tip, 4 anterior communicating artery origin, 3 middle cerebral artery, and 1 superior cerebellar artery origin) underwent stent-assisted coiling. A 300-cm 0.014-in microguidewire (Transend) was placed into the target branch by exchange technique. A 0.027-in microcatheter (Excelsior XT27) was advanced over the guidewire. When there was any resistance in the advancement, we inserted another microguide-wire (Traxcess 14) along with the already placed microguidewire in parallel fashion. Then the microcatheter was navigated further into the branch over the two guide-wires. We analyzed the incidence and pattern of microguidewire delivery difficulty and success rate of the ‘parallel-wire technique’.

Results: Among the 16 cases, we faced with navigation difficulty in 5 (31.3%). All of them were due to the bump-like transition of the aneurysm neck and parent artery branch interfering passage of the relatively large external diameter of the microcatheter tip compared to with microguidewire. In those 5 cases, we could advance the microcatheter successfully by applying parallel-wire technique in all cases. Neuroform stents were placed through the microcatheters in 4 and the microcatheter was used as a neck-protection device in 1. There was no procedure-related problem.

Conclusion: Simply by using another microguidewire together with pre-existing microguidewire in parallel fashion, the Neuroform stent-delivery microcatheter can be easily navigated into the target location in case of any advancement difficulty.

LVIS Jr ‘shelf’ technique – an alternative to Y stent

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Purpose: Y stent has been used for wide neck bifurcation intracranial aneurysms particularly when both branch arteries are incorporated into the aneurysm dome or neck. With the advent of braided stent like LVIS Jr, these stent can potentially be used with the pull and push technique to create a ‘shelf’ at the neck of the aneurysm that can obviate the need for Y stents. The purpose of our study is to describe this ‘shelf’ technique with LVIS Jr stents in wide neck intracranial aneurysms.

Methods: We retrospectively reviewed our prospectively maintained interventional neuroradiology database for use of LVIS Jr stents. We assessed the aneurysms for their size, neck diameter and location. We used the ‘shelf’ technique in all but one of these patients. We assessed the immediate post-coiling results of these aneurysms. We assessed the perioperative mortality and morbidity and short term follow up of these patients.

Results: We have total of 7 patients (5 Female and 2 Male; mean age- 55 yrs) with 1 ruptured, 2 previously ruptured and 4 un-ruptured aneurysms located at anterior communicating (2), Basilar tip (3), paraophthalmic (1) and internal carotid termination (1). The average diameter of the aneurysm was 7.5 mm (range-3-12mm). All of these aneurysms were wide neck aneurysm with average diameter of the neck was 5.4 mm (range 3-8 mm) and average dome to neck ratio was 1.4 (range 1-1.8). One patient had an in-stent thrombosis which dissolved with use of Reopro. One patient needed another stent to jail a stretched coil. None of these resulted in any clinical morbidity or mortality.

Conclusion: Our small study shows that LVIS Jr ‘shelf’ technique is safe and can obviate the need of Y stent in wide neck intracranial aneurysms.
Dose (PSD) and the skin dose mapping should be estimate. Dose metrics commonly available such as cumulative air kerma at the interventional reference point (K_{airp}) are usually employed. However, as the PSD may be substantially different from K_{airp}, it is necessary to estimate the PSD and skin dose mapping more accurately.

**Methods:** A custom made MatLab software has been developed. The code output is the PSD and a visual display of the surface dose mapped onto a spherical or cylindrical phantom. The code works by translating the K_{airp} (corrected by back-scatter factor) to the location of the patient's skin, represented by a surface of the geometrical model and using dosimetric and geometric parameters (primary and secondary angles of the two tubes, longitudinal displacement of the bed) for each radiation event stored in the radiation dose structured report. To validate the code, arrays of thermoluminescent dosimeters (TLD) were placed on the surface of phantom and on the skin of 9 patients undergoing to neuroendovascular treatments.

**Results:** The percent difference between the PSD calculated and measured by TLD is within 40%. The skin dose mapped on the surface of the geometrical model is in agreement with the dose distribution measured by TLD, used as true standard.

**Conclusion:** The algorithm we implemented can be advantageously applied for radiation exposure evaluation in Interventional Neuroradiology, helping the Neuroradiologist in monitoring the x-ray dose, and consequently adjusting its practice in order to better accomplished the ALARA recommendations during procedures.

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**Intra-Aneurysmal Neck Plasty by “Super-Masamune”, Super Complaint Double Lumen Balloon Microcatheter**

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**Purpose:** Balloon Neck plasty is very useful technique especially for wide neck aneurysm. It is usually required additional balloon microcatheter located in the parent artery. We developed new method of neck plasty which is performed by a balloon microcatheter located inside aneurysm.

**Methods:** Super-Masamune is super compliant double lumen balloon microcatheter. It can be inflated inside aneurysm. Because of double lumen, it allow coil insertion inflating its balloon. Using the Super-Masamune, we treated 5 cases by this method.

**Results:** Three cases are MCA aneurysm and 2 cases are AcomA aneurysm. One of the deriving branch is originated from aneurysmal dome in all the cases. Super-Masamune was introduced in the aneurysm and the balloon was inflated in the aneurysm where the branch is deriving. In 4 cases, coils were inserted via guidewire lumen of the Super-Masamune. Another microcatheter was introduced for coil insertion in one case. The aneurysmal dome was packed in all the cases preserving deriving artery.

**Conclusion:** Super-Masamune makes intra-aneurysmal neck plasty possible.

**Reference**


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**A Novel End-To-Side Anastomosis, Dual-Stent Endovascular Technique to Treat a Ruptured Wide-Necked Basilar Tip Aneurysm and Review of the Literature**

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**Purpose:** Basilar tip aneurysms are a group of bifurcation aneurysms. Although stent-assisted coiling is extensively used to treat wide-necked aneurysms to prevent coil migration to parent vessels, it remains technologically challenging in treating wide-necked basilar tip aneurysms. We design a novel end-to-side anastomosis, dual-stent coiling technique to treat wide-necked basilar tip aneurysms, with a review of the literature concerning the reported techniques in the treatment of this type of aneurysms.

**Methods:** In our design, two stents are aligned in the way of an end-to-side anastomosis. The first stent is placed from the basilar trunk to one posterior cerebral artery (PCA). The proximal end of the second stent is placed adjacent to the side of the first stent, without overlapping interaction with the first stent. Afterwards, embolization is accomplished with coil release into the sac of the aneurysms.

**Results:** A 60-year-old female with a ruptured wide-necked basilar bifurcation aneurysm was treated in emergency, by an end-to-side anastomosis, dual-Solitaire stent-assisted coiling system, resulting in a complete and persistent embolization.

**Conclusion:** This technique safely protected the patency of the parent artery without any neurological compromise in a simple procedure. It may represent a significant advance in the management of basilar tip and other bifurcation aneurysms.
References


12 - Paediatric

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Aneurysm on the Middle Cerebral Artery in a Premature Neonate

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Purpose: Present a middle cerebral artery aneurism in a premature neonate.

Summary of case: Male newborn, product of controlled 33 week pregnancy, birth weight 1870 g; with respiratory failure, requiring immediate resuscitation and Neonatal Intensive Care Unit transfer. Head circumference: 31 cm without changes in the neck. The anterior fontanelle is normal size and normotensive, normal-set ears, moist oral mucosa, hard palate without clefts. Irregular breathing with tachypnea and intercostal retractions; presence of crackles and mobilization of secretions on auscultation. Heart sounds were rhythmic without audible murmurs. The abdomen was soft, not distended, peristalsis present. External genitalia normal for age.

On neurological assessment patient was hypoactive, reactive to tactile stimulation, without paroxysmal movements. Limbs were mobile, symmetrical; distal and central pulses present, capillary refill of 2 seconds; skin with mild peripheral pallor. Routine sonography of the brain was normal for age. At birth, he was treated with antibiotics and ventilatory support under the impression of sepsis. On the 18th day after birth, bulging of the anterior fontanel was appreciated. Sonography of the brain showed hydrocephalus. Cranial MR imaging of the brain revealed supratentorial hydrocephalus and an apparent left frontal-parietal cerebral arteriovenous malformation. MR angiography showed a large saccular aneurysm on the left middle cerebral artery. Subsequently, the patient had neurological deterioration and died.

Conclusion: Although neonatal intracranial aneurysms are rare, their presence should be suspected with the presentation of increasing hydrocephalus and neurological decline.

With prompt diagnosis, satisfactory clinical outcome can be achieved with modern diagnostic tools and neurointerventional.

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Adjuvant Coil Assisted Glue Embolization of High Flow Vein of Galen Aneurysmal Shunt Lesions in Pediatric Patients

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Purpose: Vein of Galen aneurysmal malformation/dilatation (VGAM/VGAD) patients are often difficult to treat due to the high flow fistulous angioarchitecture. The purpose of this study is to assess the feasibility of adjuvant coils in addition to transarterial glue embolization for treatment of these patients.

Materials and Methods: Six pediatric patients (VGAM (n = 4)/VGAD (n = 2), age range; 11weeks-5 yrs 2mos) with high flow fistulous angioarchitecture were treated with adjuvant coils for flow control in addition to distal feeder glue embolization. The angiographic / clinical outcome and complications were assessed.

Results: Adjuvant coils were deployed in the distal feeding artery (n = 2), vein of Galen + distal feeding artery/ initial venous pouch (n = 3), and initial venous pouch (n = 1). Coils were deployed in the vein of Galen for flow reduction and/or as a scaffold for coil deployment in the distal feeding artery/initial venous pouch. Transarterial glue embolization in the distal feeding artery was successfully performed in all cases without distal migration. Complete occlusion was achieved for mural type cases (n = 3) with occlusion of high flow fistulae. Residual shunt remained in choroidal type and VGAD cases (n = 3) from nidal type feeders. Focal rebleed occurred after occlusion of the initial venous pouch in a VGAD case. Residual lesions were treated by additional glue embolization and/or gamma knife therapy. On follow up (2.3–95.4 mo, mean 58.2 mo), improvement of hydrocephalus was seen despite of coils in the dilated vein of Galen. One patient showed moderate mental retardation. Other patients showed normal development.

Conclusion: Adjuvant coils for flow control with glue embolization may be an effective treatment method for VGAM/VGAD patients with high flow fistulous feeders. Occlusion of flow in the draining veins with residual feeders should be avoided due to concerns of hemorrhage.
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Neuro-Intervention within the First 14 Days of Life for the Neonates with Brain Arteriovenous Fistulas

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Purpose: To report the feasibility and outcome of neuro-intervention for the neonates with brain arteriovenous fistulas (AVFs) in the first 14 days of life.

Methods: Fifteen neonates (12 boys and 3 girls) who underwent the initial neuro-intervention within the first 14 days of life were included. Deliveries were at the gestational periods between 31 weeks 0 day and 41 weeks 6 days (mean 37 weeks 1 day). Modes of delivery were 2 spontaneous deliveries and 13 caesarian sections. Birth-weight ranged from 1.538 to 3.778 g (mean 2.525 g). There was no neonate with birth-weight between 2.200 and 2.700 g. Indication of treatment was no serious brain damage on antenatal/postnatal CT/MR imaging (except for 1 neonate) and severe congestive heart failure. The clinical symptoms, diagnoses, treatments (neuro-interventions, especially access routes), and outcomes were reviewed retrospectively.

Results: All neonates presented with severe cardiac failure due to volume overload attributable to brain AVFs. Their diagnoses included 6 vein of Galen aneurysmal malformations (all choroidal types), 6 dural sinus malformations with AVFs (all medial types), 2 pial AVFs, and 1 epidural AVF. Neonates with birth-weight less than 2.200 g could not be treated by transfemoral arterial routes, but were treated by transumbilical routes or direct carotid access. Those with birth-weight more than 2.700 g could be treated through transfemoral arterial routes. In 13 neonates, transarterial embolization was performed, and in the remaining 2 neonates, both transarterial and transvenous embolization were performed. Initial treatments were performed on day 0 (3 neonates), on day 1 (4), within 7 days (13), with a mean of 3.7 days. Their overall outcomes were 6 good recovery, 1 moderate disability, 1 severe disability, 1 vegetative state (due to hemorrhage), and 5 deaths (due to hemorrhage in 4).

Conclusion: Neuro-intervention for the neonates with birth-weight less than 2.200 g requires transumbilical and/or direct carotid access routes. Those with birth-weight more than 2.700 g allow transfemoral arterial routes. Although their treatments are not straightforward, not all neonates have dismal outcomes in the circumstance of multi-disciplinary settings.

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Fetal Torcular Dural Sinus Malformations: Imaging Features, Natural History, Prognosis, and Treatment

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Purpose: Dural sinus malformations (DSMs) are rare vascular malformations encountered in fetuses and infants. Due to the rarity of the disorder, the majority of cases are described in small case series making generalizable statements about this entity extremely difficult. Furthermore, different subspecialty literature (i.e. pathology, neuroangiography, and obstetrical ultrasound) have placed different emphases on aspects of malformations which appear superficially the same, raising questions about whether there is one DSM type or multiple.

Methods: We focus on the most common DSM, the torcular DSM (tDSM). The imaging features, and natural history, the outcome of 12 previously unpublished tDSMs are presented and compared to the entire extant literature series (93 cases).

Results: Common prognostic factors across tDSMs were identified, including a trend toward better outcome for lesions with absence of detectable arterialization, shrinking overall size, absence of ventriculomegaly, and absence of parenchymal destruction. Equally important, we present evidence that the favorable finding of decreasing tDSM size is generally an irreversible event and may still occur despite initial enlargement. The presence or development of tDSM thrombus is shown to be a relatively benign finding.

Conclusion: Although a unifying explanation encompassing all the heterogeneous literature describing tDSMs may prove elusive, we identified clearly essential prognostic features that should be reported in future cases to foster understanding of these vascular malformations.

References
Atypical Presentation of a Dural Arteriovenous Fistula in Newborn: A Case Report

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Purpose: Congenital dural arteriovenous fistulae (DAVF) are rare, much rarer than the already uncommon vein of Galen malformation. They are attributed to abnormal development of the cranial dural venous sinuses and because of the high flow usually have a poor prognosis, with a high incidence of heart failure. Our aim is describe a case of DAVF in newborn, whose clinical presentation was atypical.

Methods: We report a case of a newborn with intrauterine diagnosis of a DAVF and atypical clinical status at birth.

Results: Our patient had from the sixth month of pregnancy diagnosis of a dural arteriovenous malformation associated with a deformity throughout the superior sagittal sinus. He had at birth, performed via cesarean, Apgar score appropriate, to the surprise of the attending pediatric team. It conducted an echocardiogram that showed only a slight ectasia of the descending aorta without cardiac function (ejection rate) commitment signals. After discussion among multidisciplinary teams, because of the potential risk of progression to heart failure, we opted for early treatment. Angiography confirmed the intrauterine hypothesis, showing a malformation of all the superior sagittal sinus, associated with a high flow fistula, nourished mainly by the middle meningeal and superficial temporal arteries.

Conclusion: The treatment was then conducted through microcatheterization both middle meningeal arteries, with injection of glue to 50 %, by Valsalva maneuver, with a satisfactory angiographic result to the end of the procedure.

New Material Compositions for an Increased Visibility of Flow Diverter Stents

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Purpose: Braided nitinol flow diverter stents (FD) show poor radiopacity. Therefore, it is difficult to correctly assess the wall apposition or the exact position of the implant in-vivo in many cases. Changes of the construction address this problem. To evaluate the impact of the composition on visibility and artefacts, five FDs differing in the number and type of wires (singe wire and drawn filled tube, DFT) as well as the nitinol:platinum-ratio (NPR) were investigated using X-ray imaging.

Methods: The following FD stents were imaged with fluoroscopy, radiography and volume CT in a head phantom: FD1: 40 nitinol + 2 platinum wires; FD2: 24 nitinol + 24 DFT wires, NPR 70:30; FD3: 48 DFT wires, NPR 70:30, FD4: 24 nitinol + 24 DFT wires, NPR 90:10; FD5: 48 DFT wires, NPR 90:10. Experienced neuroradiologists evaluated the data sets with regard to contrast differences between FDs and the surrounding material and wall apposition. For verification, the results of the phantom study were compared with a radiopacity test for implants based on DIN 13273-7. Radiopacity was described in aluminium thickness for corpus and marker structures.

Results: DFT wires containing platinum increase radiopacity. Measured contrast differences between implants and surrounding material in the head phantom correlated with the results of the experimental radiopacity test. Wall apposition could be judged with all implants, except FD No. 3, which contained the highest amount of platinum. A 20% increase of platinum in NPR (FD4-2, FD5-3) is equivalent to an increase of 0.41 mm and 0.54 mm aluminium, respectively. Doubling the number of DFT wires (FD2-3, FD4-5) corresponds to an increase of aluminium thickness of 0.67 mm and 0.54 mm.

Conclusion: Vascular implants produced with the DFT technique homogenously increase the visibility. All DFT implants show an improved visibility compared to the investigated conventional nitinol FD in radiography. High amounts of platinum restrict the assessment of the implants wall apposition.
imaging anatomy and variations of ISS on CT angiography and cerebral digital subtraction angiography (DSA).

**Methods:** CT angiography and DSA in 30 patients with normal cerebral venous return were reviewed by two radiologists with special interest in the tributaries of the ISS. Presence and terminations of ISS, complementarity with the superior sagittal sinus (SSS) and the posterior pericallosal vein (PPCV) were evaluated.

**Results:** ISS was identified in 26 cases (87%), which originated from genu of the corpus callosum in 18, from body of the corpus callosum in 8. ISS terminated into the straight sinus in 25 and the superior sagittal sinus (SSS) in one patient. The tributaries of the ISS were drained the blood from the corpus callosum at the genu in 13, at the body in 18, from the cingulate gyrus at the anterior third part in 7, the middle third in 13, and the posterior third in 13 patients. The PPCV were identified in 24 patients (Bil: 18, Rt: 3, Lt: 3). In the patients with the hypoplastic ISS, the PPCV was markedly developed in one patient. In one patients, with absence of anterior part of the SSS, the developed ISS drains blood from a large area of the medial surface of the cerebrum.

**Conclusion:** ISS can be identified in the most cases with normal cerebral venous circulation, and it plays important roles in cerebral venous drainage together with SSS and the PPCV.

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**Histopathology of Healing Response Following Treatment with Flow Diverter in the Canine Side-Wall Aneurysm Model**

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**Purpose:** To characterize the histopathologic progression of wide-necked, side wall aneurysm following treatment with a flow diverter in a canine aneurysm model.

**Methods:** With institutional animal care and use committee approval, 21 side wall aneurysms were created in common carotid artery of 8 dogs and treated with two different flow diverters. Angiographic follow-ups were done immediately after placement of the device, after 4 weeks and 12 weeks. At last follow-up, the aneurysm and the device-implanted parent artery were harvested. The aneurysm occlusion rate was assessed by using a 5-point scale. The harvested aneurysm–parent artery complex was fixed with 5% formalin, embedded in methyl-methacrylated, and stained with hematoxilin-eosin stain.

**Results:** Overall final occlusion rate were noted as grade 0 in 2, grade 1 in 1, Grade 2 in 6, grade 3 in 5, and grade 4 in 7 of 21 aneurysms, respectively. Contrast stagnation in aneurysmal sac after procedure was not associated with 4-week angiographic outcome (p for trend = 0.029).

Histopathologic findings of grade 4 occlusion aneurysms showed that multiple-staged thrombus formation in the aneurysmal sac, and neointimal thickening at the mid-segment of aneurysm at 4 weeks after the procedure, and markedly shrunken aneurysmal sac filled with collagenized attenuated connective tissues with collagenized neointima at 12 weeks. In a case of grade 0 occlusion at 12 weeks, 10-mm sized, wide-necked aneurysm became a small neck aneurysm with contrast stagnation at the venous phase of follow-up angiography. Histopathology of the aneurysm showed thick neointimal formation without any stage of thrombus formation in aneurysmal sac.

**Conclusion:** After the flow diverter insertion, intra-aneurysmal thrombus formation was progressed gradually according to the degree of flow modification. Neointimal formation seems to be processed independently of intra-aneurysmal thrombus formation, and it might be interrupted by inflow into aneurysmal sac.

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**Genetic Screening of Ruptured Intracranial Aneurysm: Meta-Analysis of the Relationship Between Endothelial Nitric Oxide Synthase (Enos) and Aneurysmatic Subarachnoid Hemorrhage**

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**Purpose:** Test the association between IA formation and eNOS gene polymorphism.

**Methods:** A systematic review was executed in Medline, Lilacs, Cochrane and EMBASE to identify all published case-control studies evaluating genetic polymorphisms of eNOS in intracranial aneurysms (IA) and subarachnoid hemorrhage (SAH) in humans since January 2000. The Medical Subject Headings and text words used for the search were “intracranial aneurysm,” “saccular aneurysm,” or “subarachnoid hemorrhage” in combination with “genetics,” “endothelial nitric oxide synthase,” “gene,” “single nucleotide polymorphism,” “oxide nitric synthase,” “polymorphisms,” or “genetic linkage.”

