P Wave Delineation using Spatially Projected Leads from Wavelet Transform Loops

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The visible P wave boundaries vary with the considered lead (view point) in spite of the atrial depolarization onset/end being a unique/global features. In [Almeida et al, IEEE TBME 56(8)] we have proposed an automatic delineation strategy for multilead (ML) location of wave boundaries which provides a unique lead independent mark. A transformed lead is obtained from VCG loops, by projecting the wavelet transform (WT) spatial loop into a direction (derived lead) that optimizes the SNR and so the delineation. Single-lead based delineation (SL) is then applied to the synthesized lead, providing unique locations for wave boundaries. The system was implemented and validated regarding QRS complex and T wave. In this work the methodology was extended to P wave boundaries. The Sensitivity (Se), mean (m) and standard deviation (s) of errors in P wave onset and end locations were evaluated over the CSE database (CSEDB, 27 annotated P waves, 12 standard and 3 Frank leads) using spatial loops defined by the Frank leads (F) and by the leads derived by inverse Dower transformation (D). Results were compared with SL over each lead available and with the global marks obtained by post-processing rules (SLR). 2-dimentional loops were also considered as subsets from F and D to quantify the performance loss. The 2D approach was applied over QT database files (QTDB, 2983 annotated P waves, 2 leads) and Se, average across files of the delineation errors mean (m) and deviation (s) were calculated. [Se%, m—s (ms)] of [100,-7.9—19.3]/[96,3.1—15.8] were obtained for onset/end, respectively, using F; [96,-2.8—11.0]/[93,5.2—8.2] using D, while SLR achieved [85,3.0—5.3]/[89,1.8—6.7]. None of the s values for SL results was, both for onset and end, lower than using D. Moreover, using just X and Y leads (2D) [100,-6.8—18.8]/[96,2.5—15.8] were obtained for F and [100,-2.1—7.4]/[100,5.9—6.9] for D. Regarding QTDB the results obtained were [94, 6.15—22.3]/[94, 4.59—17.45]: a higher Se and lower s than in any of the two leads itself with SL. Thus, we can conclude that ML strategy is appropriated for P wave delineation; D allows achieving lower s than SL result, with higher Se that SLR, and 2D loops were enough, allowing a more efficient processing when compared to SLR.