Magnetocardiography Imaging Based on Epicardial Sources for Mapping the Drivers of Atrial Fibrillation

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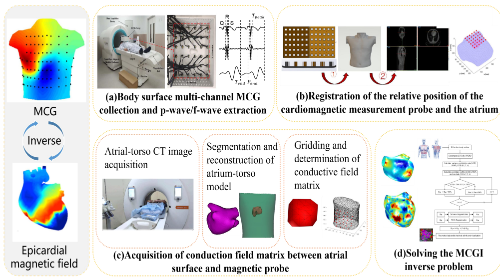
Non-invasive, non-contact, and radiation-free body surface Magnetocardiography (MCG) exhibits greater sensitivity to temporal and spatial variances in cardiac electromagnetic behavior compared to conventional ECG signals. Thus, research into MCG Imaging (MCGI) holds the theoretical potential to reconstruct the epicardial electromagnetic activity with higher spatial resolution. No previous studies treated the heart as an epicardial source in MCGI. This study aims to investigate the reliability of MCGI in mapping atrial fibrillation (AF) drivers.

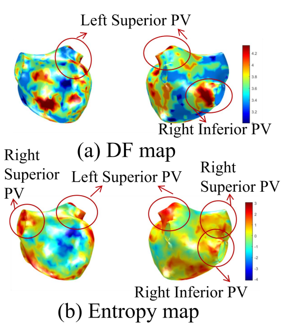


The whole research flow

The inverse problem in MCGI can be described as

$$X = L^{-1}B$$

Among them, B is the measured magnetic field, L is the forward conduction field matrix, and X is the epicardial electromagnetic activity to be reconstructed. In this study, P waves or f waves are isolated from MCG signals. The atrium-probe conduction field matrix is then generated using the boundary element method. The ill-conditioned inverse problem is tackled through a multi-scale time-frequency domain regularization scheme. Finally, post-processing of epicardial electromagnetic activity generates the dominant frequency (DF) and entropy maps.



Mapping AF drivers via MCGI: Illustrative Results

Results reveal abnormalities in left and right pulmonary veins (PV) visible in DF and entropy maps. This finding aligns with the clinical hypothesis suggesting that the PV serves as high-risk locations for the AF drivers. The study suggests initial potential for MCGI using epicardial sources in AF driver mapping.