Modeling the Effects of Myocardial Fiber Architecture and Material Properties on the Left Ventricle Mechanics during Rapid Filling Phase

Abstract
The objective of this research is to study the effects of myofiber volume fraction and fiber orientation on the deformation mechanics of left ventricular (LV) during diastole. The human LV was simulated by three-dimensional finite element (3D-FE) model. The LV geometrical model was represented as a thick-walled ellipsoid truncated at two thirds of major axis. 3D Fiber network, with parallel myofiber bundles to reproduce the globally anisotropic behavior of cardiac tissue, were embedded within the LV model. The LV wall thickness in the reference unstressed state (at hypothetical zero pressure applied inside the LV internal cavity) is divided into n different concentric thin layers (n = 3, 5, 7 and 9 layers). The presence of blood (incompressible fluid) inside the LV cavity was also simulated. Four schememodels of fiber angle definition (one symmetric, two asymmetric and one complex pattern) were used throughout this study. Complex pattern of fiber-structures are derived from diffusion tensor magnetic resonance imaging (DT-MRI) data. Simulation results have shown that the proposed FE model was able to reproduce experimental ventricular volume during the rapid filling phase and that the complex fiber orientations are in good agreement with the measurements.