Single-Layer Based Algorithms for Solving the Inverse Problem of ECG

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Introduction: Recently, the equivalent single layer (ESL) source model along with the respective regularization matrix were introduced for solving the ECG imaging (ECGI) problem with the boundary element method (BEM).

Methods: In the present work, we extend the proposed formulation by three additional ECGI methods. The first algorithm is based on the same underlying canonical boundary element equations but with the single layer derived from an alternative equation. The second extension consists in an iterative update of the two BEM equations, while alternating between the single layer source and epicardial potentials. The third solution approach results from weighting the initial ESL solution with the iterative one. We tested all four algorithms on five *in silico* and clinical datasets for ectopic ventricular excitation and qualitatively compared their performance in terms of reconstructed electrograms.

Results: All methods resulted in a distinct electrogram's morphology. The best reconstruction results in terms of ectopic localization accuracy were achieved by the initial ESL and the weighted approaches. The iterative algorithm facilitated correct classification of the excitation onset being endo- or epicardial.

Conclusions: Although employing the same ESL source model, distinct numerical formulations of the problem lead to different results enhancing distinct clinical values of interest. Furthermore, these findings suggest that an optimal combination of the ESL-based methods could provide a superior solution compared to the separate results.