An in-siloco analysis of heart position and orientation on the 12-lead ECG in a patient with left bundle branch block

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Subtle ECG criteria can play an important role in the diagnosis of left bundle branch block (LBBB). In heart-failure patients, this can affect the decision to perform pacemaker implantation. Errors in electrode placement, which cause the electrode to be placed differently with respect to the heart, are known to have important effects on the waveforms that are measured. We hypothesized that also inter-patient differences in heart position and orientation can have important effects on the ECG. We tested this hypothesis by moving the heart in a single patient, leaving all other factors unaffected - an experiment that can only be performed using a numerical model.

Using a realistic patient-tailored computer model of the human heart and torso, cardiac activation was simulated and 12-lead ECGs were computed. Models for two heart-failure patients with LBBB were used. As a baseline situation, the model was tuned to reproduce the ECG and the activation order on the left ventricular endocardium as measured with electroanatomic mapping. The heart was then moved up, down, left, and right, and was rotated to a more horizontal orientation as commonly seen in obese subjects.

Limb leads were not importantly affected in either patient. The effect on the precordial leads was much more important in the second patient than in the first. The shape and presence of notching were affected in the left precordial leads. In neither patient did our changes in heart orientation and position affect the diagnosis of LBBB.

The remarkable difference between the two patients might be attributed to the relatively large heart and small torso in the second patient, and the small heart and relatively large torso of the first patient, causing precordial leads to be less sensitive to heart position. A larger sample is necessary to prove this hypothesis.