



Lecture Notes in Mechanical Engineering

José Machado · Filomena Soares ·
Justyna Trojanowska · Erika Ottaviano ·
Petr Valášek · Mallikarjuna Reddy D. ·
Eduardo André Perondi ·
Yevheniia Basova *Editors*


Innovations in Mechanical Engineering II



Springer

Lecture Notes in Mechanical Engineering

Editorial Board Member

Francisco Cavas-Martínez , Departamento de Estructuras, Construcción y Expresión Gráfica Universidad Politécnica de Cartagena, Cartagena, Murcia, Spain


Series Editor

Fakher Chaari, National School of Engineers, University of Sfax, Sfax, Tunisia

Editorial Board Member

Francesca di Mare, Institute of Energy Technology, Ruhr-Universität Bochum, Bochum, Nordrhein-Westfalen, Germany

Series Editor

Francesco Gherardini , Dipartimento di Ingegneria “Enzo Ferrari”, Università di Modena e Reggio Emilia, Modena, Italy

Editorial Board Member

Mohamed Haddar, National School of Engineers of Sfax (ENIS), Sfax, Tunisia

Series Editor

Vitalii Ivanov, Department of Manufacturing Engineering, Machines and Tools, Sumy State University, Sumy, Ukraine

Editorial Board Members

Young W. Kwon, Department of Manufacturing Engineering and Aerospace Engineering, Graduate School of Engineering and Applied Science, Monterey, CA, USA

Justyna Trojanowska, Poznan University of Technology, Poznan, Poland

Lecture Notes in Mechanical Engineering (LNME) publishes the latest developments in Mechanical Engineering—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNME. Volumes published in LNME embrace all aspects, subfields and new challenges of mechanical engineering. Topics in the series include:

- Engineering Design
- Machinery and Machine Elements
- Mechanical Structures and Stress Analysis
- Automotive Engineering
- Engine Technology
- Aerospace Technology and Astronautics
- Nanotechnology and Microengineering
- Control, Robotics, Mechatronics
- MEMS
- Theoretical and Applied Mechanics
- Dynamical Systems, Control
- Fluid Mechanics
- Engineering Thermodynamics, Heat and Mass Transfer
- Manufacturing
- Precision Engineering, Instrumentation, Measurement
- Materials Engineering
- Tribology and Surface Technology

To submit a proposal or request further information, please contact the Springer Editor of your location:

China: Ms. Ella Zhang at ella.zhang@springer.com

India: Priya Vyas at priya.vyas@springer.com

Rest of Asia, Australia, New Zealand: Swati Meherishi at swati.meherishi@springer.com

All other countries: Dr. Leontina Di Cecco at Leontina.dicecco@springer.com

To submit a proposal for a monograph, please check our Springer Tracts in Mechanical Engineering at <https://link.springer.com/bookseries/11693> or contact Leontina.dicecco@springer.com

Indexed by SCOPUS. All books published in the series are submitted for consideration in Web of Science.

More information about this series at <https://link.springer.com/bookseries/11236>

José Machado · Filomena Soares ·
Justyna Trojanowska · Erika Ottaviano ·
Petr Valášek · Mallikarjuna Reddy D. ·
Eduardo André Perondi ·
Yevheniia Basova
Editors

Innovations in Mechanical Engineering II

Editors

José Machado
Mechanical Engineering Department
University of Minho
Guimarães, Portugal

Filomena Soares
Department of Industrial Electronics
University of Minho
Guimarães, Portugal

Justyna Trojanowska
Poznan University of Technology
Poznan, Wielkopolskie, Poland

Erika Ottaviano
Department of Civil and Mechanical
Engineering
University of Cassino and Southern Lazio
Cassino, Italy

Petr Valášek
Faculty of Engineering
Czech University of Life Sciences Prague
Prague, Czech Republic

Mallikarjuna Reddy D.
Faculty of Mechanical Engineering
Vellore Institute of Technology University
Vellore, India

Eduardo André Perondi
Mechanical Engineering Department
Federal University of Rio Grande do Sul
Porto Alegre, Brazil

Yevheniia Basova
NTU “Kharkiv Polytechnic Institute”
Kharkiv, Ukraine

ISSN 2195-4356

ISSN 2195-4364 (electronic)

Lecture Notes in Mechanical Engineering

ISBN 978-3-031-09381-4

ISBN 978-3-031-09382-1 (eBook)

<https://doi.org/10.1007/978-3-031-09382-1>

© The Editor(s) (if applicable) and The Author(s), under exclusive license
to Springer Nature Switzerland AG 2023

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume of Lecture Notes in Mechanical Engineering gathers selected papers presented at the Second International Scientific Conference (ICIE'2022), held in Guimarães, Portugal, on 28–30 June 2022. The conference was organized by the School of Engineering of University of Minho, throughout METRICs and Algoritmi Research Centres.

