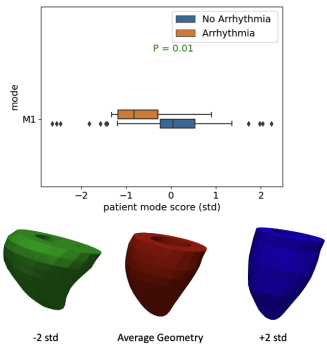
Mitral annular disjunction and arrhythmias: insights from end-systolic left ventricle shape analysis

Giulia Monopoli, Eivind Westrum Aabel, Margareth Ribe, Anna Isotta Castrini, Kristina Haugaa, Gabriel Balaban, Mary M Maleckar

Simula Research Laboratory
Oslo, Norway

Background: Mitral annular disjunction (MAD) is a structural variation of the heart valve, characterized by an abnormal separation between the posterior mitral leaflet and the atrial wall. Although it is commonly found in the general population, MAD has been linked to arrhythmic events. The anomalous curling motion of the basolateral left ventricular wall during systole is believed to contribute to the development of morphofunctional abnormalities, potentially creating an unfavorable anatomic substrate for arrhythmogenesis.
Objective: In this study, we aimed to investigate the association between MAD and arrhythmias by performing shape analysis on 3D geometries of the left ventricle (LV) at end-systole (ES). We hypothesized that the apparent abnormal curling motion, and the consequent remodeling related to severe arrhythmias in MAD patients, would be detectable via bulk shape changes of the LV.
Methods: To construct 3D ES LV geometry models for the study, we utilized short-axis MRI scans of 78 patients from Oslo University Hospital, using a pipeline previously published. To determine variations in LV shape among patients, we conducted a principal component analysis. Next, we performed a statistical analysis to identify differences between patients with and without a history of arrhythmia.
Results: Significant shape changes, including evidence of curling motion in the 3D geometries, were observed during the ES phase in the first mode of variation between MAD patients with and without a history of arrhythmia. These findings were supported by comparing the average mesh with those generated at ±2 standard deviations.



Conclusions: Our study links morphofunctional abnormalities in MAD with increased vulnerability to arrhythmia, as shown by a significant association between curling of the LV at ES and a history of arrhythmia in MAD patients. Our findings open avenues for future research using automated shape analyses to detect patient vulnerability and improve early intervention.