Influence of respiratory-induced cardiac motion on regularization parameter selection in ECGI

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Background: The relative positions of the heart and torso is fundamental to ECGI. While acquiring these positions can be done by imaging, it will not account for the changes in heart position due to respiration during recordings. Nevertheless, there is a lack of studies examining how respiration affects parameter selection methods used to stabilize the inverse solution. The objective of this work was to assess how respiratory-induced cardiac motion may influence the performance of various parameter selection techniques *(including* L-curve, GCV, RGCV, CRESO, and U-curve).

Methods: Two types of data were used: 1) Three *in-vivo* pig datasets including body surface potential recordings during sinus rhythm and ventricular pacing, and corresponding post-mortem heart-torso geometry; and 2) Clinical data from 3 patients including body surface potentials and torso geometries during sinus rhythm. For each geometry, the transfer matrix was computed using the boundary element method. For each recording, the λ values were computed using L-curve, GCV, RGCV, CRESO, and U-curve methods for each moment of time for every recording. In addition, parameters such as the solution norm, residual norm (for a fixed lambda) were computed. The mean values over the QRS interval of each beat were taken and separated into their respective respiratory phase (top 20% inhalation or top 20% exhalation).

Results: For the pig data, the L-Curve and RGCV methods, along with the solution norm and residual norm (for a fixed $\lambda = 1$), showed significant differences across respiratory phases in the pig data. For the clinical data, significant effects were also observed for the GCV method, the solution norm, and the residual norm.

Conclusion: The results indicate that respiration may introduce measurable variations in the regularization outcome and therefore solution behavior. As such, respiration-induced heart movement may need to be taken into account for more accurate ECGI reconstructions.