The aim of the conference was to present the latest engineering achievements and innovations and to provide a chance for exchanging views and opinions concerning the creation of added value for the industry and for the society. The main conference topics include (but are not limited to):

- Innovation
- Industrial Engineering
- Mechanical Engineering
- Mechatronics Engineering
- Systems and Applications
- Societal Challenges
- Industrial Property

The organizers received 139 contributions from 16 countries around the world.

After a thorough peer-review process, the committee accepted 81 papers written by 335 authors from 15 countries for the conference proceedings (acceptance rate of 58%), which were organized in three volumes of the Springer Lecture Notes in Mechanical Engineering.

This volume, with the title “Innovations in Mechanical Engineering II”, is specifically spanning from advanced materials and composites, optimization of manufacturing and production processes and converging issues and technologies in additive manufacturing and Industry 4.0. It covers applications in the transport and automotive, and medical and education sector, among others. Last but not least, it analyses important issues proposing a good balance of theoretical and practical aspects. This book consists of 30 chapters, prepared by 146 authors from ten countries.

Extended versions of selected best papers from the conference will be published in the following journals: Sensors, Applied Sciences, Machines, Management and Production Engineering Review, International Journal of Mechatronics and Applied Mechanics, SN Applied Sciences, Dirección y Organización, and Smart Science, Business Systems Research and International Journal of E-Services and Mobile Applications.

A special thank to the members of the International Scientific Committee for their hard work during the review process.

We acknowledge all that contributed to the staging of ICIE'2022: authors, committees and sponsors. Their involvement and hard work were crucial to the success of ICIE'2022.

June 2022

José Machado
Filomena Soares
Justyna Trojanowska
Erika Ottaviano
Petr Valášek
Mallikarjuna Reddy D.
Eduardo Perondi
Yevheniia Basova

Contents

Development of Guidelines for the Design of Functionally Integrated Molds for a Novel Vacuum Assisted Resin Infusion Process	1
Sven Meißner, Paul Falkenhain, Rafael Cordeiro, and Sebastian Scholz	
Challenges and Opportunities of Industry 4.0 at Mold Production Engineering and Management	13
Arminda Pata and Agostinho Silva	
Influence of Mechanical Processing on the Durability of Parts in Additive Manufacturing Conditions	24
Viktoriya Pasternak, Oleg Zabolotnyi, Kostiantyn Svirzhevskyi, Irina Zadorozhnikova, and José Machado	
ISO 2631 Vibration Analysis in Portuguese Alfa Pendular Trains	36
Patrícia Silva, Eurico Seabra, and Joaquim Mendes	
Noise Attenuation Analysis of a Multilayer Wall	47
Nicolae Adrian Nițu, Marcelin Benchea, Gelu Ianuș, and Carmen Bujoreanu	
Improving Procedures for Production and Maintenance Control Towards Industry 4.0 Implementation	58
Rúben D. F. S. Costa, Marta L. S. Barbosa, Francisco J. G. Silva, José C. Sá, Luís P. Ferreira, and Bebiana Pinto	
Industry 4.0 Technologies for Maintenance Management – An Overview	68
Małgorzata Jasiulewicz-Kaczmarek and Katarzyna Antosz	
Design Concept of a Non-invasive Tagging Device for Blue Sharks	80
José Azevedo, Tiago Bartolomeu, Senhorinha Teixeira, and José Teixeira	

Aspects Regarding Subtractive and Additive CAD-CAM Processes Applied in Prosthetic Dentistry	91
Edgar Moraru, Grigore Octavian Dontu, Tudor Catalin Apostolescu, Laurentiu Adrian Cartal, Bogdan Grămescu, and Nazem Dawod	
Design and Performance Assessment of a Double-Screen Trommel for MSW Separation	103
Luís D. Forte, Ricardo Faria, and Ana C. Ferreira	
A Comparative Study of Weld Bead Geometry of AISI 1023 with Varying Plate Width Using SAW and ASAW	116
Tejendra Singh Singhal, Jinesh Kumar Jain, Manoj Kumar, and Rajeev Agrawal	
Ecofriendly Technologies of Fish Oils and Collagen Extraction from Fishery Waste – A Review	136
Nádia Valério, Margarida Soares, Maria Cândida Vilarinho, and Joana Carvalho	
Study Concerning the Correspondence Between Optical Materials and Optical Coatings Using Matlab	148
Dana Rizescu and Ciprian Ion Rizescu	
Bat Algorithm for Discrete Optimization Problems: An Analysis	161
Bruno Sousa, Rita Guerreiro, André S. Santos, João A. Bastos, Leonilde R. Varela, and Marlene F. Brito	
Geometrical Metrology in Food Product Measurements	173
M. Wieczorowski, N. Swojak, M. Szelewski, A. Pereira, T. G. Mathia, and B. Gapinski	
Analysis and Validation of a CFD Simulation of the Wind Through a Horizontal Axis Wind Turbine as an Actuator Disc with a Porous Jump Condition	187
Diogo Silva, João Silva, Paulo Pinto, Senhorinha Teixeira, and José Teixeira	
Eutectic Modification of Al-Si Alloys by Using AlSr₁₀	200
Iryna Hren, Sylvia Kusmierczak, Nataša Naprstková, and Roman Horky	
Flow Visualizations in a PDMS Cerebral Aneurysm Biomodel	209
Andrews Souza, Maria Sabrina Souza, Conrado Ferrera, Hélder Puga, Rui Lima, and João Ribeiro	
What Times Should Be Used for fNIRS and EEG Protocol?	216
Iara Margolis, Rute Silva, Diego Pinal, Nelson Costa, and Bernardo Providência	

