Usyk, T. P.; **Mazhari, R.**; **McCulloch, A. D.**

Effect of laminar orthotropic myofiber architecture on regional stress and strain in the canine left ventricle. (English) Zbl 0974.92002

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Summary: Recent morphological studies have demonstrated a laminar (sheet) organization of ventricular myofibers. Multiaxial measurements of orthotropic myocardial constitutive properties have not been reported, but regional distributions of three-dimensional diastolic and systolic strains relative to fiber and sheet axes have recently been measured in the dog heart. A three-dimensional finite-deformation, finite element model was used to investigate the effects of material orthotropy on regional mechanics in the canine left ventricular wall at end-diastole and end-systole. The prolate spheroidal model incorporated measured transmural distributions of fiber and sheet angles at the base and apex.

Compared with transverse isotropy, the orthotropic model of passive myocardial properties yielded improved agreement with measured end-diastolic strains when: (1) normal stiffness transverse to the muscle fibers was increased tangent to the sheets and decreased normal to them; (2) shear coefficients were increased within sheet planes and decreased transverse to them. For end-systole, orthotropic passive properties had little effect, but three-dimensional systolic shear strain distributions were more accurately predicted by a model in which significant active systolic stresses were developed in directions transverse to the mean fiber axis as well as axial to them. Thus the ventricular laminar architecture may give rise to anisotropic material properties transverse to the fibers with greater resting stiffness within than between myocardial laminae. There is also evidence that intact ventricular muscle develops significant transverse stress during systole, though it remains to be seen if active stress is also orthotropic with respect to the laminar architecture.

MSC:

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65N30 Finite element, Rayleigh-Ritz and Galerkin methods for boundary value problems involving PDEs
74L15 Biomechanical solid mechanics

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