Right Ventricular Shape Distortion in Tricuspid Regurgitation

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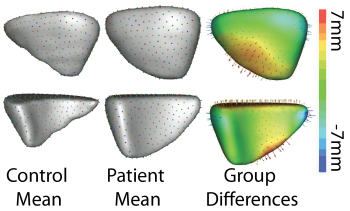
Introduction: The right ventricle (RV) and tricuspid valve (TV) are a complex, inextricably linked mechanical system. Tricuspid regurgitation (TR), caused by diverse disorders, leads to a single common pathway of RV volume overload and right heart failure. This process is marked by alterations in RV shape; however, the specific morphological changes resulting from TR are unknown. The goal of this study is to objectively characterize the RV shape changes of severe TR, relative to healthy controls.

Methods: RVs were segmented at end-systole and end-diastole from CINE MRI images in patients with greater than moderate TR, and healthy controls. Using the particle-based shape modeling (PSM) approach, a dense set of homologous landmarks were placed with geometric consistency on the endocardial surface of each RV, via an optimization of information-content. We then used principal component analysis (PCA) to identify the significant modes of shape variation across the population.

Results: Shape was compared between 25 patients and 6 healthy controls. The mean RV shape of TR patients demonstrated increased sphericity relative to controls, with the three most dominant modes of variation showing significant widening of the short axis of the heart, relative narrowing of the base at the RV outflow tract (RVOT), and protrusion of the anterior wall (see figure). To balance cohort numbers, a set of bootstrapped models were then run with multiple equal cohorts of TR and control patients; bootstrapped results were concordant with overall results. By PCA, shape changes based on the first three modes of variation correctly identified patient vs. control hearts 86.61% of the time at end diastole.



Conclusion: Using shape analysis, we identified regional changes in RV shape with TR. These modes of shape variation may further illuminate the mechanics of RV failure and recovery, providing potential targets for therapies including novel devices and surgical interventions.