

Pulse wave propagation in large arteries: Modelling, validation and applications

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Abstract

The contraction of the left ventricle in the heart produces changes in blood pressure and flow velocity at the ascending aorta (the body's main artery) that propagate in the systemic arterial network in the form of waves, called pulse waves. Understanding pulse wave propagation is important because pulse waveforms carry information on the morphology and functionality of the cardiovascular system, which can be valuable for the diagnosis and treatment of disease. Through modelling we can study the role of the different physical properties of the system in pulse wave propagation, as this presentation will show.

We have simulated pulse wave propagation in the systemic arterial network using the nonlinear one-dimensional (1-D) equations of blood flow in compliant vessels, which offer a good compromise between accuracy and computational cost when a global assessment of the arterial system is required. Indeed, we have successfully tested the accuracy of the 1-D formulation by comparison against pressure and flow measurements in an experimental 1:1 replica of the left ventricle and the larger arteries of the human systemic circulation.

This presentation will also summarise the main results of a time-domain linear analysis of the 1-D formulation that we carried out to study the mechanisms underlying the main features in the simulated pulse waveforms in normal conditions. Several clinically relevant applications of the 1-D model will also be shown.