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Biomechanical determinants of Abdominal Aortic Aneurysms- Fusiform versus Pseudo(Saccular) Formations

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ABSTRACT

The prevalence of Abdominal Aortic Aneurysms (AAAs) ranges from 2.0% to 8.8% in the elderly population and AAA rupture has a mortality rate of 90%. Pseudo(Saccular) aneurysms represent about 8% of all cases [1] and their geometrical complexity makes the definition of simple geometrical determinates complicated. Although of great scientific and clinical relevance, biomechanics of pseudo(saccular)-aneurysms has not yet attracted much attention in the literature.

This paper compares biomechanical determinates of pseudo(saccular) and the more frequently appearing fusiform formations. In particular, maximum von Mises wall stress (MMWS) and blood-flow induced wall shear stress (WSS) of the two different groups are derived and compared. To this end three-dimensional structural and blood-flow simulations were performed on a number of patient-specific AAAs, which have been reconstructed from standard clinical Computer Tomography data. The structural models account for non-linearity and non-homogeneity of the aneurysm wall and the Intra-Luminal Thrombus, and a rigid-wall and Newtonian fluid was assumed to predict blood-flow pattern.

Figure 1 presents the distribution of the MMWS of two selected patient-specific AAAs of about the same maximum diameter. The results show that the MMWS is significant lower in the fusiform formation, where, in addition a remarkable difference in the general stress pattern can be observed. Most interestingly, the highest MMWS appears at the proximal region of the pseudo(saccular) aneurysm whereas it correlates with the site of the largest diameter of the fusiform ones. As expected, much more pronounced flow separation with large regions of stagnating blood-flow are present in pseudo(saccular) aneurysms, which might have significant impact on growth and remodeling of the formation [2].

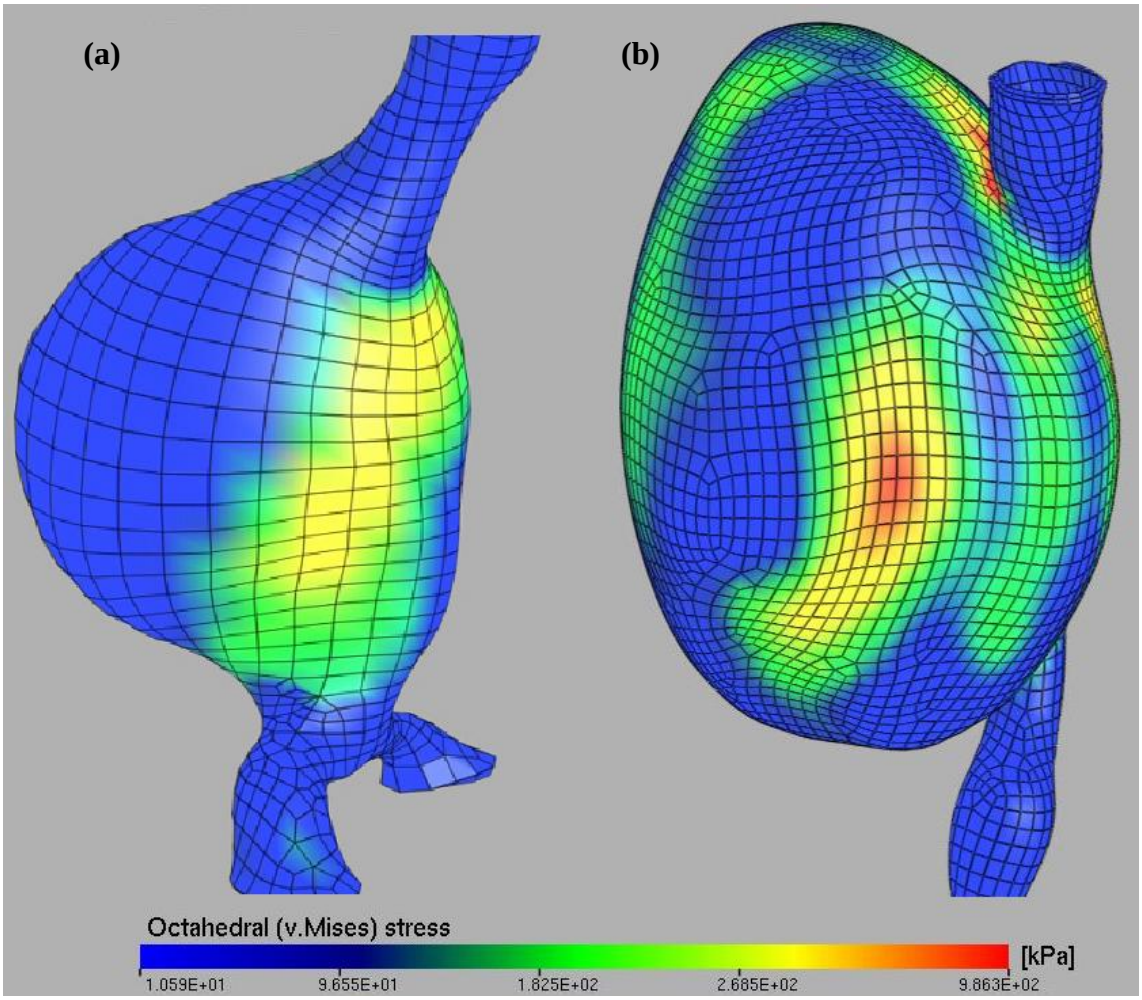

Figure 1: Predicted maximal von Mises wall stress (MMWS) in a fusiform- and (b) pseudo(saccular)-aneurysm of about the same maximum diameter.

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