**Results:** The primary search resulted in 139 papers, out of which 22 met the initial inclusion criteria. After full text analysis, nine studies met the inclusion and exclusion criteria. Four studies (Akagawa et al., 2005, Krischek et al.,
2006, Chimowitz et al., 2011, Song et al., 2006) evaluated the T786C polymorphism and its association with aSAH. Studies assessing the dominant T786C model found a significant association with IA (OR: 1.22, 95% CI: 1.04 – 1.44 p = 0.01), so did the studies of the recessive T786C model (OR: 0.37 95% CI: 0.30 – 0.45 p < 0.0001), but with opposite effect.

**Conclusion:** Our findings support the presence of the T786C SNP as a predictor for the development of intracranial aneurysm in the cerebral vascular system. However, this comprehensive meta-analysis could not come to any conclusion about this effect of an eNOS gene SNP in cerebral vasospasm. Therefore, more studies are necessary in order to elucidate the pathways of the eNOS in cerebrovascular diseases and in defining how different allelic combinations of the eNOS gene SNP could favor this pathological process.

**References**


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**Improved Image Quality by a Homogenization Algorithm for Flat Panel Detector CT Data**

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**Purpose:** Low frequent homogeneity artifacts in reconstructed 3D volume datasets can be a severe problem for a physician to reliably detect low contrast details like a bleeding, a tumor or a stroke area. These homogeneity artifacts can be cupping artifacts resulting e.g. from scatter, capping artifacts resulting e.g. from overexposure or an increase in density values towards the posterior part of the skull due to increased beam hardening of the thicker part of the calotte.

**Methods:** Entire head 3D volume datasets from 26 patients with intracranial hemorrhage were acquired by a flat panel detector CT (Artis Q, Siemens Healthcare GmbH, Germany) and processed retrospectively by a homogenization algorithm (prototype software, Siemens Healthcare GmbH, not for diagnostic use and not commercially available in all countries) based on a heuristic homogenization function with generic parameters to remove low-frequent artifacts. A thick-layered (4 mm) axial reconstruction was carried out for the homogenized as well as the non-homogenized 3D volume datasets. The evaluation of these data in terms of image quality and evaluability of soft tissue structures and bleedings was performed by experienced neuroradiologists.

**Results:** The algorithm produces images that contain less cupping artifacts and make a more homogeneous image impression. The gray values of the same structures, such as the gray matter, are more constant in the homogenized data- sets over larger spatial regions. Epi- and subdural hemorrhages are easier to detect in the homogenized datasets. The assessment of the posterior fossa remains problematic.

**Conclusion:** The homogenization algorithm seems to be capable to suppress homogeneity artifacts in already reconstructed 3D volume datasets and can potentially improve low contrast detectability. This might result, in a more reliable detection of low contrast details like bleedings, tumors or stroke areas.

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**Treatment Results of Angio-Seal and Exoseal after Neuroendovascular Therapy**

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**Purpose:** Angio-Seal and Exoseal are useful to obtain hemostasis on a short period of time than manual compres- sion. However, there are various complications. We aimed to evaluate the effective and safe of the Angio-Seal and Exoseal.

**Methods:** In a retrospective multi-center study, a total of 487 patients who underwent neuroendovascular treatment were performed. In each case, procedures with retrograde common femoral artery access and closure with Angio-Seal or Exoseal were included. The efficacy endpoint was observed in 300 of 312 patients who underwent neuroendovascular treatment were performed. In each case, procedures with retrograde common femoral artery access and closure with Angio-Seal or Exoseal were included. The efficacy endpoint was observed in 300 of 312 procedures (96.2%) assigned to Angio-Seal and 172 of 175 procedures (98.3%) assigned to Exoseal. There were no significant differences between Angio-Seal (5.8%) and Exoseal (6.9%) regarding safety endpoint. In both Angio-Seal and Exoseal, activated clotting time (ACT) was...
significantly higher in the complication group than in the no complication group.

Conclusion: These results indicate that Angio-Seal and Exoseal was effective and safe. However, high ACT requires special attention.

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Can MRA Detect Cerebral Hyperperfusion after CAS?

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Purpose: Cerebral blood flow study is necessary for diagnosis of cerebral hyperperfusion. But it is actually unsuitable to repeat SPECT or PET. The purpose of this study is to verify if MRA can detect cerebral hyperperfusion after CAS.

Methods: This study included the patients who have been accomplished SPECT within 24 hours and MRA within 48 hours after CAS from 2008 in our hospital. This study included patients who recognized cerebral hyperperfusion by SPECT more than 101 percent compared with contralateral MCA territory. Patients who had severe stenosis or occlusion in contralateral IC or M1 were excluded.

Results: Ten cases have been detected cerebral hyperperfusion by SPECT within 24 hours after CAS and the contralateral sites of them were normal. In 4 cases, ipsilateral MCA dilated or became high signal intensity by MRA. Especially, this sign was shown in all cases that had hyperperfusion more than 115 percent compared with contralateral sites.

Conclusion: Cerebral hyperperfusion can be conveniently detected with MRA if it is severe.

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Should Informed Radiation Consent Exist for Neurovascular Interventional Radiology Procedures? The Patient Perspective

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Body

Purpose: Radiation exposure is inherent in neurovascular interventional radiology (IR). A potential exposure of 1 mSv has been suggested as a cutoff for provision of risk information, as it corresponds to a 1 in 10000 increased cancer risk (Semelka et al., 2012). Informed consent requires disclosure of rare yet potentially significant risks, yet patient and non-radiologist physician knowledge of these risks is lacking (Ricketts et al., 2013). Neurovascular IR patient perception and knowledge of these risks remains unknown. The purpose of this study is to explore neurovascular IR patient perception of cancer-related radiation risk exposure and whether radiation consent is warranted.

Materials and Methods: A multiple-choice survey was administered to 42 adult patients undergoing a non-emergent neurovascular IR procedure at a tertiary care centre. 67% of patients had previously undergone a neurovascular IR procedure. Statistical analysis of with Fisher Exact test was performed based on patient past neurovascular IR history (p < 0.05).

Results: Almost all subjects (90%) wanted to be informed if the radiation-related increased cancer risk was 1 in 100. Most (82%) wanted to be informed if the risk was moderate, 1 in 1000, or low, 1 in 10000 (70%). Only half of the patients were aware that they were exposed to radiation during their procedure, irrespective of previous neurovascular IR history. The majority (74%) believed that the ordering physician should be responsible for informing patients about radiation exposure. Most (85%) believed radiation consent should include radiation-related cancer risks, and that both verbal and written radiation consent should be obtained (74%). No significant difference was present based on past neurovascular IR history (p > 0.05).

Conclusion: Neurovascular IR patient awareness of radiation exposure is suboptimal. Based on this survey, most patients want to discuss cancer-related radiation risks with the ordering physician in order to make informed decisions. This is potentially concerning as non-radiologist ordering physicians may not be as knowledgeable on radiation-related cancer risks. Neurointerventional radiologists should consider obtaining informed consent for procedures with anticipated doses of 1 mSv or greater.

References

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Giant Anterior Sacral Meningocele Confirmed by CT-Guided Paraspinal Percutaneous Contrast Injection

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Purpose: A 34 year old male presented to his general practitioner with progressive abdominal distension over several years, with increasing mild abdominal discomfort over the previous 3 months. He had also noted mild progression in the severity of weakness in his left lower limb, which had long-standing weakness and reduced function since early childhood (never investigated). Examination demonstrated disproportionate distension of the abdomen, and a pyramidal pattern of moderate weakness in the left lower limb with hyperreflexia.

Methods: Imaging findings CT imaging of the abdomen and pelvis demonstrated a giant extra-peritoneal cystic structure measuring 11.2 x 20.6 cm axial, 26.1 cm craniocaudal length. This structure was inseparable from an enlarged left S1-2 anterior sacral foramen. No contrast enhancement was seen. MRI demonstrated CSF-intensity within the structure, and likely communication with the thecal sac at the level of S1-2. MRI brain also demonstrated right cerebral open-lip schizencephaly. Demonstration of the communication was requested by the managing orthopaedic surgeon to help differentiate giant anterior sacral meningocele from a giant Tarlov cyst.

Results: With the patient in prone position, a 20 gauge spinal needle was placed in the cystic structure within the left side of the pelvis under CT-guidance using a left para-sacral, trans-gluteal approach. Fluid was aspirated for cytological assessment. 20 ml of Iovue 200 contrast was instilled into the cyst.

The patient was turned supine, and CT imaging was performed through the sacrum and pelvis with both early (2 minutes delay) and delayed (40 minute delay) acquisitions. On delayed imaging, contrast was seen with the lumbar thecal sac, confirming communication.

Conclusion: Diagnosis of giant anterior sacral meningocele was confirmed using a percutaneous paraspinal approach for contrast injection into the pelvic component of the meningocele.

Methods: We report a case of a purely epidural AVF of the thoracic spine associated with spinal cord compression which was successfully treated with endovascular occlusion.

Results: A 40 year-old male presented with right-sided back pain and right anterior thigh numbness after a sports-related back injury six months previously. Spinal magnetic resonance imaging and computed tomography angiography showed an enhancing, extradural mass lesion at T12, with characteristics suggestive of a vascular lesion. Spinal angiography showed an epidural AVF, supplied by a muscular branch of the right T12 subcostal and draining into the paravertebral lumbar veins, as well as a 20 mm saclike area of contrast filling, compatible with a dilated draining venous varix or pseudoaneurysm. There was no evidence of intradural venous drainage. We elected to proceed with endovascular treatment of the lesion. At the time of intervention five days later, the contrast-filling lesion had enlarged to a maximal diameter of 26 mm. The microcatheter would not advance into the saclike area of contrast filling, suggesting that this was a dilated varix rather than a pseudoaneurysm. The right T12 subcostal artery was occluded with coils, distal to the origin of the posterior spinal artery but proximal to the point of fistulization. Follow-up spinal angiography one month after embolization showed no residual AVF. Follow-up thoracic spine MRI performed three months after embolization showed complete resolution of the enlarging venous varix and spinal cord compression. At three months clinical follow-up, the patient was completely asymptomatic.

Conclusion: An endovascular approach can be successfully employed for the treatment of appropriately selected spinal epidural AVFs, even in the setting of spinal cord compression.

References

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Endovascular Treatment of a Spinal Epidural Arteriovenous Fistula with an Enlarging Venous Varix
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Purpose: Spinal arteriovenous fistulas (AVF) completed isolated to the epidural compartment are exceptionally rare. As such, the optimal management of these lesions is poorly defined.

Multidetector CT Angiography in Diagnosing Type I and Type IV Spinal Vascular Malformation: Technical Note
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Conventional angiography has been used as a primary imaging technique for the localization of the shunt of spinal dural arteriovenous fistula (SDAVFs) and perimedullary spinal cord simple arteriovenous fistula (SCAVFs). The
search for a SDAVF with conventional angiography is often tedious and requires selective injections into multiple bilateral thoracic intercostal, lumbar, and sacral arteries. Multidetector CT (MDCT) angiography is an imaging technique that can provide high resolution and high-contrast images. We present our experience in diagnosing type I and type IV spinal vascular malformation in 2 cases with similar spinal MR imaging abnormalities. Sixty-four row spinal CTA images led to diagnosis of a type I (spinal dural arteriovenous fistula) and type IV (perimedullary spinal cord arteriovenous fistula fed by a single arterial feeder) spinal vascular malformation, both confirmed by conventional angiography. MDCT angiography can localize the feeding vessel and the fistula, thus greatly reduce the amount of time required for conventional angiography.

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CT Myelogram to Find the Leak and Patch in Spontaneous Intracranial Hypotension

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Purpose: Computed Tomography (CT) guided epidural blood patching has been reported for the treatment of spontaneous intracranial hypotension and cerebrospinal fluid (CSF) leak. This exhibit is a case study of CT myelogram for the identification of the leak site and CT guided epidural blood patching for the treatment in a 39 year old gentleman who presented with postural headache.

Methods: Imaging findings, treatment details and clinical outcomes were reviewed for a patient referred for the management of spontaneous intracranial hypotension. Pre-treatment Magnetic Resonance Imaging (MRI) of brain and spine were performed which indicated spinal manifestation of intracranial hypotension and CSF leak.

Results: Fluoroscopic CT myelogram was performed to detect the CSF leak site. CT myelogram favoured the contrast leak to be located at T12/L1 level. Targeted epidural blood patching was performed at this location guided by CT imaging. Clinical evaluation indicated symptomatic relief following the treatment.

Conclusion: This case study suggested that CT guided epidural blood patching targeting observed leak sites can be effective for the treatment of spontaneous intracranial hypotension and CSF leak. Controlled studies are necessary to study the efficacy of this method in comparison with other methods.

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The Utility and Technical Consideration of Spinal Angiography: Importance of Cooperation with Spine Surgeons

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Purpose: Although endovascular approach is a useful option for treatment of spinal diseases, endovascular neurosurgeons haven’t had many opportunities to use this approach in spinal lesions. We investigated our institutional experience with spinal endovascular procedures before surgical operation.

Methods: From Mar. 2013 to Sep. 2014, seventeen patients underwent twenty-four spinal endovascular procedures before surgical operation. Nine patients were males and mean age was 56.7 (from 28 to 84). There were fourteen cases of catheter angiography and ten cases of embolization. We investigated location, diagnosis, and described case presentation.

Results: Out of total twenty-four cases, there were four cases with cervical, eighteen cases with thoracic, and two cases with lumbar spine lesion. Six cases were spinal cord tumor and ten cases were spinal arteriovenous fistula (AVF). Eight cases were spinal metastasis, which originated from lung, prostate, breast, gastric, hepatic and renal cancer. Polyvinyl alcohol (PVA) particle was used for all embolization in metastatic spinal tumors. Coil and N-butyl cyanoacrylate (NBCA) were used for embolization of spinal AVF. No patients had procedure-induced complications. However, in patients with spinal AVF, the paraesthesia (chief complaint) did not improve after embolization.

Conclusion: When we treat spinal lesions, cooperative approach with endovascular and surgical specialists working closely together is paramount to achieve the best possible results.

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Comparison between Stenting Treatment and Medical Treatment for Vertebral Artery Origin Stenosis and Analysis of Risk Factors for In-Stent Stenosis

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Purpose: To confirm the efficacy and safety of treatment of vertebral artery origin stenosis stenting and to compare the difference of clinical effects between stenting treatment and medical therapy for the vertebral artery origin stenosis and to investigate the related risk factors of vertebral artery in-stent restenosis after stent implantation, which can be used
to provide the basis for vertebral artery in-stent restenosis after stent implantation.

**Methods:** The clinical data of 82 patients with moderate or severe vertebral artery origin stenosis (stenosis rate > 50%) from January 2011 to January 2013 were retrospectively analyzed, including 40 cases treated with stenting plus medication and 42 cases treated with medication alone. One year later, the degree of vascular stenosis, restenosis rate, probability of cerebral infarction and the incidence of ischemic cerebrovascular diseases of the patients were recorded again. In addition, each patient also underwent the National Institutes of Health Stroke Scale. The measurement data were shown as Mean ± SD. As One-sample kolmogorov-smirnov Test showed that the measurement data was not in line with normal distribution, We used Rank sum test. Qualitative data was analyzed by chi-square test, if the sample is small (n < 40) or theoretical frequency is too small (T < 1), using Fisher’s exact test. We defined it as statistic significant when p < 0.05. Finally, analyze the clinical data of 39 patients who successfully underwent vertebral artery origin stent implantation and reviewed digital subtraction angiography one year later. The patients were divided into in-stent restenosis group (n = 11) and non in-stent restenosis group (n = 28). Univariate analysis and logistic regression analysis were used to study the relationship between in-stent restenosis and risk factors influencing vertebral artery origin stenosis after stent implantation.

**Results:** 44 stents were implanted in 40 patients, of which a patient had residual stenosis of 60% because of hard plaques. The operation success rate reached to 97.5% without any serious perioperation complications. The vascular stenosis degree in the stenting plus medication group decreased significantly (73.4 ± 12.9)% vs. (13.6 ± 10.6)% P < 0.05. However, there were 11 stent restenosis (27.5%) in the stenting plus medication group, including 2 cases (5%) with stent fracture one year later. In the medication group, in 4 of 42 artery origin occlusion occurred (9.5%), but only 2 patients appeared the corresponding clinical symptoms. After the treatment, the NIHSS scores in both groups showed no statistically significant difference (P = 0.093), but the ischemic events in the stenting plus medication group was significantly lower than that in the medication group (17.5% vs. 38.1%, P = 0.038). Single factor analysis showed diabetes, smoking, and high ratio of residual stenosis were the effective factors of in-stent restenosis. Multivariate stepwise logistic regression analysis indicated that diabetes and high ratio of postoperative residual stenosis were the risk factors of in-stent restenosis. Among them, residual stenosis rate was positively correlated with stent restenosis.

**Conclusion:** Stenting treatment for vertebral artery origin stenosis is safe and effective, which can significantly improve the vertebral origin stenosis. As for preventing the occurrence of the posterior circulation ischemic events, stenting treatment plus medication may be better than medical treatment, but the incidence of vertebral artery in-stent restenosis after stent implantation was high. Diabetes and high ratio of postoperative residual stenosis may be independent risk factor for in-stent restenosis, the other related factors still remain to be further studied.

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**Mechanical Thrombectomy with the Trevo device in Acute Vertebrobasilar Occlusion**

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**Purpose:** The purpose of this study is to investigate the efficacy and safety of mechanical thrombectomy in acute vertebrobasilar artery occlusion (VBAO) using the Trevo Stentriever™ device

**Methods:** Six patients diagnosed with VBAO underwent digital subtraction angiography with the intention to perform mechanical thrombectomy with stent-retrievers between September 2014 and March 2015.

**Results:** Thrombectomy with the Trevo device was performed in 6 patients. Stentriever™ was used as the sole device (100%). The device could be deployed and retrieved in all maneuvers (100%). Twelve clot retrieval maneuvers were performed (mean 2 ± 1, range 1–3). No device-related complications occurred. Mean duration of the endovascular intervention was 58 min. Complete or near complete recanalization (thrombolysis in cerebral infarction (TICI) ≥ 2b) was achieved in 6 patients. All patients survived and showed a good clinical outcome at discharge, defined as modified Rankin Scale (mRS) 0–2 or National Institute of Health Stroke Scale (NIHSS) improvement ≥ 10 points.

**Conclusion:** Mechanical thrombectomy in patients with acute VBAO using the Trevo Stentriever™ is feasible and seems to be similarly effective and safe as in the anterior circulation compared to reported data in the literature.

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**Diagnosis and Endovascular Management of Carotid Webs: Case Report**

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**Purpose:** A carotid web can be defined as an endoluminal shelf-like projection at the internal carotid artery. Diagnosis of the carotid web as underlying cause of recurrent ischemic stroke is infrequent and can be overlooked. Surgery used to be the standard management for secondary stroke prevention in this condition.

**Methods:** Two patients were admitted to our institute in the last two years with recurrent ischemic strokes in the same territory that were investigated by computed tomographic
angiograms (CTA) which revealed internal carotid artery (ICA) web.

**Results:** The diagnosis was confirmed by digital subtraction angiogram (DSA) and both of them underwent endovascular stenting as an alternative for surgery for purpose of secondary stroke prevention.

**Conclusion:** Carotid web is a rare cause of ischemic stroke recurrence in young and middle age adults which can be identified by CTA and managed successfully managed by endovascular stenting.

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**Compare the Clinical Outcomes of the IV-Tpa Only and IV-Tpa Plus Additional IA-Tx**

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**Purpose:** Intravenous tissue plasminogen activator administration (IV-tPA) for acute ischemic stroke patient, is the only standard treatment but its recanalization rate and therapeutic effectiveness on a large artery intracranial occluded disease (LAICOD) patients are questionable. The object of this study was to find out the difference between LAICOD patients and other acute stroke patients on thrombolytic therapy and proper management in LAICOD patients.

**Methods:** 315 patients who treated IV-tPA therapy were analysis, recurrent stoke patients were excluded. Brain CT-angiography was an initial imaging study and just finished IV-tPA, acute stroke MRI, which included diffusion, perfusion and MRA image, was undertook. In 72 patients who was not recanalized after IV-tPA, additional intraarterial thromboysis (IA-Tx) was tried.

**Results:** 238 patients were defined as LAICOD, among them 166 patients underwent IV-tPA treatment only and 72 patients underwent IV-tPA and IA-Tx. Over all recanalization rate after IV-tPA was 27.3% (86/238 patients) and these recanalized patients showed 61.4% favorable neurologic outcome (mRS: 0 ~ 2). But recanalization rate of whom defined as LAICOD patients was 12.8%. 72 patients who underwent additional IA-Tx, recanalization rate was 81.5% but favorable neurologic outcome (mRS 0 ~ 2) after IA-Tx was non-significant compare with the IV-tPA treatment only patients (p = 0.116). But neurologic improvement (NIHSS at admission minus NIHSS at 3 month after treatment) was significantly better in IA-Tx group (p = 0.020).

