Effects of Interpolation on the Inverse Problem of Electrocardiography

Y S Dogrusoz, L R Bear, J Bergquist, R Dubois, W Good, R MacLeod, A Rababah, J Stoks

Background: Electrocardiographic Imaging (ECGI) aims to reconstruct electrograms from the body surface potential measurements. "Bad leads" with poor quality signals are usually excluded before solving the inverse problem. Alternatively, interpolation can be applied. This study explores how sensitive ECGI is to different interpolation methods.

Methods: Experimental data from a Langendorff-perfused pig heart suspended in a human-shaped torso-tank was used. Epicardial electrograms were acquired during 30s (31 beats) of RV pacing using a 108-electrode array, simultaneously with torso potentials from 128 electrodes embedded in the tank surface. Six different bad lead cases (2-7) were designed based on clinical experience. The inverse problem was solved by applying Tikhonov regularization for i) bad leads removed data and ii) interpolated data. We used three different interpolation methods: inverse-distance weighting (IDW), Kriging, inverse-forward method (I-F). Reconstructed electrograms and activation times (AT) were compared to those directly recorded by the sock.

Results: IWD and I-F improved the overall mean correlation of reconstructed electrograms (CC_{EGM}) by 0.01 and 0.07 compared to removing bad leads. Kriging reduced CC_{EGM} by 0.01. I-F and IWD provided the best reconstruction of activation maps and showed similar accuracy with mean correlation (CC_{AT}) 0.09 larger than removing bad leads. Kriging also improved CC_{AT} by 0.01. There was no significant difference in localization error for all methods, providing an accuracy of approximately 2±0.1 mm. Bad lead locations also affected performance; IWD provided best interpolation for case 4 (bad leads over the chest) with only a small reduction in CC_{EGM} and improving AT results. I-F was the only interpolation to improve EGM accuracy in case 7 (combining all bad leads).

Conclusions: Interpolation improves results when removed electrodes are not over the chest. Best interpolation method depends on bad lead locations. IWD seems the most stable, but I-F can give the biggest improvement.

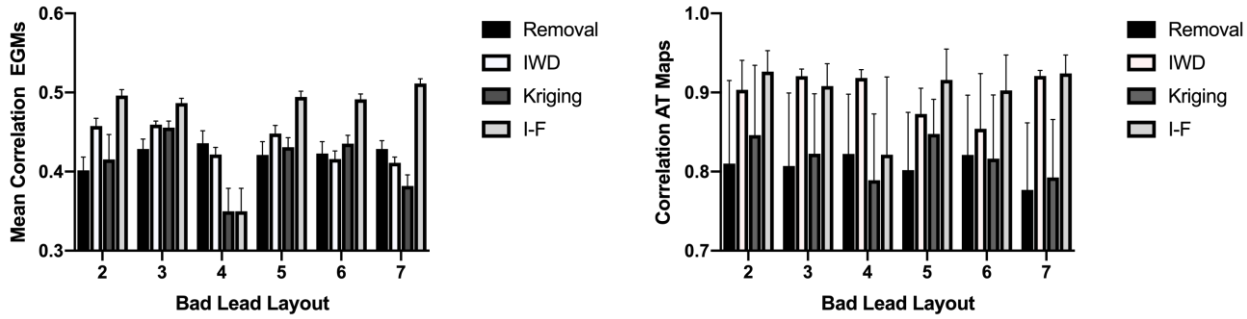

Figure 1. Mean correlation coefficient values of the reconstructed electrograms (CC_{EGM}) (left), and correlation values of the AT maps (CC_{AT}) (right) for all bad lead configurations and all methods.