The Effect of Left Ventricular Scar Location on Simulated Electrocardiograms

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As a routine standard-of-care test, an electrocardiogram (ECG) provides primary indicators of pathology. This study aims to assess the effect of scar location on ECG morphology.

The left ventricle of an anatomically accurate biventricular tetrahedral mesh was divided into 17 segments according to the American Heart Association (AHA). The myocardial wall was divided into endocardium, mid-myocardium and epicardium, each layer taking up 33% of the wall thickness. In addition, an endocardial layer (up to 80% of the endocardium) was determined in both ventricles to act as a surrogate for the Purkinje network. Sequentially, each of the 17 regions and their three transmural layers were set as non-conductive to mimic myocardial scar except for the apex. The biventricular mesh was inserted inside a torso, and the 12-lead ECGs were simulated for each scenario. A reference ECG was obtained from a mesh with all 17 AHA segments being set as conductive for comparison.

Each region being tested for 4 scar cases (endocardium, mid-myocardium, epicardium and whole wall) show fluctuation in the shape of the QRS with smaller peaks compared to the reference no scar ECG and most affected were scars in the mid-myocardium or in the whole cardiac wall (Figure1). Normalized cross-correlation shows that endocardial and epicardial scar ECGs are most similar to the no-scar ECG, while mid-myocardial and fully transmural scars are the least similar across all leads. ECGs of scars in mid-inferior, apical-inferior, mid-lateral and apico-lateral segments (10,11,15 and 16) correlate the least with the no scar simulation.

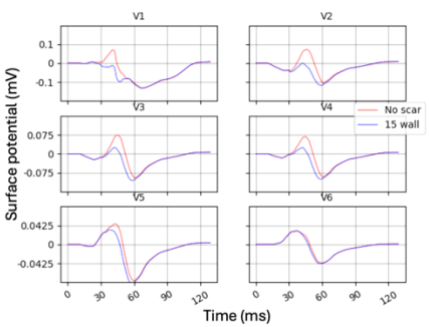

Figure 1: ECG comparison of no scar and transmural scar in segment15

Our approach helps link ECG morphology to scar location and depth: transmural and mid-myocardial scars visibly alter the ECG, while small scars in most regions have minimal impact. Moreover, by varying the scar location, size and number this could help in creating an atlas map for scar effects.