Unexpected Errors in the Electrocardiographic Forward Problem

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Introduction: The forward problems of electrocardiographic imaging are expected to achieve high levels of accuracy because they are physically well posed. However, unexpectedly high residual errors are still found between the computed and measured torso signals in experiments. A possible source of these errors is the limited spatial coverage of the cardiac sources in most experiments; most capture potentials only from the ventricles. In this study, we introduce a new metric by comparing the projected potentials from the sock and cage with each other and with respect to the measured potentials on the torso.

Methods: To resolve the relationship between spatial coverage and accuracy of the forward simulations we combined two methods of capturing cardiac potentials using a 240-electrode sock and a 256-electrode cage both surrounding a heart suspended in a 192-electrode torso tank and observed the differences. Both the sock and the cage were fixed in the tank filled with an electrolyte solution to mimic the conduction in the human torso. We analyzed beats from three pacing sites.

Results: We found that the root mean square error (RMSE) was higher for the sock, while both the spatial and temporal correlations were higher for the cage. The ventricular paced beats returned results similar to one another for each measurement. Their RMSE values ranged between 0.21 mV and 0.12 mV, while the values for the sinus were smaller, ranging between 0.13 mV and 0.05 mV. Furthermore, they both returned spatial correlations between 0.98 and 0.89 and temporal correlation between 0.99 and 0.47.

Conclusion: Our study has shown that the projections from the cage to the torso have overall better results compared to those from the sock and we suggest some possible explanations for these differences.

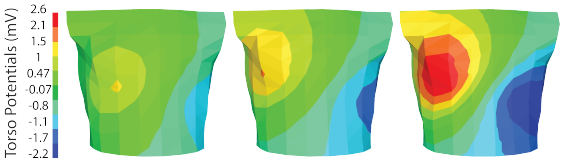

Figure 1. Reconstruction of the projected torso potentials from the sock (left), the experimentally recorded torso potentials (center), and the projected torso potentials from the cage (right).