Inclusive Platform: GUS for Social Inclusion and Competencies Development in Cerebral Palsy	228
Gil Dias, Filomena Soares, Vítor Carvalho, Armanda Pereira, and Tiago Martins	
Kinematic Analysis from Solar Panel Tracking System	240
Andreea Dana Alionte, Cristian Canacheu, Alexandru Costin Ciobanu, Ion Murzac, Dana Mirela Văleanu, and Liviu Marian Ungureanu	
Continuous Improvement of Logistics Processes in a Production Line of Electric Buses Chassis	250
Beatriz Especial Gomes, Maria Teresa Pereira, Marisa Oliveira, and Fernanda A. Ferreira	
3D Print Technology Used in High Technical Education	259
Jan Novotný, Martin Jaskevič, and Tomáš Vysloužil	
Is Critical Thinking a Skill or a Way to Develop Skills? An Overview in Engineering Education	266
Celina P. Leão and Ana C. Ferreira	
Solving Manufacturing Orders Scheduling Problem Using Annealing Simulation	279
Kamil Musiał, Artem Balashov, Anna Burduk, and Dominika Rysińska-Wojtasik	
Dynamic Sectorization - Conceptualization and Application	293
Filipe Soares de Sousa, Maria Margarida Lima, Elif Göksu Öztürk, Pedro Filipe Rocha, Ana Maria Rodrigues, José Soeiro Ferreira, Ana Catarina Nunes, and Cristina Oliveira	
Research of Features of Oxide Coatings Deposition by D-gun Spraying	305
Oleksiy Romanchenko, Olga Porkuian, Yuriy Kharlamov, Volodymyr Sokolov, and Oleg Krol	
Key Performance Indicators: A Perspective on Developing and Implementing Performance Indicators in a Textile Company Warehouse	317
Ana Francisca Costa, Ana Pinto, Ana Catarina Mendes, Ana Rita Quinteiro, Carla Coelho, Carla Meira, Isac Pereira, Jorge Marinho, José Barbosa, Natacha Cunha, Rui Miranda, Nuno Drumond, and Rui M. Lima	
Composite Materials Based on GPPS/PE-HD Matrix Used in Automotive Industry	329
Lucia Knapčíková, Justyna Trojanowska, Matúš Martiček, and Jozef Husár	

On the Suitability of Instrumented Orthogonal Cutting Tests Towards Cutting Load Modelling in Turning Operations	339
T. Silva, V. Sousa, F. Silva, and A. M. P. Jesus	
Author Index.	351



Flow Visualizations in a PDMS Cerebral Aneurysm Biomodel

Andrews Souza¹ , Maria Sabrina Souza² , Conrado Ferrera³ , Hélder Puga⁴ ,
Rui Lima^{1,5} , and João Ribeiro^{2,6}

¹ METRICS, University of Minho, Guimarães, Portugal
r1@dem.uminho.pt

² Instituto Politécnico de Bragança, Bragança, Portugal

³ Depto. de Ingeniería Mecánica, Energética y de los Materiales and Instituto de Computación Científica Avanzada, Universidad de Extremadura, Badajoz, Spain

⁴ CMEMS, University of Minho, Guimarães, Portugal

⁵ CEFT, Faculty of Engineering of the University of Porto, Porto, Portugal

⁶ CIMO, Instituto Politécnico de Bragança, Bragança, Portugal

Abstract. Cerebral aneurysm is an abnormal dilatation of the blood vessel which affects a high percentage of the worldwide population. One way to investigate this pathology is using *in vivo* techniques, but these types of experiments have a high cost and low reproducibility. Thus, to understand the local hemodynamics of brain aneurysms, it is imperative to manufacture *in vitro* models that simulate real brain aneurysms. These biomodels are suitable for experimental testing, as well as for evaluating and validating computational models. In this work, was manufactured a biomodel of a cerebral aneurysm made by polydimethylsiloxane (PDMS), combining rapid prototyping technology with a PDMS gravity casting process. Experimental flow visualizations were performed at different flow rates. The flow visualizations results have shown that there is a transition from laminar to turbulent flow for a flow rate near 6 ml/min. The proposed PDMS biomodels have shown the ability to perform flow visualizations and have the potential to help the development and validation of computational models.

