Mini-symposium

Modelling and Simulation of Aneurysm Mechanics

Monday July 6, 2015

Modelling and Simulation of Aneurysm Mechanics I 10:15 - 12:15
Modelling and Simulation of Aneurysm Mechanics II 14:30 - 16:30
Modelling and Simulation of Aneurysm Mechanics III 17:00 - 19:00

Tuesday July 7, 2015

Modelling and Simulation of Aneurysm Mechanics IV 10:00 - 12:00
Modelling and Simulation of Aneurysm Mechanics V 14:15 - 16:15
Modelling and Simulation of Aneurysm Mechanics VI 16:45 - 18:45

Room: 4.0.E.03

Higher Polytechnic School of the Carlos III University of Madrid, located in Leganés, Madrid.

Organisers:

Paul Watton¹,³, Paul Evans²,³, Daniel Rufenacht⁴, Anne Robertson⁵

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²Department of Cardiovascular Science, University of Sheffield, UK
³Insigneo Institute of in silico Medicine, University of Sheffield, UK
⁴Neuroradiology, Swiss Neuro Institute, Klinik Hirslanden, Switzerland
⁵Department of Mechanical and Material Engineering, University of Pittsburgh, USA
Aneurysm Mechanobiology: An Interdisciplinary Forum

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\textsuperscript{5}Dept. of Mech. Engineering and Materials Science, University of Pittsburgh, USA

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ABSTRACT

Aneurysms are pathological enlargements of the artery wall that are found in both extracerebral and cerebral arteries. The altered geometry influences both the shear stresses acting on the wall as well as the intramural stresses. Both types of loads are sensed by the cells in the aneurysm wall and thereby influence the cellular activities such as collagen maintenance and remodeling. The flow within aneurysms is substantially different than that in the originating artery and it is believed that some aspect of the resulting abnormal wall shear stress is, at least partially, responsible for a cascade of cellular activities that drive the wall toward stabilization, growth or rupture. The health of the aneurysm wall is further impacted by inflammatory cells and thrombus formation. Aneurysm research spans a broad spectrum of approaches to address this complex pathology. In \textit{vivo}, \textit{in vitro} and \textit{in silico} models are employed to address fundamental questions from basic science to translational research. To hasten progress in this challenging research field, there is a need to provide multi-disciplinary forums to bring together researchers of different disciplines, \textit{e.g.}, with expertise in: mathematical modelling, solid mechanics, fluid mechanics, imaging, vascular biology, translation of models into clinical practise.

It is the objective of this mini-symposium to provide a stimulating, multi-disciplinary environment to share recent advances in knowledge, establish new collaborations and design new approaches to drive research forward. We build on the success of the previous aneurysm modelling symposium which consisted of 25 invited multidisciplinary talks, dedicated interactive discussion sessions and evening social events for symposium attendees. We warmly invite you to join us in Madrid in the summer of 2015.

\textit{Mini-symposium on 'Modelling and Simulation of Aneurysm Mechanics (organisers: Anne Robertson and Paul Watton), 8th European Solid Mechanics Conference, 9-13 July, Grazer Conference, Graz, Austria, 2012.}
### Modelling and Simulation of Aneurysm Mechanics I

