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Importance of mitral subvalvular apparatus in terms of cardiac energetics and systolic mechanics in the ejecting canine heart.

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To assess the importance of the intact mitral subvalvular apparatus for left ventricular (LV) energetics, data from nine open-chest ejecting canine hearts were analyzed using piezoelectric crystals to measure LV volume. After mitral valve replacement with preservation of all chordae tendineae, baseline LV function was assessed during transient caval occlusion: A quadratic fit of the LV end-systolic pressure-volume data was used to determine the curvilinear end-systolic pressure-volume relationship (ESPVR). All chordae were then divided with exteriorized snares. Reassessment revealed deterioration of global LV pump function: (a) the coefficient of nonlinearity, decreased (less negative) by 90% (P = 0.06); (b) slope of the curvilinear ESPVR at the volume axis intercept, decreased by 75% (P = 0.01); and V100, end-systolic volume at 100 mmHg end-systolic pressure, increased by 42% (P less than 0.02). Similarly, preload recruitable stroke work fell significantly (-14%) and Vw1,000 (end-diastolic volume [EDV] at stroke work [SW] of 1,000 mmHg.ml) rose by 17% (P less than 0.04). With respect to LV energetics, the total mechanical energy generated by the ventricle decreased, as indicated by a decline in the slope of the pressure volume area (PVA)-EDV relationship (120 +/- 13 [mean +/- SD] vs. 105 +/- 13 mmHg, P less than 0.001). Additionally, comparison of LV SW and PVA from single beats with matched EDV showed that the efficiency of converting mechanical energy to external work (SW/PVA) declined by 14% (0.65 +/- 0.13 vs. 0.56 +/- 0.08, P less than 0.03) after chordal division. While effective systemic arterial elastance, Ea, also fell significantly (P = 0.03) after the chordae were severed, the Ea/Ees ratio (Ees = slope of the linear ESPVR) increased by 124% (0.91 +/- 0.53 vs. 2.04 +/- 0.87, P = 0.001) due to a proportionally greater decline in Ees. This indicates a mismatch in ventriculo-arterial interaction, deviating from that required for maximal external output (viz., Ea/Ees = 1). These adverse effects of chordal division may be related to the observed changes in LV geometry (i.e., eccentricity). We conclude that the intact mitral subvalvular apparatus is important in optimizing LV energetics and ventriculo-vascular coupling in addition to the enhancement of LV systolic performance.

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