ECG Imaging Ventricular Ischemia Using Torso Electrodes: A Computational Study

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Introduction: Ventricular arrhythmia although not the most common arrhythmia is very lethal and can lead to sudden death. Myocardium ischemia is linked with lethal ventricular arrhythmias and identifying the location of the ischemia can be beneficial in both identification of the ischemic region and as a tool for assessing potential treatments. In this study, we aim to investigate how different ventricular ischemia regions affect the inverse solution. To further this we will evaluate the effect the number of electrodes used on the torso surface effects the solution, and on whether we can establish a minimum number to resolve the ischemic region.

Methods: The forward problem was used to create a body surface potential (BSP) using the ventricle containing the ischemic region. A reconstruction of the BSP from the electrode map was calculated using linear interpolation. From this new BSP, the heart surface potential (HSP) was then calculated solving the inverse problem. Three forms of Tikhonov regularisation, 0 order, 1st order, 2nd order methods were used to reconstruct the HSP using the L curve approach to pick a suitable lambda variable.

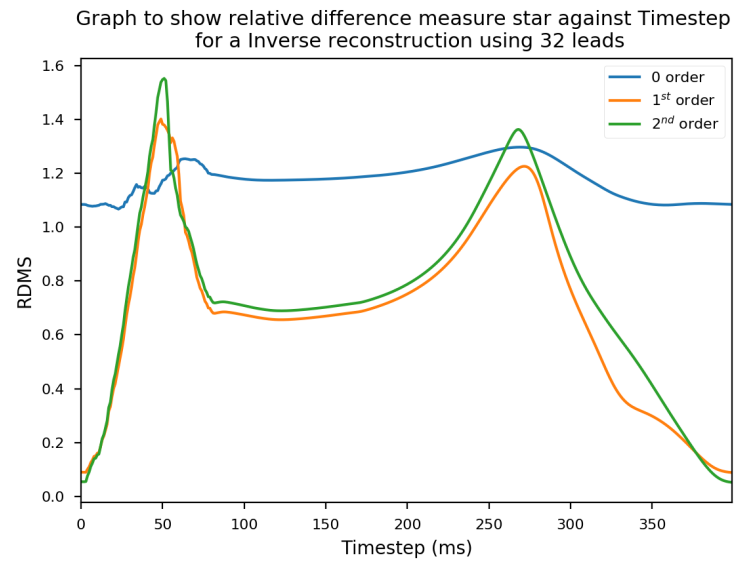

Figure 1

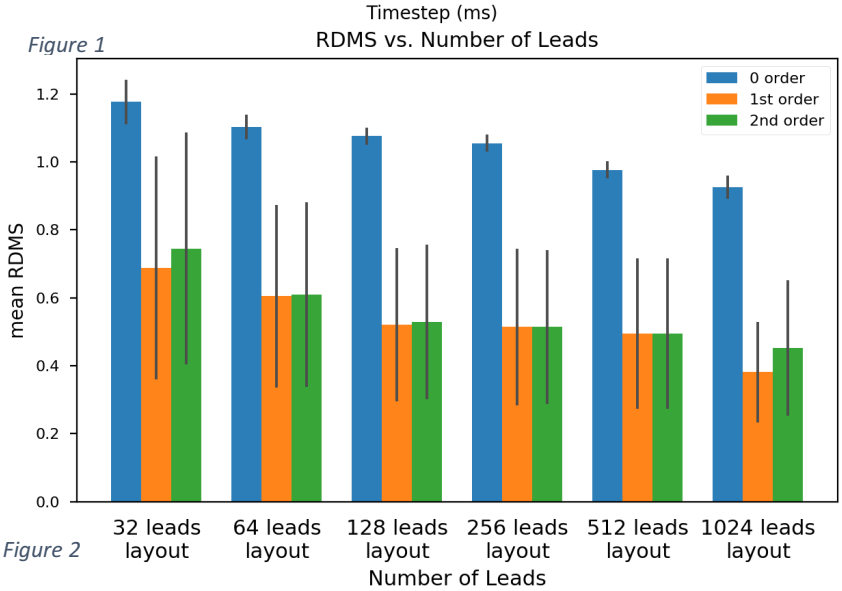

Figure 2

Results:
Figure 1 shows how the relative difference measure star (RDMS) changes over 400 ms. The 1st/ 2nd order solutions perform similarly. The RDMS error is shown to follow the spatial difference of the solution. Analysing 52 ms timestep we can reconstruct the ischemic region. From this we calculate that at least 128 electrodes are needed to resolve the region clearly. Figure 2 shows how the RDMS for each solution changes as we increase the number of electrodes, it can be seen again how the 1st and 2nd order solutions for ventricular ischemia produce similar results.