Statistical Shape Models
Changing Clinical Practice in Cardiac Arrhythmia Management

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In partnership with the Comprehensive Arrhythmia Research and Management Center, the Center for Integrative Biomedical Computing has pioneered the use of statistical shape modeling to quantify morphological changes in the heart for patients with atrial fibrillation, a disease that significantly increases morbidity and mortality in millions of people and incurs billions in healthcare costs annually. Our results suggest that shape-based metrics can inform the management of atrial fibrillation in the clinic by helping the doctor judge whether a patient may or may not be a good candidate for radiofrequency ablation and helping estimate risk of clot formation in the heart.

We model the shape of the left atrium of patients using ShapeWorks

1. A dissection of the left atrium (LA), showing left and right superior/inferior pulmonary veins (LSPV, RSPV, LIPV, RIPV), the left-atrial appendage (LAA) opening, and the mitral valve (MV)

2. Volumetric segmentations of the left atrium and its structures (b) are derived from Cardiac MRI (a) using Seg3D

3. Shape models are computed from LA segmentations of hundreds of atrial fibrillation patients and normal controls

Our models reveal significant morphological changes in sick hearts

The severity of atrial fibrillation is characterized by statistically significant differences in left-atrial shape (p<0.0001)

A characteristic anterior-posterior (AP) dilation is seen in atrial fibrillation and is more pronounced in sicker patients

Two modes of shape variation in the left-atrial appendage (LAA) are associated with spontaneous echo contrast (SEC) in transesophageal echo (p<0.01), a risk factor for clot formation and stroke

We are translating these results into clinical practice

A weighted combination of left-atrial shape parameters (LASSO technique) forms a powerful index for prediction of the recurrence of arrhythmia (BLUE) after radiofrequency catheter ablation (Harrell’s C-statistic = 0.78). Patients with a lower shape score may therefore be better candidates this procedure.

A Cox proportional hazards model illustrates four distinct shape classes. Patients in shape Class 1 and 2 have a significantly higher failure rate for radiofrequency ablation.

Selected References


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