**Date:** July 06, 2015  
**Time:** 10:15 - 12:15  
**Room:** 4.0.E.03

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<td><strong>Intracranial aneurysms rupture risk clinical assessment</strong> (#786)</td>
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|       |         | *Philippe Bijlenga*¹, *Sven Hirsch*²  
|       |         | ¹Neurochirurgie Neurosciences Cliniques, Gabrielle-Perret-Gentil 4, 1211 Genève, Switzerland  
|       |         | ²Institute of Applied Simulation ZHAW Life Sciences and Facility Management, Einsiedlerstrasse 32, 8820 Wädenswil, Switzerland |
| 10:55 | 1.12    | **Computational Framework for Personalized Characterization of Aneurysm Physics and Physiology, as well as Disease Progression Modelling** (#339)  
|       |         | *Esra Neufeld*¹, *Phillipp Wissmann*¹, *Dominik Szczerba*¹, *Frederico Teixeira*¹, *Sven Hirsch*³, *Niels Kuster*¹,²  
|       |         | ¹IT’IS Foundation for Research on Information Technologies in Society Computational Life Sciences, Zeughausstrasse 43, 8004 Zurich, Switzerland  
|       |         | ²Swiss Federal Institute of Technology (ETHZ), Zurich, Switzerland  
|       |         | ³Zurich University of Applied Sciences (ZHAW), Wädenswil, Switzerland |
| 11:15 | 1.13    | **Comprehensive Computational Modeling of Brain Aneurysms: from Preload Analysis to 3D-1D FSI Simulations** (#137)  
|       |         | *Gonzalo Damián Ares*¹,², *Pablo Javier Blanco*¹,², *Santiago Adrián Urquiza*³,², *Raúl Antonino Feijóo*¹,²  
|       |         | ¹LNCC, Laboratório Nacional de Computação Científica, Av. Getúlio Vargas 333, Petrópolis, Rio de Janeiro, 25651-075, Brazil  
|       |         | ²INCT-MACC, Instituto Nacional de Ciência e Tecnologia em Medicina Assistida por e Computação Científica, Av. Getúlio Vargas 333, Petrópolis, Rio de Janeiro, 25651-075, Brazil  
|       |         | ³Universidad Nacional de Mar del Plata Laboratorio de Bioingeniería, Av. Juan B. Justo 4302, 7600 Mar del Plata, Argentina |
| 11:35 | 1.14    | **Nonuniform tissue changes in aneurysm growth** (#237)              |
|       |         | *Aichi Chien*, *Fernando Vinuela*  
|       |         | Division of Interventional Neuroradiology Department of Radiological Sciences David Geffen School of Medicine at UCLA, Ronald Reagan UCLA Medical Center, 10833 LeConte Ave, Los Angeles, uS |
| 11:55 | 1.15    | **Finite element analysis of abdominal aortic aneurysm wall stresses using an individual constitutive equation determined based on 3D ultrasound in vivo full field displacement measurements** (#817)  
|       |         | *Andreas Wittek*¹,², *Derwich Wojciech*³, *Claus-Peter Fritzen*², *Thomas Schmitz-Rixen*³, *Christopher Blase*¹  
|       |         | ¹Goethe University Frankfurt Life Sciences, Max-von-Laue-Straße 13, Frankfurt, Germany  
|       |         | ²University Siegen Mechanical Engineering, Paul-Bonatz-Str. 9-11, 57076 Siegen, Germany  
|       |         | ³Goethe University Frankfurt Vascular and Endovascular Surgery, Frankfurt, Germany |
2.14 Variation in Collagen Architecture Remodelling and Wall Mechanics in Unruptured Intracranial Aneurysms (#593)
Xinjie Duan¹, Anne M. Robertson¹, Bong Jae Chung², Khaled Aziz³, Juan Cebral²
¹University of Pittsburgh Mechanical Engineering and Materials Science, Pittsburgh, United States
²George Mason University Dept of Bioengineering, Fairfax, Virginia United States
³Allegheny General Hospital Neurosurgery, Pittsburgh, PA United States

2.15 The role of clot maturation inside intracranial aneurysms using a viscoelastic thrombosis model (#730)
Julien Egger¹, Dominik Szczerska², Daniel Rüfenacht³, Gabor Szekely¹, Sven Hirsch⁴
¹ETH Zurich ITET, Sternwartstr. 7, 8092 Zurich, Switzerland
²IT’IS Foundation, 8004 Zurich, Switzerland
³Hirslanden Clinic Swiss Neuro Institute, 8032 Zürich, Switzerland
⁴Zurich University of Applied Sciences Life Science and Facility Management, Einsiedlerstrasse 31a, 8820 Wädenswil, Switzerland

2.16 Parametric study of the influence of intraluminal thrombus and collagen stiffness and turnover on the aneurysmatic wall (#923)
L. Virag¹, V. Vindiš¹, J. Wilson², Prof. J. D. Humphrey², Prof. I. Karšaj¹
¹University of Zagreb Faculty of Mechanical Engineering and Naval Architecture - Zagreb, Croatia
²Yale University Department of Biomedical Engineering - New Haven, United States

2.17 Modelling the evolution of rabbit elastase aneurysms: An integrative in vivo, in vitro and in silico approach (#721)
Aikaterini Mandaltsi¹, Anne M. Robertson², Paul Watton³,⁴
¹University of Oxford Engineering Science, Oxford, Great Britain
²University of Pittsburgh Mechanical Engineering and Materials Science, Pittsburgh, US
³University of Sheffield Computer Science, , Sheffield, S1 4DP, Great Britain

2.18 Cavitation instability as a trigger of aneurysm rupture (#93)
Konstantin Volokh
Technion - I.I.T. CEE, Technion City, 32000 Haifa, Israel

2.19 Computational modeling suggests good, bad, and ugly roles of glycosaminoglycans in arterial wall mechanics and mechanobiology (#564)
Sara Roccabianca¹, Chiara Bellini², Jay D. Humphrey²
¹Michigan State University Mechanical Engineering, 428 S. Shaw Lane, 48824, Michigan East Lansing, United States
²Yale University Department of Biomedical Engineering, 55 Prospect Street, New Haven, Connecticut 06520, United States
Modelling and Simulation of Aneurysm Mechanics III

