Impact of baseline drift removal on ECG beat classification and alignment

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Introduction: Accurate beat classification and alignment is fundamental to any signal averaging method. This process may be improved or hindered by any signal preprocessing used, in particular by baseline drift removal.

Methods: Experimental data came from a Langendorff-perfused pig heart suspended in a human-shaped torso tank. 108 epicardial electrograms (EGM) and 256 body surface ECG were recorded simultaneously during two 2-minute episodes of sinus rhythm (SR) and left ventricular pacing (LVP) (n=4). "Gold-standard" classification and alignment were semi-automatically obtained from EGMs. Beats were classified as "goal" (the most common QRS seen), "near-goal" (close to goal but with regional differences in EGMs) or "not-goal" (e.g. PVCs), as demonstrated in Fig. A. Six different methods of baseline drift removal (BDR) were applied to ECG ("simple", "butterworth 0.5 Hz", "wavelet", "savitzky-golay", "cubic spline" and "Beat-box"). Subsequently, 3 different signal averaging (SA) methods were used to extract "goal" QRS complexes and align them ("PCA", "Pfeiffer" and "K-means").

Results: The LVP and SR sequences were composed of a total 582 and 419 "goal", 5 and 8 "near-goal" and 7 and 15 "not-goal" QRS-complexes respectively. The F2-score was used to assess correct identification of "goal" beats by each BDR and SA method as this penalizes specificity over sensitivity (Fig B). Of note, the wavelet and savitzky-golay methods resulted in less "near goal" or "not-goal" QRS complexes being incorrectly identified as "goal", improving their F2-scores. These two BDR methods also produced smaller errors in alignment (Fig C). However, the biggest differences came from the SA method used, not the BDR.

Conclusion: Pre-processing methods had only a small impact on beat classification and alignment compared to the methods of signal averaging themselves. This does not exclude the possibility that signal processing may alter waveform morphologies, and thus the final averaged beat.