IN-VITRO MEASUREMENT OF HIGH PEAK FLUID PRESSURE GRADIENTS ACROSS PROSTHETIC HEART VALVES AT CLOSING

Ronald F. Carey, Bruce A. Herman, Matthew R. Myers, Food and Drug Administration, Rockville MD USA

Mechanical stability and durability of prosthetic heart valves are dependent upon the stresses to which the components are subjected in vivo. To determine maximum dynamic pressure gradients upon occluder impact at valve closing, we evaluated four different valve types (tilting disk, bi-leaflet, ball-in-cage, pericardial), mounted in both the mitral and the aortic position of a pulse duplicator. Using Millar sensor-tipped catheters on either side of the valves, we measured high negative pressure pulses in the left atrium, at the moment of mitral valve closure, and high positive pressure pulses in the aorta, at the moment of aortic valve closure. Pulse widths were often less than one millisecond and pulse amplitudes were as large as 700 mm Hg (for one of the tilting disk valves). Similar pulses were also observed for the other valve types but with amplitudes on the order of, or less than, the maximum systolic ventricular pressure. Pulse amplitude was not strongly dependent upon cycle rate, stroke volume, or systolic pressure over normal ranges of these parameters. The amplitude was, however, strongly dependent upon geometry. A model of acoustic wave propagation accounts qualitatively for the presence of the pulse in the atrium and in the aorta and for the lack of such in the open ventricle of our duplicator. These results suggest that catheterization of animals with valve implants be performed, with appropriate instrumentation (responsive to at least 5 kHz), to evaluate stresses critical to valve reliability.