Influence of the Right Atrium for Arrhythmia Vulnerability: Geometry Inference Using a Statistical Shape Model

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Background

Personalized computer models incorporate clinical data to simulate arrhythmia mechanisms in a patient-specific manner with the potential to guide therapy planning. The geometry can be obtained from magnetic resonance images (MRI) and other imaging techniques as well as from electro-anatomical mapping system (EAMS). However, the availability of clinical data can be limited and, in some cases, only information from the left atrium (LA) is available. Such single chamber models would neglect the influence of the right atrium (RA) on the initiation and maintenance of the arrhythmia. In this context, statistical shape models (SSM) can be a way to infer a bi-atrial geometry when only mono-atrial data are available.

Objective

Compare the differences in arrhythmia vulnerability under 4 different LA and RA combinations: A) Bi-atrial geometry from MRI, B) Bi-atrial model where both LA and RA were used to fit the SSM, C) Bi-atrial model where only the LA was used to fit the SSM, D) Mono-atrial LA model from MRI.

Methods

Data were collected from 6 healthy volunteers and 2 AF patients. For each patient, the bi-atrial MRI model was defined as the reference scenario (A). First, the bi-atrial MRI geometry was used to fit a bi-atrial SSM (B) [1]. Then, an additional bi-atrial model was generated (C) in which the RA geometry was inferred from the population-level statistical distribution based purely on patient-specific LA information. The last case (D) was composed of just LA MRI data. Fiber orientation and anatomical regions were annotated [2] and the Pacing at the End of the Effective Refractory Period (PEERP) protocol [3] was used to test arrhythmia inducibility in all model variants by pacing from a set of evenly distributed points covering the epicardial surface. To simulate monodomain simulations conducted with openCARP [4]. Finally, the number of inducing points, the complexity of the arrhythmia and the areas prone to maintain micro-reentries were compared between the four geometrical instances.

Discussion

When assessing vulnerability in a LA-only model, some rotors may not be sustained due the reduced area. Therefore, we inferred the RA and generated a bi-atrial model to overcome this limitation. This approach could be considered as well when only LA-EAMS data are available.

References

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