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Distant downstream steady-state flow studies of a mechanical heart valve: PIV study of secondary flow in a model aortic arch[1] BRANDON R. FIX, CHRISTOPHER J. POPMA, KARTIK V. BULUSU, MICHAEL W. PLESNIAK, The George Washington University — Each year, hundreds of thousands of aortic and mitral heart valves are replaced with prosthetic valves. In efforts to develop a valve that does not require lifelong anticoagulation therapy, previous experimental research has been devoted to analyzing the hemodynamics of various heart valve designs, limited to the flow up to only 2 diameters downstream of the valve. Two-component, two-dimensional (2C-2D) particle image velocimetry (PIV) was used in this study to examine secondary flow velocity fields in a curved tube modeling an aorta at five locations (0-, 45-, 90-, 135-, 180-degrees). A bileaflet valve, opened to 30-, 45-, and 59-degrees, and one (no-valve) baseline condition were examined under three steady flow inflows (Re = 218, 429, 634). In particular, variations in the two-dimensional turbulent shear stresses at each cross sectional plane were analyzed. The results suggest that bileaflet valves in the aortic model produce significant turbulence and vorticity up to 5.5 downstream diameters, i.e. up to the 90-degrees location. Expanding this research towards aortic heart valve hemodynamics highlights a need for additional studies extending beyond the typical few diameters downstream to fully characterize valvular function.

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