Advanced Feature Tracking on 4D Echo Images Defines Anterior, Septal and Apical Dysfunction in Open Chest Pigs Subjected to Intermittent LAD Occlusion

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Background: We validated the accuracy of 3D echo mechanics for tracking left ventricular (LV) myocardial deformation in four 40-45 kg open-chest pigs subjected to intermittent LAD ligation.

Methods: Circumferential strain was mapped along multiple segments on a myocardial shell of 4D gated full-volume images acquired on a Toshiba Applio Artida system with a matrix transducer placed over the cardiac apex, using liver as a stand-off. Three triangles of sonomicrometry (sono) crystals were placed - just below the mitral valve at the mid level and just below the tips of the papillary muscle - to provide validation for circumferential strain.

Results: Baseline sequences in all the pigs showed -28 ± 6% uniform circumferential strain at the apex, -23 ± 6% at the mid level, and -21 ± 4% at the base level. There was close correlation for the segmental results to each other and to sono data for circumferential strain (r² = 0.81). After partial temporary ligation (5 times in each pig) at the mid LAD level, during ischemia circumferential strain was paradoxically positive over the anterior and apical segments (up to -20% with a late minimal shortening of 5%). Processing of these high quality images had less than 8% interobserver variability for segmental circumferential strain calculations.

Conclusions: Although this study focused on 4D volume data for circumferential strain, the same loops can be processed for radial, longitudinal, rotational or torsional deformations.