Directed Network Mapping Hints the Ablation Strategy for Atrial Flutter: a Proof of Concept

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Background

Atrial flutter (AFL) is typically characterized by electrical activity propagating around specific anatomical regions and it is usually treated with catheter ablation. In this study, we modeled the electrical propagation pattern of AFL using directed network mapping (DNM). DNM is a recent method that makes use of network theory (NT) to characterize the electrical propagation [1, 2], such as the identification of cycles and focal points. The network is composed by nodes and edges resembling electrodes located across the atrial surface and the direction of the electrical propagation from one electrode to another.

Objective

The aim of the study was to verify whether DNM can recommend an ablation strategy to stop the mechanism generating AFL.

Methods

To test the algorithm, we set up a computational scenario based on a simulated AFL around the mitral valve in counterclockwise direction, as implemented in a previous work [3]. Electrograms and 3D anatomy were used in the DNM algorithm to build the network N. Then, electrical cycles were detected using a standard network search algorithm. In order to recommend ablation lines in an automatic fashion we proceeded as follows. First, a second network A, based on the Voronoi tessellation, was built on top of N in such a way that the edges connecting the nodes of A would cross the edges of N (thus resembling an ablation line capable of interrupting the electrical propagation between two connected electrodes). A list of all possible ablation lines from the network A was built using an implementation of the shortest path algorithm. Then, among these, we determined those capable, by themselves, of stopping the electrical cycles (and possibly the AFL).

Results

We identified all the ablation lines capable of interrupting, at the same time, every cycle detected in N. An example is in Figure 1.

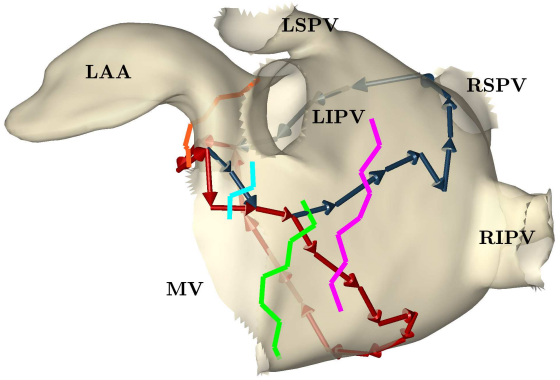

Figure 1: 3D model of the left atrium along with the detected cycles (red and blue arrows) and ablation lines (magenta, green, cyan and orange).

Discussion

We proposed a proof-of-concept algorithm, based on DNM, to automatically recommend ablation lines for the treatment of AFL.

References

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