Inverse Solution Accuracy Using 12-Lead ECG vs. 9 Significant Electrodes Derived by Greedy Algorithm

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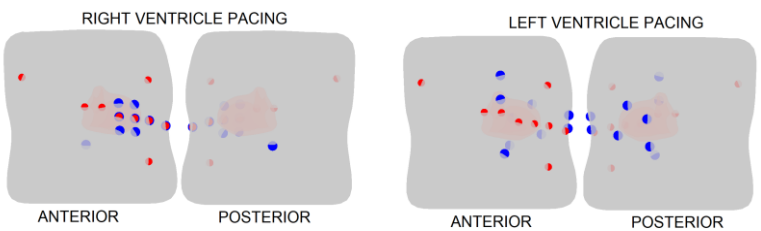
The inverse problem of electrocardiography (ECG) is solved using potential recordings from many torso electrodes. However, there is growing interest in developing methods to reduce the number of electrodes required for accurate reconstruction. In this study, the accuracy of the inverse solution was investigated using three different electrode configurations.

A total of 8 datasets from patients with pacemakers (5 right and 3 left ventricular pacing) were used (EDGAR database, EP Solutions data). The potential recordings were obtained from 196 ± 28 electrodes. The inverse problem, assuming a single dipole cardiac source, was solved using three electrode configurations: all electrodes, 9 electrodes corresponding to the 12-lead ECG, and 9 most significant electrodes selected by a greedy algorithm using the singular value decomposition of the transfer matrix for each dataset. The accuracy of the inverse solution was expressed as the localization error (LE) computed as the Euclidean distance between the pacemaker electrode and the inverse solution.

In contrast to the 12-lead ECG, the electrodes selected by the greedy algorithm were found to be localized on both the anterior and posterior torso side. The average LE computed for all 8 datasets using all torso electrodes was 26.1 ± 6.1 mm. Comparatively, the LE obtained using 9 electrodes corresponding to the 12-lead ECG was 40.5 ± 23.1 mm, while using 9 electrodes selected by the greedy algorithm resulted in a LE of 29.6 ± 14.0 mm.

The results of this study indicate that while using all torso electrodes yielded the lowest average LE, the use of a greedy algorithm for electrode selection in the inverse problem resulted in more accurate localization compared to the 12-lead ECG. This suggests that optimizing electrode positions has the potential to reduce the number of electrodes while maintaining the accuracy of the inverse solution.



The 9 electrodes of the 12-lead ECG (red) and 9 significant electrodes estimated by the greedy algorithm (blue), for one case of LV and RV pacing.