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DETERMINATION OF SENSED AND PACED ATRIAL-VENTRICULAR DELAYS IN CARDIAC RESYNCHRONIZATION THERAPY PATIENTS USING ELECTRICAL DYSSYNCHRONY MAPPING

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Background: We hypothesized that electrical resynchronization occurs via wavefront fusion and, if so, the time delay between atrial-sensed (As)-right ventricular (RV) sensed (AsRVs) and atrial-paced (Ap)-RV sensed (ApRVs) intervals should be identical to the time delay between optimally electrically-synchronized atrial-ventricular delays (AVD) during LV-only pacing (LVp).

Objective: To determine electrically optimal sensed AVD (SAVD) and paced AVD (PAVD) in CRT patients using the novel cardiac resynchronization index (CRI) metric, and compare the time difference in SAVD/PAVD to the difference in AsRVs/ApRVs intervals.

Methods: CRT patients \( n=40 \) with LBBB/IVCD were studied. AsRVs/ApRVs intervals were calculated from intracardiac electrograms (iEGM). Electrical dyssynchrony was measured using a multi-lead ECG system to quantify CRI during LVp. CRI was calculated as % change (compared to native) in area under multiple combinations of anterior/posterior electrograms.

Results: Peak CRI was 93\( \pm \)6.5% at SAVD of 109\( \pm \)29 ms and 92\( \pm \)5% at PAVD 170\( \pm \)40 ms. Mean AsRVs and ApRVs intervals were 181\( \pm \)31 ms and 242\( \pm \)42, respectively. Figure 1 shows CRI during As+/LVp at different AVDs. The 68 ms difference between AsRVs and ApRVs by iEGM was identical to the difference in CRI-optimized AVD during As and Ap. Figure 2 shows strong linear correlation (slope 0.98, y-intercept 0.63) between AsRVs/ApRVs time difference and CRI-determined electrically-optimal SAVD/PAVD time difference \((r=0.979, p<0.001)\).

Conclusion: The AsRVs/ApRVs time difference is nearly identical to the CRI-determined optimal SAVD/PAVD time difference. This strongly supports the concept of wavefront fusion of native and LV-paced wavefronts during LVp.

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QUADRIPOLAR LEFT VENTRICULAR LEADS AND ELECTRICAL DYSSYNCHRONY IN HEART FAILURE PATIENTS WITH CARDIAC RESYNCHRONIZATION THERAPY

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Background: Quadripolar left ventricular (LV) leads in cardiac resynchronization therapy (CRT) provide different electrical resynchronization.

Objective: To quantify electrical resynchronization when pacing from different quadripolar LV cathodes.

Methods: Electrocardiographic data from a 53 lead body surface mapping system in 62 CRT patients with quadripolar LV leads was used to compare cardiac resynchronization index (CRI), a novel metric quantifying electrical resynchronization, between pacing cathodes under otherwise identical pacing conditions. CRI was calculated as the % change in area under multiple combinations of anterior and posterior electrograms as compared to native.

Results: CRI changed in dose dependent manner with ventricular-ventricular delay (VVD) changes and varied across cathodes (Figure). Mean absolute difference in CRI of 14.3\( \pm \)10.7% \((p<0.001)\) was found when pacing biventricular or LV-only at the same settings but from different LV pacing cathodes. LV cathodes had optimal VVD that differed by 15.0\( \pm \)18.5 ms for sequential biventricular pacing settings at the same atrial-ventricular delay. Following VVD optimization, the difference in maximal achievable CRI between LV pacing cathodes was 10.7\( \pm \)12.0%. The spacing between LV pacing cathodes was directly related to the absolute difference in CRI when pacing at identical settings from 2 different cathodes. No universally superior cathode position was identified.

Conclusion: Electrical synchrony, as measured by CRI, varies greatly with LV pacing cathode. Patient-specific LV pacing vector optimization using CRI in patients with quadripolar leads may be a strategy to improve electrical resynchronization with CRT.