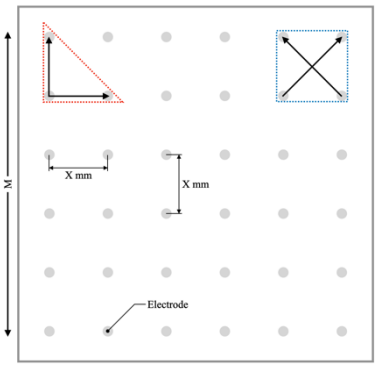
Novel method for Orientation-Independent Analysis in Equi-Spaced Multi-Electrode Arrays

Izan Segarra[1], Samuel Ruiperez-Campillo[1,2,3], Francisco Castells[1], Jose Millet[1]

ITACA Institute at Universitat Politecnica de Valencia; Stanford University; UC Berkeley.



Introduction: Novel multi-electrode catheters, such as Abbot HD Grid with equidistant spacing between the electrodes, have emerged in recent years. Their arrangement provides a more accurate mapping and visualisation of the heart tissue. These systems typically use unipolar signals, sensitive to low-frequency noise, and bipolar signals - highly dependent on the direction of propagation. Thus, the full potential of these new devices is not fully exploited. We propose a new configuration to compute omnipolar signals to take full advantage of novel multi-electrode catheters.

Methods: The current 3-electrode clique technique has an important limitation: the centre of the signal obtained does not correspond to the centre of the area comprised by the four electrodes – being one overused. A new configuration (the cross-clique) is proposed for calculating the electrogram to improve the robustness and reduce the errors in the estimation of parameters such as the local activation time (LAT). 1000 simulations implemented with a synthetic signal that emulates flat wave and homogeneous propagation over cardiac tissue. The methods used to calculate the signal with the proposed shape are: obtaining the bipoles, 45 degree correction of the signal, detection of the propagation angle, rotation of the detected angle and estimation of the LAT.

Results: The results obtained show the improvement of the proposed method. We highlight the average amplitude increasing from the old configuration: 600.36 ± 116.40 mV; to our cross-clique: 840.47 ± 160.09 mV. As for the local activation time, a significant improvement in the estimation error is observed: 22.75 ± 29.426 μs, in contrast with 207.50 ± 256.91 μs in the triangular one.

Conclusions: Our novel configuration considerably reduces the LAT estimation error and, on average, captures a larger signal amplitude than the classic triangular clique method. Thus, it allows using the full potential of new catheters, improving the omnipolar analysis.