Keywords: Cerebral aneurysm · In vitro tests · PDMS flow biomodels

1 Introduction

A cerebral aneurysm is an abnormal dilatation of a blood vessel [1]. Its appearance is caused by a combination of physical and biological factors such as the weakening of the arterial wall with increasing age [2], atherosclerotic changes, hypertension and smoking. This set of factors alters blood flow and, consequently, the vessel wall. Therefore, it is extremely important to obtain more information on how the different flow regimes affect blood vessels and brain aneurysms.

In vivo experiments are an effective way of investigating this pathology, but besides the ethical issues, these types of experiments are expensive and have low reproducibility

[3]. *In silico* studies have been a widely used tool in recent years and have achieved substantial progress in the study of aneurysms. However, the limitation of numerical studies is the need for experimental validation, according to recommended international guidelines [4]. Thus, for a better understanding of the pathology and to study the blood flow inside aneurysms, it is necessary to develop *in vitro* models. These biomodels are suitable for refining endovascular treatments and validating theoretical and computational models [5].

In vitro models can be idealized or patient-specific [6]. Currently, the 3D printing technique has been used for the construction of the initial mold of the vessel lumen and polydimethylsiloxane (PDMS) is the material commonly used for the manufacture of biomodels. This material is transparent, biocompatible and can replicate the geometry of veins [7, 8]. Due to its advantages, PDMS has been used in a wide variety of applications in the biomedical field [9–17]. Pinho et al. [6] developed a biomodel of aneurysms in PDMS, based on clinical data, and this model was used for experimental studies using the digital image correlation technique and *in silico* tests [2, 18]. However, this model did not allow visualization of the flow within the cerebral aneurysm.

In order to improve the existing model, in this work, we propose a simple process to manufacture an *in vitro* PDMS cerebral aneurysm biomodel by combining rapid prototyping technology with a PDMS gravity casting process. Additionally, the model allows the visualization of the different behaviors of blood flow within the aneurysm. Thus, this work reports the acquisition of the real geometry of the cerebral aneurysm by using a prototyping technique to manufacture the mold and the biomodel in PDMS. It was also performed an experimental work of flow visualizations at different flow rates.

2 Materials and Methods

2.1 Geometry and Manufacturing Process

The geometry of the *in vitro* biomodel was obtained by performing image treatment from angiography images from a real cerebral aneurysm. The use of this type of geometry is essential to study the flow phenomena that occur within an aneurysm more realistically. Figure 1 illustrates the general measurements of the cerebral aneurysm model obtained from angiography images.

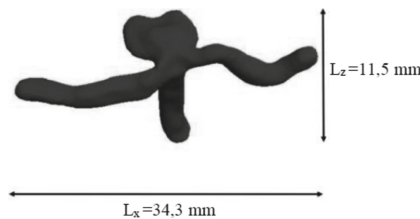


Fig. 1. General measurements of the cerebral aneurysm model.

The treated angiography images were converted into STL format and manufactured by means using a 3D printer model ProJet 1200 (3D Systems, USA). The geometry

was printed with the Visijet FTX Green resin as shown in Fig. 2. This process was chosen because the SLA (stereolithography) technique has good accuracy and high print resolution.

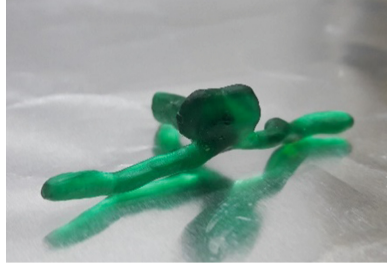


Fig. 2. Cerebral aneurysm model produced by the 3D Systems ProJet 1200 printer.

2.2 *In Vitro* PDMS Aneurysm Biomodel

To obtain the biomodel, the PDMS was prepared with a ratio of 10:1, i.e., 10 g of the PDMS base polymer correspond to 1 g of the curing agent. To perform the mixture, it was used a vacuum pump to remove the bubbles and after that, the physical model was placed in an acrylic box and the PDMS was poured into the mold by means of a gravity casting process. The curing period of PDMS was 48 h. In order to obtain the lumen of the blood vessel, the mold was placed in a glass beaker with acetone to remove the printed material. The described process is shown in Fig. 3.