**Conclusion:** From this study, large proportion of ischemic stroke was caused by large-vessel occlusion and these patients’ recanalization rate after IV-tPA was very low. Authors would like to propose that initial image study should be include CT-angiography, and IA-Tx might be consider if the patients defined LAICOD and nonrecanalized after IV-tPA therapy.

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**Delayed Reocclusion of Recanalized Intracranial Arteries after Mechanical Thrombectomy in Acute Stroke Patients**

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**Purpose:** Occlusions of major intracranial vessels are presented with acute infarcts, which can lead to serious morbidity and mortality. Mechanical thrombectomy is an effective revascularization therapy for acute intracranial large vessel occlusion. Results of mechanical thrombectomy are varied according to the studies. Complications including dissection, hemorrhage, reocclusion are also varied. We reviewed the patients of reocluded intracranial arteries which had initially recanalized by mechanical thrombectomy.

**Methods:** We reviewed 180 patients who have undergone Mechanical thrombectomy with Solitaire FR stent from March 2011 to January 2015. We achieved revasculisation (TICI 2) in 163 (91%) among 180 patients. But, we experienced delayed reocclusion of recanalized arteries after mechanical thrombectomy in 3 of 163 patients.

**Results:** Three patients were found with reocclusion of initially recanalized intracranial arteries with mechanical thrombectomy. Two of whom had occlusion of MCA, and one had reoclusion of petrous ICA. We suspect the reasons of reocclusion were the dissection of occluded vessels in one patient and the thrombosis of remained thrombus (TICI2a,2b) in 2 patients. Initial NIHSS (National Institute of Health Stroke Scale) score were 21, 5 and 15, respectively and NIHSS score at discharge were 17, 4 and 15, respectively. For all 3 patients, TICI grade were 2b, 2b and 2a after the first mechanical thrombectomy. Follow-up Angiogram showed complete reocclusion with TICI grade 0. And Final TICI grade were 2a, 2b and 2b, respectively. All three patients had concomitant PTA with balloon catheter.

**Conclusions:** We reviewed these patients and found that delayed reocclusion of recanalized vessels were noted within 24 hours after first mechanical thrombectomy. The factors contributed to these results are assumed as TICI grade before and after the first mechanical thrombectomy. But, further evaluation of factors such as NIHSS score, underlying disease, laboratory findings and follow-up angiogram are needed. Also, procedural complications as vasospasm, dissection and hemorrhage should be investigated.
Patients were treated either with Trevo stent or Solitaire Stent according to the neurointerventionist preference. Recanalization was classified by TICI grade. Efficacy and safety during MT was analyzed first recanalization TICI grade after puncture, clot retrieve rate, final recanalization grade, pass number of stent, necessity of rescue method, hemorrhagic complication and thromboembolic complication.

Results: Twenty nine were treated with Solitaire stent and 23 patients with the Trevo stent. Overall good recanalization (TICI 2b and 3) was achieved in 18 patients (62%) in the solitaire group and in 20 (87%) of the Trevo group (P = 0.043). First recanalization TICI grade after puncture, pass number of stent, necessity of rescue method were not significant between two groups. However, clot retrieve rate was 100% in Trevo group and 79% In solitaire group (P = 0.023). Rate of symptomatic ICH was 14.2% for Trevo versus 11.5% for Solitaire. Rate of thromboembolism was 14.2% and 19.2% for Trevo and Solitaire.

Conclusion: Our study showed superiority of Trevo stent to achieve successful recanalization and to retrieve the clot from the vessel. Higher recanalization rates of Trevo stent may be caused by higher clot retrieve rate.
in common carotid artery (CCA) and/or ICA. The most common (m/c) site of atherosclerotic lesion was cavernous ICA (n = 24, 29.3%), and 2nd m/c site was carotid bulb (n = 22, 26.8%). The maximal degree of stenosis in the ICA were mild in 27 patients (32.9%), moderate in 7 patients (8.5%) and severe in 3 patients (3.7%). Of the 38 patients with atherosclerotic lesion in CCA and/or ICA, 15 (39.5%) patients had an irregular and/or ulcerated plaque. There was no statistical difference of recanalization after IAT between ophthalmic flow from ICA and ECA. In addition, there was also no difference according to the stenotic degree of ophthalmic artery.

**Conclusion:** Angiographic features in patients presenting with RAO were diverse, while their procedural outcomes were similar. The atherosclerotic lesion in the ipsilesional ICA and/or OA were prevalent in patients with acute CRAO.

**References**


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**Intra-arterial Therapy for Acute Basilar Artery Occlusion; the Past and Present Status in Real Practice**

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**Purpose:** Recently published reports showed that mechanical thrombectomy leads to better procedural and clinical outcomes in patients with acute large arterial occlusion of anterior circulation. (Berkhemer, Fransen et al., 2015, Campbell, Mitchell et al., 2015, Goyal, Demchuk et al., 2015) However, it is uncertain those beneficial effects in patients with acute basilar artery occlusion (BAO). (Lutsep, Rymer et al., 2008) The aim of this study was to evaluate the procedural and clinical outcomes in patients with acute BAO treated with intra-arterial therapy using the different methods.

**Methods:** After retrospectively reviewed our registry of consecutive pati (Lindsberg and Mattle 2006)ents with acute ischemic stroke who underwent ERT from September 2003 to January 2015, patients with acute BAO admitted to our hospital within 12 hours from stroke onset or last normal time were enrolled. And then they were categorized as thrombolytic-based ERT group (TLG) and thrombectomy-based ERT group (TEG) according to the primary technical option. We compared the procedural and clinical outcomes between the groups.

**Results:** Fifty-four patients were found to have acute BAO and 26 patients were assigned to TLG and 28 patients to TEG. The time from groin puncture to reperfusion was shorter in the TEG than those in the TLG, but it was not statistically significant. (p = 0.07). And the rate of complete recanalization (mTICI ≥ 2b) was significantly higher in the TEG than those in the TLG (TEG vs. TLG, 85.7% vs. 46.2%; p < 0.01). However, the functional outcome of mRS ≤ 2 and mortality at 3 months were not significantly different between the two groups.

**Conclusion:** Although thrombectomy based ERT in patients with acute BAO seems to be superior to thrombolytic based ERT in terms of the improvement of the rate of complete reperfusion, we failed to show its beneficial effect on the clinical outcome of these patients.

**References**


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**Central Retinal Artery Occlusion as a Warning Sign of Carotid Lesions**

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**Purpose:** Central retinal artery occlusion (CRAO) is a rare disease with poor visual prognosis. We evaluated clinical effectiveness of local intra-arterial (IA) fibrinolysis and the rate of accompanying carotid lesion as a cause of CRAO.
Methods: A total 34 patients with CRAO were enrolled in this retrospective study between 2009 and 2014. Thirty patients underwent local IA fibrinolysis, 4 were excluded due to time window and inaccessible carotid lesion. The patients were divided into two groups: Group 1 (treated within 24 hrs.), Group 2 (treated after 24 hrs.). Fibrinolysis was performed with Urokinase with/without nimodipine. We evaluated carotid lesion by CTA or DSA, visual acuity (VA) before and after treatment, and VA improvement evaluated by ophthalmologist.

Results: In group 1 (18 patients), 3 patients (16.7%) had full recovery, 5 (27.8%) had partial recovery and 6 (55.8) were not recovered. All patients of group 2 were not recovered. There was 1 (3.3%) periprocedural complication. Among 34 patients, 11 patients (32.3) had carotid lesion which was same side of ophthalmologic symptom.

Conclusions: Although, the efficacy of intra-arterial thrombolysis for the treatment of CRAO needs to be further evaluated in a controlled trial, we suggest that ophthalmic artery thrombolysis may improve visual acuity of patients who are treated within 24 hours after the onset of symptoms. Because CRAOs are related to carotid lesion more than we are expected, the patients are referred to a highly specialized center with immediate access to the experienced interventionist.

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Rapid Learning Curve and Fast Recanalization Time of Stent Retriever Compared to Suction Catheter for Acute Ischemic Stroke

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Purpose: In acute ischemic stroke, good outcome depends on time and high successful recanalization rate. In this study, we compared our initial experience of mechanical thrombectomy using the stent retriever (Solitaire or Trevo) and the suction reperfusion catheter (Penumbra) in patients with acute ischemic stroke in our hospital.

Methods: We retrospectively reviewed the 30 patients who were performed mechanical thrombectomy in our hospital from November 2012 to April 2015. Because stent system was introduced in our hospital in July 2014, we could only access to Penumbra system before that time. Both anterior and posterior circulation stroke patients were included in this study. We compared parameters between patients treated with each device.

Results: 30 patients were treated with mechanical thrombectomy (10 were with Penumbra and 20 were with stent retriever). To evaluate time interval trends, patients were divided into three chronologically sequential groups of equal number. The first group included 10 Penumbras, the second group 10 first stent retrievers and the third group 10 second stent retrievers. Although successful recanalization rates (Thrombolysis in Cerebral Infarction (TICI) score ≥2b: 40.0% vs. 80.0% vs. 80.0%, p = 0.122) were not significantly different between the three groups, puncture to recanalization time or final DSA time was significantly shorter compared to Penumbra and 2 stent retriever groups (140.5 min vs. 70.3 min vs. 61.1 min, p < 0.001) which was the significantly different in first group (Penumbra) and third group (second stent).

Conclusion: Although the two thrombectomy systems were associated with no significant difference in successful recanalization rates, stent system allows more rapid recanalization time than Penumbra system. There is a learning curve involved in the efficient use of stent system in acute ischemic stroke therapy.

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The Usefulness of an Early Retrieval Stent Pull-Back Technique with Balloon Guide Catheter for Acute Ischemic Stroke

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Purpose: The aim of this study was to evaluate the efficacy of early stent retrieval technique with balloon guide catheter in patients with acute ischemic stroke.

Methods: The study group comprised 21 consecutive acute ischemic stroke patients who were treated by intra-arterial thrombectomy using retrieval stent device as a first-line endovascular procedure. The stent was deployed to cover the thrombus and then left in place for 2–3 minutes. The modified Thrombolysis in Cerebral Infarction score was used for grading degrees of vessel recanalization. Immediate angiographic results were evaluated. Successful recanalization was defined as a TICI score of 2b or 3.

Results: Successful recanalization was achieved in 20 of the 21 (95.2%). The mean number of passes for maximal recanalization was 2.19. No patient showed thrombus migration to a different territory. There was one procedure-related complication.

Conclusion: The early retrieval stent pull-back technique with balloon guide catheter provides a high potential for recanalization in patients with acute ischemic stroke.
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Purpose: The purpose of this study was to evaluate the agreement of findings of plaque between carotid US and MR vessel wall imaging especially MPRAGE in the plaque characterization related to the timing of carotid intervention.

Materials and Methods: 21 patients (3 female, 18 male: mean age, 68 years) 33 sites carotid lesions with carotid stenosis more than 50% degree were examined from January 2014 to March 2015. We retrospectively analyzed the signal intensity and echogenicity of the plaque using MR vessel wall images including MPRAGE, T2WI, fat suppressed T1WI, and carotid US. Short term follow up DWI were evaluated for embolic infarction after carotid intervention in 7 patients. Statistical analysis was performed to calculate concordance of vulnerable or stable plaque between the two techniques employed.

Results: McNemar test showed low agreement of findings of vulnerable plaque between MR vessel wall imaging and carotid US (p > 0.05). Follow up DWI showed low probability of embolic infarction after carotid intervention with either technique.

Conclusions: We observed a poor agreement between carotid US and MR vessel wall imaging in the evaluation of vulnerable plaque. And the findings of vulnerable plaque in either technique cannot predict the embolic infarction after carotid intervention.

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CAS Based on Plaque Imaging

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Purpose: Carotid plaque constituents such as hemorrhage, lipid core, fibrosis, and calcification are important factors in predicting the clinical outcome of carotid artery stenting (CAS). Magnetic resonance imaging (MRI) can noninvasively assess changes in carotid plaque composition by evaluating the Sp/Sm ratio calculated with the signal intensity of carotid plaque (Sp) compared to that of sternocleidomastoid muscle (Sm) using the black-blood technique.

Purpose – We assessed the clinical result of CAS compared before with MRI plaque imaging to after with that

Methods: Number of subjects 137 cases (group A : before using MRI plaque imaging 87 cases, group B : using MRI plaque imaging 50 cases). In group B, 5 cases excluded because of the plaque volume, we treated with CEA. We assessed baseline characters (age, gender, symptoms, heart disease, lesion position, lesion side, lesion length, diameter by bifurcation, ulceration and calcification)

And chose technique and devices are assessed such as protection devices and stents.

Results: At two intervals, Group B was thought to have good results, but recognized the dominant difference only in a part.

Conclusion: We think that it is very significant to investigate a property, quantity of the plaque thoroughly by MRI before treatment. think that we can expect the improvement of further results in what I combine with device choice in accord with a lesion in performing CAS safely.

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Carotid Stent Vessel Wall Scaffolding May Not Depend on Calculated Free-Cell Area

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Purpose: Free-cell area is defined as a ratio between quantities of stent material in comparison to the amount of vessel tissue, and is considered the best index of the scaffolding ability of the stent. A lower value indicates better scaffolding ability that prevents plaque protrusion or extrusion. The closed-cell design has a lower free-cell area compared to the open-cell stent. We evaluated the scaffolding of stents in a silicone carotid artery stenosis model simulating the in vivo placement of the device.

Methods: Comparable stents (Precise, Protégé, and Wall) were deployed in a 60% carotid artery stenosis silicone model. The scaffolding of the stents at the stenosis and the shoulder of the stenosis were visually inspected. Then, covering ratio of the stent material to the vessel wall was calculated using a digital picture image processed through a Photoshop software.

Results: The calculated free-cell area of the Precise, Protégé, and Wall stents was 5.89 mm², 10.71 mm², and 1.08 mm² respectively. Visually, covering of the stenotic portion was dense in the Precise and Protégé stents, and the Wall stent showed dense covering at the shoulder of the stenosis. Covering ratio at the stenotic area for the Precise, Protégé, and Wall stents were 45%, 49%, and 30% respectively, and 17%, 18%, and 22% respectively at the shoulder of the stenosis.

Conclusion: Scaffolding of the vessel wall may not depend on the calculated value of the free-cell area. In particular, open-cell stents may show better covering at the stenotic
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Arterial Spin Labeling Perfusion MRI for Acute Territorial Infarct, Compared with Dynamic Susceptibility Contrast-Enhanced Perfusion MRI

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Purpose: Arterial spin labeling (ASL) is a technique of non-invasive perfusion MR imaging, using endogenous labeled arterial blood water. This study aims to evaluate the clinical usefulness of ASL perfusion MR image for evaluating hemodynamic change in patients with acute territorial infarct, compared with dynamic susceptibility contrast-enhanced (DSC) perfusion MR image.

Methods: 86 patients were enrolled, who confirmed as acute territorial infarct on diffusion weighted image. All patients also underwent the brain MRI including ASL and DSC perfusion images, for evaluating acute infarct. Acute infarct territory on ASL perfusion images were assessed and categorized as four subtypes, I (-/-), II (+/-), III (+/+), and IV (-/+)+ according to the visualization of hyperintense vessel signal/parenchymal perfusion defect. DSC perfusion images were evaluated for the perfusion defect as matched and mismatched areas. The correlation between ASL subtypes and abnormal DSC perfusion was statistically evaluated.

Results: ASL subtype IV and matched perfusion defect on DSC perfusion images showed an excellent correlation. ASL subtype II/III and mismatched perfusion defect on DSC perfusion images showed a good correlation. Interrater agreement was very good.

Conclusion: ASL perfusion MR image can provide a reliable estimate of the severity of perfusion defect, corresponding to the DSC perfusion MR image.

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Hyperintense Vessel Signal on Arterial Spin Labeling MR Image in Acute Ischemic Stroke

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Purpose: Susceptibility vessel sign by the susceptibility effect of intravascular clot on susceptibility weighted image (SWI) depends on the clot composition, which is significantly more common in RBC dominant and mixed clots than fibrin-dominant clots. Meanwhile, the hyperintense vessel signal on arterial spin labeling (ASL) depends on the delayed arterial transit time of magnetically labeled blood water (Jahng et al., 2014, Tada et al., 2014, Yoo et al., 2015). The purpose of this study is to evaluate the hyperintense vessel signal on ASL in acute ischemic stroke, comparing with susceptibility vessel sign on SWI.

Methods: All images of patients who performed MRI for suspected acute ischemic stroke were analyzed with the respect to followings: hyperintense vessel signal on ASL, susceptibility vessel sign on SWI, arterial occlusion on time-of-flight MR angiography, and diffusion restricted area on diffusion weighted image. Hyperintense vessel signal on ASL was statistically compared in groups with and without arterial occlusion, and groups with territorial-pattern and small cortical pattern infarct. And, hyperintense vessel signal on ASL was compared with the susceptibility vessel sign on SWI at arterial occlusion.

Results: Hyperintense vessel signal on ASL was significantly more identified in groups with arterial occlusion and territorial-pattern diffusion restricted area than in groups without arterial occlusion and cortical-pattern small diffusion restricted area (79% [22/28] versus 31% [16/51], 64% [30/47] versus 38% [21/55], respectively, P < 0.05). Hyperintense vessel signal on ASL had a significantly higher sensitivity for the detection of occlusion than the susceptibility vessel sign (79% [22 of 28] versus 57% [16 of 28], P < 0.05).

Conclusion: Hyperintense vessel signal on ASL could identify arterial occlusion and acute territorial-pattern infarct in patients with acute ischemic stroke, which may be associated with stagnant flow at occlusion sites.

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Predictors for Good Functional Outcome after Mechanical Thrombectomy in Acute Cerebral Artery Occlusion

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Purpose: To investigate good prognostic factors for an acute occlusion of a major cerebral artery using mechanical thrombectomy.

Methods: A single center retrospective analysis of 37 consecutive patients with acute occlusion of a major cerebral artery treated by mechanical thrombectomy with stent retrievers was conducted. Collaterals were assessed by the Thrombolysis in Myocardial Infarction (TIMI), and recanalization was assessed by the Thrombolysis in Cerebral Infarction (TICI) score. Outcome was assessed by National Institutes of Health Stroke Scale (NIHSS) and modified Rankin Scale (mRS) at 90 days.

Results: Most patients (27/37) demonstrated good recanalization (TICI 2b or 3) after thrombectomy. At the 90-day follow up, 19 patients had good (mRS, 0–2), 14 had moderate (mRS, 3–4) and four had poor outcomes (mRS, 5–6).
Early recanalization, high TIMI, and low baseline NIHSS were closely related to 90-day mRS, whereas high TICI was related to both mRS and the decrease in the NIHSS.

**Conclusion:** NIHSS decreased markedly when recanalization was successful. A good mRS was related to low initial NIHSS and good collateral and early and successful recanalization.

**References**

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**Critical Use of Balloon Angioplasty after Recanalization Failure with Retrievable Stent in Acute Cerebral Artery Occlusion**

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**Purpose:** To examine mechanical recanalization with a retrievable self-expanding stent and balloon in acute intracranial artery occlusions.

**Materials and Methods:** Twenty-eight consecutive patients with acute intracranial artery occlusions were treated with a Solitaire retrievable stent. Balloon angioplasty was added if successful recanalization was not achieved after stent retrieval. The angiographic outcome was assessed by Thrombolysis in Cerebral Infarction (TICI) and the clinical outcomes were assessed by the National Institutes of Health Stroke Scale (NIHSS) and the modified Rankin Scale (mRS).

**Results:** At baseline, mean age was 69.4 years and mean initial NIHSS score was 12.5. A recanalization to TICI 2 or 3 was achieved in 24 patients (85%) after stent retrieval. Successful recanalization was achieved after additional balloon angioplasty in 4 patients. At 90-day follow-up, 24 patients (85%) had a NIHSS improvement of ≥4 and 17 patients (60%) had a good outcome (mRS ≤2). Although there was sICH, there was one death associated with the procedure.

**Conclusion:** Mechanical thromboembolectomy with a retrievable stent followed by additional balloon angioplasty is a safe and effective first-line therapy for acute intracranial artery occlusions especially in case of unsuccessful recanalization after stent thrombectomy.

**References**

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**Acute Stroke Due to Complete ICA Occlusion in a Young Patient with Fibromuscular Dysplasia**

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**Purpose:** Fibromuscular dysplasia (FMD) of the extracranial ICA (internal carotid artery) is an infrequent benign condition. Disastrous acute stroke can happen to a previously health young patient with FMD. Surgical management of the lesion is possible in selected cases. We report a case of an acute ischemic stroke by fibromuscular dysplasia with successful endovascular management.

