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Simulation Prediction of Optimal Targets for Catheter Ablation of Left Atrial Flutter in Patients with Atrial Structural Remodeling

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Technology description

Unmet Need

Left atrial flutter (LAFL) is a common atrial arrhythmia that develops in up to 31% of patients who had prior cardiac surgery or atrial fibrillation ablation. LAFL is caused by the presence of a reentrant circuit, which occurs when an electrical impulse continues to propagate and re-excite cardiac tissue, leading to uncoordinated, repeated contractions in the left atrium (arrhythmia). The reentrant circuit is typically located near areas with ablation lesions, fibrosis, or scarring. LAFL must be carefully managed because it raises patients? risk of thromboembolic events, and recurs frequently after cardioversion. Since LAFL is difficult to manage with standard arrhythmia treatments such as antiarrhythmic drugs or rate control therapy, the preferred treatment is catheter ablation to render the tissue responsible for sustaining LAFL non-conductive, thus cutting off the electrical circuit. However, success rates are suboptimal because it is difficult to pinpoint the optimum sites for ablation. Current procedures rely on electro-anatomical mapping to locate the reentrant circuit and ablation sites, but it is invasive, cumbersome, and time-consuming. Other strategies to determine LAFL ablation targets include entrainment and activation mapping during invasive clinical electrophysiologic studies, but these options are tedious, time-consuming, and can require hundreds of distinct acquisition points or be technically challenging when there are multiple circuits. The limitations of these treatment strategies result in long procedural times, which may increase complication rates and radiation exposure. Thus, there is need to develop a novel strategy for minimally invasive and efficient identification of the optimal LAFL ablation targets.

Technology Description

This method, non-invasively determining the optimal LAFL ablation sites, uses images obtained through late gadolinium enhancement magnetic resonance imaging (LGE-MRI), which is commonly used in clinical settings to quantify the extent of atrial structural remodeling (i.e. atrial fibrosis, lesions, scarring) in patients. Using the LGE-MRI images, 3D personalized computational models are constructed that represent the patient?s unique distribution of atrial structural remodeling. These models allow in silico simulations of LAFL and visualization of electrical propagation as a flow network, which enables the location of the critical isthmus (region of slow-conduction tissue in the reentrant circuit) to be established and pinpoints the optimal ablation sites that will stop LAFL.

Compared to existing invasive methods of locating ablation sites, this non-invasive method is safer and has lower complication rates. In current methods, the operation is semi-blind, so the surgeon may make more ablation lesions than necessary to ensure that the reentrant circuit has been broken, which increases scarring on patients? cardiac tissue. Instead, this method enables efficient determination of the most critical ablation site(s), relying on a principle known as ?minimum cut? to break the reentrant circuit with the least possible number of ablation lesions. Consequently, this method significantly reduces the scarring and invasiveness of the procedure, pinpoints the sites with much higher accuracy, and improves surgical efficiency.

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