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Material modeling of cardiac valve tissue

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With around three billion heartbeats during an average life span [1], cardiac valves regulate the blood flow through the organ and are subjected to varying loads and stresses based on their specific location. Hereby, a key element of the cardiac cycle of the human heart is the opening and closing of the four heart valves, viz. the mitral, tricuspid, aortic as well as the pulmonary valve. However, relatively little is known about the material properties of the leaflet tissues, which fundamentally contribute to determine the mechanical response of the valves.
The present study aims to provide data and insight into the material behavior of porcine heart-valve tissue from samples spanning all of the different valve and leaflet types and under uniaxial as well as biaxial loading. The tests show a fair degree of reproducibility and the data are clearly indicative of a number fundamental properties of the response of heart-valve tissue, including a progressively stiffening response with increasing elongation and a marked anisotropy in the elasticity of the tissue. Furthermore, a composite material model is devised and fitted to the experimental data set in order to characterize and represent analytically the mechanical response of heart-valve tissue.

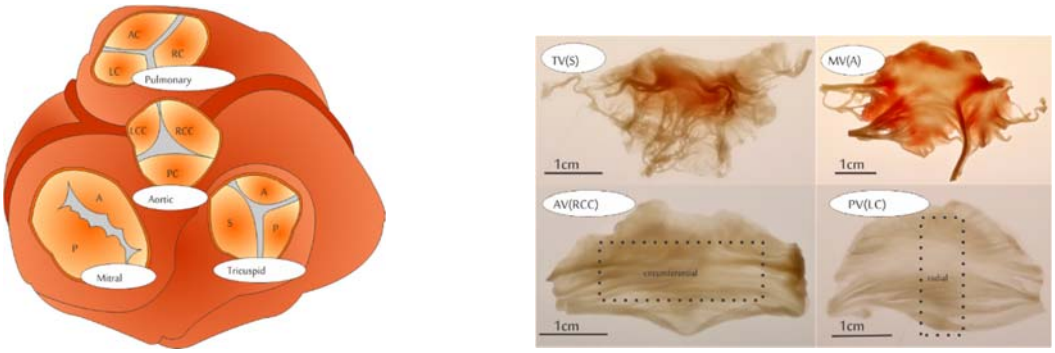

Figure 1: Cardiac valve apparatus (left) and porcine leaflet samples after dissection.

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