

Electrocardiographic Imaging in Atrial Fibrillation: Selection of the Optimal Tikhonov-Regularization Parameter

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Introduction. Electrocardiographic imaging (ECGI) allows evaluating the complexity of atrial fibrillation (AF) signals using the Boundary Element Method and Tikhonov regularization. An accurate ECGI reconstruction is dependent on a proper selection of the regularization parameter (λ). In this work, two ranges of λ are explored to define how the selection of λ and the studied λ range affects the quality of the ECGI reconstruction.

Methods. ECGIs of 20 AF patients were computed using zero (T0), first (T1) and second (T2) order Tikhonov regularization (TR) for two ranges of λ : from 10^{-9} to 10^2 and 10^{-12} to 10^{-4} . Dominant frequencies (DF) and rotors of the signals obtained with the two ranges and methods were compared.

Results. Zero-order Tikhonov showed to be more robust in λ selection for different λ ranges. For lower λ ranges, higher DF was found (T2, $p < 0.05$) and more rotors were detected for T1 and T2 ($p < 0.01$), Fig 2A. Differences between TR methods compared by λ ranges showed more variability in derived metrics for lower λ range ($p < 0.01$), Fig 2B.

Conclusion. Optimal ranges for λ search differ among T0, T1 and T2. Election of lower than optimal λ values result in an increased estimated electrical complexity.

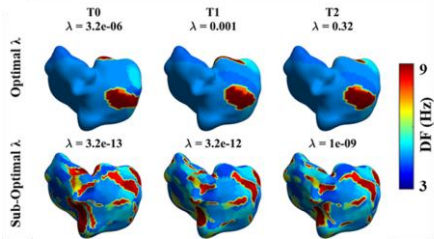


Figure 1. Dominant frequency from an AF signal obtained by Tikhonov regularization of zero, first, and second-order (T0, T1, and T2) for optimal and sub-optimal λ .

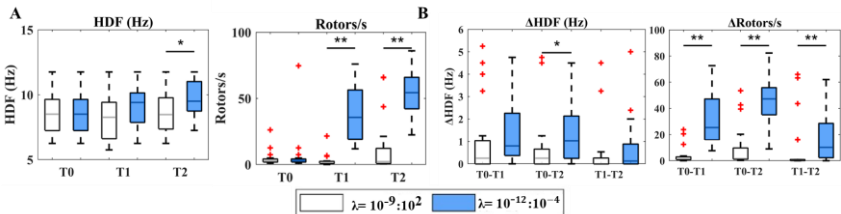


Figure 2. Comparison of ECGI metrics for each TR order for a high range of λ (white) and a low range of λ (blue). B. Comparison of the difference of ECGI derived metrics between TR orders and λ ranges.