The electro-anatomical pathway for normal and bundle branch block ECGs

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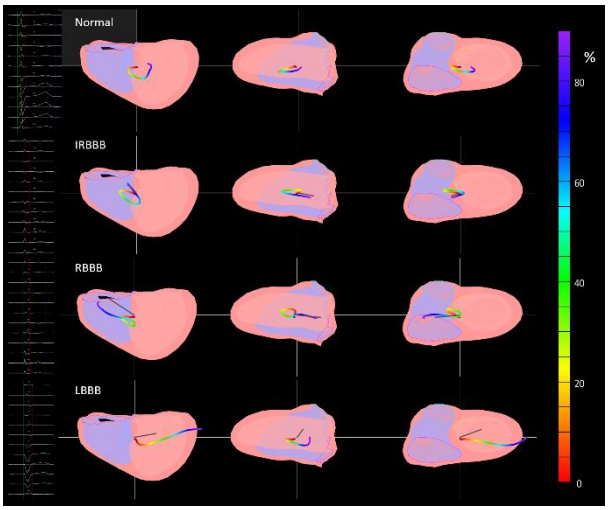
Background: Conventional ECG based diagnosis of bundle branch block (BBB) in patients can be ambiguous. Left BBB can be difficult to detect in patients with left ventricular hypertrophy, whereas the definition of incomplete and complete right BBB is solely based on ECG waveforms and not on the electro-physiological activation of the heart. In this feasibility study we propose and evaluate the sensitivity of a new inverse ECG (iECG) tool, visualizing and classifying the average electro-anatomical pathway of the cardiac activation.

Methods: We developed a new inverse ECG method (*i*ECG), to study the cardiac activation pathway by deriving the mean temporal spatial isochrone (*mTSI*) from the recorded 12-lead ECG. The mTSI describes the trajectory of the average electro-anatomical pathway within the cardiac anatomy. This enables the quantification of the activation progression to specific cardiac areas, such as the RVOT to the left free wall. A total of 62 of ECGs were analyzed divided in six groups . The ECG data was obtained from the certified Physionet PTB Diagnostic ECG Database. The cases included in the study were selected based on ECG morphology, i.e. normal, iRBBB, RBBB, and LBBB.

Results: Each of the ECGs were then classified using a) the cardiac anatomical *mTSI* direction of the terminal QRS segment and the ST segment, b) the *mTSI* trans-cardiac ratio and, c) the spatial location of the *mTSI*. 97% of the Normal ECGs were classified correctly, the remaining ECGs did deviate from the normal waveform, but also did not match any of the other classifications. All (i)RBBB, and LBBB ECG waveforms were classified correctly.

Conclusion: This study shows that the iECG technology is able to improve the detection and the understanding of the normal and left and right bundle branch block pattern. This electro-anatomical view on the ECG might help to obtain a better definition of the conduction disturbances represented by the ECG wave patterns.



Typical examples of normal, incomplete right bundle branch block (IRBBB), complete right bundle branch block (RBBB) and left bundle branch block (LBBB). The colored lines represent the mean temporal spatial isochrones (mTSI) of the QRS waveforms (red early, purple the terminal part). The mTSI started always in the center of ventricular mass, near the mid left septum. The terminal part (purple) of the mTSI points towards the latest activated area.