

Understanding Cerebrovascular Disease through Computational Simulations

Chang-Joon Lee^{1*,†}

¹The Australian School of Advanced Medicine, Macquarie University, Australia.

*Presenting author: chang-joon.lee@mq.edu.au

†Corresponding author: chang-joon.lee@mq.edu.au

Abstract

Cerebral aneurysms is a disorder in which weakness in the wall of a cerebral artery causes a local dilation or ballooning of the blood vessel. These aneurysms enlarge slowly and become structurally weaker as they grow. In some cases, these aneurysms rupture resulting in severe subarachnoid hemorrhage (SAH) which can be fatal or at the very least, cause severe brain damage. The reason why some aneurysms rupture is still not fully explained, although it has been generally accepted by clinicians and researchers that aneurysmal hemodynamics play an important role in rupture mechanism.

Given the importance of hemodynamics in understanding the pathogenesis and rupture of aneurysms, researchers have turned to computational fluid dynamics (CFD) because it provides valuable insights to what is happening inside an aneurysm in a relatively simple and cost-effective way that other experimental methods. The application of patient-specific CFD modelling in the field of cerebrovascular disease has proven to be valuable in helping clinicians to make critical therapeutic and surgical decision-making. However, there are still many areas that patient-specific CFD modelling can improve upon and limitations it must overcome to become a more trustworthy clinical tool, such as segmentation and computing resources.

In this session, I will present some of our recent CFD projects to illustrate the current status of patient-specific CFD modelling in treating cerebrovascular diseases, from the methods that we use to the type of results that can be gained through simulations. Some of these methods include fluid-structure interaction (FSI), and porous medium methods for representing flow diverting stents. Furthermore, I will discuss where we are (or should be) headed in the future in order to enhance the level of understanding that can be gained through computational simulations.

Keywords: Hemodynamics, Cerebral Aneurysms, FSI, Patient-Specific CFD