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A Hybrid Windkessel Model of Blood Flow in Arterial Tree Using Velocity Profile Method YASSER ABOELKASSEM[1], Johns Hopkins University, ZDRAVKO VIRAG[2], University of Zagreb — For the study of pulsatile blood flow in the arterial system, we derived a coupled Windkessel-Womersley mathematical model. Initially, a 6-elements Windkessel model is proposed to describe the hemodynamics transport in terms of constant resistance, inductance and capacitance. This model can be seen as a two compartment model, in which the compartments are connected by a rigid pipe, modeled by one inductor and resistor. The first viscoelastic compartment models proximal part of the aorta, the second elastic compartment represents the rest of the arterial tree and aorta can be seen as the connection pipe. Although the proposed 6-elements lumped model was able to accurately reconstruct the aortic pressure, it can't be used to predict the axial velocity distribution in the aorta and the wall shear stress and consequently, proper time varying pressure drop. We then modified this lumped model by replacing the connection pipe circuit elements with a vessel having a radius R and a length L. The pulsatile flow motions in the vessel are resolved instantaneously along with the Windkessel like model enable not only accurate prediction of the aortic pressure but also wall shear stress and frictional pressure drop. The proposed hybrid model has been validated using several in-vivo aortic pressure and flow rate data acquired from different species such as, humans, dogs and pigs. The method accurately predicts the time variation of wall shear stress and frictional pressure drop.

[1]Institute for Computational Medicine, Dept. Biomedical Engineering
[2]Mechanical Engineering and Naval Architecture

Yasser Aboelkassem
Johns Hopkins Univ

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