Heart valve function: a biomechanical perspective

The results presented and described in figures 2 and 3 are based on a sophisticated three-dimensional computational fluid dynamics (CFD) model developed by Dr Fotis Sotiropoulos and Dr Liang Ge at the University of Minnesota. These early results, as described in the article, are those obtained by them and are the first numerical simulations to describe the differences in shear stress patterns on the ventricular and aortic surfaces and qualitatively agree with in vitro (Weston et al. 1999) and in vivo (Simmons et al. 2005) experimental observations. The CFD model is the curvilinear immersed boundary (CURVIB) method of Ge & Sotiropoulos [J. Comp. Phys. 225(2), 1782–1809, 2007], which is capable of performing high-resolution simulations of heart valve haemodynamics at physiological conditions. The kinematics of the leaflets were prescribed as input to the CFD model and were obtained from the experimental measurements performed in Dr Yoganathan’s laboratory (Leo et al. 2006) and a tissue deformation model developed by Dr Rami Haj-Ali (at Georgia Tech). The heart valve CFD studies were funded by a grant from the National Heart Lung and Blood Institute (HL70262). The data shown in figures 8, 9, 11 and 12 were taken from Grashow et al. (2006a,b), Merryman et al. (2006a), Huang et al. (2007), Merryman et al. (2006b), respectively.

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