8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

PATIENT-SPECIFIC MODELLING OF HAEMODYNAMICS IN AN ANEURISMAL THORACIC AORTA

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Key Words: *Computational Fluid Dynamics, Biomedical Simulation.*

ABSTRACT

Cardiovascular disease is responsible for the death of over eight million people every year. Aortic aneurysm is an example of such disease. An aneurysm is a localized, dilatation (bulge) of a blood vessel (e.g. for the aorta: aortic aneurysm) caused by disease or weakening of the vessel wall. The larger the aneurysm becomes, the more likely it would burst with fatal consequences. In normal patients (excluding the Marfan's) the recommended cut off point for surgery is 5.5 cm for ascending and 6.5 cm for descending thoracic aortic aneurysms. Beyond this point, the risk of rupture increases significantly, therefore, the cost of a late surgical intervention due to miscalculation of risks in cardiovascular diseases becomes very high. In order to estimate the proper timing of surgery, it is necessary to monitor the size of the aneurysm and to predict its growth. The size is normally (in the UK) determined from a magnetic resonance imaging (MRI) scan. The prediction of aneurysm's growth is carried out by the clinicians from previous scans, clinical data and their experience.

Patient specific modelling can certainly help to reduce the mortality and the cost. A better prediction of the growth of aortic aneurysm from a detailed flow feature must be based on modern fluid dynamics or fluid-structure interaction tools. Thus, not only a more accurate intervention date can be predicted but the need for several scans and extra clinician time can be eliminated. More importantly, the numerical modelling can suggest different solutions to the aneurysm prior to any surgical intervention. The great advantage of the patient specific modelling is that different intervention options could be carried out digitally and post surgical implications could be studied as well.

In this work numerical simulation of blood flow in an aorta with an aneurysm has been carried out. The true geometry of the aorta has been obtained through MR as well as from the CT (computer tomography) images. The geometries have been reconstructed by the AMIRA software. The mesh has been

generated by a code developed at the Swansea University based on Delaunay method. The mesh quality has been essentially improved by Lloyd's iterations used for generation of the Centroidal Voronoi triangulation (CVT) [1]. The characteristic based split (CBS) integration scheme [2] has been used for the calculations. The blood has been considered as a Newtonian fluid that is true for the blood flow in aorta. The blood pressure fluctuations as well as the wall shear stress (WSS) have been computed.

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