Assessment of the effect of fibrillatory waves in the analysis of spatial heterogeneity of ventricular repolarization

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Aims: This study aimed to assess the effect the presence of f-waves may have on the $\nu$-index, an ECG-based estimator of the standard deviation of ventricular myocytes’ repolarization times ($s_\theta$), as a preliminary process for the study of Atrial Fibrillation (AF).

Methods: 12 lead ECGs were generated using synthetic T-waves and real QRS templates extracted from clinical data. The T-waves were simulated using a re-implementation of the forward ECG model creating seven 300 T-waves bundles with increasing values of $s_\theta$. The $\nu$-index ($t\nu$-index) was preliminarily compared to the values of $s_\theta$ to assess the validity of the index as a measure of repolarization times. Then, the $t\nu$-index was compared to the $\nu$-index calculated after 50 sets of real f-waves randomly extracted from AF patients were added to the ECGs ($f\nu$-index) and after the f-waves were removed ($c\nu$-index). Student’s t-test was used to ensure firstly, a significant difference (p-value $\leq 0.05$) between the $f\nu$-index and the $c\nu$-index as well as between the $f\nu$-index and the $t\nu$-index and secondly, a non-significant difference (p-value $> 0.05$) between the $c\nu$-index and the $t\nu$-index.

Results: A strong correlation ($r = 0.99$, p-value < 0.001) was shown when comparing the $t\nu$-index and $s_\theta$, validating the $\nu$-index computation method. Regarding the comparison between the $f\nu$-index, the $c\nu$-index and the $t\nu$-index: the $f\nu$-index had highly significant differences (***, p-value < 0.001) with the $c\nu$-index and significant differences (*, p-value < 0.05) with values of the $\nu$-index below 53.3 ms, while the $c\nu$-index and the $t\nu$-index had non-significant differences for the whole range of values studied.

Conclusion: During AF the T-waves get corrupted by f-waves, typical of AF, making it meaningful to implement the cancellation of f-waves when applying the $\nu$-index to ECG during AF.