**Methods:** A 29-year-old man was admitted due to right side weakness, aphasia with NIHSS 19. He had repeated TIA (transient ischemic attack) previously. No abnormal vascular lesions were identified on MRI which was taken one year ago. Initial CTA work-up showed occlusion of left ICA with cross-filling of left middle cerebral artery via anterior communicating artery. Administration of t-PA (plasminogen activator) did not improve his symptom. Left CCA angiography showed occlusion of left carotid bulb with irregular appearance. Retrograde filling of petrous ICA was noted. Microcatheter angiogram showed patent petrous ICA. ICA dissection was treated with direct stenting with rapid luminal gain and flow to the left cerebral hemisphere. Right ICA angiography showed lobulating contour of carotid bulb. Considering young age and bizarre shape bilateral ICAs, biopsy of temporal artery was done resulting in fibromuscular dysplasia with internal lamina defect on H&E.

**Results:** The patient was discharged with dual antiplatelet regimen with mRS 1 and NIHSS 0. 3 month follow-up angiography showed patent carotid bulb but another right distal cervical ICA. The patient shows no symptoms on 1 year follow-up.

**Conclusion:** FMD can cause acute ischemic in a previously health young patient in a form of ICA dissection and
endovascular approach is feasible. Follow-up imaging is mandatory because another lesion can be identified.

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Intimal Dissestion Caused by Mechanical Thrombectomy with Stentriever Proven by MR Imaging

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Purpose: Stentriever are FDA-approved devices for acute ischemic stroke with promising clinical results. However, intimal vascular damage might be noticed. We report a case of intimal dissection of MCA due to mechanical thrombectomy in a patient with acute ischemic stroke.

Methods: A 59-year-old patient presented with global aphasia. On admission, tPA (plasminogen activator) was administered resulting marked improvement of symptom from NIHSS 13 to 2. Imaging evaluation with CT and MRI was performed. Left ICA flow was decreased although left MCA was patent on CTA. MRI showed small acute lesions in the left internal border zone and left temporal subcortical white matter. PWI showed marked delay of left cerebral hemisphere. Due to marked improvement, intra-arterial treatment was waived. The patient’s symptom, however, recurred after 6 hours later with NIHSS 16. Emergency angiography showed occlusion of left ICA from carotid bulb with minimal reconstitution of left supraclinoid ICA and MCA flow. ICA occlusion was crossed with a microwire and microcatheter under balloon-tipped guide catheter. MCA occlusion was recanalized with Solitaire FR (Covidien, Irvine, CA, USA) and carotid bulb occlusion was treated with balloon angioplasty and stenting. High density at left sylvian fissure was identified on CT the following day. We regarded this as an intimal damage rather than localized SAH as patient’s symptom has improved. Serial follow-up CT showed gradual decrease of the lesion. 12 days after the procedure, GRE showed prominent blooming low signal intensity along left M1 branch, although CT showed nearly disappeared high density. Follow up DSA showed improvement of the calibre of M2 with patent ICA and MCA flow. Patient was discharged with mRS 1 and NIHSS 1.

Conclusion: Although stentriever is highly effective in acute ischemic stroke, its deployment can cause intimal damage which interventionist should be cautious of.

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The Role of Micro-RNA in Ischemic Stroke: A Systematic Review

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Purpose: Describe and analyze the existing findings of micro-RNA (miRNAs) in ischemic stroke.

Methods: Execute a systematic review based on the MOOSE Guidelines (Stroup et al., 2000) in MedLine, Embase and Lilacs with the keywords: “miRNA”, “micro-RNA”, “stroke” and “cerebral ischemia”. Additionally, we hand searched the reference lists of selected and pertinent articles for any missing potential studies. Our search was restricted to cohort studies realized in humans with a stroke and non-stroke control group.

Results: Primary results listed 88 articles, out of which fifteen met the inclusion and exclusion criteria; and eight were included in the systematic review after a full text analysis. The included studies reported 46 significantly altered miRNAs in ischemic stroke patients: 27 up-regulated and 19 down-regulated. A meta-analysis with the specificity and sensitivity data confirmed that these miRNAs are associated to stroke. Hsa-miR-30a, hsa-let7b, hsa-miR-126, hsa-miR221, hsa-miR-21 and hsa-miR210 present a sensitivity for ischemic stroke. A functional analysis of the 47 miRNAs correlates these with vascular, inflammatory and atherosclerotic processes. In addition, hsa-miR-210 has proven to define prognosis based on its level of expression. Despite its down-regulation in stroke, studies (Zeng et al., 2013, Zeng et al., 2011) affirm that the less down-regulated, the better the prognosis. Taken this in consideration we identify a dependent variable pre-defining the clinical course of stroke.

Conclusion: In ischemic stroke patients, 46 miRNAs are significantly altered. Some of these are highly sensitive for stroke, which favors its use as a screening tool. The functional miRNA analysis found that these are involved in various vascular, inflammatory and atherosclerotic processes that are known to cause stroke. There is also evidence that miRNA levels interfere in the clinical presentation, as noticed with hsa-miR-210. Current literature affirms the association and interference of miRNAs in stroke. However, more studies need to be done, to test if these miRNAs are necessary and/or sufficient to develop stroke.
Introduction: Intravenous thrombolysis used since 1990’s has been supported by different studies resulting in the use of endovascular approach as a second line of treatment. In February of 2015 new clinical trials involving endovascular approach (MR. Clean, EXTEND-IA, ESCAPE) has shown impressive favorable results with combined intravenous plus endovascular management (IV-EV) of acute ischemic stroke, with results ranging from 50 to 70% of good functional outcomes and an index of cerebral reperfusion reaching above 80%.

Objective: Analyze the efficacy and safety of endovascular treatment plus intravenous thrombolysis in patients with acute ischemic stroke.

Materials and Methods: Prospective observational study included 10 patients with acute stroke receiving endovascular treatment and 9 patients receiving IV-EV. Epidemiological data included: localization of arterial occlusion, time of onset of stroke to treatment, National Institutes of Health Stroke Scale (at admission and upon hospital discharge), complications and functional evolution based on the modified Rankin Scale during hospital stay and by telephone interview.

Results: Among patients, 6 were men, mean age 57 y/o (range 21–79) with a mean hospital stay of 6 days at Stroke unit (range 1–21). Localization in all patients was in anterior circulation. Endovascular treatments included stent retriever (4 patients), aspiration (3), aspiration plus stent retriever (1), intra-arterial thrombolysis (1) and wire manipulation (1). Complete recanalization (TICI 3) was achieved in 5 patients, and partially complete (TICI 2a-2b) in 4. Five patients had a good recovery (mRS <2). 2 patients presented ICH bleeding after reperfusion and 2 patients died.

Conclusions: Endovascular treatment in the management of acute stroke provides a high degree of recanalization with a good functional outcome and few complications. We consider the need for systematic studies to compare the different modalities of mechanical thrombectomy.

Bibliography

References
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Does Association with IV. Thrombolysis Improve Mechanical Thrombectomy in Acute Ischemic Stroke?
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Purpose: To assess if the association between i.v. thrombolysis and mechanical thrombectomy (MT) improves time to recanalization (TTR), rate of recanalization and outcome compared to pure MT.

Methods: We analyzed 907 stroke patients treated at 28 different centers in Italy. Patients with documented intracranial artery occlusion were treated with MT alone (n = 557) due to clinically or time related contraindication for i.v. thrombolysis or with a combination of MT and i.v. thrombolysis (MT+i.v.; n = 350) as rescue therapy. In 689 cases were used stentriever and thromboaspiration for the others. Arterial recanalization was rated according to the TICI score. Outcome was determined with 3 months mRS (good outcome as mRS = 0–2). The onset CT to recanalization time, number of stentriever passes, thrombotic fragmentation and symptomatic intracranial haemorrhage (SICH) at 24 hours were recorded.

Results: There were no differences regarding sex, median NIHSS at onset and TTR were treated with MT alone (n = 557) due to clinically or time related contraindication for i.v. thrombolysis or with a combination of MT and i.v. thrombolysis (MT+i.v.; n = 350) as rescue therapy. In 689 cases were used stentriever and thromboaspiration for the others. Arterial recanalization was rated according to the TICI score. Outcome was determined with 3 months mRS (good outcome as mRS = 0–2). The onset CT to recanalization time, number of stentriever passes, thrombotic fragmentation and symptomatic intracranial haemorrhage (SICH) at 24 hours were recorded.

Conclusion: Our data suggest that the association with i.v. thrombolysis reduces the number of device passes during thrombectomy, thus improving the efficacy of MT.

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Early Reocclusion after Successful IV Thrombolysis
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Purpose: The most recognized stroke syndromes occur in the middle cerebral artery (MCA) region. In addition to extracranial embolic sources, intracranial atherosclerotic stenosis is considered to be the leading cause of ischemic stroke. Endovascular stroke therapy is used for patients with ischemic stroke after failed intravenous thrombolysis or in patients not eligible for thrombolysis. With increasing experience, acute reocclusion after IV Thrombolysis has been described and Early reocclusion has worsens clinical outcomes. We present a case of Rt. Middle cerebral artery (MCA) infarction with early reocclusion after successful IV Thrombolysis successfully treated By Mechanical thrombectomy and Rt. MCA M1 Stenting.

Methods: A 76-year-old man who had Lt. side motor weakness, dysarthria visited our clinic. Neurological examinations revealed Lt side motor GI and checked NIHSS 18. Magnetic resonance imaging revealed Rt. MCA M1 Segment severe stenosis. Neurology had a diagnosis MCA infarction and apply t-PA Treatment. After treatment, Lt side motor GIV-, and checked NIHSS 2 had recovered. But The next day he had Lt side weakness (GI) and checked NIHSS 18. Computer tomography-Perfusion imaging reveal Rt. MCA M1 reocclusion, we performed Mechnical thrombectomy and Rt.MCA M1 stenting. The patients had recovered Lt side motor GV.

Results: The post-stenting course were uncomplicated, and neurologic deficits were resolved post-stentin and the patients had checked NIHSS 1.

Conclusion: The aim of intravenous thrombolysis or endo-vascular therapies is recanalization of occluded cerebral arteries. Early reocclusion can occur because of the appearance of early platelet aggregates after thrombolysis or when an underlying atheromatous lesion is present. Reocclusion has been linked to poor clinical outcomes. We concluded that even though Early reocclusion after IV Thrombolysis can appropriate and immediate recanalization should be consider to do the best.

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Treatment Results and Risk Factors of CAS at the Institution of CAS First-Line Treatment for Internal Carotid Artery Stenosis
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Purpose: The existence of particular risks of carotid artery stenting (CAS) has become pointed out, while CAS is a well-established treatment for patients with internal carotid artery (ICA) stenosis. We therefore aimed to evaluate risk factors of CAS at our institution which takes CAS as first-line treatment for ICA stenosis.

Methods: We retrospectively reviewed 125 consecutive adult patients who underwent CAS at our institution between 2010 and 2013. Preoperative dual antiplatelet therapy (DAPT) and perioperative anticoagulation therapy were admitted in all cases. We evaluated association with suspected risk factors in CAS, such as plaque characteristics
based on MRI and CT, type of aortic-arch and past history, and findings in postoperative MRI diffusion weighted image (DWI) and symptomatic stroke. We defined ipsilateral high intensity area over 5 mm in maximum diameter in DWI as positive remark.

**Results:** The mean age was 71 years and 83% were male. Postoperative MRI DWI demonstrated positive remarks in 35 patients (28%). In regard to each evaluation point, frequency of appearance of positive remarks were relatively less in calcification in entire circumference (11%) and patients on dialysis (20%), whereas the frequency were high in intraluminal thrombus (43%), type of aortic-arch, 2 or 3 or bovine (42%), high intensity lesion in MRI time of flight (33%). In univariate analysis, there were significant differences in type of aortic-arch ($p = 0.007$) and age ($p = 0.02$). Symptomatic stroke associated with procedure occurred in 3 patients (2.4%), and had significant association with age ($>70$) alone in univariate analysis.

**Conclusions:** Selection of proper devices and admittance of antithrombotic therapy resulted in good outcome for even the patients who have risk factors of CAS. Postoperative ischemic lesions are relatively high frequency in elderly people, aortic-arch to reduce the accessibility and intraluminal thrombus, which suggest to need more careful manipulation and rethink of treatment methods.

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**Intracranial Hemorrhagic Complication after Acute Thrombectomy: The Effect of Tortuosity of the Target Vessels**

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**Purpose:** Intracranial hemorrhagic complications after acute thrombectomy are not rare. The purpose of this study was to elucidate the effect of tortuosity of the target vessel on the hemorrhagic complication.

**Methods:** A total of 71 consecutive patients who underwent mechanical thrombectomy for acute large vessel occlusion between Sep. in 2013 and May in 2014 were included. The patients were classified into two groups; hemorrhagic group and non-hemorrhagic group, based on the findings on head CT performed 12 to 24 hours after the procedure. Vessel tortuosity was assessed by measuring the distance between the highest and lowest points of M1 in the middle cerebral artery (MCA).

**Results:** Among 71 patients, 27 (38%) were classified into hemorrhagic group and 44 (62%) were in non-hemorrhagic group. The distance of highest and lowest points in M1 was significantly larger in hemorrhagic group compared to non-hemorrhagic group (8.8 vs 7.0, $p = 0.01$). Hemorrhagic group had higher baseline NIHSS (21.0 vs 16.5, $p = 0.01$), but there was no significant difference in procedure time, or time to reperfusion. The percentage of the favorable outcome (modified Rankin Scale 0–2) on discharge was less in hemorrhagic group compared to non-hemorrhagic group (38 % vs 51%, $p = 0.02$).

**Conclusion:** The results obtained in the present study indicated that the incidence of intracranial hemorrhagic after thrombectomy was significantly correlated with tortuosity of the target vessel.

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**Are Endovascular Procedures Better? A Meta Analysis**

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**Purpose:** The purpose of this meta analysis is to compare the functional outcome (90 day mRS) among patients with acute ischemic stroke treated with either intravenous thrombolysis (iv tPA) or endovascular therapy

**Methods:** Through data-base search we identified randomized controlled trials from articles published between January 2012–June 2013. We analysed the treatment effect of intravenous thrombolysis (iv tPA) and endovascular therapy for acute ischemic stroke. The treatment effect was interpreted as 90 day modified Rankin’s Score (mRS)

**Results:** Three randomized controlled trials with 1109 patients reported treatment effects of intravenous thrombolysis and endovascular procedures for acute ischemic stroke. Good outcome mRS ≤ 1 was achieved in 32.58 % (n = 145) in the intravenous arm versus 29.81 % (n = 198) in endovascular arm. Odds ratio 0.90 CI[0.69 to 1.17]. The P value 0.45.

**Conclusion:** The results trend to be marginally in favour of intravenous thrombolysis. We suggest more randomized controlled trials comparing two arms.
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Relationship between Neurological Severity and CBF Grade of MR Perfusion in Acute Stroke Patients with the Carotid Artery Occlusion

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Purpose: It has recently been recognized that perfusion study is required to identify candidates suitable to endovascular therapy (ET) in hyperacute stroke. However, it remains unclear how strongly perfusion findings are related to neurological severity (NS) and MR-DW images (DWI). The aim of our study was to assess whether or not CBF grade based on MR perfusion (MRp) is related to NS or DWI and then to find CBF grade suitable to ET.

Methods: Included in our retrospective analysis were acute ischemic stroke patients 1) who were admitted to our stroke center within 24 hours of the onset between Jan 2004 and May 2015, 2) who presented NIHSS as NS of 0 or more, 3) who underwent MRA, displaying complete occlusion of the affected carotid artery. We evaluated patients' baseline features, NIHSS, DWI-ASPECTS (ACT) at arrival and CBF grade, which was calculated by using bilateral time-intensity curves (TICs) of MR perfusion. TICs were generated on the region of interests set at symmetrical positions of the bilateral MCA territories. According to the time to peak (TP) and the peak signal (PS) comparing the affected side (a) with the contralateral side (c), we regarded the affected-sided PSA divided by TPa as possible CBFa and the contralateral-sided PSc divided by TPc as possible CBFc. CBF grade 1 was defined as CBFa divided by CBF (CBF%) less than 0.2, grade 2 as CBF% of 0.2 or more and CBF% less than 0.7 and grade 3 as CBF% of 0.7 or more.

Results: During the study period, 176 patients matched our criteria for analysis. An average age was 77 years old, median NIHSS was 18, and median ACT was 6. There were 30 patients with CBF grade 1, 81 with grade 2 and 65 with grade 3. Median NIHSS in grade 1, 2, and 3 patients was 23, 19, and 7 (p < 0.0001), respectively, and there was a statistical significant difference between any grade groups (p < 0.016). Median ACT in grade 1, 2, and 3 was 1, 5, and 8 (p < 0.0001), respectively, and there was a statistical significant difference between any grade groups (p < 0.016).

Among 32 patients with NIHSS of 7 or less and as ACT of 8 or more, there were 0 in grade 1, 4 in grade 2, and 28 in grade 3. Among 10 patients with NIHSS of 23 or more and ACT of 1 or less, there were 9 in grade 1, 1 in grade 2 and 0 in grade 3.

Conclusion: CBF grade defined by MRp had strong relation to NIHSS and ACT. Patients of grade 1 had higher NIHSS score and lower ACT score and patients of grade 3 had lower NIHSS score and higher ACT score. Patients with lower NIHSS score but higher ACT score were probable candidates for ET and many among them belonged to CBF grade 2.

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Initial Clinical Experience of Novel Cloud Based Telestroke System

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Purpose: Fast and precise diagnostic and therapeutic decision making is a key factor in emergencies such as cerebral stroke and that highly depends on the skills and experience levels of the physicians involved. However, these levels may vary, depending where and when the patient gets treated. Telestroke has been used to cover up this deficiency, by connecting two physicians remotely for information sharing between them, resulting in better medical decisions in such emergencies, wherever the patient is. ‘JOIN’ was developed to bring such communication among physicians to the next level, by taking advantage of today’s most common communication format: SNS in smartphones.

Methods: ‘JOIN’ is a closed environment SNS with an objective to share and discuss patient information and images between hospital systems and paramedical staff members in and out of the hospital and is designed to maximize the communication in emergencies. ‘JOIN’ allows treating physician and experts to have a real time discussion in the chat room, as well as share information such as clinical data, CT, MR, Angiographic and intraoperative images in same environment, making ‘JOIN’ an unique and ultimate hub for the professionals to understand ‘what’s going on’ with the patient on fly.

Results: A pilot run of ‘JOIN’ in our hospital showed adequate performance and proper information flow, resulting in proper diagnosis and management of all stroke patients. ‘JOIN’ was introduced to our institution in August 2014, for communication with our affiliated hospitals. Since then, over 200 cases have been efficiently assisted.

Conclusions: ‘JOIN’ is an efficient tool to standardize the time demanding treatment of conditions such as stroke. We expect that adoption of this app on smartphones will allow us to help and save the lives of more patients with cerebral stroke.
Clinical Significance of Bilateral Paramedian Thalamic Infarction on Baseline DWI in Patients Receiving Stent-Retriever Thrombectomy for Acute Basilar Artery Occlusion

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Purpose: We sought to investigate the diagnostic and prognostic significance of bilateral paramedian thalamic infarction on baseline diffusion-weighted imaging (DWI) in patients with acute basilar artery occlusion who were treated with stent-retriever thrombectomy.

Methods: The data from 50 consecutive patients with acute basilar artery occlusion who underwent DWI before stent-retriever thrombectomy were retrospectively analyzed. The presence or absence of bilateral paramedian thalamic infarction was correlated to various patient characteristics (age, sex, risk factors, posterior circulation DWI-ASPECTS, underlying intracranial atherosclerotic stenosis, baseline NIHSS score, and successful revascularization [defined as modified TICI 2b or 3]) and clinical outcomes. A good outcome was defined as a mRS score of 0–2 at 3 months.

Results: Bilateral paramedian thalamic infarction was observed in 9 patients (18%). Patients with bilateral paramedian thalamic infarction had higher mean baseline NIHSS scores (15.3 versus 11.2, \(P = 0.040\)), a higher rate of futile revascularization (defined as poor outcome despite successful revascularization) (77.8% versus 38.5%; OR 6.067, 95% CI 1.114–33.046, \(P = 0.024\)), and a lower rate of good outcome (22.2% versus 60.9%; OR 0.183, 95% CI 0.034–0.993, \(P = 0.049\)) than those without it. Underlying intracranial stenosis was less frequently found in patients with bilateral paramedian thalamic infarction than those without it (0% versus 36.6%, \(P = 0.043\)).

Conclusion: Our study suggests that bilateral paramedian thalamic infarction on pre-treatment DWI is a poor prognostic marker in patients receiving stent-retriever thrombectomy for treatment of acute basilar artery occlusion. In addition, this finding can be used in negatively predicting underlying intracranial stenosis in patients with acute basilar artery occlusion.

Impact of Pretreatment DWI-ASPECTS on Functional Outcome after Stent-Retriever Thrombectomy for Acute Anterior Circulation Stroke

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Purpose: It is unclear whether pretreatment diffusion-weighted imaging (DWI) predicts outcomes after stent-retriever thrombectomy in patients with acute ischemic stroke. This study aimed to investigate the impact of Acute Stroke Prognosis Early CT score (ASPECTS) applied to DWI images (DWI-ASPECTS) on functional outcome in acute stroke patients receiving stent-retriever thrombectomy.

