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Quantifying the Incoming Jet Past Heart Valve Prostheses Using Vortex Formation Dynamics OLGA PIERRAKOS, Virginia Tech, PAVLOS VLACHOS, COMPLEX THERMO-FLUID SYSTEMS TEAM — Heart valve (HV) replacement prostheses are associated with hemodynamic compromises compared to their native counterparts. Traditionally, HV performance and hemodynamics have been quantified using effective orifice size and pressure gradients. However, quality and direction of flow are also important aspects of HV function and relate to HV design, implantation technique, and orientation. The flow past any HV is governed by the generation of shear layers followed by the formation and shedding of organized flow structures in the form of vortex rings (VR). For the first time, vortex formation (VF) in the LV is quantified. Vortex energy measurements allow for calculation of the critical formation number (FN), which is the time at which the VR reaches its maximum strength. Inefficiencies in HV function result in critical FN decrease. This study uses the concept of FN to compare mitral HV prostheses in an in-vitro model (a silicone LV model housed in a piston-driven heart simulator) using Time-resolved Digital Particle Image Velocimetry. Two HVs were studied: a porcine HV and bileaflet MHV, which was tested in an anatomic and non-anatomic orientation. The results suggest that HV orientation and design affect the critical FN. We propose that the critical FN, which is contingent on the HV design, orientation, and physical flow characteristics, serve as a parameter to quantify the incoming jet and the efficiency of the HV.

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