Developing an Iterative Tracking Algorithm to Guide a Catheter Towards Atrial Fibrillation Rotor Sources in Simulated Fibrotic Tissue

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Abstract: Locating atrial fibrillation (AF) rotor sources can help target ablation therapy for AF, but how to use the information provided by multi-polar diagnostic catheters to locate AF sources remains unclear. Our aim was to develop a catheter tracking algorithm to locate AF focal and rotor sources using a conventional 20-electrode circular catheter. We simulated rotor-driven arrhythmias in a 10cm x 10cm fibrotic human atrial tissue with single and double rotor cases using Nygren *et al.* ionic model with collagenous septa (average length 2.5 mm) characteristic of fibrosis. The rotor meandering path was a circuit line approximately 1.5 cm long through the center of the tissue. We modeled a Lasso catheter (Biosense Webster, Diamond Bar, CA) to obtain 10 bipolar electrograms. We have designed a new iterative catheter tracking algorithm, which guided the catheter to locate a rotor source on the atrial tissue. Sequential temporal activations around the circular catheter were tagged as a cycle, and cycle length (CL), total conduction delay (TCD, sum of conduction delays) and first activated bipole were identified. At every catheter placement, the algorithm located a rotor source if the rotor criterion of TCD/CL≥0.6 was met at two locations with less than 1cm apart. If not, it provided the location of the next catheter placement. This iterative process was repeated until a rotor source was located. We repeated the algorithm for 114,921 different initial catheter positions. The algorithm detected a rotor in all cases with a success rate of greater than 94% independently of the initial position of the catheter with an accuracy of 1.18±1.12 and 1.36±1.17 in single and double rotor cases, respectively. The developed algorithm successfully guided a Lasso catheter towards the center of a rotor on fibrotic tissue using only the electrograms and may allow for customized and improved AF ablation.

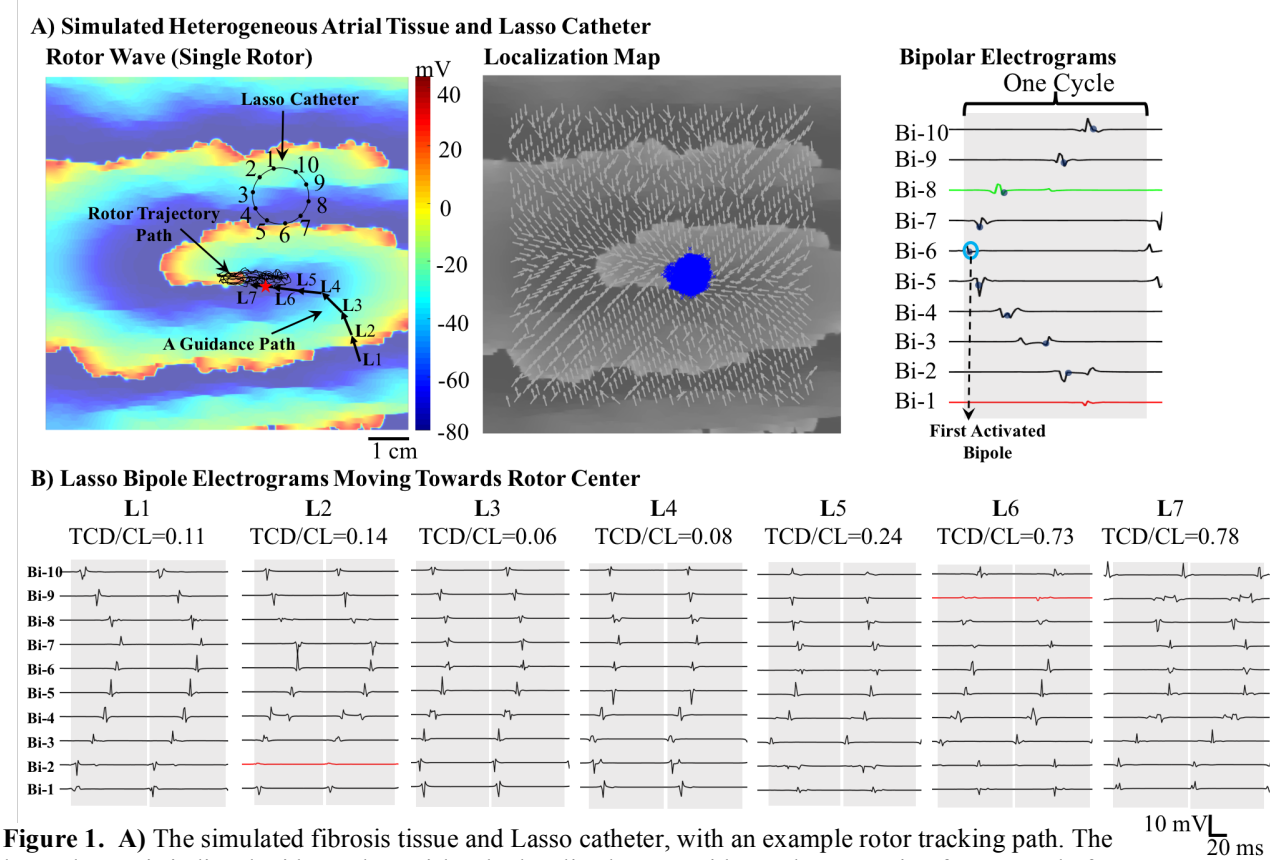

Figure 1. A) The simulated fibrosis tissue and Lasso catheter, with an example rotor tracking path. The located rotor is indicted with a red asterisk. The localized rotors with a catheter starting from a total of 114,921 uniformly spaced initial positions are shown with "x". The gray arrows show the guidance direction at every 25mm Lasso placements. **B)** Lasso bipole electrograms along L1-L7 tracking path. The Red traces indicate low voltage electrograms. Vertical grey bands indicate arrhythmia cycles.