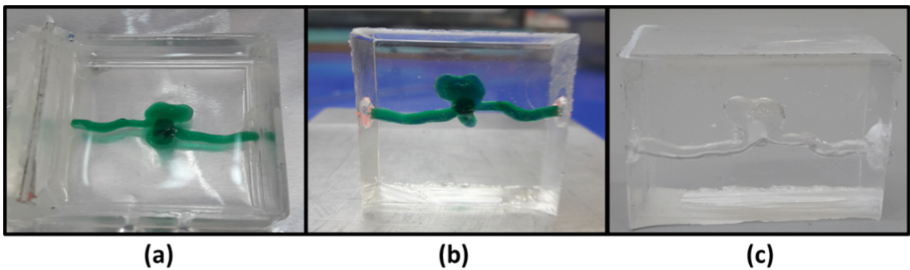


Fig. 3. Process of obtaining the transparent biomodel. (a) curing the PDMS in the acrylic box; (b) biomodel in PDMS with the printed model; (c) transparent PDMS biomodel with a cerebral aneurysm to perform the fluid experiments.

2.3 Flow Visualizations Setup

In the flow visualization tests, it was used a high-speed video microscopy system consisting of an inverted microscope (IX71, Olympus, Japan) combined with a high-speed

camera (Photron FASTCAM SA3) and an objective lens (ZEISS, $2.5\times$). To visualize the movements of the particles inside the cerebral aneurysm, it is necessary that the working fluid has the same value as the PDMS refractive index, which is 1.412. A particulate blood analog fluid composed of 61% glycerol and 39% water (w/w) was developed [19, 20] and this fluid has the same refractive index as PDMS, which allows the visualization of the particles. 0.1% of suspended Polymethylmethacrylate (PMMA) particles of 60 μm (diameter) were added to the fluid. The experiments were performed at room temperature ($T = 20 \pm 2^\circ\text{C}$). Figure 4 illustrates the experimental setup used to perform the flow visualizations. To process the images previously recorded was used the ImageJ software being the flow behavior automatically analyzed by the Z Project plugin [21].

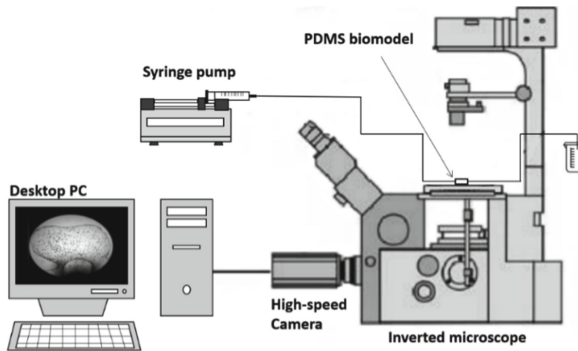


Fig. 4. Setup for *in vitro* experimental tests.

3 Results and Discussion

The developed cerebral aneurysm biomodels, in PDMS, proved to be suitable for experimental flow assays, managing to reproduce the geometry of the blood vessel and with good transparency.

To perform the flow visualizations, the PDMS biomodel was placed under the microscope and the analog fluid was injected into the biomodel through a syringe pump with a constant flow rate. In this study, it was tested different flow rates, i. e., 3 mL/min and 6 mL/min, in order to visualize the moment of transition of the flow behavior and the beginning of recirculation in the aneurysmal sac. The recorded images, shown in Figs. 5 and 6, were processed in the ImageJ software by using the Z Project plugin. With this plugin, the PMMA trajectories captured by a video record were converted automatically into one single image as is shown in Figs. 5 and 6.

From these flow experiments, it was shown that the manufactured PDMS biomodels were suitable to perform hemodynamic studies. Qualitatively, it is possible to observe (Figs. 5 and 6) that at the regions close to the channel inlet and outlet, typical laminar flows were observed for all the tested flow rates. However, when the trace particles get closer to the neck of the aneurysm, the flow tends to suffer a deviation into the direction of the aneurysm and as a result, it was observed the formation of vortices at a flow rate of 6 mL/min. In contrast, at a lower flow rate of 3 mL/min, no recirculation was observed.

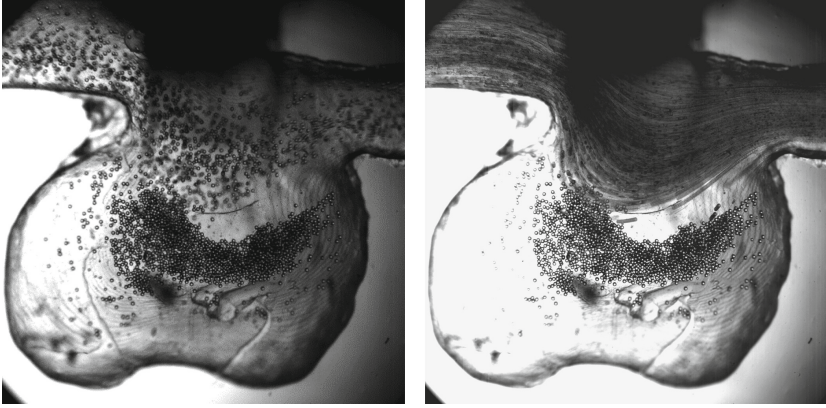


Fig. 5. Flow visualizations of the blood analogue fluid recorded from a high-speed camera at a flow rate of 3 mL/min of an individual recorded image (right side); treated by the Z Project plugin (left side).

