Colorado Cervantes, Ivan; **Sansalone, Vittorio**; **Teresi, Luciano**
The heart function as a motor-brake system. (English) Zbl 1409.92068
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Summary: The controversy between passive and active ventricular filling has been debated for decades and the question about the existence of an active diastole remains open. In this work, we advocate the model of active diastole by considering the heart as a suction pump and we add some more clues to support this point of view by the analysis of the pressure-volume (PV) loops of the left heart, comprising of the left ventricle (LV) and atrium (LA). Our working hypothesis is based on the dichotomy motor-brake: the cardiac muscle can act as a motor, when shortening against a load, or as a brake, when lengthening to a load. We discuss our hypothesis by means of a lumped model of the left heart, where both chambers are considered as hollow spherical shells. The notion of active stretch, introduced to describe the contractile behavior of the muscle fibers, plays a major role in our model. Then, the contraction of the muscle is related to the pressure and volume of the chamber through a nonlinear hyperelastic energy density function. Despite its simplicity, the model enlightens some important features of the LV-LA coupling and of the pumping function of the heart. Based on experimental PV data of the left heart of a normal human subject, it is shown that the contraction patterns of the LV and LA are synchronized with each other and have distinguishing features in each phase of the cardiac cycle. These results highlight the interplay between the two chambers and support the idea that the heart may act as a suction pump functioning in turn as a motor or a brake in order to meet specific demands in each phase of the cardiac cycle.

MSC:

92C30 Physiology (general)
92C10 Biomechanics

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