AN EXPERIMENTAL MODEL TO VALIDATE ELECTROCARDIOGRAPHIC INVERSE ALGORITHMS
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We present the development of an in-vivo experimental framework to validate inverse algorithms of electrocardiology and, in particular, a recently published activation inverse algorithm (2). This algorithm is based on determining the underlying cardiac activation sequence rather than in terms of epicardial potentials. The validation framework is based on concurrently recording body surface and epicardial potentials in the anaesthetised pig. The measured activation sequence in the heart can then be compared to the predicted activation sequence from the inverse algorithm applied to the recorded body surface signals using a computational model of the pig torso.

To obtain a computational model of the pig torso a pig was placed in a computed tomography (CT) scanner. The surface of the endocardium, epicardium, right and left lung and muscle and skin surfaces were then digitised from the CT images. A three-dimensional torso model was then constructed by fitting a high-order \( C^1 \) continuous mesh based on cubic Hermite elements to the data using a non-linear fitting procedure (1). This model can be further customised to tailor the mesh to the individual porcine anatomy used in the individual experiments.

To concurrently record the electrocardiographic potentials young domestic pigs were anaesthetised, artificially ventilated and thoracotomised. An elasticated electrode sock containing 127 electrodes (with an inter-electrode spacing of ca. 7 mm) was then placed over the epicardium in a known orientation. The chest was re-closed and an elasticated vest containing 256 electrodes (with an inter-electrode spacing of ca. 15 mm) was fitted. Simultaneous body surface and epicardial potentials were then recorded at a 2 kHz sampling rate.

In order to test the performance of the inverse algorithms in a variety of conditions a number of patho-physiological cases are investigated. These cases include (i) epicardial pacing; (ii) regional ventricular ischaemia and (iii) global hyperkalaemia. The results presented illustrate the various procedures involved in the validation study and show some preliminary inverse reconstructions. An example of a simulated inverse result is shown in Figure 1. As can be seen the inverse results from the simulation are close to the goal activation sequence even in the presence of a large amount of noise.


This work was funded by the Wellcome Trust and the British Heart Foundation. Experiments were performed under British Home Office Project Licence PPL 30/1133.