A Computational Investigation into Rate-Dependant Vectorcardiogram Changes due to Specific Fibrosis Patterns in Non-Ischæmic Dilated Cardiomyopathy

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Aims: Patients with scar-associated fibrotic tissue remodelling are at greater risk of ventricular arrhythmic events, but current methods to detect the presence of such remodelling require invasive procedures. We present here a potential method to detect the presence, location and dimensions of scar using pacing-dependent changes in the vectorcardiogram (VCG), which traces the net electrical dipole generated by the electrical activity of the heart.

Methods: Using a clinically-derived whole-torso computational model, simulations were conducted at both slow and rapid pacing for a variety of scar patterns within the myocardium, exploring a range of sizes and positions of scar. Various VCG-derived metrics were calculated, with rate-dependent changes in these metrics being assessed for their ability to discern the presence, size and location of scar.

Results: Our results indicate that differences in the dipole angle at the end of the QRS complex, and differences in the QRS area and duration, may be used to predict scar properties. Using machine learning techniques, we were also able to predict the location of the scar to high accuracy, using only these VCG-derived rate-dependent changes as input.

Conclusions: The use of VCG-derived metrics would provide a non-invasive functional predictive tool for the presence of scar, representing a potentially useful clinical tool for identifying patients at arrhythmic risk.