The Effects of Higher-Order Approximations in a Fluid-Filled Elastic Tube with Stenosis

Hilmi Demiray

Department of Statistics and Computer Science, Faculty of Arts and Sciences, Kadir Has University
Cibali, 30083 Fatih-Istanbul, Turkey

Reprint requests to H. D.; E-mail: demiray@isikun.edu.tr

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Treating arteries as thin-walled prestressed elastic tubes with a narrowing (stenosis) and blood as an inviscid fluid, we study the propagation of weakly nonlinear waves in such a fluid-filled elastic tube by employing the reductive perturbation method in the long wave approximation. It is shown that the evolution equation of the first-order term in the perturbation expansion may be described by the conventional Korteweg-de Vries (KdV) equation. The evolution equation for the second-order term is found to be the linearized KdV equation with a nonhomogeneous term, which contains the contribution of the stenosis. A progressive wave type solution is sought for the evolution equation, and it is observed that the wave speed is variable, which results from the stenosis. We study the variation of the wave speed with the distance parameter τ for various amplitude values of the stenosis. It is observed that near the center of the stenosis the wave speed decreases with increasing stenosis amplitude. However, sufficiently far from the center of the stenosis stenosis amplitude becomes negligibly small.

Key words: Progressive Waves; Elastic Tubes; Stenosed Tubes.