Date: July 06, 2015
Time: 17:00 - 19:00
Room: 4.0.E.03

17:00 3.06 KEYNOTE

Studying Local Hemodynamics and Wall Properties in Intracranial Aneurysms (#493)
Juan Cebral 1, Xinjie Duan 2, Bongjae Chung 1, Christopher Putman 3, Khaled Aziz 4, Anne M. Roberton 2
1George Mason University Bioengineering, 4400 University Drive, Fairfax, VA 22030, United States
2University of Pittsburgh Mechanical Engineering and Materials Sciences, Pittsburgh, United States
3Inova Fairfax Hospital Interventional Neuroradiology, Falls Church, United States
4Allegheny General Hospital Neurosurgery, Pittsburgh, United States

17:40 3.07 Live-cell imaging and mathematical prediction of nuclear NF-κB concentration in vascular endothelial cells exposed to shear stress (#491)
Daniel Baeriswyl 1, Rob Krams 2, Yiannis Ventikos 1
1University College London Mechanical Engineering, Torrington Place, London, WC1E 7JE, Great Britain
2Imperial College London Bioengineering, Exhibition Road, London, SW7 2AZ, Great Britain

18:00 3.08 Role of wall shear stress on the pathophysiology of intracranial aneurysms (#709)
Akira Takahashi 1, Shinichiro Sugiyama 2, Teiji Tominaga 2
1Tohoku University Graduate School of Medicine Department of Neuroendovascular Therapy, 1-2 Seiryo-machi, Aobaku, Sendai 9808575, Japan
2Tohoku University Graduate School of Medicine Department of Neurosurgery, 1-1 Seiryo-machi, Aobaku, Sendai 9808574, Japan

18:20 3.09 Temporal Variation of Wall Shear Stress at the Aneurysm Initiation Site (#796)
Arjan J. Geers 1, Herman G. Morales 1,2, Ignacio Larrabide 1,3, Constantine Butakoff 4, Alejandro F. Frangi 5
1CISTIB - Universitat Pompeu Fabra, Barcelona, Spain
2Medisys - Philips Research Paris, Paris, France
3PLADEMA-CONICET - UNICEN, Tandil, Argentina
4PhySense - Universitat Pompeu Fabra, Barcelona, Spain
5CISTIB - The University of Sheffield, Sheffield, Great Britain

18:40 3.10 Surface treatment on wire for increasing endothelialization (#1087)
Makoto Ohta 1, Sho Matsumoto 2, Xiaobo Han 3, Hisatoshi Kobayashi 3
1Tohoku University Institute of Fluid Science, 2-1-1 Katahira Aoba-ku, Miyagi, Sendai 980-8577, Japan
2Tohoku University Graduate school of Biomedical Engineering, Miyagi, Sendai, Japan
3National Institutes for Materials Science International Center for Materials Nanoarchitectonics(MANA), 1-2-1 Sengen, Ibaraki, Tsukuba 305-0047, Japan
10:00 1.13 KEYNOTE

Biomechanics of Thoracic Aortic Aneurysms (#377)
Namrata Gundiah 1, Anju Babu 1,2
1Assistant Professor Department of Mechanical Engineering, Indian Institute of Science, Select State/Province, 560012 Bangalore, India
2Doctoral Student Centre for Nanoscience and Engineering, , Bangalore 560012, India

10:40 1.14 Biomechanical modeling of human heart left ventricle pathologies (#460)
Leonid Kossovich 1, Irina Kirillova 1, Konstantin Morozov 2, Anastasiya Golyadkina 1,
Asel Polienko 1, Elena Kossovich 1, Aleksey Kalinin 1
1Saratov State University, Astrakanskaya str, 410012 Saratov, Russia
2Moscow State Medical University Clinic of aortic and cardiovascular surgery, Moscow, Russia

11:00 1.15 A New Thrombosis Formation Model (#549)
Dr. G. Courbebaisse 1, Y. Zhang 1, Prof. B. Chopard 2, Dr. J. Latt 2, Dr. O. Malaspinas 2, Dr. K. Zouaoui 3
1INSA Lyon CREATIS - Villeurbanne, France
2University of Geneva CUI - Departement d'Informatique - Carouge, Switzerland
3CHU Charleroi-Hop Vesale Laboratory of Experimental Medicine - Montigny-le-Tilleul, Belgium

Samuel Voß 1, Philipp Berg 1, Sylvia Glaßer 2, Thomas Hoffmann 3, Gabor Janiga 1
1University of Magdeburg Department of Fluid Dynamics and Technical Flows, Universitätsplatz 2, 39106 Magdeburg, Germany
2University of Magdeburg Department of Simulation and Graphics, Universitätsplatz 2, 39106 Magdeburg, Germany
3University of Magdeburg Department of Neuroradiology, Leipzigerstr. 44, 39120 Magdeburg, Germany

