

His Bundle Pacing but not Left Bundle Pacing Corrects Septal Flash in Left Bundle Branch Block Patients

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Background: His bundle pacing (HBP) and left bundle pacing (LBP) are novel delivery methods for cardiac resynchronisation therapy for left bundle branch block (LBBB) patients. Septal flash, an abnormal pre-ejection motion of the septum towards the left ventricle (LV) arising from dyssynchronous activation, has been shown in the past to be a robust and independent predictor for CRT response. We investigated whether HBP and LBP can correct abnormal septal motion with the use of computational modelling.

Methods: We simulated ventricular activation, ECGs and mechanical contraction on four heart failure four-chamber heart meshes, inclusive of transmural ventricular myofiber orientation and His-Purkinje network. Our mechanics model accounts for ventricular preload, ventricular afterload and the effect of the pericardium on the heart by means of spatially varying Robin boundary conditions. We simulated normal activation, LBBB, LBBB+HBP and LBBB+LBP. We computed the peak of normal septal displacement before LV ejection, negative towards the LV and positive towards the right ventricle (RV).

Results: LBBB results in increased leftwards septal motion compared to synchronous activation (synchronous: -0.4 ± 0.5 mm vs LBBB: -3.8 ± 1.1 mm). HBP results in reduced LV latest activation times (LAT) compared to baseline (LBBB: 140 ± 30 ms vs HBP: 107 ± 6 ms). This translates in correction of septal flash, with pre-ejection septal motion similar to synchronous activation (HBP: -0.4 ± 0.5 mm). LBP also reduces LV LAT (107 ± 5 ms), but leads to slow RV activation (RV LAT LBBB: 106 ± 13 ms vs LBP: 131 ± 8 ms). RV pressure rise during isovolumic contraction is slower than LV pressure rise. Due to this pressure imbalance, the septum moves to the right (0.9 ± 0.6 mm).

Conclusion: HBP resynchronises ventricular activation without affecting RV activation, resulting in restored normal septal motion. LBP shortens LV activation but leads to slow RV activation, leading to abnormal rightwards septal motion.

