Modeling the peripheral circulation in the human arterial system and nonlinear waves in fractal networks

Radu C. Cascaval
Department of Mathematics
University of Colorado at Colorado Springs
USA

We describe a new time domain analysis of the pressure waves in the peripheral circulation, using a nonlinear model for wave propagation along trees. The key ingredient is the evidence that dispersion (amplitude-dependent velocity) of the pressure waves plays an important role, in particular in the formation and propagation of the reflected waves, a phenomenon not captured by linear models. The timing of the reflections as well as the different speeds of the reflected waves are particularly relevant in view of the complex geometry of the peripheral circulation. The advantage of the time domain analysis, compared with linear impedance models, is that it applies for non-periodic flows and also allows the direct implementation of accurate time-dependent controls, such as those exhibited in the control of the peripheral resistance. We will also illustrate the impact of these nonlinear dispersive models on the dynamics of pressure and flow rates in the entire human arterial system.