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Optimal bending rigidity of the aortic valve leaflets YE CHEN, HAOXIANG LUO, Vanderbilt University — Proper bending stiffness and the ability to quickly respond to the dynamic pressure load on their surfaces are critical for the heart valves to carry out their physiological functions. Studies on how the flexibility of the leaflets affects the fluid-structure interaction (FSI) of heart valves are still very limited. In this talk, three-dimensional FSI simulations of a bioprosthetic aortic valve are performed using a parallelized immersed-boundary method. The pressure distribution over the leaflets and transient force on the valve are calculated The thickness of the leaflets is varied from 0.1 mm to 0.8 mm, which results a wide range of non-dimensional bending rigidity EB*, normalized by the transvalvular pressure gradient. For valves with low bending rigidity (EB* around 1.0E-2), the valve functions normally and produces physiological characteristics of healthy valves. However, exceedingly low rigidity (for example, EB* = 1.2E-3) leads to flapping motion of the leaflets and impairs the valve's performance. Stiffer valves (EB* greater than 0.2) are more difficult to open and slower to close, which leads to higher resistance and a reduced flow rate during systole. The results reveal the existence of an optimal range of bending rigidity for the valve, where EB* is roughly between 0.003 and 0.04. Effects of bending rigidity on valve deformation and flow characteristics will also be discussed.

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