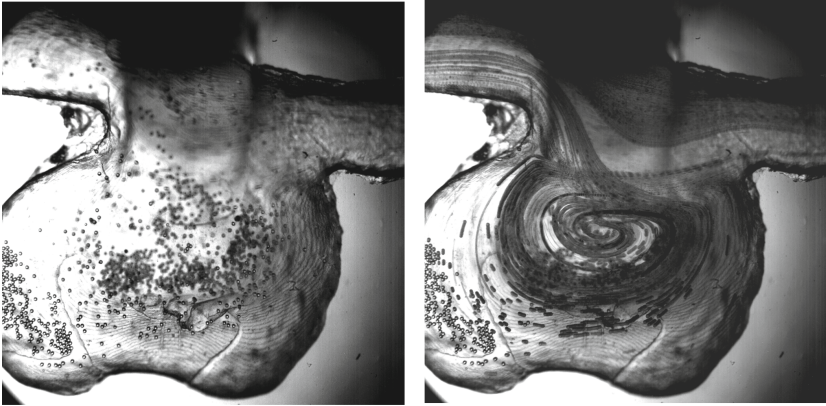


Fig. 6. Flow visualizations of the blood analog fluid recorded from a high-speed camera at a flow rate of 6 mL/min of an individual recorded image (right side); treated by the Z Project plugin (left side).

Hence, these qualitative results indicate that there is a transition from laminar to turbulent flow at a flow rate of about 6 mL/min. The experiments also demonstrate the potential for classifying blood flow patterns within the brain aneurysm. According to the study developed by Cebal et al. [22, 23] who showed that ruptured brain aneurysms are more likely to have complex flow patterns, unstable flow, concentrated inlet jets and small impact regions. Through the final images obtained, we can visualize a single recirculation region indicating a simple flow pattern. The change in flow behavior indicates flow instability. It is also possible to observe that only a part of the flow enters the aneurysmal sac, characterizing it as concentrated inlet jets. Although the flow rate used in the tests was lower than the actual flow rates of a cardiac cycle, the technique used in this study

indicates great potential and additional tests are in progress and will be published in due course.

4 Conclusion

It has been reported that the brain aneurysm is caused by a set of factors that are still not well understood. Although many numerical flow studies have been carried out still the majority of these models need to be validated. With the difficulty of performing *in vivo* assays, the *in vitro* study of aneurysms has proved to be an efficient alternative with great potential to validate numerical studies, test new medical devices and improve surgical techniques. However, in order to carry out an *in vitro* test, it is necessary to build biomodels that allow the visualization of the particulate flow. The proposed PDMS biomodels have the potential to be used as *in vitro* models and to study hemodynamics within a brain aneurysm, through the visualization of the flow. By using this flow visualization technique, it will be possible to identify the kinds of flow and to relate them to the flow patterns that the literature indicates as possible causes of aneurysm rupture. The used technique also shows great potential to assist in the development and validation of computational models.

Acknowledgements. The authors acknowledge the financial support provided by Fundação para a Ciência e a Tecnologia (FCT), through the projects EXPL/EME-EME/0732/2021, PTDC/EEI-EEE/2846/2021, funded by NORTE 2020, PORTUGAL2020, and FEDER. This work was also supported by Fundação para a Ciência e a Tecnologia (FCT) under the strategic grants UIDB/04077/2020, UIDB/00690/2020, UIDB/04436/2020 and UIDB/00532/2020. Andrews Souza acknowledges the PhD scholarship 2021.07961.BD attributed by FCT. Partial support from the Junta de Extremadura through Grants No. GR21091 and IB21015 (partially financed by FEDER funds) is gratefully acknowledged.

References

1. Rodriguez-Régent, C., et al.: Non-invasive diagnosis of intracranial aneurysms. *Diagn. Interv. Imaging.* **95**, 1163–1174 (2014)
2. Cardoso, C., Fernandes, C.S., Lima, R., Ribeiro, J.: Biomechanical analysis of PDMS channels using different hyperelastic numerical constitutive models. *Mech. Res. Commun.* **90**, 26–33 (2018)
3. Bosman, W.M.P.F., et al.: Aortic customize: an *in vivo* feasibility study of a percutaneous technique for the repair of aortic aneurysms using injectable elastomer. *Eur. J. Vasc. Endovasc. Surg.* **40**, 65–70 (2010)
4. Berg, P., Saalfeld, S., Voß, S., Beuing, O., Janiga, G.: A review on the reliability of hemodynamic modeling in intracranial aneurysms: why computational fluid dynamics alone cannot solve the equation. *Neurosurg. Focus.* **47**, 1–9 (2019)
5. Bosman, W.M.P.F., et al.: The effect of injectable biocompatible elastomer (PDMS) on the strength of the proximal fixation of endovascular aneurysm repair grafts: an *in vitro* study. *J. Vasc. Surg.* **52**, 152–158 (2010)

