Investigation into Physical and Pathophysiological Changes of Hemodynamics on Segmented Patient-Specific Cerebral Aneurysm Models through Computational Analysis

Lim Sheh Hong
Medical Engineering & Health Intervention Team (MedEHiT), College of Engineering, Universiti Malaysia Pahang, Kuantan, Pahang, Malaysia
Mohd Azrul Hisham Mohd Adib
Medical Engineering & Health Intervention Team (MedEHiT), College of Engineering, Universiti Malaysia Pahang, Kuantan, Pahang, Malaysia
Mohd Shafie Abdullah
School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia
Nur Hartini Mohd Taib
School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia
Radhiana Hassan
Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia
Azian Abd Aziz
Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia

ABSTRACT

Growth and rupture of human cerebral aneurysm are risky as both of these stages may lead to human organ dysfunction arisen from neurological disorders. The rupture of cerebral aneurysm can even lead to fatal hemorrhaging and other serious health issues. Several sets of medical images from patients have been utilized to reconstruct patient-specific cerebral aneurysm model geometries with different threshold value through image segmentation for computational analysis. In this paper, the physical and pathophysiological changes on hemodynamics, namely geometry volume, inlet area, outlet area, wall shear stress (WSS) distribution, and velocity flow field in the particular models are discussed. A prediction on the location where the aneurysm grows and ruptures has been made. Besides, the model geometries have been validated with varied mesh size. The simulation results show that the mesh size which is applied on the model geometry has significant effect on the generated WSS and velocity values, when varying within certain range. From the findings, the mesh size is one of the important elements which should be optimized, other than the threshold value used for model geometry reconstruction.

KEYWORDS: Geometry, Image segmentation, Computational modeling, Simulation, Aneurysm, Hemodynamics, Image reconstruction

DOI:

ACKNOWLEDGMENT

The support from UMP under grant RDU190153 and PGRS2003201, Ministry of Higher Education under FRGS grant FRGS/1/2018/TK03/UMP/02/23 and Medical Engineering & Health Intervention Team (MedEHiT) are gratefully acknowledged.