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A novel methodology for the description acute type IIIb aortic dissection treated in patient's treated with TEVAR – Numerical reconstruction of blood hemodynamic

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Introduction: The aim of the study was to reconstruct a blood hemodynamic for patients with type IIIb aortic dissection (TBAD) before and after thoracic endovascular aortic repair (TEVAR) with the use of computational fluid dynamics (CFD).

Methods: We prepared 3D models of the aorta with adjacent arteries using pre- and post-operative CT data from five patients treated for TBAD. Hemodynamic parameters (like, blood flow rate or wall shear stress (WSS)) were calculated with CFD technique. Results were verified with ultrasonography (USG) data.

Results: CFD indicated that TEVAR caused 7-fold improvement in overall blood flow through aorta (p=0.0001). Comparison of CFD and ultrasonography (USG) showed no significant change in blood flow through analysed arteries but a significant increase in flow rate for thoracic trunk and renal arteries, which was in accordance with USG (accuracy 90% and 99.9%). Moreover, we observed a significant decrease in wall shear stress (WSS) values within the whole aorta after-TEVAR compared to pre-TEVAR (1.34±0.20 Pa vs. 3.80±0.59 Pa; p=0.0001). This decrease was associated with a significant reduction in WSS in the thoracic

Conclusions: CFD technique denoted that post-operative remodeling of the aorta after TEVAR for TBAD improved hemodynamic patterns reflected by flow, velocity and WSS with accuracy of 99%. Aorta (3.10±0.27Pa -1.34±0.11Pa; p=0.043) and renal arteries (4.40±0.25 Pa -1.50±0.22 Pa; p=0.043).

Recent Publications

1. Polanczyk A, Podyma M, Trebinski L, Chrzastek J, Zbicinski I and Stefanczyk L A (2016) Novel Attempt to Standardize Results of CFD Simulations Basing on Spatial Configuration of Aortic Stent-Grafts. PLoS ONE 11(4):e0153332.
2. Polanczyk A, Podyma M, Stefanczyk L, Szubert W and Zbicinski I (2015) A 3D model of thrombus formation in a stent-graft after implantation in the abdominal aorta. Journal of Biomechanics 48(3):425-431.
3. Duvernois V, Marsden A L and Shadden S C (2013) Lagrangian analysis of hemodynamics data from FSI simulation. International Journal for Numerical Methods in Biomedical Engineering 29:445-461.
4. Cheng Z, Juli C, Wood N B, Gibbs R G and Xu X Y (2014) Predicting flow in aortic dissection: comparison of computational model with PC-MRI velocity measurements. Medical Engineering and Physics 36:1176-1184.5.
5. Yu S C, Liu W, Wong R H, Underwood M and Wang D (2016) The Potential of Computational Fluid Dynamics Simulation on Serial Monitoring of Hemodynamic Change in Type B Aortic Dissection. CardioVascular and Interventional Radiology 39:1090-1098.

Biography

Andrzej Polanczyk is a Researcher and a Team Leader at the Lodz University of Technology, Poland. He earned his PhD in Medical Engineering in 2013. He participated in scientific grants in which he build the installation to simulate the blood flow through the abdominal section of the aorta. Recently he received a grant funded by The National Centre for Research and Development. His research areas comprise biomedical, chemical and environmental engineering.