6. Pinho, D., Bento, D., Ribeiro, J., Lima, R., Vaz, M.: An in vitro experimental evaluation of the displacement field in an intracranial aneurysm model. In: Flores, P., Viadero, F. (eds.) *New Trends in Mechanism and Machine Science*. MMS, vol. 24, pp. 261–268. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-09411-3_28
7. Hassler, C., Boretius, T., Stieglitz, T.: Polymers for neural implants. *J. Polym. Sci. Part B Polym. Phys.* **49**, 18–33 (2011)
8. Lima, R., et al.: In vitro blood flow in a rectangular PDMS microchannel: experimental observations using a confocal micro-PIV system. *Biomed. Microdev.* **10**, 153–167 (2008)
9. Maitz, M.F.: Applications of synthetic polymers in clinical medicine. *Biosurf. Biotribol.* **1**, 161–176 (2015)
10. Miranda, I., et al.: Properties and applications of PDMS for biomedical engineering: a review. *J. Funct. Biomater.* **13**, 2 (2022)
11. Ariati, R., Sales, F., Souza, A., Lima, R.A., Ribeiro, J.: Polydimethylsiloxane composites characterization and its applications: a review. *Polymers (Basel)*. **13**, 4258 (2021)
12. Carvalho, V., et al.: 3d printing techniques and their applications to organ-on-a-chip platforms: a systematic review. *Sensors* **21**, 7 (2021)
13. Souza, A., et al.: 3D manufacturing of intracranial aneurysm biomodels for flow visualizations: low cost fabrication processes. *Mech. Res. Commun.* **107**, 103535 (2020)
14. Rodrigues, R.O., Lima, R., Gomes, H.T., Silva, A.M.T.: Polymer microfluidic devices: an overview of fabrication methods. *U.Porto J. Eng.* **1**, 67–79 (2015)
15. Souza, R.R., et al.: Recent advances on the thermal properties and applications of nanofluids: From nanomedicine to renewable energies. *Appl. Therm. Eng.* 201 (2022)
16. Sadek, S.H., Rubio, M., Lima, R., Vega, E.J.: Blood particulate analogue fluids: a review. *Materials (Basel)*. **14**, 16–21 (2021)
17. Carvalho, V., et al.: In vitro stenotic arteries to perform blood analogues flow visualizations and measurements: a review. *Open Biomed. Eng. J.* **14**, 87–102 (2020)
18. Rodrigues, R.O., Pinho, D., Bento, D., Lima, R., Ribeiro, J.: Wall expansion assessment of an intracranial aneurysm model by a 3D Digital image correlation system. *Measurement* **88**, 262–270 (2016)
19. Pinho, D., Campo-Deaño, L., Lima, R., Pinho, F.T.: In vitro particulate analogue fluids for experimental studies of rheological and hemorheological behavior of glucose-rich RBC suspensions. *Biomicrofluidics* **11**, 054105 (2017)
20. Campo-Deaño, L., Dullens, R.P.A., Aarts, D.G.A.L., Pinho, F.T., Oliveira, M.S.N.: Viscoelasticity of blood and viscoelastic blood analogues for use in polydimethylsiloxane in vitro models of the circulatory system. *Biomicrofluidics* **7**, 034102 (2013)
21. Carvalho, V., et al.: Manual and automatic image analysis segmentation methods for blood flow studies in microchannels. *Micromachines* **12**, 1–20 (2021)
22. Cebal, J.R., Mut, F., Weir, J., Putman, C.M.: Association of hemodynamic characteristics and cerebral aneurysm rupture. *Am. J. Neuroradiol.* **32**, 264–270 (2011)
23. Cebal, J.R., Castro, M.A., Burgess, J.E., Pergolizzi, R.S., Sheridan, M.J., Putman, C.M.: Characterization of cerebral aneurysms for assessing risk of rupture by using patient-specific computational hemodynamics models. *Am. J. Neuroradiol.* **26**, 2550–2559 (2005)

Author Index

A

Agrawal, Rajeev, [116](#)
Alionte, Andreea Dana, [240](#)
Antosz, Katarzyna, [68](#)
Apostolescu, Tudor Catalin, [91](#)
Azevedo, José, [80](#)

B

Balashov, Artem, [279](#)
Barbosa, José, [317](#)
Barbosa, Marta L. S., [58](#)
Bartolomeu, Tiago, [80](#)
Bastos, João A., [161](#)
Benchea, Marcelin, [47](#)
Brito, Marlene F., [161](#)
Bujoreanu, Carmen, [47](#)
Burduk, Anna, [279](#)

