11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Numerical simulation of the blood flow in the aortic root with a non-Newtonian fluid model

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Key Words: Aortic root, Heart valve, Pulsatile Flow, non-Newtonian models.

Numerical simulations of the blood flow through the functional unit aortic root/aortic valve are becoming a precious tool to improve surgical techniques and performance of prosthetic devices. In fact, numerical simulations allow the evaluation of potentially any primitive or derived quantity that would be prohibitive in *in vivo* or even *in vitro* measurements, they permit the proof of concept of innovative technologies and, in the near future, they could be used for patient–specific diagnoses or surgical planning. On the other hand, the reliability of numerical simulations depends both on the suitability of the numerical schemes and of the *fluid model*. The blood is a concentrated suspension of cells (red blood cells) in a Newtonian matrix (plasma) and consequently its overall behaviour is that of a non–Newtonian fluid. The common practice, however, accepts the assumption that blood in large vessels behaves as a Newtonian fluid since the rate–of–strain is generally high and the effective viscosity becomes independent of the shear–rate. In this study we show that this is not always true not even in the aorta (the largest artery) owing to the pulsatile and transitional nature of the flow. Using a Newtonian and a non-Newtonian fluid model, numerical simulations, of the blood flow through a bileaflet mechanical aortic valve, are performed with the aim of verifying which features remain unchanged and which are altered.

Predicting the effects in the system dynamics is not trivial since from one hand the increased viscosity (induced by the shear thinning behaviour) amplifies the viscous stresses and, on the other hand, a more viscous system has less small scales. We will show that some features like the valve dynamics or the transvalvular pressure drop are unaffected by the non Newtonian fluid nature while red blood cells haemolysis and platelet activation are impacted by the shear thinning fluid model..

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