Fluid Mechanics Analyses of Cardiac Pumping and Balloon Assist

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The data and technology of echocardiogram are very valuable for fluid mechanic analysis and for clinical assessment/classification of the left ventricular abnormality. The physiological performance of the left ventricle can be evaluated from the information conceived in the work energy equation of the blood flow processes. Two methodologies are developed for classifying hemo-dynamic performance of the left ventricular pumping. First, a kinetic energy index is formulated to assess the ventricle wall motion. It is a ratio of the aortic kinetic energy flux to the kinetic energy flux of the wall motion. This index can be calculated from the information and data stored in the echocardiogram. It is used to correlate with the clinical diagnosis of a patient, indicating a specific type and degree of cardiac abnormalities.

Second, the wall motion recorded by the echocardiogram will be used for computational simulation of blood flow during systole and diastole. The results will yield the pulsating velocity and pressure distributions. They will be used to analyze the relationship of this newly defined kinetic energy index with the rate of work down by pressure and viscous stresses, and the dissipation of energy. The potential occurrence of poor circulation in the ventricle will be addressed.

Other topics to be covered in this keynote lecture are the computational analyses of intra-aortic balloon pumping and the intra-vena cava balloon pumping. They are based on the computational flow simulations for blood flows in the descending aorta and in the vena-cava. Because of the rapidly disturbed blood flow processes, the detailed characteristics can not been obtained by animal experiments, making it desirable to resort to the computational flow analyses.