A Wavelet-Based Approach for Automatic Diagnosis of Strict Left Bundle Branch Block

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Aim: Cardiac resynchronization therapy (CRT) is widely used in heart failure patients with left bundle branch block (LBBB). However, the high false-positive rates obtained with the conventional LBBB criteria limit the effectiveness of this therapy what has yielded to the definition of a new stricter criteria in order to improve specificity. They require prolonged QRS duration, QS or rS pattern in the QRS complexes at leads V1 and V2 and the presence of mid-QRS notch/slurs in ≥2 of leads within V1, V2, V5, V6, I and aVL. The aim of this work was to develop and assess a fully-automatic algorithm for strict LBBB diagnosis in the context of the LBBB initiative promoted by the International Society of Cardiac Electrocardiology and the Telemetric and Holter Wharehose (http://thew-project.org/LBBB_Initiative.htm).

Methods: 12-lead, high-resolution, 10-second ECGs from 602 patients enrolled in the MADIT-CRT trial were available. Data were labelled for strict LBBB by 2 experts and divided into training (n=300) and validation (n=302, blind annotations to the investigators) sets for assessing algorithm performance. After QRS detection, a wavelet-based delineator was used to detect individual Q-R-S waves, QRS onsets and ends, and identify the type of QRS pattern on each standard lead. Then, multilead QRS boundaries were determined in order to compute the QRS width. Finally, an automatic algorithm for notch/slur detection within the QRS complex was applied based on the same wavelet approach used for delineation.

Results and conclusion: In the training set, sensitivity and specificity rates of Se=89.8% and Sp=71% were obtained. Errors were mainly due to discrepancies in the presence of notches/slurs between the automatic algorithm and annotations. In the validation set, LBBB was diagnosed with a sensitivity and specificity of Se=76% and Sp=69% (Acc=71%, PPV=54% and NPV=85%). Results confirmed an accurate diagnosis of strict LBBB based on a fully-automatic extraction of temporal and morphological QRS features.

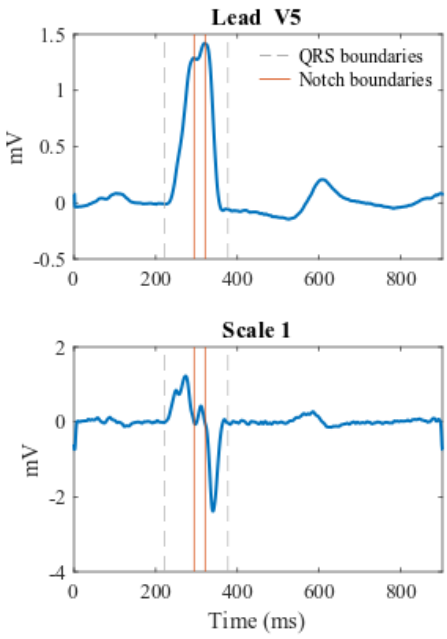

Figure 1: *One example of QRS and notch boundaries obtained using the wavelet-based approach. (a) One beat from lead V5, (b) Wavelet transform of signal represented in (a).*