C

Canacheu, Cristian, [240](#)
Cartal, Laurentiu Adrian, [91](#)
Carvalho, Joana, [136](#)
Carvalho, Vítor, [228](#)
Ciobanu, Alexandru Costin, [240](#)
Coelho, Carla, [317](#)
Cordeiro, Rafael, [1](#)
Costa, Ana Francisca, [317](#)
Costa, Nelson, [216](#)
Costa, Rúben D. F. S., [58](#)
Cunha, Natacha, [317](#)

D

Dawod, Nazem, [91](#)
de Sousa, Filipe Soares, [293](#)
Dias, Gil, [228](#)
Dontu, Grigore Octavian, [91](#)
Drumond, Nuno, [317](#)

F

Falkenhain, Paul, [1](#)
Faria, Ricardo, [103](#)
Ferreira, Ana C., [103](#), [266](#)
Ferreira, Fernanda A., [250](#)
Ferreira, José Soeiro, [293](#)
Ferreira, Luís P., [58](#)
Ferrera, Conrado, [209](#)
Forte, Luís D., [103](#)

G

Gapinski, B., [173](#)
Gomes, Beatriz Especial, [250](#)
Grănescu, Bogdan, [91](#)
Guerreiro, Rita, [161](#)

H

Horky, Roman, [200](#)
Hren, Iryna, [200](#)
Husár, Jozef, [329](#)

I

Ianuș, Gelu, [47](#)

J

Jain, Jinesh Kumar, 116
 Jasiulewicz-Kaczmarek, Małgorzata, 68
 Jaskevič, Martin, 259
 Jesus, A. M. P., 339

K

Kharlamov, Yuriy, 305
 Knapčíková, Lucia, 329
 Krol, Oleg, 305
 Kumar, Manoj, 116
 Kusmierczak, Sylvia, 200

L

Leão, Celina P., 266
 Lima, Maria Margarida, 293
 Lima, Rui, 209
 Lima, Rui M., 317

M

Machado, José, 24
 Margolis, Iara, 216
 Marinho, Jorge, 317
 Martiček, Matúš, 329
 Martins, Tiago, 228
 Mathia, T. G., 173
 Meira, Carla, 317
 Meißner, Sven, 1
 Mendes, Ana Catarina, 317
 Mendes, Joaquim, 36
 Miranda, Rui, 317
 Moraru, Edgar, 91
 Murzac, Ion, 240
 Musiał, Kamil, 279

N

Naprstková, Nataša, 200
 Nițu, Nicolae Adrian, 47
 Novotný, Jan, 259
 Nunes, Ana Catarina, 293

O

Oliveira, Cristina, 293
 Oliveira, Marisa, 250
 Öztürk, Elif Göksu, 293

P

Pasternak, Viktoriya, 24
 Pata, Arminda, 13
 Pereira, Armanda, 173, 228
 Pereira, Isac, 317
 Pereira, Maria Teresa, 250

Pinal, Diego, 216
 Pinto, Ana, 317
 Pinto, Bebiana, 58
 Pinto, Paulo, 187
 Porkuian, Olga, 305
 Providência, Bernardo, 216
 Puga, Hélder, 209

Q

Quinteiro, Ana Rita, 317

R

Ribeiro, João, 209
 Rîzescu, Ciprian Ion, 148
 Rîzescu, Dana, 148
 Rocha, Pedro Filipe, 293
 Rodrigues, Ana Maria, 293
 Romanchenko, Oleksiy, 305
 Rysińska-Wojtasik, Dominika, 279

S

Sá, José C., 58
 Santos, André S., 161
 Scholz, Sebastian, 1
 Seabra, Eurico, 36
 Silva, Agostinho, 13
 Silva, Diogo, 187
 Silva, F., 339
 Silva, Francisco J. G., 58
 Silva, João, 187
 Silva, Patrícia, 36
 Silva, Rute, 216
 Silva, T., 339
 Singhal, Tejendra Singh, 116
 Soares, Filomena, 228
 Soares, Margarida, 136
 Sokolov, Volodymyr, 305
 Sousa, Bruno, 161
 Sousa, V., 339
 Souza, Andrews, 209
 Souza, Maria Sabrina, 209
 Svirzhevskiy, Kostiantyn, 24
 Swojak, N., 173
 Szelewski, M., 173

T

Teixeira, José, 80, 187
 Teixeira, Senhorinha, 80, 187
 Trojanowska, Justyna, 329

U

Ungureanu, Liviu Marian, 240

VVăleanu, Dana Mirela, [240](#)Valério, Nádia, [136](#)Varela, Leonilde R., [161](#)Vilarinho, Maria Cândida, [136](#)Vysloužil, Tomáš, [259](#)**W**Wieczorowski, M., [173](#)**Z**Zabolotnyi, Oleg, [24](#)Zadorozhnikova, Irina, [24](#)