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Saddle Shape of the Mitral Annulus Reduces Systolic Strains on the Mitral Valve Leaflets

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Objectives:

The non-planar saddle shape of the mitral annulus is postulated to play a key role in mitral valve (MV) mechanics during systolic valve closure. The objective of this study was to investigate the effect of the mitral annular saddle shape on the systolic strains on the MV leaflets.

Method:

Porcine MV's (28-30mm) were studied in the Georgia Tech left-heart simulator. The valves were sutured onto an adjustable shape annulus, whose shape can be changed from a flat (0% saddle), to 10% and 20% saddle. Miniature markers (6 x6 arrays) were placed on the anterior and posterior leaflets (AL & PL), and studied under pulsatile hemodynamic conditions of: 120 mm Hg peak transmitral pressure, 5L/min cardiac output at 70 bpm. The marker arrays were imaged throughout the cardiac cycle using high speed cameras (250 frames/sec) and the leaflet strains were computed offline.

Results:

Mitral annular saddle reduced the systolic strains on both leaflets. Compared to the flat annulus, the AL areal strain reduced by 18.6±18.9 % (for 10% saddle) and by 27.9±35.1% (for 20% saddle). Similarly, on the PL the maximum areal strain reduced by 18.4±8.0% (for 10% saddle), and by 60.3±5.5% (for 20% saddle). Most strain reduction was in the radial direction on the AL, but on the PL the strains reduced in both circumferential and radial directions.

Conclusions:

Mitral annular saddle benefits the valve by reducing leaflet strains during valve closure. This finding may be of immense importance to in surgical repair of degenerative MV disease, and increase repair durability.