Performance of iterative methods of ECGI in the atria

Jorge Vicente[1,2], Ismael Hernández-Romero[2,3], Raúl Moreno-Lopez[3], Clara Herrero-Martin[3], Maria S. Guillem[2,3] Andreu M. Climent[2,3], Judit Chamorro-Servent[1]

[1]Universitat Autònoma de Barcelona, Spain
[2]Corify Care S.L., Spain
[3]ITACA Institute, Universitat Politècnica de València, Spain

Introduction: This study aims to evaluate Electrocardiographic Imaging (ECGI) by comparing the traditional Zero Order Tikhonov regularization with three iterative methods (Landweber, ART, and RRGMRES) in the context of simulations of atrial ectopics and reentries.

Methods: For the forward problem, we employ the Boundary Element Method, constructing a transfer matrix from body surface to pericardial potentials. For regularization, this study tests Tikhonov regularization with the L-curve method against three iterative methods: Algebraic Reconstruction Technique (ART), Landweber, and Range Restricted GMRES (RRGMRES). Due to the semi-convergent nature of the iterative methods, we employ two specific stopping criteria: the Residual-Error criterion (RE) and the Discrepancy Principle (DP). The effectiveness of these computational techniques is assessed by computing the Correlation Coefficient (CC) for reconstructed electrograms and latest activation times on 5 atrial ectopics and 5 atrial reentries simulations.

Results: The CC of the estimated electrograms indicated superior performance of the iterative methods with the RE criteria compared to Tikhonov regularization. Respect to LATs, the iterative methods with the RE criteria obtain better mean results than Tikhonov regularization. However, Tikhonov regularization slightly outperformed the other methodologies for the reentry simulations.

CC of Latest Activation Times

	Ectopics	Reentries
Tikhonov	0.64 ± 0.11	0.60 ± 0.05
ART RE	0.75 ± 0.07	0.56 ± 0.08
Landweber RE	0.71 ± 0.05	0.59 ± 0.38
RRGMRES RE	0.70 ± 0.06	0.53 ± 0.06
ART DP	0.74 ± 0.07	0.25 ± 0.15
Landweber DP	0.66 ± 0.16	0.34 ± 0.13
RRGMRES DP	0.11 ± 0.01	0.15 ± 0.02

Conclusion: This work provides a preliminary study on iterative methods for atrial ectopics and atrial reentries in ECGI. The iterative methods emerged as useful inverse methods with an effective stopping criteria.