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Direct Validation Electrocardiography Imaging (ECGi) by Epicardial Contact Mapping during VT Ablation

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Introduction: ECGI uses body surface electrical data to calculate epicardial unipolar electrograms which are displayed on the epicardial surface of the heart. This gives insight into the electrophysiological substrate customarily available only with invasive contact electroanatomical mapping (EAM). ECGI offers the potential to rapidly elucidate exit sites for unstable ventricular arrhythmias and provide information on potentially arrhythmogenic substrate. Invasive validation of the system is limited in humans. Studies have shown good correlation between electrogram morphology, and pacing sites. However, validation of the system in the intact human heart during physiological conditions is lacking. We present the first real world invasive validation of the most recent iteration of the system in the intact human heart.

Methods: Six patients undergoing epicardial catheter ablation of ventricular tachycardia (VT) were studied. An EAM (Carto, Biosense-Webster, CA, USA) of the epicardial surface of the heart was created during RV pacing and an aortic geometry was created. Pacing was performed from multiple locations on the epicardium.

A 252-body surface electrode vest was in situ during the procedure, allowing for simultaneous recording of electrical data. ECGi maps were formed during creation of the contact map and during pacing from different anatomical locations. Offline analysis included co-registration of the geometries using the aorta and comparison of unipolar electrograms between the different mapping systems. Those <8mm apart on each system were paired for analysis. Morphology match of the unipolar electrograms was assessed, along with local activation time (QRS dV/dtmin) and repolarisation time (T wave dV/dtmax). The site of earliest activation on ECGI was compared to the location of the catheter on Carto for the different pacing points.

Results: Correlation co-efficient for activation times was 0.70 ± 0.34 and repolarisation time 0.60 ± 0.31. The overall QRS morphology correlation was lower at 0.65 ± 0.32. These correlations were significantly higher (p= <0.05) when no low pass filter was used on the body surface unipolar electrograms. A total of 28 pacing sites with S-QRS interval lower than 30 ms were analysed. The average distance of the pacing point on Carto to the area of earliest activation on ECGI was 18.7 ± 14.5 mm. Pacing sites with a long S-QRS (>30msec) had a significantly higher distance to earliest area of activation (p= <0.05).

Conclusion: This first study in the intact human heart demonstrates that ECGi offers a reliable non-invasive strategy for assessing activation and repolarisation times of the cardiac epicardium. It can locate sites of early activation with an accuracy of 18.7mm. This data would have potential use for locating regions of interest during haemodynamically non-tolerated ventricular arrhythmias and for non-invasive assessment of arrhythmogenic substrate.

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