Methods: We retrospectively analyzed the clinical and imaging data from 177 consecutive patients with acute anterior circulation stroke who were treated with stent-retriever thrombectomy within 6 hours of symptom onset. Pretreatment DWI-ASPECTS scores were assessed by two readers. DWI-ASPECTS scores were categorized into 0–3 (n = 6), 4–7 (n = 89), or 8–10 (n = 82) for analysis of prognostic impact on outcome. Good outcome was defined as an mRS score of 0–2 at 3 months.

Results: Overall, successful revascularization (defined as modified TICI grades 2b or 3) occurred in 83.1% (147/177), symptomatic hemorrhage in 3.4% (6/177), and good outcome in 45.8% (81/177) of patients. Mortality was 9% (16/177) at 3 months. No patient with DWI-ASPECTS scores 0–3 showed a good outcome. Good outcome was achieved in 43.8% (39/89) of patients with DWI-ASPECTS 4–7 and 51.2% (42/82) of those with high DWI-ASPECTS 8–10; this difference was not statistically significant (\(P = 0.360\)). There were also no significant differences in the rates of successful revascularization, symptomatic hemorrhage, and mortality between patients with DWI-ASPECTS 4–7 and those with DWI-ASPECTS 8–10.

Conclusion: Outcomes after stent-retriever thrombectomy in acute anterior circulation stroke were not different between patients with intermediate DWI-ASPECTS scores and those with high scores. Our study suggests that acute stroke patients with intermediate DWI-ASPECTS scores can benefit from stent-retriever thrombectomy.
Predictors for the Requirement of Rescuing Therapy after Stent Retriever Based Thrombectomy

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Purpose: Thrombectomy with stent retriever is one of the most promising techniques currently available for its remarkable efficacy in vessel recanalization and tissue reperfusion. Instant re-occlusion or lesions refractory to thrombectomy are more frequently reported among populations with higher rate of intracranial stenosis (ICAS), despite that the correlation between ICAS and refractory lesion has not been proven. Rescuing therapy including intra-arterial administration of GPIIb/IIIa inhibitor, angioplasty or stenting are often applied in these cases. The object of this study is to analyze and evaluate the factors (especially ICAS related risk factors) in predicting the requirement of rescuing therapy after stent retriever based thrombectomy.

Methods: Patients' eligibility: consecutive cases received mechanical reperfusion therapy in our database from September 1st 2013 to January 31st 2015. Patients were divided into rescuing therapy group and non-rescuing therapy group. Baseline information like number of risk factors for ICAS, the existence of high risk cardiac embolus factors, initial National Institute of Health Stroke Scale (NIHSS), hyperdense large artery sign, richness of collaterals and clot burden score and outcome (extend of reperfusion) were compared between groups. Univariate logistic regression analysis was adopted for odds ratio evaluation.

Results: 53 cases with 16 in rescuing therapy group and 37 in non-rescuing therapy group were enrolled. Baseline NIHSS, number of ICAS risk factors, hyperdense large artery sign and cardiac embolus factors differs between groups with statistical significance. Lack of hyperdense large artery sign and more ICAS risk factors were taken into logistic regression model.

Conclusion: Patients requiring rescuing therapy are lower in baseline NIHSS score, have more ICAS risk factors and lower odds of hyperdense large artery sign in baseline cranial CT.

Infiltrated Embolization for Meningiomas with the Penetration of Very-Diluted Glue

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Purpose: Meningiomas are often embolized before their surgical resection to reduce blood loss during surgery. We have used low concentration n-butyl cyanoacrylate (NBCA). Since 2011, we report the efficacy and technical aspect of infiltrated preoperative embolization for meningiomas with the penetration of very-diluted glue.

Methods: In this method 13% NBCA-lipiodol mixture is extremely slow injected from the middle meningeal artery like a plug and push injection of Onyx after the tortuous side feeders are proximally embolized. The glue is infiltrated into small tumor arteries like a snow crystal and extends to the inaccessible feeders from pial artery or deep meningeal arteries. If the careful embolization not to reflux too much and migrate the glue into the normal arteries is achieved, this method is very useful to get the extremely effective devascularization on surgical extirpation, and also may
applicable to the surgically untreatable meningiomas as a semi-radical treatment option.

**Results:** Since 2011, 32 cases preoperatively diagnosed with meningioma were embolized with this technique. Intratumoral embolization was possible in 30 cases (94%), and more than 50% reduction of contrast area in T1 Gd was achieved in 18 cases (56%).

**Conclusion:** Preoperative embolization of meningioma with the penetration of very-diluted glue was useful. We assessed the extent of intratumoral embolization and its effect on tumor removal.

**References**


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**Meningioma Embolization with SQUID Using the Pressure Cooker Technique**

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Meningioma embolization is mainly performed by selective injection of microparticles and to a lesser extent by the injection of cyanoacrylate glue or Onyx, an ethyl vinyl alcohol copolymer (EVAC). The Pressure Cooker Technique (PCT) has recently been introduced as a technique to maximize the efficiency of Onyx embolization of cerebral arteriovenous malformations. It consists in the creation of an anti-reflux plug by trapping the detachable part of a DMSO-compatible microcatheter with coils and glue in order to obtain wedge-flow conditions and allows more comprehensive, forceful and controlled Onyx embolization.

This is, to our knowledge, the first report of the use of the PCT for the embolization of a meningioma with SQUID.

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**Development and Validation of an Intravascular Chemotherapy Filter Device to Enable High Dose Intra-Arterial Doxorubicin Therapy: In Vitro Proof of Concept in Whole Blood**

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**Purpose:** A temporary intravenous chemotherapy filter (CF) device with ionic resin material was developed to remove doxorubicin (Dox) from the blood via an ionic mechanism. Filtration based targeted drug delivery could be important in expanding intra-arterial therapy to head and neck cancer by enabling high-dose therapy while limiting systemic toxicity. Previous studies demonstrated high-capacity rapid Dox binding of the resin in phosphate buffered saline (PBS), swine serum, and human serum in vitro. In this study, we aim to determine Dox binding rate and capacity of the CF prototype in porcine and human whole blood in vitro.

**Methods:** Research grade swine and human whole blood was collected and mixed with heparin to form a heparinized solution at 20 IU/ml. Dox was introduced and equilibrated into whole blood (37°C) at a concentration of 0.05 mg/ml. Ionic resin was then introduced at 2.5 ml of resin per liter of solution and mixed. Samples were collected periodically over 60 or 90 minutes, centrifuged at 1,300g, and decanted. Dox concentrations were measured via HPLC-fluorescence spectrophotometry, and compared to controls without resin. Swine and human whole blood results were compared to respective serum results from previous studies, where similar methods were used.

**Results:** In porcine whole blood, the resin removed 29.4%, 50.7%, and 78.4% of available Dox at 10, 30, and 60 minutes respectively, compared to 52.3%, 78.8%, and 84.9% in porcine serum. In human whole blood, the resin removed 15.5%, 27.0%, and 52.0% of available Dox at the same time points, compared to 28.1%, 56.3%, and 76.1% in human serum.

**Conclusion:** Rapid and high-capacity capture of Dox by ionic resin in swine and human whole blood solutions were successfully demonstrated. The high rate of Dox binding by a small volume of resin paves way for a pre-clinical swine study testing in vivo Dox binding by a CF prototype containing over ten times more resin.

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**Superselective Intra-Arterial Chemotherapy Delivery is a Safe and Effective Technique in Advance Retinoblastoma. Five Years Experience in Argentina**

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**Purpose:** To evaluate the safety and effective technique in superselective intra-arterial chemotherapy (SIAC) for advanced intraocular retinoblastoma.
Methods: Between May 2010 to May 2015, a total of 157 eyes of 111 patients with unilateral (n:42) and bilateral (n:69) advance intraocular retinoblastoma were treated. Mean age was 24 months (range 6–81, 53% women). We used direct OA micro-catheterization, in case inadequate choroidal crescent blush, alternative routes including the orbital branch of the MMA or the TSA were performed. The chemotherapies used were melphalan, topotecan, and/or carboplatin. Pulsatile Infusion technique was performed during 30 minutes. The main outcome measures were: procedural success and ocular and systemic complications.

Results: There were 411 chemotherapy injections. Delivering the drug in the choroidal ophtalmic blush was successful in 98.3% of procedures. Treatment routes included: 366 sessions of direct OA, 44 in MMA and only 1 TSA. Mean number of infusions was 3.7 per patient (range 1–14). Transient ocular complications were: 10 eyes with pericocular edema, 5 epiema of the frontal skin and 3 third cranial nerve ipsilateral neuritis. Reversible extracranial occurrences were: 7 bronchospasm, 6 significant neutropenia, 4 loss of femoral pulse reversed by aspirin and 2 allergic reaction to iodinated contrast. Permanent complication: 11 avascular retinopathy, 10 intra-vitreous retinopathy. All children are alive.

Conclusion: SIAC delivery in the choroidal crescent is safe and effective technique for trained hands, with low rate of complication.

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Solitaire Stent-assisted Chemical Angioplasty for Resistant Vasospasm in SAH Patients – Initial Experience

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Purpose: To report our initial experience with Solitaire-assisted chemical angioplasty for medically refractory vasospasm in patients with subarachnoid hemorrhage (SAH).

Methods: We evaluated the retrospective series of patients with SAH and symptomatic vasospasm refractory to chemical only angioplasty, who were treated with Solitaire-assisted chemical angioplasty. Instead of balloon angioplasty, we deployed Solitaire stent temporarily at the spastic vessel segment for 2 minutes and retrieved completely before or after low dose vasodilator infusion. Immediate and follow-up angiographic results, procedure-related complications, and clinical outcomes were assessed.

Results: From April 2011 to May 2015, 12 patients with medically refractory vasospasm underwent Solitaire-assisted chemical angioplasty. There were 8 women (67%); patients were 40 to 85 years of age. A total of 27 vessels were angioplastied (20 proximal and 7 distal). Two cases of procedure-related thrombosis and one case of vessel injury occurred. Additional treatment was needed for 7 patients and vasodilator was infused before the temporary deployment of Solitaire in all of them. Good clinical outcomes or no vasospasm-related neurological aggravation was observed in 10 (83%) patients.

Conclusion: Solitaire stent-assisted chemical angioplasty for SAH-induced vasospasm can be considered as another option for medically resistant cases.

Reference


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Analysis of the Endothelial Nitric Oxide Synthase (Enos) Gene Single Nucleotide Polymorphisms in Post-Aneurysmal Subarachnoid Hemorrhage: Amazon Indigenous Population

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Purpose: Find the specific alterations in the eNOS and associate these findings to the occurrence and severity of cerebral vasospasm post-aneurysmal subarachnoid hemorrhage. In addition, we crossed the information with other ethnicities to test the ethnic influence on genotype expression.

Methods: We conducted a prospective cohort study of patients that suffered an aneurysmal subarachnoid hemorrhage followed by vasospasm or not. Vasospasm was determined by angiogram or transcranial ultrasonography Doppler findings. A sample of peripheral blood (5 ml) was collected to genotype the promoter SNP (T-786 C). As follow, we analyzed the data using t student analysis and multivariable logistic regression to test the association of eNOS polymorphisms in patients with vasospasm and of indigenous ethnicity.

Results: Patients with vasospasm were 3.7 times more likely to have a T allele (95 CI 1.3–9.6, p = 0.014, TT OR 12.7). Patients with T allele of eNOS gene and of South American indigenous ethnicity were more likely to present a more severe episode of cerebral vasospasm. Studies have
demonstrated a link between single nucleotide polymorphisms (SNP) in the endothelial nitric oxide synthase (eNOS) gene with high incidence and aggressiveness with cerebral vasospasm (Wu et al., 2010, Li et al., 2009, Starke et al., 2008).

**Conclusion:** We believe that the presence of this genotype may allow the identification of individuals with more susceptibility and vulnerability for high-risk cerebral vasospasm post aneurysmal subarachnoid hemorrhage. These genetic testing are easy and fast to analyze and serve as a functional blood biomarker. Its result can alert the medical team to early detect and aggressively manage these patients to prevent this condition.

**References**


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**Endovascular Treatment for Ruptured Intracranial Aneurysms Associated with Cerebral Vasospasm**

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**Purpose:** To discuss the therapy for ruptured intracranial aneurysms with cerebral vasospasm.

**Method:** The data of 51 patients diagnosed as ruptured intracranial aneurysms with cerebral vasospasm (CVS) by DSA examination were reviewed retrospectively. According to Hunt and Hess grade, grade I 7 cases, grade II 14 cases, grade III 19 cases, grade IV 7 cases and grade V 4 cases were among the patients. No one were found multiple aneurysms. The responsible aneurysms are respectively with 20 anterior communicating aneurysms, 15 posterior communicating aneurysms, 6 paraclinoid internal carotid artery aneurysms, 10 middle cerebral artery aneurysms. CVS were found on proximal part of aneurysms in 23 cases, on distal part in 9 cases and on both parts in 20 cases. All the patients were received coiling embolization following super selected within aneurysm sac. Successively the spasm arteries on the aneurysm side or the contralateral side were separately performed the artery perfusion, balloon or stent angioplasty.

**Result:** 51 aneurysms were successfully embolized with coils. To improve the CVS, all the patients were performed artery perfusion on the spasm sides. Moreover, 5 patients accepted balloon angioplasty, 2 patients accepted balloon and stent angioplasty on the condition that the CVS could not be relieved after artery perfusion. After endovascular interventions, the CVS were obviously relieved on the CAG images. There were no aneurysms re-rupture, artery occlusion, artery rupture and dissection in all the procedures. During follow-up, no aneurysms ruptured again, 40 patients got GOS 4 ~ 5, 7 patients got GOS 3 ~ 4, 4 patients were dead.

**Conclusion:** Relief of CVS improve the prognosis of patient with Hunt & Hess grade III. The procedures, such as artery perfusion, balloon and stent angioplasty, should be performed on the CVS in ruptured aneurysm patients. These positive endovascular treatments were safe after ruptured aneurysm embolization.
ICS Abstracts

Analysis of Relationship Between Stent Structure and Flow Stagnation Using Self-Organizing Maps for Realistic Aneurysm

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Purpose: A lot of hemodynamic parameters have been introduced to evaluate flow reduction by stent, however, the relationship between stent geometry and each hemodynamic parameter is not clear enough. In this study, we applied Self-organizing Maps (SOM) to search the detailed relationship between stent strut and hemodynamic parameters (Kohonen, 1982).

Material and Methods: Two thousands of stent design candidates evaluated with three hemodynamic parameters and 49 stent geometry parameters were stored during the optimization process. By using SOM software, 2,000 design candidates were visualized into 52 2D-maps while preserving their own features in the original 52-dimensional design space. Each map was divided into 17 clusters to characterize stent design and flow reduction.

Results: By comparing each cluster, critical design for reduction effect of each hemodynamic parameter is suggested. Strut placement on the inflow area is important to reduce velocity, vorticity, and shear rate. In addition to the inflow area, strut on the outflow area is required to reduce shear rate near the aneurysm wall.

Conclusions: Self-organizing Maps can be an effective tool to find the detailed relationship between stent design and hemodynamic parameters.

Reference

Cerebral Aneurysm as a Hemodynamic Stress-Regulated Inflammatory Disease

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Cerebral aneurysm can cause a subarachnoid haemorrhage after rupture as a major cause of it. Given the poor outcome of subarachnoid haemorrhage (mortality of 50%) and absence of medical therapy for unruptured aneurysm to prevent progression/rupture, mechanisms underlying cerebral aneurysm formation/progression/rupture should be clarified. To address this issue, we have used animal model of cerebral aneurysm and revealed some important machinery regulating cerebral aneurysm formation and progression (Aoki et al., 2015, 2013, 2012, 2011, 2009, 2007). In brief, cerebral aneurysm is a long-lasting inflammatory disease in intracranial arteries. In this process, NF-κB activation to induce pro-inflammatory factors and macrophage infiltration is revealed as crucial steps. Importantly, hemodynamic force loaded on endothelial cells of intracranial arteries greatly affects macrophage infiltration and inflammation in lesions. In this talk, recent insight regarding molecular mechanisms regulating cerebral aneurysm will be discussed.

References
Impact of the Flow-Diverter Deployment Strategy on Side Branch Endothelialization: Over- Versus Undersizing

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Flow-diverting devices are promising treatment options for intracranial aneurysms, since they reduce the blood flow into the dilatation and induce a stabilizing thrombosis. A previous study in rabbits concluded the safe use of flow-diverters regarding side branch patency. However, this conclusion has recently been challenged by published clinical cases and jailed side branches might occlude leading to insufficient blood supply. Especially differences in the local stent strut compression may have a drastic influence on subsequent endothelialization.

To investigate the outcome of different treatment scenarios, over- and undersized stent deployments were realized experimentally as well as computationally. Two Pipeline Embolization Devices were placed in the common carotid artery of large white swine. DSA and PC-MRI measurements were acquired pre- and post-stenting and after three months. To evaluate the stent strut endothelialization and the corresponding ostium patency, the swine were sacrificed and scanning electron microscopy measurements were carried out. A more detailed analysis of the near-stent hemodynamics was enabled by a realistic virtual stenting in combination with highly resolved Computational Fluid Dynamics simulations using case-specific boundary conditions.

The oversizing resulted in an elongated stent deployment with more open stent pores, while for the undersized case a shorter deployment with more condensed pores was present. In consequence, the side branch of the first case remained patent after three months and the latter almost fully occluded. The virtual investigation confirmed the experimental findings by identifying differences between the individual velocities and stent shear stresses at the distal part of the ostia.

The choice of flow-diverting device and the subsequent deployment strategy strongly influences the patency of jailed side branches. Therefore, careful treatment planning is required to guarantee sufficient blood supply in the brain territories supplied by those branches.

The Aneurysm DataBase and AneuX Project

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The prevalence of intracranial aneurysms is estimated to be around 3% of the Western World population. The incidence of unruptured intracranial aneurysm diagnosis is increasing due to an easier access to head imaging in the context of trauma, headaches or ill defined spells. Most of patients diagnosed are younger than 65 years and the average age of the patient population is around 53 years.

Currently many factors need to be assessed as proposed by the PHASES score study and the UIATS consensus to optimally manage patients identified with an incidental aneurysm. Nevertheless the clinical usability and predictive value of both scores and other currently available tools have yet not been validated nor quantified.

The personalized estimation and balance of risks associated with the natural history or different treatment strategies is therefore difficult to judge and it lacks comparable quantitative measurements. Suboptimal management may severely impact on the patient future quality of life and healthcare costs.

The aim of the SwissNeuroFoundation is to develop and provide technologies and tools to create a global AneurysmDataBase to stratify intracranial aneurysms and quantify risk associated with different management strategies.

The database is currently populated with information provided by the former @neurIST Project. The database supports collecting structured information about each patient's clinical condition, it represents the anatomy of the cerebrovascular tree and aneurysm as well as contains a whole genome scan and aneurysm dome microscopic analysis.

With increasing number of cases registered and careful analysis of the data the team was able to publish quantitative observations regarding risk factors associated with rupture. The results of the latest analysis of the AneurysmDataBase will be reported.
The future perspective to reduce the number of factors to be analyzed and possibly increase the objectivity of the risk balancing, resides in the development of a strategy using aneurysm location and advanced aneurysm dome shape analysis as principal factors. The model of aneurysm wall stability estimation based on shape will be tested against the PHASES and UIATS scores using the AneurysmDataBase. The efforts are executed within the AneuX project, supported by SystemsX.ch.

### Connecting Hemodynamics and Wall Inflammation in Cerebral Aneurysms

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**Purpose:** The purpose of this study was to evaluate the possible association between intra-saccular hemodynamic characteristics and markers of wall inflammation in intracranial aneurysms.

**Methods:** A total of 20 cerebral aneurysms, which underwent surgical clipping, were studied. Patient-specific computational fluid dynamics (CFD) models were constructed from pre-surgical CTA images. Numerical simulations were carried out using pulsatile flows and a number of hemodynamic variables were computed to characterize the intra-saccular flow environment. After clipping the aneurysm, a tissue sample was resected from the dome and analyzed histologically with CD45 to search for evidence of wall inflammation. For analysis, the sample was divided in two different manners. First, aneurysms were classified into an “inflammation” group if the number of CD45+ cells was larger than the median of CD45+ cells in the entire sample of 20 aneurysms; otherwise they were classified as “no-inflammation”. Hemodynamic variables were then statistically compared between these two groups. Secondly, aneurysms were subdivided into three groups according to their mean wall shear stress (WSS): 1) “low WSS” if $WSS < 0.5*median(WSS)$, 2) “high WSS” if $WSS > 2*median(WSS)$, and 3) “mid WSS” otherwise. The numbers of CD45+ cells in each group were then statistically compared. All statistical comparisons were carried out using the Wilcoxon rank sum test and differences were considered statistically significant if $p < 0.05$ (95% confidence).

