In Silico Evaluation of New Approaches in Cardiac Resynchronization Therapy

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Background: Cardiac resynchronization therapy (CRT) is a widely used technique in the clinical setting to solve desynchronization problems in ventricular contraction caused by alterations in the cardiac conduction system. Among the different CRT approaches, the most widespread is biventricular pacing, however, other newer approaches are beginning to be used, such as His optimized CRT (HOT-CRT) or left bundle branch area pacing (LBBAP). In silico cardiac models allow assessing the effectiveness of the different approaches of CRT in a non-invasive way, becoming a powerful tool to guide clinicians.

Objective: The aim of this study was to evaluate in silico the effectiveness of HOT-CRT and LBBAP in patients with heart failure (HF), left bundle branch block (LBBB), and right bundle branch block (RBBB).

Methods: A biventricular model was used in which the different pathologies were modelled and both CRT approaches (HOT-CRT and LBBAP) were programmed considering different atrioventricular delays and capture modalities. In addition, multiple parameters have been considered when evaluating the effectiveness of each therapy, such as QRS duration (QRSd), time until 90% of ventricular activation (t90) or the time until 90% of QRS area is reached (a90).

Results: The results showed that both therapies were found to be effective, significantly reducing QRSd, QRSa, and a90 values with respect to the pathological values. In particular, HOT-CRT managed to reduce QRSd from 180 ms (pathological value) to 167 ms, a90 from 135 ms to 128 ms, and t90 from 144 ms to 126 ms in patients with RBBB, HF, and left ventricular delay. Regarding LBBAP, this therapy managed to reduce these values by around 20 ms in patients with LBBB and HF.

Conclusion: Through this study, in silico models clearly help evaluate which could be the best approach when applying CRT, optimizing results and reducing the risk for the patient.