Statistical Model of Catheter Ablation Targets for Treatment of Paroxysmal Atrial Fibrillation

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INTRODUCTION Cardiac arrhythmia due to atrial fibrillation (AFib) is commonly treated by catheter ablation when anti-arrhythmic medications only are ineffective. Pulmonary vein isolation (PVI) is a dedicated catheter-based treatment for paroxysmal AFib, which involves the creation of circumferential lesions around the pulmonary vein (PV) ostia [1]. We developed a left atrial probability map for catheter ablation of paroxysmal AFib. The proposed model is based on intra-procedural ablation target data from fifteen patients with AFib, which aims to facilitate the following:

1) to select the region of interest for pencil beam wall thickness imaging with MRI [2],
2) to distinguish necrotic tissue due to ablation from fibrotic tissue due to AFib,
3) to enable patient-specific ablation strategy planning and annotation,
4) to study variations in ablation patterns between different centers, and
5) to help drive automated robot-assisted ablation procedures [3].

METHODS First, ablation targets from all patient specific electro-anatomical meshes were mapped and projected to a left atrial mean model mesh, which served as a reference model. This was achieved using landmark registration (LM), iterative closest points (ICP) rigid registration, and non-rigid transformation. Ablation target locations related to the patient-specific meshes were transformed along with these meshes. Second, a probability density map for PVI lesion sets was deduced from the projected ablation target density. Due to the uncertainty in localization of catheter position as well as the errors introduced by the ablation target mapping steps, the deduced probability distribution is propagated by convolution with a 3D Gaussian kernel. Then, the smoothed probability density function is visualized on the left atrial mean reference mesh as a color encoded lesion map as shown in Figure 1.

RESULTS The resulting probability distribution shows PVI contours around PV ostia as recommended for paroxysmal AFib treatment [1]. The right inferior pulmonary vein (RIPV) shows a lower overall ablation probability than the other PVs.

DISCUSSION The ablation target probability density model for the left atrium has the potential to guide successful ablation strategies and reveal differences in ablation patterns between treatment centers or even individual physicians. The lower overall ablation probability around the RIPV may be due to the difficulty in accessing the RIPV by the catheter from the RA through the atrial septum.

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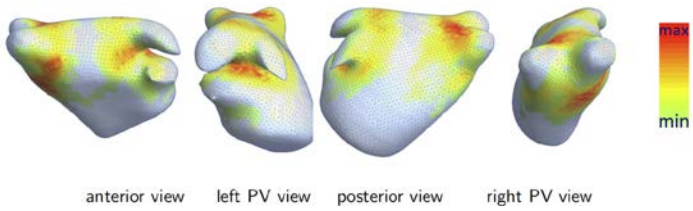

Figure 1. Probability distributions projected on the left atrial mean mesh