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Fluid-Structure Interaction in Abdominal Aortic Aneurysms: Effect of haematocrit

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Abstract

It is accepted that anaemia is a condition that strongly affects haemodynamics and more specifically blood viscosity [1]. It is also widely reported that cardiovascular diseases are affiliated with blood viscosity anomalies [2]. The current study investigates the possible link between the dynamic behavior of an abdominal aortic aneurysm (AAA) and irregularities in blood viscosity due to iron-deficiency anaemia. AAAs are local dilations of the aortic wall usually found in the infrarenal segment of the abdominal aorta. Little is understood about the complete mechanism of AAA creation, which is needed since AAA patient's mortality - even for treated ruptured AAA - is around 40% in German male patients [3]. Risk factors for the development of AAAs include complex biochemical processes occurring in parts of the aortic wall, erosion of the tunica intima, as well as physiological haemodynamic abnormalities that alter the interaction of the blood flow with the arterial wall [4]. It is also reported [5] that the relationship between blood viscosity and AAA haemodynamics has not been thoroughly investigated.

Thus, the aim of this study is to investigate, using simulation tools that implement a Fluid-Structure Interaction *(FSI)* method, the influence of blood viscosity, which is a function of haematocrit and shear rate, on the blood flow dynamics within the aneurysm. Specifically, for three typical haematocrit values (30, 40 and 50) we have numerically estimated the values of pressure, the equivalent stress (*von Mises*) (*Fig. 1*) and the total displacement of the wall. Pulsatile blood flow during a typical heartbeat (1 Hz), a non-Newtonian model (*Casson*) for blood viscosity and a hyperelastic model for the arterial wall mechanical properties were employed.

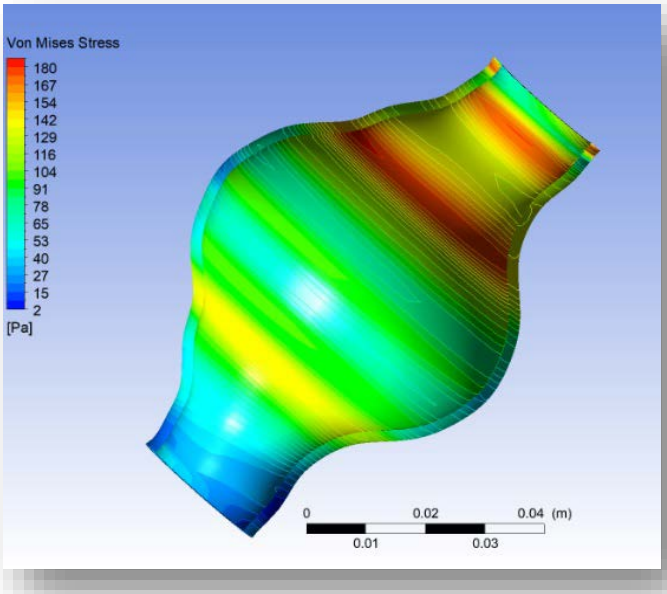

Fig.1. Von Mises Stresses on the wall of an AAA.

Preliminary results revealed that low blood haematocrit values cause higher mechanical fatigue on the arterial wall. This correlation between blood viscosity and dynamic behavior of an AAA can be potentially used in patient specific treatment, especially in cases of iron-deficiency anaemia. Additional work is needed, and indeed is in progress, to further elucidate the effect of haematocrit on an AAA.

References

1. Merrill, E. W., (1969). *Physiol Rev*, **49**(4), 863-888.
2. Diehm et al. (2007). *J Vasc Surg,* ***46***(4), 676-681.
3. Kühl et al. (2017). *Dtsch Artztebl Int,* ***114***(22-23), 391-398.
4. Finol, E. A., & Amon, C. H. (2001). Hemodynamics. *Transactions of the ASME,* ***123***, 474-484.
5. Wang, X., & Li, X. (2011). *Comput Biol Med,* ***41***, 812-821.