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NOVEL NON INVASIVE DETECTION OF ARRHYTHMIA SUBSTRATE USING SUPPORT VECTOR MACHINE LEARNING

J A Rosengarten,[1] S M Dima,[2] C Panagiotou,[2] P A Scott,[1] K H O Chui,[3] E B Mazomenos,[2] K Maharatna,[2] N P Curzen,[1] J M Morgan[1] *[1]University Hospital Southampton NHS Foundation Trust; [2]School of Electronics and Computer Science, University of Southampton; [3]Faculty of Medicine, University of Southampton*

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Introduction Myocardial scar burden, quantified by MRI, predicts ventricular arrhythmogenesis. MRI use is resource and cost limited in contrast to conventional 12 lead ECG. Manual assessment of ECG time domain features lacks specificity for scar. We hypothesise that frequency and phase domain ECG analysis could yield data indicative of myocardial scar burden. A supervised learning method (support vector machine, SVM) was used to develop a novel computerised algorithm capable of screening ECGs for the presence of myocardial scar, so allowing large data volumes to be processed.

Methods 153 consecutive adult patients (age 63±12, male 65%), attending for cardiac MRI with scar analysis for clinical reasons were recruited, and underwent digital ECG acquisition (500Hz, 18bit) at the time of scanning. Semi automated quantification of late gadolinium contrast enhancement was used to identify myocardial scar. The ECGs from those with no scar were used to construct a median template beat for each of the standard 12 leads. ECGs from 35 patients with scar and 35 with no scar were used to train the SVM by feature comparison with the median beat. The algorithm was then tested on the remaining 83 ECGs.

Results 16 comparative parameters were included: cross correlation, covariance, magnitude and phase of wavelet coherence, mean value, median value, variance, SD, inter-quartile range, skewness, kurtosis, mobility and complexity of the power spectrum, Hurst exponent slope, detrended fluctuation factor, and differential entropy.

Clinical and ECG characteristics in those with scar (age 64±11, LVEF 56±17%, QRS width 115±22 ms) and no scar (age 61±13, LVEF 60±19, QRS width 110±18 ms) were similar (p=NS). The test set consisted of ECGs from 72 patients with scar and 11 patients with no scar. SVM was able to classify the test ECGs with 80.6% sensitivity and 72.7% specificity.

Conclusions Digital ECG analysis of frequency and phase signals, using a newly developed SVM, characterises features which classify myocardial scar, but our observations require confirmation in larger prospective studies. The sensitivity and specificity of this approach could make it valuable in population screening for more costly complex investigations such as MRI scanning.