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Computational study of blood flow patterns in a wall-deforming model of the left ventricle under healthy and LVAD-assisted conditions

TINGTING YANG, VENKAT KESHAV CHIVUKULA, ALBERTO ALISEDA, University of Washington, Seattle, WA, MULTIPHASE AND CARDIOVASCULAR FLOW LAB TEAM — Left ventricular assist device (LVAD) induce non-physiological flow patterns that are associated with thrombus formation. Numerical modeling of the hemodynamic environment inside simplified geometries of the human left ventricle incorporate wall deformation to simulate healthy and LVAD-assisted conditions. Input boundary conditions and wall deformation are derived from patient-specific measurements. Q-criterion, lambda-2 and streamline visualizations are used to compare the healthy and LVAD cases, better characterizing the impact of LVAD implantation on intraventricular flow patterns. Two vortex rings are formed during mitral filling that break down as they flow towards the ventricular apex, with the remaining filaments washed out through the aortic valve or inflow cannula. Small scale vortices, unreported in previous research with rigid ventricle walls, are found between the apex and the outer cannula wall. A methodology to investigate the physics underlying ventricular filling and emptying with different levels of ventricular contractility (ejection fraction) is demonstrated. LVAD surgical configurations, such as the inflow cannula and outflow graft angles, are studied to provide insights on risk assessment of these surgical techniques.

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