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A rods model of the mitral valve

I will discuss a bare-bones mathematical model able to account for the elementary mechanics of the mitral valve, when the leaflets of the valve close under the systolic pressure. The mechanical model exploits the aspect ratio of the valve leaflets, that are represented as inextensible rods, subject to the blood pressure, with one fixed endpoint (on the endocardium) and an attached wire anchored to the papillary muscle. Force and torque balance equations are obtained exploiting the principle of virtual work, where the first contact point between rods is identified by the Weierstrass-Endermann condition of variational nature. The chordae tendineae are modelled as a force applied to the free endpoint of the flaps. Different possible boundary conditions are investigated at the mitral annulus and, by an asymptotic analysis, we demonstrate that in the pressure regime of interest generic boundary conditions generate a tensional boundary layer. Conversely, a specific choice of the boundary condition inhibits the generation of high tensional gradients in a small layer.