Correlation of Hemorheology Parameter Hematocrit with Hemodynamic Factors

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Received: 26.6.2010, Final version: 15.9.2010

Abstract:
Blood rheology and hemodynamics models show positive correlation between hematocrit and hemodynamic factors that has implication to physiological and arterial disease processes. Blood flow is modeled by the Navier-Stokes equation and its non-Newtonian property by the Casson equation. Hematocrit dependent parameters in the Casson equation integrate the hematocrit level in the mathematical model. Then the mathematical model was linearized on a tetrahedral computational grid using the finite volume method. Results show strong correlation between hematocrit and hemodynamic factors. The determined hemodynamic factors and their strong correlation with the hematocrit provide explanation how these factors promote the atherosclerotic process in the right coronary artery at a steady flow and how influence arterial disease process.

Zusammenfassung:
Blutrheologie und hämodynamische Modelle weisen starke Korrelationen zwischen Hämatokrit und hämodynamischen Faktoren auf, die Bedeutung für physiologische und arterielle Krankheitsprozesse haben. Das Verhalten von Blut wird mit Hilfe der Navier-Stokes-Gleichung modelliert und seine nicht-Newtonschen Eigenschaften durch die Casson-Gleichung. Parameter in der Casson-Gleichung, die von Hämatokrit abhängig sind, berücksichtigen den Hämotokrit-Anteil in dem mathematischen Modell. Dieses mathematische Modell wurde auf einem tetraedrischen Gitter mit Hilfe der Finite Volumen-Methode linearisiert. Die Ergebnisse weisen eine sehr enge Korrelation zwischen den hämatokritschen und hämodynamischen Faktoren auf. Die ermittelten hämodynamischen Faktoren und ihre enge Korrelation mit Hämatokrit geben eine Erklärung dafür, wie diese Faktoren atherosklerotische Prozesse in der rechten Herzarterie bei einer stationären Strömung fördern und wie sie arterielle Krankheiten beeinflussen.

Résumé:
La rhéologie du sang et les modèles hémodynamiques montrent une corrélation positive entre les facteurs hémodynamiques et hématocrites, qui a une implication sur les processus physiologiques et sur les maladies artérielles. L'écoulement du sang est modélisé par l'équation de Navier-Stokes, et sa propriété non Newtonienne par l'équation de Casson. Les paramètres hématocrites dans l'équation de Casson intègrent le niveau hématocrite dans le modèle mathématique. Ensuite, le modèle mathématique a été linéarisé sur une grille informatique tétraédrique en utilisant la méthode des volumes finis. Les résultats montrent une forte corrélation entre les facteurs hématocrites et hémodynamiques. Les facteurs hémodynamiques déterminés et leur forte corrélation avec l'hématocrite fournissent une explication de comment ces facteurs facilitent le processus atérosclérotique, dans l'artère coronaire droite à un régime d'écoulement établi, et de comment ils influencent le processus de maladie artérielle.

Key words: hemorheology, hematocrit, blood rheology, hemodynamics, arterial disease, Navier-Stokes equation, Casson equation

1 INTRODUCTION

The aggregation, dispersion and deformation of cellular components of blood in the vasculature affect blood rheology to a greater extent. At low shear rate erythrocytes tend to aggregate and form rouleaux and at a high shear rate they disperse and get deformed into ellipsoid with their long axis aligned in the flow direction. While rouleaux formations increase viscosity, dispersion and deformation of erythrocytes minimizes and maintains it to a constant value. Phenomenological hemorheology models can provide more scientific meaning if they are expressed in terms of the constituent elements of blood. They can provide fundamental explanation to complex biological and disease processes. When hematocrit is included in the Casson blood rheology model, hemodynamics model shows the strong correlation between hematocrit and

DOI: 10.3933/ApplRheol-20-64092

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