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Non-Newtonian Flows in Stenotic Vessels

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Extended Abstract

This paper presents a study on the numerical simulations of blood flow in a representative model of an arterial stenosis in the common carotid artery for various degree of severity using five blood rheological models.

The partial obstruction of arteries due to a stenosis is one of the most frequent anormalies in blood circulation. It is well known that, once such an obstruction is formed, the blood flow is significantly altered and fluid dynamic factors such as velocity, pressure or shear stress play an important role as the stenosis continues to develop . So far, the specific role of these factors is not yet well understood. The ability to accurately describe the flow through a stenosed vessel would provide the possibility of diagnosing these diseases in its earlier stages. Furthermore, the presence of the anomaly itself may produce flow disturbances such as vortex formation, which has been reported as a contributing factor to atherogenesis and thrombogenesis .

The aim of this study are three fold: firstly, to investigate the variation in wall shear stress in an artery with a stenosis at different flow rates and degrees of severity; secondly, to compare the various blood models and hence quantify the differences between the models and judge their significance and lastly, to determine whether the use of the Newtonian blood model is appropriate over a wide range of shear rates.

The results show that there are significant differences between simulating blood as a Newtonian or non- Newtonian fluid. It is found that the Newtonian model is a good approximation in regions of mid-range to high shear but the Generalized Power Law model provides a better approximation of wall shear stress at low shear.

These conclusions are presented under the assumption that the arterial walls are rigid and zero pressure is assumed at the outlet. A more realistic simulation would include elastic walls and incorporate the effects of upstream and downstream parts of the circulatory system into the boundary conditions. This is a long term objective of this study.