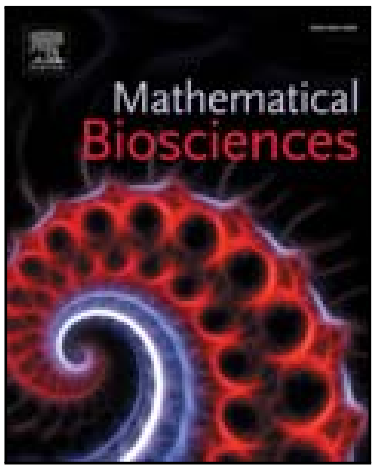

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Numerical Simulation of Mitral Valve Prolapse Considering the Effect of left Ventricle

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ABSTRACT

Heart failure is one of the most important issues that has been investigated in recent research studies. Variations that occur in apparatus of mitral valve, such as chordae tendineaea rupture, can affect the valve function during ventricular contraction and lead to regurgitation from the left ventricle into the left atrium. One method for understanding mitral valve function in such conditions is computational analysis. In this paper, we develop a finite element model of mitral valve prolapse, considering the direct effect of left ventricular motion on blood flow interacting with the mitral valve. Ventricular wall motion is used as a constraint for fluid domain. Arbitrary Lagrangian-Eulerian finite element method formulation is used for numerical solution of transient dynamic equations of the fluid domain. Leaflets' stresses and chordal forces during prolapse are determined and compared to previous healthy results, as well as flow characteristics in the computational domain. Results show considerable increases in the stress magnitudes of interior and posterior leaflets in prolapse condition in comparison with previous healthy studies. In addition, chordae tendineae forces are distributed non-uniformly with higher maximum value here, as a result of other chordae tendineae rupture.

Keywords: Fluid structure interaction; Ventricular motion; Mitral-valve prolapse; hemodynamics.

1. Introduction

Mitral valve prolapse is the most common cause of mitral regurgitation. More than 150 million people worldwide are estimated to have mitral valve prolapse (MVP)[1]. Mitral valve consists of anterior and posterior leaflets, chordae tendineae, annulus and papillary muscles. It is connected to the left ventricle through chordae tendineae. It is responsible for the unidirectional flow of blood from the atrium into the ventricle. Furthermore, it prevents regurgitation of blood back into the atrium. The appropriate functioning of mitral valve is dependent on the harmonic function of all its elements[2]. However, sometimes rupture occurs in chordae tendineae that leads to blood regurgitation. These anatomic abnormalities result in the incomplete closing of the mitral orifice, causing regurgitation[3]. In most cases, repair is preferred to valve replacement since prosthetic valves may cause many undesirable consequences such as thrombosis.

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