Improved methods for processing optical mapping signals from human left ventricular tissues at baseline and following adrenergic stimulation

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Background: Optical mapping (OM) is a fluorescent imaging technique that allows ex vivo measurement of electrophysiological signals at high spatio-temporal resolution. The signal-to-roise ratio of OM recordings is, however, commonly very low, which requires heavy processing to extract relevant information. A variety of software options have been proposed, being ElectroMap the most advanced tool currently available. In this study, improved methods are presented for processing OM recordings of cardiac transmembrane voltage.

Materials and Methods: A software called OMap was developed that incorporates novel techniques into ElectroMap for improved baseline drift removal, spatio-temporal filtering and characterization of action potential duration (APD) maps. The performances of OMap and ElectroMap were compared over synthetically generated signals contaminated with baseline wander, white noise and the combination of both. Both software were applied to assess the effects of β-adrenergic stimulation in human ventricular tissue specimens.

Results: In synthetic signals, absolute errors in APD between noisy and clean signals were remarkably lower for OMap than ElectroMap, particularly for high noise levels. When adding both baseline wander and white noise, OMap showed errors (median [Q1-Q3]) between 10.1 [7.3-12.5] ms for low noise levels and 15.7 [12.5-19.7] ms for high noise levels. Corresponding errors in ElectroMap were 60.9 [13.0-192.9] ms and 144.5 [41.2-215.2] ms. In OM signals, OMap allowed to characterize the APD shortening effect induced by β-adrenergic stimulation, whereas ElectroMap rendered highly overlapped APD distributions for baseline and β-adrenergic stimulation (see figure).

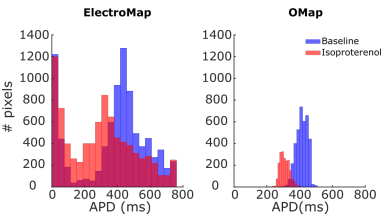

Figure 1 - APD histograms, before (blue) and after (red) isoproterenol administration.

Conclusion: Improved methods are proposed and tested to characterize human ventricular electrophysiology from noisy OM recordings.