**Results:** It was found that aneurysms in the “inflammation” group had on average significantly larger mean wall shear stress ($p = 0.018$), shear rate ($p = 0.015$), vorticity ($p = 0.018$), and viscous dissipation ($p = 0.015$) than aneurysms in the “no-inflammation” group. Conversely, it was also found that aneurysms in the “high WSS” group had on average significantly larger numbers of CD45+ cells ($p = 0.0046$) than the “mid WSS” and “low WSS” groups. Interestingly, it was observed that aneurysms with stable flow patterns tended to have larger numbers of inflammatory cells ($p = 0.040$) than aneurysms with unstable flows.

**Conclusion:** Our preliminary results suggest that there is a connection between intra-aneurysmal flow characteristics and wall inflammation in cerebral aneurysms. In particular, inflamed walls seem to be associated with higher levels of wall shear stress.

### How can Physicians Benefit From Hemodynamic Simulations? An Individualized Therapy Planning Approach for Intracranial Aneurysms

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Flow-diverting devices are promising options to treat intracranial aneurysms minimal-invasively. However, due to the high diversity of aneurysm shapes and locations as well as the risk of jailed side branches, therapy planning can become challenging for neuroradiologists and neurosurgeons. Therefore, physicians would benefit from a reliable assistance using hemodynamic simulations.

In this study, a new method is introduced that combines a realistic deployment of a virtual flow-diverting stent for a given aneurysm with three-dimensional Computational Fluid Dynamics simulations and in-house optimization algorithms. Arbitrary treatment scenarios with different local compressions can be considered in a fully automated simulation loop. To proof the concept and demonstrate the clinical usability of this approach, the workflow was applied to different patient-specific aneurysm cases (e.g., terminal or lateral aneurysm). The impact on the corresponding blood flow behaviour was evaluated qualitatively as well as quantitatively and the optimal configuration was identified for each case under given conditions.

The virtual evaluation of a giant aneurysm, which was actually treated using a commercial flow diverter, revealed the impact of the local stent compression. The blood flow reduction into the dilatation ranged from 24% to 33%. Additionally, wall shear stress distributions on the luminal surface show clear variations depending on the treatment scenario. For the terminal aneurysm located at a cerebral bifurcation the optimal stenting configuration was found that reduces the aneurysmal inflow. Simultaneously, sufficient blood supply of the jailed side branches is maintained decreasing the interventional risk.

The findings illustrate the variability of a flow diverter deployment. Depending on the target function of the fully-automatic optimization workflow, improved treatment options for intracranial aneurysms can be identified.
virtually. Hence, physicians can be supported during their individualized therapy planning at no risk for the patient.

**Chopsticks Technique for the Recanalization of T Junction Occlusions—Cases Report**

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**Purpose:** To report an approach using 2 stent-retrievers in combination for the recanalizing of T junction occlusions.

**Materials and Methods:** Three consecutive T junction occluded cases treated with this initiative technique were collected. Each was treated with following procedures directly or after failure of single stent retriever based thrombectomy. A rebar 18 micro-cathe ter loaded with a 6/30 Solitaire AB device was navigated to the middle cerebral artery through an 8F guiding catheter. Another rebar 18 micro-catheter loaded with revise 4.5/22 was placed in the anterior cerebral artery through the same guiding catheter. Unsheathe the two stent retrievers in sequence and gently pull them back together into the guiding catheter with constant aspiration through the guiding catheter. All of the 3 cases were recanalized with one single pass of the whole system. Embolus was found to be clamped by two retrievers.

**Summary of Cases:** Chopsticks technique might an alternative for T junction occlusions, especially those failed to recanalize by single stent-retrievers and whose chance of embolus migration was high.

**Estimation of Recanalization for Cerebral Aneurysms after Coil Embolization by Computational Fluid Dynamics Analysis**

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**Purpose:** Recurrence of aneurysms after coil embolization remains a serious problem. The risk assessment protocol for preventing recanalization has not been established, and mechanisms of that phenomenon are not understood clearly, either. In this study, we investigated the flow characteristics on aneurysms after endovascular embolization to clarify the mechanisms of recanalization and estimate recurrence using computational fluid dynamics (CFD).

**Materials and Methods:** 12 recanalized cases and 14 stable cases were identified with 3-dimentional digital subtraction angiography. We investigated the flow characteristics of the aneurysms before and after initial coil embolization. An original parameter called Force per VER (FpV) was defined. The FpV considers simultaneously morphological factors (the area of the aneurismal neck and the volume embolization ratio (VER)), and a hemodynamic one (the maximum pressure at the coil surface). It implies force per unit VER. ROC analysis was conducted to specify the suitable VER value for each aneurysm case. The cut off value, which distinguishes whether one aneurysm will be a recanalized or not in the future was obtained from the ROC curve.

**Results:** The FpV showed statistically significant difference between recanalized and stable cases (P = 0.01); the value of FpV in recanalized cases tended to be higher than that in stable cases (recanalized: FpV = 0.016, stable: FpV = 0.008). ROC analysis shows that the cut off value of the FpV is 0.007 from the ROC curve.

**Conclusion:** Both hemodynamic and morphological factors may play an important role in the recanalization of aneurysms. By establishing the most suitable VER for each case from the cut off value of the FpV, the pressure on coil surface and the aneurismal neck area, the recurrence of aneurysms may be able to be prevented more effectively.

**Flow Competition as a Factor of Patency or Occlusion of Side Branches After Flow Diverting Stent Placement in Intracranial Arteries: From Animal Translational Research to CFD Simulation and to Clinical Practice**

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**Purpose:** Jailing arterial branches emerging from the vicinity of intracranial aneurysms during flow diverting stent
deployment has recently raised concerns. Even though initial animal studies showed patency of jailed branches (Kallmes, Ding et al., 2007, Darsaut, Bing et al., 2012), recent clinical data challenge their conclusions (Brinjikji, Murad et al., 2013). Clinical observations (Brinjikji, Lanzino et al., 2014, Saleme, Iosif et al., 2014, Iosif, Camilleri et al., 2015) suggest that the type of vascularization of the covered branch has an important role in its patency.

Materials and Method: We report the results of a translational animal research aiming to investigate the role of flow competition as a factor contributing in jailed branch patency. Fourteen large White swine were blindly allocated in two groups, modified by endovascular means to correspond to the anastomotic and terminal type of arterial circulation at the level of the ascending pharyngeal arteries (APhAs). Endovascular deployment of flow diverter in the right APha bifurcations followed. Blood flow rates and velocities were quantified by 4D phase contrast MRA before and after stenting. Computational fluid dynamic simulations were generated. After three months the jailed ostia were evaluated by Scanning Electron Microscopy (SEM).

Results: Statistically significant correlation was found between flow rates post-stenting and group allocation. Circulating ostia surfaces, quantified by SEM, showed statistically significant difference between the two groups. Jailing an artery by a flow diverting stent, in the presence of flow competition, results in immediate flow rate reduction, with subsequent significant ostium endothelization. In the absence of flow competition, flow rates and maximal velocities are preserved post stenting and ostia remain patent.

Conclusion: These results find their application in therapeutic decision-making. We adjunctively discuss a single-center case series of patients harboring distal, bifurcation, patent.

References

Hemodynamic Differences of the Same Location Aneurysms According to the Rupture Status
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Purpose: Hemodynamics characterizes the rupture status of cerebral aneurysms using computational fluid dynamics (CFD). However, aneurysm location and subarachnoid hemorrhage (SAH) would affect the quantitative hemodynamic metrics. Therefore, we investigated the hemodynamic parameters in two patients with SAH and multiple aneurysms at the same location.

Methods: 3D-CT angiography revealed ruptured and unruptured cerebral aneurysms in the same parent artery. Eleven morphological parameters and seven hemodynamic parameters were evaluated to diagnose the rupture status, and then the ruptured aneurysms were confirmed during the surgical clipping.

Results: Morphological examination revealed the higher maximum size and aspect ratio in both ruptured aneurysms compared with unruptured aneurysms. Lower wall shear stress (WSS), WSS gradient and aneurysm formation indicator were observed in both ruptured aneurysms. In contrast, the ruptured aneurysms had higher oscillatory shear index and oscillatory velocity index which was the novel hemodynamic parameter to quantify the fluctuation of flow velocity vector to detect complex flow pattern in 3D fluid domain.

Conclusion: Quantitative characterization of hemodynamic environment could identify the ruptured aneurysm without the bias of SAH and aneurysm location. Our results indicated that not only higher OSI but also 3D complex flow pattern in the fluid domain would be useful to discriminate the aneurysm rupture status.

References
In Vitro Investigation of Contrast Flow Jet Timing after Flow Diversion in Patient-Specific Intracranial Aneurysms

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Purpose: After deployment of a flow diverter, visible changes of intra-aneurysmal flow can be observed on angiograms. This hemodynamic change is a critical mechanism for thrombosis and a fundamental basis of contrast stasis. However, these changes may not be consistent and vary by how the contrast is administrated. Our study investigates the factors that may control the appearance of intra-aneurysmal flow.

Materials and Methods: Three patient-specific aneurysm models between 11 and 25 mm were manufactured and each was implanted with a flow diverter. X-ray angiographic experiments of these models were performed at injection rates of Omnipaque between 0.2 and 2 ml/s. The timings of intra-aneurysmal flow jets were quantified.

Results: Significant changes of flow pattern are observed after placement of a flow diverter. At higher contrast injection rates, contrast influxes arrive at the aneurysm faster than those for slower injection rates. The flow patterns associated with slower injection rates exhibit strong inertia and correspond to the systole flow. Flow jets arrive at both the ICA and MCA aneurysms at the peak systole when the contrast is injected at 0.2 ml/s.

Conclusion: Visualization of intra-aneurysmal flow jet at the acceleration phase of the systole is possible by controlling the contrast injection rate. The systolic flows for both the ICA and MCA aneurysms can be visualized with low injection rates (<0.5 ml/s), while the diastolic flow jets can be appreciated better with an injection rate between 1 and 1.5 ml/s for the ICA aneurysms.

Hemodynamic Study of Stent Effects on Cerebral Aneurysm Models Using Scanning Stereoscopic Particle Image Velocimetry

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Purpose: Flow diverter (FD) stents are new devices for cerebral aneurysm treatment. According to past treatment results, over 70% of aneurysms were successfully occluded by FD treatment. However, some complications (e.g. headache and rupture) have been reported. Generally, hemodynamics change after treatment was considered to play an important role in these complications, but details are unclear. This study aims to reveal the effects of FD treatment on hemodynamics.

Methods: A flow measurement was conducted for four patient-specific aneurysm models. The silicone phantoms of these models were created based on digital subtraction angiography (DSA) images taken from three patients (i.e. one patient had two aneurysms). All the patients were treated with a FD. All aneurysms were side-wall type, one straight and the others - curved. For each aneurysm, pre- (without stent) and post- (with stent) operative models were prepared. Our original new FD stent (NS, porosity: 88%) was deployed into the parent artery part of the post-operative models. Scanning stereoscopic particle image velocimetry (SSPIV) was applied to obtain three-dimensional velocity fields in the models. Velocity root mean square (VRMS) and wall shear stress (WSS) were calculated from the measured velocity field. Inflow rate was calculated at the neck of the aneurysm. We compared these parameters between pre- (w/o stent) and post- (w/ stent) operative models.

Results: For post-operative models, VRMS, inflow rate, and WSS decreased in all the cases. Especially a large rate reduction was identified at the straight side-wall type model. The measurement results showed that treatment with NS promoted occlusion of aneurysm, i.e. preventing its rupture.
Conclusion: The current results showed that side-wall aneurysm treatment with NS, especially in the straight type, reduced VRMS, inflow rate and WSS.

Development of an Integrated 1D-0D Simulation System for Patient-Specific Cerebral Circulation

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In order to predict blood flow changes in the cerebral circulation resulted from carotid artery stenting, a patient-specific simulation can be a practical technique. Since the blood flow is altered by the surgical operation, it is necessary to include the effects of the entire circulatory system. A 1D-0D simulation can take account of them in a more practical manner comparing to a 3D-1D-0D simulation, and also can be performed with a patient-specific cerebral circulation which takes the entire cardiovascular system into account. The purpose of this study is to develop an integrated 1D-0D simulation system combined with multi-modal medical data such as MRI, CT and SPECT to obtain information of cerebral circulation for an individual patient.

The present integrated system consists of three processes: an image-based 3D geometric modeling,¹ 1D-0D simulation,² and 3D visualization processes. The modeling system plays two roles: extraction of arterial geometries represented as the centerlines and quantification of patient’s arterial geometries such as radii along the arterial centerlines for the 1D-0D simulation. In the simulation, the 1D simulation is performed in a part of the cerebral circulation uses the patient-specific geometry and flow information. The 3D visualization is developed so as to describe the results of the 1D-0D simulation such as flow rate, cross-sectional area in the region where the patient-specific data are used.

We have applied to medical images in pre- and post-operation of carotid artery stenting. The 1D-0D simulation process has been performed to use not only arterial geometric data but also flow data obtained from PC-MRI and SPECT. The 3D visualization showed that it became easy to understand flow distribution changes in Circle of Willis between pre- and post-operation.

References

International Aneurysm CFD Challenge 2015 (Introduction Talk)

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Purpose: Computational Fluid Dynamics (CFD) of intracranial flows has gained much interest over the past years and is arguably a useful tool for future clinical use. Drs. Steinman and Loth launched the “Aneurysm CFD Challenge 2012”, and concluded that pressure drop was reasonably well predicted among the vast majority of the participants (Steinman et al., 2012). Dr. Janiga followed up in 2013 and assessed whether CFD modellers could predict the ruptured aneurysm of two cases (Janiga et al., 2015). However, in both previous challenges, segmented surface geometries were provided along with other constraints, which may not reflect a normal collaboration between physicians and engineers.

Materials and Methods: We have launched the Aneurysm CFD Challenge 2015 that is designed to mirror a “real-world” collaboration starting from Digital Imaging and Communication in Medicine (DICOM) data of five aneurysms. There are three questions we wish to answer in the current challenge: (i) what are the variabilities of image segmentations and (ii) what are the differences in CFD results when surface and boundary conditions are not provided and (iii) and is CFD really adding value with respect to rupture status prediction? The latter will be answered through providing clinicians the “normal” clinical data as clinicians’ challenge.

Results: Twenty-eight teams all over the world have participated in this challenge. We have obtained predictions from more than 200 clinicians. There are large variabilities of segmentations, CFD methods, and predictions. We have been analysing large data sets, and will open the results at the ICS.

Conclusion: This CFD challenge will uniquely reveal¹ variabilities of segmentations and² comparison of predictions of rupture status between CFD teams and clinicians. This challenge will be presented in two sessions: introduction talk by an organizer, and a workshop session with talks by an organizer and a few participants.
Li plotted to show the optimal set of trade-offs between the competing with each other and thus the Pareto fronts are strongly found. Results: this study.

Multiobjective Particle Swarm Optimization (MOPSO) algorithm is adopted for performing the robust optimization in this study. The uncertainty and its effects on design of coronary stents.

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Purpose: Coronary stents are used widely as a minimally invasive device for unblocking occluded coronary arteries. Restenosis is the re-occlusion of the artery post stent implantation, largely caused by an injury to the artery during stent deployment (Lim et al., 2008), which necessitates careful design of stent to minimize such adverse effects. There are two critical issues involved in the design of stent structures. First, the risk of arterial injury should be minimized by imposing multiple design objectives, which can for example include reduction in dog-boning, foreshortening, elastic radial recoil, and stresses developed in the arterial wall during stent deployment (Li et al., 2009). Some of these objectives could compete with each other (Lim et al., 2008). Second, the stent insertion and deployment process is subject to uncertainties (noise) such as slight movement of the stent on balloon catheter, and changes in stent material properties during manufacturing and patient specific arterial size and properties. These critical issues place significant challenge in design optimization.

Materials and Methods: The nonlinear finite element analyses of a parameterized stent model are first conducted in a series of different models. The surrogate models are then constructed which formulate the mathematical relationship between stent geometrical parameters (control parameters) and the objective functions. The surrogate models include both mean and standard deviation responses. To address the issue of stent design involving uncertainties, a multi-objective robust optimization is adopted here (Sun et al., 2011, 2014 and Gu 2013) such that the effects of uncertainties on optimal objectives can be minimized. The Multiobjective Particle Swarm Optimization (MOPSO) algorithm is adopted for performing the robust optimization in this study.

Results: The different design objectives are found strongly competing with each other and thus the Pareto fronts are plotted to show the optimal set of trade-offs between the different objective functions. The uncertainties are of considerable effects on the optimisation results. The robust design minimised the effects of uncertainties by sacrificing some degree of multiobjective optimisation.

Conclusion: The design of coronary stents should take into account the multiple design objectives for addressing the clinical concerns. The design should also consider uncertainties whenever possible as they will largely affect the design and clinical outcomes.

References

Uncertainty and Its Effects on Design of Coronary Stents

Comparison Between CFD and MRI with 2D Velocity Vector Field and 3D Streamline in the Cerebral Aneurysm

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Purpose: Hemodynamic parameter could be obtained by many methods, like computational fluid dynamics (CFD) and magnetic resonance imaging (MRI) (Haruo, 2010). However, each method has its own merits and limitations. In order to achieve better understanding of the difference in each method, discussion of the results between different methods is necessary. This research shows the comparison between CFD and MRI with the same patient-specific geometry, with providing the 2D flow pattern, as well as 3D streamline.

Materials and Methods: A silicone phantom of the patient-specific aneurysm was manufactured. To decrease the geometrical difference between the silicone phantom and the 3D model in CFD, the silicone phantom was scanned by a...
Association Between Flow-Rate Waveform-Based Flow Instabilities and Rupture Status Indicators in Cerebral Aneurysms: A CFD Study

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CFD (computational fluid dynamics) has been proved to be of great potential but with challenge in cerebral aneurysm risk diagnosis. Recent studies report that flow instabilities appear to play an influential role in the evolution and rupture of aneurysms. However, how physiologically realistic inlet flow rate waveforms influence the flow instabilities and hence wall shear stress (WSS) fluctuations in aneurysms is still unclear. We used a CFD model of an anatomically realistic cerebral aneurysm to investigate the association between inlet waveform’s harmonic frequencies and flow fluctuations in the cerebral aneurysm. The three dimensional, unsteady Navier-Stokes equations were solved with the assumptions of rigid vessel walls and incompressible Newtonian fluid. The inlet waveform was given based on a one-dimensional (1D) model of the human cardiovascular system, and decomposed into Fourier series with a constant term and 8 harmonics. To identify the harmonic frequency dependence of the inlet waveform on flow instability mechanisms, we further performed power spectral density (PSD) analysis on the WSS fluctuations. Our simulated results demonstrated remarkable temporal and spatial WSS fluctuations in the aneurysm at late systolic when flow decelerates. There was an obvious relationship between the inlet waveform’s harmonic frequencies and the WSS fluctuations: the low-frequency harmonics in the inlet waveform caused pronounced WSS fluctuations corresponding with a maximal dominant frequency at 128 Hz but high-frequency harmonics seemed to influence less on flow instabilities in the cerebral aneurysm. There exists a harmonic frequency dependency in inlet flow rate waveforms associated with flow instabilities in cerebral aneurysms: low-frequency harmonics play a dominant role in causing significant WSS fluctuations. This is partly explained by that the low-frequency harmonics govern a primary adverse pressure gradient at late systole during flow deceleration, which induces transitional flow while giving it sufficient time to develop into flow instabilities whereas high-frequency harmonics do not but decay gradually.

Reference

High-Resolution Magnetic Resonance Vessel Wall Imaging (MR-VWI)

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High-resolution magnetic resonance vessel wall imaging (MR-VWI) is a newer imaging paradigm that is increasingly being used to characterize steno-occlusive diseases, for example, intracranial atherosclerosis and cerebral vasculitis. We reported for the first time thick vessel wall enhancement in 5 patients with ruptured intracranial aneurysms, and demonstrated its utility in determining the site-of-rupture in 3 patients harboring multiple aneurysms. More recently, Edjlali et al., reported that 16 of 17 ruptured aneurysms demonstrated circumferential wall enhancement. Nagahata et al., reported wall enhancement in 60 of 61 ruptured aneurysms. Taken together, these data establish a strong association between aneurysm wall enhancement and rupture status. Whether vessel wall enhancement is also a risk factor for future aneurysmal rupture is not known. However the recent demonstration by Edjlali et al., that circumferential wall enhancement was observed in unstable (and unruptured) aneurysms is certainly enticing. Herein, we describe our growing experience with MR-VWI in the evaluation of more than 100 intracranial aneurysms, 25 brain arteriovenous malformations (AVMs), and 3 cranial dural arteriovenous fistulas (DAVFs). We propose a new, unified hypothesis that spontaneously ruptured vascular structures demonstrate thick vessel wall enhancement and

Micro-CT scanner, and reconstructed to a 3D model. Working fluid used in MRI has similar property to human blood. Corresponding boundary conditions and fluid properties were set in CFD, to ensure that flow conditions are the same in each method.

