The effects of electrode configuration on omnipolar signals: An in-silico approach

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Atrial Fibrillation (AF) is one of the most common cardiac arrhythmias, involving pathological triggers and substrate in the atria. In the clinical catheter lab, the contact electrogram is an essential tool to characterise AF. Omnipolar signals (OS), derived from three or more adjacent electrodes are thought to be superior compared to traditional unipolar and bipolar electrogram signals by correcting for wavefront incidence angle and eliminating far-field effects. However, OSs are yet to be fully characterised and may be influenced by electrode configurations.

We sought to understand the changes in OS morphology under different electrode configurations using 2D simulation of healthy tissue and scarred tissue. Virtual unipolar signals were generated from a 4x4 grid of electrodes which were used to predict the electric field and subsequently calculate OSs in cliques of 3, 4 and 6 electrodes.

Example OS morphologies are shown in Figure 1, for different electrode spacings. A set of five feature points (onset, offset, minimum, Peak 1 and Peak 2) were identified on each OS to measure changes in morphology under different electrode configurations. All time intervals between feature points, except between the first peak and the minimum, increased with interelectrode distance. The voltage at the feature points increases except minimum point and amplitude. The number of electrodes in a clique influences the OS morphology. Amplitude and duration between peak 1 and the minimum point did not increase, whilst the other intervals between the feature points and the voltage at the feature point did show an increasing trend. The OS of scar tissue takes more time to repolarise compared to the healthy tissue.

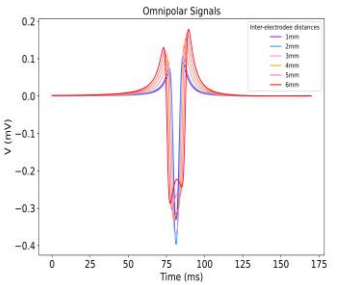

Figure 1. Omnipolar signals collected from inter-electrode distance between 1mm and 6mm.

The appropriate OS was obtained via interelectrode distances between 2mm and 3mm using either 3 or 4 electrodes in a clique. The pattern of OS is influenced by the conductivity of the tissue and electrode configurations.