11:40 1.17 Searching for valuable hemodynamic parameters for applying to optimization study (#1145)
Hitomi Anzai 1, Yuuki Yoshida 2, Mingzi Zhang 2, Makoto Ohta 1
1Tohoku University Institute of Fluid Science, Katahira 2-1-1, Miyagi, Sendai 980-0857, Japan
2Tohoku University Graduate School of Engineering, Aramaki 6, Miyagi, Sendai 980-0859, Japan
14:15 2.06 A histomechanical growth and remodeling framework for arteries with application to AAA rupture risk assessment (#1100)
T. Christian Gasser
Royal Institute of Technology (KTH), Teknikringen 8, Stockholm 10044, Sweden

14:35 2.07 Arterial Growth & Remodeling – the Finite Element Implementation (#1135)
Igor Karšaj 1, Vedran Vindiš 1, Lana Virag 1, Gerhard A Holzapfel 2
1University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, 10000 Zagreb, Croatia
2Graz University of Technology Institute of Biomechanics, Kronesgasse 5-I, 8010 Graz, Austria

14:55 2.08 Branch-Related Ruptures in Tunica Media prior to AAA Formation in Angiotensin II-Infused Apoe−/−Mice: Synchrotron Imaging vs FSI Modelling (#448)
Bram Trachet 1,2, Joris Bols 1, Lydia Aslanidou 2, Nikolaos Stergiopulos 2, Patrick Segers 1
1Ghent University - IMinds Medical IT IBITech-bioMMeda, De Pintelaan 185B, 9000 Ghent, Belgium
2Ecole Polytechnique Federale de Lausanne Institute for Bioengineering, 1015 Lausanne, Switzerland

15:15 2.09 Patient-specific modeling of aortic pathologies: biomechanical approach (#464)
Leonid Kossovich 1, Irina Kirillova 1, Konstantin Morozov 2, Anastasiya Golyadkina 1, Asel Polienko 1, Elena Kossovich 1, Aleksey Kalinin 1
1Saratov State University Educational and Research Institute of Nanostructures and Biosystems, Astrakhanskaya str, 410012 Saratov, Russia
2Moscow State Medical University Clinic of aortic and cardiovascular surgery, Moscow, Russia

15:35 2.10 A Thick-Walled Fluid-Solid-Volumetric-Growth Model of Abdominal Aortic Aneurysm Development (#1082)
Andrii Grytsan 1, Thomas S.E. Eriksson 2, Paul N. Watton 3, 4, T. Christian Gasser 1
1KTH Royal Institute of Technology Solid Mechanics Department, 10044 Stockholm, Sweden
2Swedish Defence Research Agency, 16490 Stockholm, Sweden
3University of Sheffield Department of Computer Science, Sheffield, Great Britain
4University of Sheffield INSIGNEO Institute of in silico Medicine, Sheffield, Great Britain

15:55 2.11 Wall Shear Stress Analysis and Risk Assessment in Multiscale AAA Patient-Specific Fluid-Structure Interaction Models (#277)
Dr. M. G. C. Nestola 3, Dr. A. Gizzi 1, Dr. C. Cherubini 1, 2, Prof. S. Filippi 1, 2
1University Campus Bio-Medico of Rome Department of Engineering-Nonlinear Physics and Mathematical Modeling Lab.- Rome, Italy
2International Center for Relativistic Astrophysics, ICRANet, - Rome, Italy
**Modelling and Simulation of Aneurysm Mechanics VI**

**Date:** July 07, 2015  
**Time:** 16:45 - 18:45  
**Room:** 4.0.E.03

### 16:45 3.08 Computational Model of the Progession of Abdominal Aortic Aneurysms (#71)

**J.D. Humphrey, J.s. Wilson, P. di Achille, C. Cyron**  
Yale University Biomedical Engineering, Malone Engineering Center, New Haven, CT 06520, US

### 17:05 3.09 Current perspectives on intracranial aneurysm wall biology (#685)

**Riikka Tulamo**  
Postdoctoral Researcher Neurosurgery Research Group, Biomedicum, Haartmaninkatu 8, 00290 Helsinki, Finland

### 17:25 3.10 Aneurysm Mechanobiology: An Interdisciplinary Forum (#767)

**Paul Watton13, Paul Evans, Daniel Rufenacht, Anne M. Robertson**  
1University of Sheffield Department of Computer Science, Sheffield, Great Britain  
2University of Sheffield Department of Cardiovascular Science, Sheffield, Great Britain  
3University of Sheffield INSIGNEO Institute of in silico Medicine, Sheffield, Great Britain  
4Hirslanden Clinic Swiss Neuro Institute, 8032 Zürich, Switzerland  
5University of Pittsburgh Mechanical Engineering and Material Sciences, Pittsburgh, United States