Results: From the comparison between MRI and CFD, the shape of the edge of the geometry shows some discrepancies, as well as the flow pattern around the wall.

Conclusion: The low resolution in MRI may affect the measurement of geometry shape as well as the flow movement in the model, which need to be improved in future study.

Reference

provide further evidence to support the contention that circumferential wall enhancement predicts future rupture.

References:

The Use of Computational Fluid Dynamics in the Diagnosis and Prognosis of the Cardiovascular Diseases (CVDs): An Update

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Purpose: The Cardiovascular Diseases (CVDs) are well known as the leading cause of the mortality and morbidity worldwide. Early diagnosis and prognosis of CVDs could effectively reduce these high mortality and morbidity rate. The recent developments of various innovative non-invasive diagnosis and prognosis tools to enhance our knowledge of cardiovascular physiological phenomena have been widely reported. In particular, the computational fluid dynamics (CFD) techniques have been effectively utilized in the analysis of cardiovascular hemodynamics, a key element in the initiation and propagation of the CVDs. However, despite the huge achievements of utilizing the CFD for analysing the cardiovascular fluid dynamic, the clinical implication of this technique has not yet well been accepted due to its limitations. This study set out to analysis the vortex formation and propagation in patient-specific left ventricle (LV) using the image-based CFD technique.

Methods: We implemented the cardiac images of patient-specific LV obtained using the Magnetic Resonance Imaging (MRI) in order to reconstruct the time-resolved 2D geometry of LV. All required image processing has been conducted using the freely available Segment software (http://segment.heiberg.se), and other steps include the geometry reconstruction, mesh generation, and CFD simulation has been conducted in the commercial solver ANSYS FLUENT.

Results: One of the more significant findings to emerge from this study was that an asymmetric and large vortex was generated beneath the aortic valve during the diastole that can enhance the ventricular pumping efficiency by redirecting the flow toward the aorta once systole phase starts. Moreover, the finding indicated that the blood flow pattern during the systole was considerably smooth and straightened toward the aortic valve.

Conclusion: The findings indicate that our proposed semi-automated IB-CFD to simulate the intraventricular blood flow dynamic over the whole cardiac cycle can provide insights to enhance our understanding of patient-specific intraventricular vortex formation and propagation.

The Parent Artery Configuration can Induce Flow Pattern and its Stent Pattern?

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Background and Purpose: In recently, the relationship between aneurysm and blood flow is discussed to be a classification for effective stent replacement. The role of stent is to reduce the blood flow speed in cerebral aneurysm. Previously, we found that there may be two types of flow pattern in the inflow of aneurysm and have developed the optimization of stent strut pattern using computational fluid dynamics (CFD) system. In this study, we investigated effect of stent strut pattern to the flow pattern in aneurysm neck.

Materials and Methods:
- The blood vessel shape
  1. Patient-specific parent artery shape with a cerebral aneurysm was reconstructed using OsiriX from medical treatment images.
  2. The center line of patient-specific parent artery shape was extracted using a vascular modeling tool kit.
  3. The parent artery shape was reconstructed based on this center line using computer aided design (CAD).
- The aneurysm shape
  The shape was a combination of a straight pipe and a half sphere, and the aspect ratio (AR) value was fixed at 1.0.
- Stent
  The three stents based on z-type stent shape were implanted on the neck of the aneurysm.
- CFD analysis
  The constructed parent vessel, aneurysm, stent shape data were merged on computer, CFD analysis was performed by the comitual code (Ansys 15.0, Ansys Inc.).
Results and Conclusion: After stent implantation, the maximum WSS was increased in only one case and was decreased in the other cases. The maximum blood flow speed was increased in some case, and was decreased in the other cases. Although we found the classification of inflow and the stent with average WSS and speed, we still need to investigate the relationship the maximum WSS and the maximum blood flow speed.

Reference

In-Vitro Model with Flow for Surface Treatment for Endothelialization

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Purpose: Quick endothelialization on and around stent wire is important for suppression of restenosis after stent placement for stenosis. In previous research, it was described that endothelial cells suppress the intimal hyperplasia leading to restenosis and promote antithrombogenicity of stent. It is expected that immobilization of Type I collagen which has cell adhesiveness on stent wire will promote endothelialization on wire, so this study examined the influence of collagen immobilization by HMDI on endothelialization and around wire with shear stress (WSS) environment.

In this study, at first, observation methods for endothelialization were examined. Next, endothelialization on bare wire and collagen immobilized wire under no flow and with WSS environment examined.

Materials and Methods: A circuit was connected in a flow exposure system called flow chamber consisted of roller pump, pulse damper and reservoir. And, Medium 199 added 20% FBS and penicillin (Proliferative Medium, PM) was circulated with 170 ml/min flow rate which made 2 Pa Wall Shear Stress (WSS) on the bottom of flow circuit before implanting wire, for 24 hours. Before wire placement, the flow circuit’s height is 0.6 mm and width is 1.8 mm as a rectangle and the flow is run along the width. Then a flat WSS of 2 Pa is distributed in the circuit.

Results: More endothelial cells (ECs) attached on collagen immobilized wire than on bare wire. This result is similar result to the chamber without flow. However, the cells in upstream on bare wire is higher density than that in downstream whereas the cells on collagen wire is the same. This result is a specific result in the flow condition. These results suggest that the flow condition is important factor when the pre-clinical (or pre-animal) test is established. And collagen immobilization will promote endothelialization on wire. In addition, around the wire, increase of EC density occurred in the area with WSS gradient (WSSG), and this result suggested that WSS occurred by placement of wire will affect endothelialization around wire.

Conclusion: The flow chamber we developed can be used for the first trial before a clinical or animal test to check the endothelialization of wire and around the wire. Collagen treatment may be a good method for endothelialization.

References

Patient-Specific Modelling of Leukocyte Transport in Cerebral Aneurysms

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Purpose: Inflammation plays a key role in the initiation, progression and rupture of aneurysms (Chalouhi et al., 2012), but is difficult to be monitored in patients. Our objective was to demonstrate that computational fluid dynamics (CFD) combined with digital subtraction angiogram (DSA) could be used to study leukocyte transport phenomenon inside cerebral aneurysms in a patient-specific manner.

Methods: A 63-year-old woman presented with symptoms due to a giant unruptured ophthalmic internal carotid artery (ICA) aneurysm, while a 47-year-old woman due to a small unruptured left cavernous segment ICA aneurysm. The 3D models of both aneurysms were reconstructed from DSA images. CFD simulations were performed on these models where blood was modelled as multiphase flow with particles of erythrocytes and leukocytes (Jung, 2006).

Results: The difference of leukocyte distributions between these two aneurysms was significant. Though the average concentrations of leukocytes in both cases were about the same level, the elevated level of leukocyte concentration was observed in some small regions on the giant aneurysmal wall, where may have inflammation and bear a high risk of rupture (Frosen, 2004).
**Conclusion:** We demonstrated the feasibility to study leukocyte transport phenomenon inside cerebral aneurysms by an image-based patient-specific CFD analysis. More studies are needed before it applies for evaluating aneurysm rupture risk in clinical applications.

**References**

**Y-Configured, Dual Stent-Assisted Coiling of 12 Basilar Apex Aneurysms**

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**Purpose:** Due to the special and complex anatomical features of the basilar apex aneurysm, the methods of the endovascular treatments are diverse. Y-configured, dual stent-assisted coiling is one of the favourite treatments nowadays. To research such kind of endovascular treatment is necessary.

**Methods:** We retrospectively reviewed 12 basilar apex aneurysms treated with Y-configured, dual stent-assisted coiling during 1st January, 2014 to 31st March, 2015 in our hospital. 10 of 12 aneurysms were in the acute phase of subarachnoid hemorrhage. Another 2 cases were unruptured aneurysms without any clinical symptoms. All of endovascular treatments were performed under general anesthesia. In hybrid stenting, a NEUROFORM stent and a SOLITAIRE stent were successfully placed and implanted in proper order before coiling. All of coil embolization were accomplished successfully. 9 of 12 cases were followed up by DSA from 3 months to 9 months.

**Results:** 11 of 12 cases had excellent clinical outcomes. Neurologic disorder appeared 2 days after treatment in remaining 1 case, whose clinical symptom performed blurry vision. After 10 days’ positive pharmacotherapy, the clinical symptom was recovered well. Follow-up DSA examinations showed stable and total occlusion of all coiled aneurysms.

**Conclusion:** The results of this retrospective analysis show that Y-configured, dual stent- assisted coiling of apex aneurysm can achieve good clinical outcome. But much longer term follow-up is advocated to assess the prognosis of such kind of coil embolization.

**International Aneurysm CFD Challenge 2015: Solutions Using the Commercial Finite Volume Solver, Ansys CFX**

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**Purpose:** To predict the likelihood of rupture in 5 cerebral aneurysms, computational fluid dynamics were carried out for these 5 models.

**Methods:**
- **Solver type:** Finite volume.
- **Solver details:** implicit.
- **Types of elements:** tetrahedral and prisms (boundary layer).
- **Spatial grid resolution:** Global element size is 0.08 mm; Minimum limit of element size is 0.01 mm. 5 layers of prism elements were assigned in boundary layer. The height of the first prism layer near the vessel wall is 0.04 mm and the height ratio of adjoining boundary layer is 1.1.
- **Maximum iteration number of time steps is 500 for steady flow and the convergence criterion is 10−3 for root mean square.**
- **Boundary conditions:** Velocity boundary conditions at the inlet are Poiseuille flow (steady flow).

The maximum speed (0.81 m/s) and mean speed (0.6 m/s) were assigned at the inlet respectively. Vascular wall was assumed to be rigid. No-slip boundary conditions were applied to the walls. Blood is assumed to be a Newtonian fluid. The flow is laminar. Blood pressure was set to 0 Pa at the exit section (two outlets for case1 case2 case3 and case5, three outlets for case4). The same boundary conditions and model parameters were used in the five cases.

**Results:** Pressure Loss Coefficient (PLC) was used to predict which aneurysm was the ruptured one according to the conclusion by Takao, who suggested that the values of PLC were lower in ruptured aneurysms (Takao et al., 2012). Based on our calculations, the values of PLC from case1 to case5 are 0.787, 0.7754, 0.874, 0.885 and 2.260 respectively. The difference of PLC in case1, case2, case3, case4 and case5 is significant.

**Conclusion:** So we predict that case5 is the unruptured one, and the others are the ruptured ones.

**Reference**
Flow Analysis in Recanalization of Cerebral Aneurysms After Coil Embolization using Magnetic Resonance Fluid Dynamics (MRFD)

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Purpose: The high recurrence rate after coil embolization of cerebral aneurysm is still disadvantage against clipping surgery. In morphological aspects large and wide neck aneurysms are previously reported to have tendency to be recurrent. During coiling low packing density and neck remnant and residual filling in immediate angiographic results also cause future recurrence. (Sluzewski, van Rooij et al., 2004) Moreover, several studies showed the hemodynamic feature is involved in recanalization using computational fluid dynamics (CFD)(Luo, Yang et al., 2011) and flow dynamics studies using phase contrast magnetic resonance imaging (PC-MRI). (Kono and Terada 2014) These studies are retrospective and analysed coiled aneurysms and few studies focused on preoperative aneurysmal flow dynamics assessment for risk of recanalization. This prospective study was performed to evaluate the relationship of preoperative flow dynamics of cerebral aneurysm and recanalization.

Materials and Methods: From August 2012 to September 2013, we coiled 11 unrepaired cerebral aneurysms. For each aneurysm, a preoperative four-dimensional (4D)-PC-MRI was performed. We obtained intra-aneurysmal velocity and volume using magnetic resonance fluid dynamics (MRFD). 6–12 months after coil embolization aneurysms were classified into recanalization (n = 3) or unchanged (n = 8) groups based on the angiographic appearance. Flow parameters involved in neck plane of aneurysm were calculated. Flow parameters, morphological parameters and packing density were compared between recanalization and unchanged groups.

Results: Flow analyses were completely calculated in all aneurysms (mean size, 10.13 mm). The inflow volume (P = 0.049) and velocity (P = 0.049) of neck plane of aneurysm were significantly larger in the recanalization group. Among morphological parameters, maximum dome size (P = 0.030) was significantly larger and packing density (P = 0.024) was significantly lower in recanalization group.

Conclusion: We first demonstrated relationship of preoperative flow analysis of cerebral aneurysm based MRFD and recanalization after coil embolization. MRFD may provide predictable flow information to reduce high recurrence rate.

References

Numerical Simulations of Post-Surgical Flow and Thrombosis in Basilar Artery Aneurysms

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Purpose: The treatment of fusiform cerebral aneurysms is a major challenge for neurosurgeons since it is often impossible to exclude these lesion from the circulation. In some cases, fusiform basilar artery aneurysm not amenable to stenting or coiling, can be treated by clipping some of the vessels feeding the aneurysm as well as adding a bypass to supply downstream vasculature. The goal of such treatment is to reduce the flow into the aneurysm in order to prevent it further progression and rupture. The surgeons have a limited information on the potential impact of the intervention on the flow patterns and subsequent thrombus deposition. Patient-specific CFD models based on medical imaging data can provide guidance by simulating postoperative flow fields that would result from alternative treatment options.

Method: In this study alternative surgical options were evaluated for three patients with fusiform aneurysms of the basilar artery. Patient-specific models were generated from contrast-enhanced MR angiography data obtained prior to the treatment. The inflow conditions were prescribed using phase-contrast MR velocimetry measurements. Several treatment scenarios were simulated for each patient by changing the model’s geometry to calculate the flow fields and to predict the flow field that would occur after the interventions. Computational domain consists of around 1 million unstructured tetrahedral elements generated using mesh generation tool Hypermesh by ALTAIR, and imported to ANSYS Fluent for the simulation. Unsteady patient specific inlet flow conditions were used under Newtonian fluid with rigid wall and incompressible flow assumptions. Virtual contrast injection were also carried
Validation of New Outlet Boundary Condition for CFD Simulation in Carotid Artery Stenosis Cases

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Purpose: Currently, computational fluid dynamics (CFD) is a widely used analysis method in the medical field, and there are many studies investigating carotid lesions. However, outlet boundary conditions strongly affect CFD results. This is particularly remarkable in cases with high ICA stenosis rates. In these cases, there is still no appropriate outlet boundary condition. For this problem, new approaches of setting outlet boundary conditions are proposed for CFD simulations of the human common carotid arteries (CCAs) bifurcation based on the concept of energy loss minimization at flow bifurcation (Qian et al., 2013). The purpose of this study is to investigate whether this approach is appropriate for CFD simulations in CCAs with high ICA stenosis ratios.

Methods: This study included patient-specific models from 19 patients who had high ICA stenosis ratios (>65%). Three-dimensional surface data were obtained from the angiography images. ANSYS 15.0 package (ANSYS, Canonsburg, Pennsylvania, USA) was used for both mesh generation and blood flow simulation. The minimum energy loss (MEL) method was used for the outlet boundary condition. The $Q_{ICA}/Q_{CCA}$ outflow ratios of boundary condition of MEL method through the CCA ($Q_{CCA}$), ICA ($Q_{ICA}$) were calculated. We compared the CFD results of this outlet boundary condition with experimental data (Groen et al., 2010).

Results: The results indicated that the stenosis regions with increased likelihood of thrombus deposition that would result from each surgical treatment. Some of the considered procedures would result in compromised flow through the vital branches of the basilar artery not compatible with patient’s survival. Based on comparison of the postoperative flows modelled for alternative procedures, it was demonstrated that an option involving a clipping of the posterior cerebral arteries accompanied with bypasses from the anterior circulation is likely to provide the most favourable outcomes. The contrast transport results show a delay in flow to the basilar artery thus inducing self-thrombosis.

Conclusion: Our results can help explain in vivo thrombus formation within an aneurysm after surgical intervention that is compatible with local hemodynamics. A detailed result will be shown in the conference. This demonstrates that CFD modeling can help improve the outcome of surgeries altering the flow in basilar aneurysms.

Embedding Quality into Interaction Between Animal Models and Mechanical Evaluation

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As our labs shift our focus to broaden translational research more, it will be important to characterize animal experiment models and mechanical evaluation systems that might fall on us for the artificial internal organ research as well as the development of medical devices or therapeutic methodologies. In order to share the preclinical evaluation systems using large animals and mechanical circulatory models, we placed a new institutional function of preclinical research to be in an academic specific repository based on the biomedical research network in Tohoku University for the first step. These clinically indirect preparation work that may not lead to a breakthrough in the treatment or therapy will be useful to bridge between the developmental research to the clinical trials as well as to carry out any qualified therapeutic attempt with the basis of the new animal and mechanical evaluation quality systems. In the study, some specific projects including the prevention and anticipation of thrombogenesis during the ex-vivo...
circularly support using ventricular assist devices were introduced based on the chronic animal studies and the mechanical observation circulatory models.

**Prognosis of Cerebral Aneurysm After Surgical Flow Diversion**

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**Purpose:** Surgical flow diversion is one of the last resorts to manage refractory cerebral aneurysms. However, some aneurysms might enlarge or rupture even after successful surgical flow diversion. In order to investigate how the aneurysms respond after flow diversion, three aneurysms were analysed retrospectively with CFD.

**Material and Methods:** Two aneurysms ruptured and the other aneurysm shrank after surgical flow diversion. Three-dimensional steady CFD simulations were performed retrospectively with 3D-CT angiography obtained before and after surgical flow diversion using a finite-volume solver SCRYU/Tetra (Software Cradle, Osaka, Japan). Blood was treated as an incompressible Newtonian fluid. Vessel wall was treated as rigid. The inlet flow volume was scaled to make the WSS at the inlet 2.0 Pa and it was re-distributed according to the Poiseuille law. The flow volume was allocated to each outlet of the vessel geometry according to Murray’s law.

**Results:** Case 1: Antegrade flow of basilar artery was obliterated by clipping of basilar artery in a case of a giant basilar tip aneurysm with posterior communicating artery. This flow diversion resulted in 60% reduction of the aneurysm flow, but the WSS increased by two times and resulted in rupture.

Case 2: Distal vertebral artery was obliterated to reduce the outlet of a giant vertebral artery aneurysm involving posterior inferior cerebellar artery. The aneurysm flow was reduced, however, the increased flow resistance resulted in the increased wall stress and the aneurysm ruptured eventually.

Case 3: Antegrade flow of internal carotid artery was obliterated with EC/IC bypass in a case of a recurrent large internal carotid artery aneurysm. After surgery, the flow dynamic stress reduced and the aneurysm shrank.

**Conclusion:** It is not easy to predict the aneurysm prognosis after flow diversion, however, the CFD analysis and the accumulation of the cases might improve our prediction.

**Virtual Stent Deployment**

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**Purpose:** The effectiveness of intracranial stenting depends on a number of factors such as the released configuration of the stent, alteration of the vessel haemodynamics, incidence of an arterial injury, etc. (Pierot, 2011). However, there is currently no means for a clinician to obtain this vital information in clinical setting. Additionally, knowing the accurate positioning of the device inside the vessel would enable the subsequent blood flow analysis and possible prevention of such complications as stent migration, endoleakage, etc. Motivated by this clinical need, this study aimed at modeling virtual deployment of stents with fast computational times to be used in clinical practice.

**Method:** We modelled stent expansion process based on springs analogy (Blom, 2000), where stent structure is represented as a mesh of springs. Further, we have compared different methods with different springs’ properties: linear, semi-torsional and torsional springs. The comparison was based on the comparison of two devices – a stent and a flow diverter – in the case of free expansion, in the idealised straight and bent vessels and in real patient cases.

**Results:** The 3 spring analogy methods converged; however, they did so at different rates. The convergence was assessed by measuring displacements and force evolution. One of the interesting findings was that the lineal springs method displayed faster convergence. Additionally, it produced final results comparable with those obtained by its more sophisticated semi-torsional and torsional counterparts. This was surprising since the lineal method constitutes the base for the other two methods and is associated with the simplest implementation.

**Conclusion:** Our study demonstrated the overall ability of spring-based methods to model virtual stent expansion in a computationally expedient manner, which constitutes a valuable base for future extensions of the model, with the ultimate goal of enabling predictive simulations of the minimally invasive methods in clinical setting.

**References**


**Reference**

How do Porosity and Pore Density of a Flow Diverter Affect the Flow Reduction Effect?

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Purpose: It has been reported that “porosity” and “pore density” are the major factors determining the flow reduction effect of a flow diverter stent (FD). Many variations of stents can be designed by changing those two specifications. Therefore, it is important to understand the relation between the reduction effect of a FD and its porosity or pore density, in order to design useful and effective stents. Investigating this relation was the aim of this study.

Materials and Methods: An idealized sidewall IA model, composed of a spherical aneurysm of diameter 10 mm and a parent artery of diameter 4 mm, was generated. Additionally, 5 variations of the stent model, having the same porosity but different pore densities and strut sizes were generated (strut size d₀ = 0.030, 0.035, 0.040, 0.045, 0.050 mm). Furthermore, 3 of the 5 first models were selected (strut size d₀ = 0.030, 0.040 and 0.050 mm) and for each one of them, 2 variations with different porosities were created. Finally, computational fluid dynamics (CFD) simulations were performed in the models without and with stent configurations. The reduction ratios (pre/post deployment) of velocity, wall shear stress (WSS) and inflow rate were processed and compared among the stents.

