Equivalent conductivity estimation improves the ECGI reconstruction

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Aims: The method of fundamental solutions (MFS) has been extensively used for the electrocardiographic imaging (ECGI) inverse problem. One of the simplifying assumptions is that the torso is homogeneous and isotropic. To refine this assumption, we introduced an equivalent conductivity coefficient in the kernel of the MFS and studied its effect on the inverse solution.

Methods: Test data were prepared with a reaction-diffusion model and three different models of the torso geometry. The first was fully homogeneous and isotropic, the second piecewise heterogeneous (lungs, liver, blood, skeletal muscles, and the remaining tissue) and isotropic, and the third model was the same as the second but the skeletal muscles were anisotropic. We simulated three cases with different stimulation sites. The effect of an equivalent conductivity of the torso on the MFS method was introduced by dividing the kernel function of the MFS by the square root of the equivalent conductivity coefficient, which could be seen as a rescaling coefficient. We then computed the ECGI inverse solution for rescaling coefficient values varying from 1 to 100, and computed the relative error (RE) and correlation coefficient CC.

Results: For each of the three torso models, we found an optimal equivalent conductivity that improved the RE and CC independently of the pacing site. For instance for LV septal pacing, the optimal coefficient improved the RE (respectively, CC) from 74% to 37% (respectively, 61% to 91%) for the homogeneous case, from 80% to 64% (respectively, 63% to 79 %) for the piece-wise constant case and from 83% to 69% (respectively, 63% to 78%) for the anisotropic case.

Conclusion: Using the MFS with an optimal equivalent conductivity value improves the quality of the ECGI inverse solution in terms of RE and CC.