A computational Model of Electroactive Polymer Assisted Left Ventricular Contraction

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Abstract: Left ventricular systolic dysfunction (LVSD) is classified as asymptomatic heart failure and is the most common cause of heart failure comprising about 60 percent of patients. LVSD is associated with reduced left ventricle (LV) contractility, and can therefore be diagnosed in patients with a reduced ejection fraction (EF). The purpose of this research is to create and analyze three separate computational models of LV contraction. One model will illustrate normal LV contraction while another model will show LV contraction with systolic dysfunction. The third model will show restoration of normal LV contraction by incorporating a ventricular assistive device (VAD) into the model made from electroactive polymers. The three models will be set up in COMSOL Multiphysics 4.4 using the Fluid Structure Interaction (FSI) and MEMS modules. Currently, only the model illustrating normal LV contraction is being considered. To reduce computing time, the left ventricle is modeled in 2D, and the geometry is consistent with end-diastole LV dimensions. Material properties for both the blood and myocardium were found from literature. Additionally, initial conditions and most boundary conditions were determined through literature. The model is being computed using a time-dependent study, allowing transient analysis of the fluid-structure interaction. After computing the results, a measurement tool in COMSOL will be used to determine the end-diastole and end-systole areas. Using these measurements, the EF will be determined for each of the three models. Normal EF values range from 55-75% and an EF of less than 40% is generally diagnosed as heart failure. Overall, a successful model will show the electroactive polymer assisting in the contraction of the left ventricle while restoring normal EF values. This research is a foundation for emerging technologies that will give hope to those with LVSD and heart failure.

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