Results: With the stent of porosity 79.8%, pore density 5.2 pores/mm² and strut size 0.045 mm, the reduction rates of velocity, WSS and inflow rate were 75.5%, 38.6% and 90.0% respectively. With the stent of porosity 84.6%, pore density 7.1 pores/mm² and strut size 0.030 mm, these values were 75.4%, 37.0% and 89.9%, respectively, leading to the same reduction effects in both cases.

Conclusion: By changing the combination of wire density and porosity, stents having different specifications but the same efficacy can be designed. Further investigations with respect to other characteristics such as mechanical properties may lead to optimized stent implementations.

Numerical Study on the Effect of STA-MCA Anastomosis Position on Its Mass Flow Rate

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Purpose: To prevent stroke, an STA-MCA anastomosis is often performed to increase cerebral artery perfusion. However, there are no general criteria on its efficiency, and the failure shown in COSS study exemplifies that. If its efficiency can be predicted for each patient, the success rate will increase. This study aims to reveal the perfusion effect of anastomosis by investigating the post-operative flow field under various anastomosis conditions.

Materials and Methods: A patient who underwent bypass surgery in which a single STA was anastomosed to a M4 branch (MCA distal position), was analyzed by using computational fluid dynamics. The arterial vascular tree from the M4 part to the ICA, and their branches were included in the analysis. Two additional models: one with STA anastomosed to the M2-Superior trunk and the other to the M2-Inferior trunk were made, based on the above model. To investigate the influence on perforators, seven cylinders simulating perforators were added in these three geometries. RDH (Relative Difference to Healthy) was defined to measure how MFR (Mass Flow Rate) at each branch were close to the normal condition. Where, positive RDH indicated that patient’s MFR was more than that of normal adult, and negative RDH indicated that the MFR was less than that of normal adult, respectively.

Results: When STA was anastomosed to the M4 branch (STA-M4), RDH was positive near the anastomosis, and negative at the proximal MCA. When anastomosed to the M2-Superior and Inferior trunk (STA-M2 Super., STA-M2 Infer.), RDH became positive at all branches. For perforators, the RDH was not higher than −10.1% in the STA-M4, while, in the STAM2_Super. and STA-M2_Infer. models, it was at least +31.1% and +27.5%, respectively.

Conclusion: The STA-M2 surgical technique would provide better perfusion than the STAM4 one.
Stagnation and Complex Flow in Ruptured Cerebral Aneurysms: A Possible Association with Hemostatic Pattern

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Purpose: Histopathological examination revealed that ruptured cerebral aneurysms had different hemostatic patterns depending on the location of the clot formation. In this study, we determined whether the hemostatic patterns had specific hemodynamic features on the computational fluid dynamics (CFD) analysis.

Materials and Methods: Twenty-six ruptured middle cerebral artery aneurysms were evaluated by three-dimensional (3D) computed tomographic (CT) angiography, and then harvested at surgical clipping. Histopathological examination determined the hemostatic patterns at the rupture points, and the patient-specific geometries were generated as stereolithography (STL) using preoperative 3D CT angiography. Numerical modelling was performed using a CFD package (ANSYS CFX CFD15.0; ANSYS Inc., Canonsburg, PA, USA). Blood was assumed to be incompressible Newtonian fluid with a density of 1056 kg/m³ and a viscosity of 0.0035 Pa s. CFD simulation were performed under pulsatile flow conditions driven from typical flow waveform of phase-contrast magnetic resonance imaging was scaled to achieve a physiological wall shear stress (WSS), and the following parameters were calculated: WSS, WSS-related hemodynamic parameters at the dome and invariant Q for the vortex core detection. The morphological and hemodynamic parameters were compared among the hemostatic patterns.

Results: The hematoxylin-eosin stain of the aneurysm wall including rupture points showed 13 inside pattern, 9 outside pattern and 4 other pattern aneurysms. Among 26 aneurysms, 3 aneurysms were excluded because their geometry models could not be generated for low vascular CT values. A Mann-Whitney U test revealed that smaller aneurysm size, lower gradient oscillatory number, lower Invariant Q and higher aneurysm formation indicator was significantly related to the inside pattern aneurysms.

Conclusion: The inside pattern aneurysms may have simpler flow patterns and less flow stagnation compared with the outside pattern aneurysms. CFD may be useful for diagnosing the hemostatic pattern of ruptured cerebral aneurysms.

References

An ‘Onion-Skin’ Multilayer Type of Model for Thrombus Formation

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Purpose: Specific biological mechanisms help make thrombus in the cavity of a patient-specific intracranial aneurysm but the underlying processes are often not widely known. Specialized biological endpoints play an essential role in the healing of the treated patient. Therefore, the objective of the presented multidisciplinary research concerns the modelling of the formation of a thrombus mimicking onion-skin behaviour and investigates the effect of blood flow velocity on thrombus formation.
Materials and Methods: This scientific research is a patient-oriented research which focuses on the choice of biological phenomena and biophysical interactions involved in the thrombus growth process by using an efficient Computational Fluid Dynamics tool implemented via the lattice Boltzmann method. Low wall shear stresses, which can significantly influence the endothelial cells’ behaviour, are selected to be the trigger of the whole process of the thrombosis (Ouared et al., 2008). A giant patient-specific aneurysm case is taken in consideration which formed thrombus spontaneously; different velocity profiles are applied in order to estimate their influence on the initialization of the different phenomena leading to the thrombus formation, such as platelets’ aggregation.

Results: Thrombus formation with onion-skin structure is investigated and by changing the magnitude and the pulsatility index based on the upstream-downstream gradient, the thrombus formation can be triggered. Different locations and final shapes of the thrombus are also observed through the results generated by the numerical simulation. The preliminary results show that the magnitude and the pulsatility index of velocity profile can play an important role for initiating thrombus formation and the final shape of the thrombus.

Conclusion: This study will not only have important repercussions in understanding the thrombus formation process, but also in providing an in-depth knowledge to deliver optimized endovascular treatment for each patient.

Reference

Another EBM (Engineering Based Medicine)
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“EBM” is widely recognized as an “Evidence Based Medicine”, however, we have proposed a new concept as “Another EBM: Engineering Based Medicine”. Our trial on practically interdisciplinary alliance has been conducted at TWIns, which is an abbreviation for Tokyo Women’s Medical University and Waseda University for joint Institution. It was opened in 2008 as the first collaborative institution between a school of medicine and a school of science and engineering in Japan. The number of the residents is 600, including 300 graduate students, and 20% of the residents have a mechanical engineering background. In the biomechanical engineering section, we have established dry-laboratories, aiming at providing practical tools to assess safety and effectiveness of medical treatments and establishing reliable and practical test platforms for assessing the performances of keep-coming new medical devices. Throughout our trials, we have developed several types of mock circulatory system, some of them have an Australian
The Role of Patient-Specific Vessel Wall Thickness for the Rupture Prediction of Intracranial Aneurysms

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Computational Fluid Dynamics (CFD) is known to have a huge potential to assist physicians during therapy planning at no risk for a patient harbouring an intracranial aneurysm. However, numerous simplifications are required in order to handle the computational effort. One of the primary assumptions is the consideration of non-flexible vessel walls. Due to limited temporal and spatial resolution of existing imaging methods, reliable assessment of wall properties such as thickness or elasticity is challenging.

In contrast to recent numerical investigations, which consider a constant wall thickness, this study incorporates local vessel wall differences. The complete Circle of Willis of a patient, who died from an untreated, ruptured aneurysm, was extracted post-mortem and the rupture site was identified by a neuroradiologist. The thickness of the inner and outer wall of the aneurysm and the parent artery were measured with intravascular ultrasound. After reconstruction of the geometry, CFD simulations considering fluid-structure interactions with 1) variable and 2) constant wall thickness allow the evaluation of its role regarding rupture prediction.

Preliminary results of the investigation indicate the importance of non-constant, non-rigid vessel walls. Compared to a non-flexible vessel, the wall shear stress distribution varies significantly. Furthermore, changes in the stresses and particularly in the locations of highest values were observed. Therefore, the consideration of rigid walls may lead to the prediction of false endangered regions or even the classification as a safe situation although the case possesses a high rupture risk.

To further evaluate the role of the patient-specific wall thickness regarding rupture risk assessment of intracranial aneurysms, qualitative and quantitative comparisons of the different numerical approaches will be presented at the conference. Hence, the reliability of CFD methods can be increased in order to make them applicable for a clinical use.

Therapeutic Effect Observation of Endovascular Recanalization to Treat Symptomatic Subacute or Chronic Vertebrobasilar Artery Occlusion

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Objective: To observe the effect and feasibility of endovascular stent-assisted endovascular recanalization to treat intracranial symptomatic subacute or chronic vertebrobasilar artery occlusion.

Methods: Twelve patients with subacute or chronic vertebrobasilar artery occlusion were chosen in our study, including eight males and four females, the mean age is 58.5 years old. Each patients were attacked in significant symptoms of posterior circulation, and endovascular stent-assisted endovascular recanalization were performed in at least 3 days from the appearance of clinic symptoms. Neurological status of the patients before operation and 24 hours after stenting were assessed using the modulate RANK score (mRs score). All patients undergoing angiography were successfully accomplished with six months follow-up

Results: Successful recanalization was achieved in 11 of 12 patients. One patients failed to achieve recanalization for long occlusion time (more than six months). There were not any complications such as bleeding and stroke in operations. Improvement in neurologic function (mRs score) at 6 months was observed in all patients, and there were no reocclusion.

Conclusion: Endovascular stent-assisted endovascular recanalization is a safe and effective treatment method for symptomatic subacute or chronic vertebrobasilar artery occlusion.
Influence on Branch Arteries after Flow Diverter Deployed to Oclude Cerebral Aneurysms

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Purpose: To study the influence on the branch arteries when the flow diverters deployed to occlude the cerebral aneurysms.

Materials and Methods: A giant cerebral aneurysm involved a branch artery was treated virtually by three kinds of flow diverters (LVIS, Pipeline and Tubridge) with fast virtual deployment method (Larrabide et al., 2012 & Ma et al., 2013). The blood flow in the giant aneurysm before and after treatment was simulated by computational fluid dynamics method. The variations of the hemodynamic characteristics on the giant aneurysm and flow rate at the branch artery were investigated.

Results: When LVIS deployed, the flow rate at the branch artery was raised about 14%. When Pipeline deployed, the flow rate at the branch artery was raised about 12%. When Tubridge deployed, the flow rate at the branch artery was raised about 8%.

Conclusion: In the three flow diverters, Tubridge is the most effective to occlude the aneurysm when considering the reduction of the velocity inside the aneurysm sac. The three kinds of flow diverters do not occlude the branch artery even if they covered the orifice of the branch and they can increase the flow rate at the branch artery on the contrary.

References

Parametric Imaging for the Objective Grading of Collateral Flow in Acute MCA Occlusion

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Purpose: To report a quantitative and objective way of leptomeningeal collateral assessment using parametric color coding digital subtraction angiography (DSA).

Materials and Methods: Fifteen consecutive acute middle cerebral artery occlusion who received endovascular reperfusion therapy were recruited. Target downstream territory (TDT) of Middle Cerebral Artery in anterior-posterior view and reference point of each patient was drawn by 5 raters separately. Two parameters, relative maximum density of TDT (rDensitymax) and peak time interval between reference and TDT (ΔPT) were measured and tested for inter-rater reliability using intra-class correlation coefficients (ICC). Only parameters with substantial inter-rater reliability (ICC ≥ 0.75) were assessed for correlation with both the American Society of Interventional and Therapeutic Neuroradiology collateral grading (ACG) system and clinical outcome to evaluate its efficacy in characterization of collateral quality.

Results: ICC of rDensitymax and ΔPT were 0.982, P < 0.001 and 0.796, P < 0.001, respectively. The parameter rDensitymax shows strong correlation with ACG score (r of Spearman correlation test is 0.928, P < 0.001), yet ΔPT_average doesn’t (r = 0.327, P = 0.159). Partial correlation coefficient between rDensitymax and modified rankin scale (mRS) at 3 month is 0.563, P = 0.036; that of ΔPT and mRS is 0.119, P = 0.685, controlled by the state of reperfusion. A cut-off point of 0.224 in rDensitymax provides high sensitivity (0.875) and specificity (100%) to predict patients with favourable clinical outcome (mRS ≤ 2).

Conclusion: A quantitative collateral assessment method based on parametric color coding 2D-DSA may present an alternative over subjective evaluation of collateral in acute M1 occlusion cases.

New Technology for Visualizing Hemodynamic Changes Introduced by Flow Divers at the Ostium of Patient-specific Pcom Aneurysm Models – Preliminary Results

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Purpose: Treatment of PCOM aneurysms where the PCOM originated from the aneurysm dome using flow diverters (FD) is challenging due to the necessity of maintaining flow through this artery while obliterating the aneurysm. Computational fluid dynamics (CFD) simulations may be helpful to develop a better understanding of how hemodynamics is modulated after FD placement.
**Materials and Methods:** A new technique is presented for visualizing focal high velocities and pressures at the FD post treatment. Sampling the velocity field calculated with CFD by a porous medium patch constructed using the geometry from a virtual FD (calculated with a research CFD prototype, Siemens Healthcare GmbH) allows quantifying inflow into and outflow from the aneurysm and to put this into relation to flow changes in the PCOM artery.

**Results:** Feasibility of this new technique is illustrated by quantifying flow in proximal and distal parent artery, the inflow and outflow area at the ostium and the flow into the PCOM artery before and after FD treatment. Our preliminary results indicate that under certain flow conditions flow in the PCOM artery pre and post virtual FD treatment remains almost unchanged while reducing inflow into the aneurysm by 17.75%.

**Conclusion:** A new technology is presented based on advanced reconstruction of the aneurysm ostium for better understanding flow changes in PCOM aneurysm pre and post virtual FD treatment.

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**In Vitro Characterisation of Aneurismal Haemodynamics With and Without a Flow Diverter Using Particle Image Velocimetry**

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**Background and Purpose:** In vitro experimental investigations of haemodynamic profiles inside two patient-specific silicone models of intracranial aneurysms were carried out with the aid of a non-intrusive particle image velocimetry (PIV) measurement technique. Multi-plane fluid flow structures, including two-dimensional time-mean velocities as well as their fluctuating components, across the aneurysm model were obtained before and after the deployment of a flow diverter stent. Moreover a high-speed camera was employed to visualise the effectiveness of the flow diverter on intra-aneurysmal flow patterns. Both qualitative and quantitative experimental data will not only help the fundamental understanding of the haemodynamic phenomena occurring in the intracranial aneurysms, but be utilised to validate the numerical predictions using computational fluid dynamics (CFD).

**Materials and Methods:** Two patient-specific, full-scale silicone models of aneurysms were fabricated using rapid prototyping and 3D printing techniques. The working fluid used was a mixture of sodium iodide, glycerol and distilled water with its refractive index matching to the silicone resin. The 2D PIV system consisted of a CCD camera, a Nd:YAG pulsed laser and a synchroniser. Rhodamine B fluorescent particles were used as the seeding particles for the PIV measurements. At each measuring plane, 400 pairs of successive images were taken at the laser repetition rate of 4 Hz. Hence a mean velocity flow pattern at that plane was obtained by statistically averaging 400 successive instantaneous velocity vector maps over a time period of approximately two minutes.

**Results:** The multi-plane intra-aneurysmal flow patterns under various flow rates from 80 ml/min to 470 ml/min were obtained before and after the deployment of the flow diverter. It was clearly observed from the quantitative PIV measurements that the overall averaged velocity magnitude at one particular plane had a four-to-seven-fold decrease for the cases with a flow diverter compared to those without a flow diverter; similar ratios were also found for the fluctuating velocity components. In general, both PIV and high-speed filming techniques were able to capture the fluid flow structures inside a particular geometry of aneurysm. The flow patterns ranged from a single large recirculation zone to complex multi-recirculation regions depending on the location of the measuring plane.

**Conclusion:** The results demonstrated that the quantitative PIV measurement technique is suitable for quantifying the intra-aneurysmal flow velocities, as well as their fluctuating components, at high resolution. Significant mean and fluctuating intra-aneurysmal velocity reductions were observed for aneurysms in which a flow diverting stent deployed, compared to those without a flow diverter.

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**Modeling of Blood Flow with Pathology in Cerebral Aneurysms**

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Aneurysmal wall pathology varies in space and presents site-dependent lesion, such as blister-like and hypertrophic natures. The present studies aimed to find a correlation between local blood flow and pathologies. Specific focus is given to the direction of wall shear stress vectors, by which the local flow was classified quantitatively into 1) parallel flow, 2) merging flow, 3) rotating flow, and 4) impinging flow. The data showed the full impinging flow matched the site of blister at the prediction rate of 90%, and rotating matched the site of sclerotic lesions at 80%. The results revealed the potential ability of flow-based diagnostics of aneurysmal wall pathology.
### Visualization of Flow Patterns through the Aneurysmal Orifice after Flow Diverter Optimizations with Different Objective Functions

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**Background and Purpose:** Flow diverting stent (FDS) becomes increasingly favourable in treating giant and wide-neck brain aneurysms. Flow diversion efficiency is thought to be of great importance in predicting the prognosis of FDS treatment. To visualize the flow pattern through the aneurysmal orifice under different FDS implantation potentially helps engineers with the upgraded design of FDS device.

**Methods:** In this study, a deployed FDS device was mimicked by eight helices including 4 clockwise and 4 counter-clockwise clinging to the wall of the parent artery of an idealized aneurysm model. Different objective functions-aneurysmal average velocity (AAV) and aneurysmal maximum velocity (AMV)-were applied in obtaining better designs of FDS device. A pre-constructed combination (Anzai u. a., 2014) of lattice Boltzmann method (LBM) and simulated annealing (SA) procedure was used to automatically identify an optimal device shape. Visualization of flow patterns through the aneurysmal orifice was performed by using an open source post-processing software Paraview.

**Results:** We obtained the optimized FDS shapes after hundreds of SA iterations. Streamlines and velocity vectors through the aneurysmal orifice were obtained. The same tendency of FDS wires concentrating inside the bundle of inflow (BOI) area was identified by visualizing the optimization results. Flow reduction rate of the initial FDS structure has a reduction of 83.63% and 90.48% for AMV and AAV, respectively. Optimizations using AMV as objective function improved the AMV/AAV to 92.77% and 92.15%, respectively. Optimizations using AAV as objective function improved the AMV/AAV to 90.28% and 95.65%, respectively.

**Conclusion:** Visualization suggested that wires concentrating inside BOI area might be an important factor to divert blood from flowing into the aneurysmal luminal.

### Photoluminescent Nanomaterials for Visualisation of Intracellular Molecular Trafficking, Diagnostics and Therapy

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Development of new approaches for the diagnosis and therapy of tumours (taken together, termed Theranostics) - one of the most dynamic areas of Biomedicine, where new nanomaterials afford new opportunities. The nanomaterial merits include: programmability of their physical and chemical properties; abundance of reactive functional groups on the surface; large effective surface area; optimum size, which determines preferential accumulation of nanoparticles in tumour tissue due to the so-called enhanced permeability and retention effect, EPR (Maeda, 2010). This paper reports on multifunctional theranostic agents based on a new-generation biologically compliant photoluminescent nanoparticles with unique optical properties - fluorescent nanodiamonds (Bradac, Gaebel et al., 2010), nanorubies (Edmonds, Sobhan et al., 2013) and upconversion nanoparticles (Guller, Generalova et al., 2015).

Reported here fluorescent nanodiamonds (FND), nanorubies and upconversion nanoparticles (UCNP) were applied to visualise and probe biomolecular processes in their comprehensive cellular context. The exceptional photophysical properties of these nanoparticle pushed the sensitivity limit to the single biomolecule detection, whereas the nanoparticles surface can host various surface moieties, enabling anchoring of targeting and/or therapeutic cargo molecules. These nanoparticle biocomplexes, e.g. FND-EGFP, nanoruby-DAMGO, (quantum dot)-somatostatin or UCNP-(mini-antibody) are pieced together to form hybrid nanocomplexes capable to enter cells or pathology lesions to enable diagnosis and therapy.

Optical imaging of our photoluminescent nanoparticles in cells using a home-built epiluminescent microscope allowed visualisation of single nanorubies on the hefty background of cell autofluorescence and fluorescence dye staining. Target-delivered UCNP rendered breast adenocarcinoma cells conspicuous among normal cells. The in vivo accumulation of UCNP in a tumour grafted on the chicken embryo chorioallantoic membrane via EPR is shown, demonstrating target-delivery of drugs to cancer sites. The therapeutic potential of such drugs as photodynamic therapy active miniSOG-mini-antibody loaded onto UCNP was also successfully demonstrated in cells.

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