Clinical Practice

Initial Experience with MultiPoint Pacing Cardiac Resynchronization Therapy in China

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Recently, cardiac resynchronization therapy (CRT) with multipoint left ventricular (LV) pacing in a single coronary sinus branch (MultiPoint™ Pacing [MPP], St. Jude Medical, Inc., Sylmar, CA, USA) has been introduced commercially. The CRT system with MPP feature offers a new strategy for physicians to further enhance CRT in patients with heart failure. Early clinical studies have shown that MPP, compared with conventional biventricular (BiV) pacing, provides acute benefits to LV dP/dt max, LV dyssynchrony, LV peak radial strain, and LV electrical activation, and improves CRT response at 12 months. In this report, we presented two MPP CRT cases in China with acute hemodynamic assessment under various MPP and conventional BiV pacing configurations, demonstrating that MPP can offer further benefits to patients.

Patient 1 was a 77-year-old female with high blood pressure (BP), nonischemic cardiomyopathy, left-bundle-branch block (LBBB), 160 ms QRS width, II–III New York Heart Association (NYHA) functional class, 24.3% LV ejection fraction (LVEF), 45-mm LV end-systolic diameter (ESD), and 55-mm LV end-diastolic diameter (EDD). Patient 2 was a 66-year-old male with high BP and diabetes, ischemic cardiomyopathy and stent implants, LBBB, 163 ms QRS width, III NYHA class, 24.3% LVEF, 65-mm LV ESD, and 72-mm LV EDD. Both patients received a CRT implant (Quadra Assura MP™ CRT-D, St. Jude Medical, Inc., Sylmar, USA). The implantation procedure was exactly the same as that of a quadripolar CRT. The LV lead was implanted into a lateral branch in patient 1 and a posterior-lateral branch in patient 2. All four electrodes of the LV lead (referred to as D1, M2, M3, and P4 from distal to proximal) were successfully placed in the targeted branch in both patients. Acute pacing tests indicated no PNS in either patient, but D1 related vectors in patient 1 had high capture thresholds (>4 V) and were excluded from further assessment. After the implantation, a 0.014-inch pressure wire (PressureWire™, St. Jude Medical, Inc., Uppsala, Sweden) was inserted retrograde into the LV via a 4-F multipurpose catheter at the right radial artery. Once the pressure wire was in a stable position within the LV cavity, the multipurpose catheter was withdrawn into the aorta. LV pressure waveform was continuously recorded during an acute pacing protocol for offline analysis.

We evaluated various conventional BiV and MPP configurations using the available LV pacing vectors as well as atrial-only and right ventricular (RV) only pacing in a randomized order. Conventional BiV pacing configurations using each of the available LV electrodes as the cathode of the LV pacing vector were tested. Three MPP programming strategies were tested in each patient, including selecting the cathodes of the first and second LV pacing vectors (LV1 and LV2) as: (1) two of the most anatomically separated LV electrodes, (2) two of the most electrically separated LV electrodes, and (3) two of the latest electrical activation.
LV electrodes. RV Coil was selected as the anode for all LV pacing vectors. A fixed AV delay of 120 ms was used throughout the pacing protocol. The VV delay was programmed to simultaneous for conventional BiV pacing and 5 ms (between LV1 and LV2, and between LV2 and RV) for MPP. A minimum of 20-second recording was obtained for each configuration. To minimize the influence of background variation in hemodynamics during the evaluation, a reference configuration (RV-only pacing) was delivered before each of the test pacing configurations. LV $\frac{dp}{dt_{\max}}$ percent change relative to the reference configuration was used to identify the optimal CRT configuration.

The RV to LV conduction time was measured by the built-in function of the device programmer (Merlin™, St. Jude Medical, Inc.) under RV paced mode. For patient 1, the conduction time from RV to D1, M2, M3, and P4 was 115 ms, 138 ms, 146 ms, and 154 ms, respectively. For patient 2, the conduction time was 187 ms, 186 ms, 193 ms, and 193 ms, respectively. Table 1 shows the MPP configurations tested in the patients. Figure 1 shows the percent changes in LV $\frac{dp}{dt_{\max}}$ relative to the reference. All MPP and conventional BiV pacing configurations provided better LV $\frac{dp}{dt_{\max}}$ than atrial pacing only and RV only pacing. In both patients, the highest LV $\frac{dp}{dt_{\max}}$ was obtained by one of the MPP configurations.

### Table 1: Tested MPP configurations of two patients

| MPP configuration strategy* | Patient 1                  | Patient 2                  |
|----------------------------|----------------------------|----------------------------|
| Most anatomically separated| P4 → M2 → RV               | P4 → D1 → RV               |
| Most electrically separated| P4 → M2 → RV               | P4 → M2 → RV               |
| Two of the latest           | P4 → M3 → RV               | P4 → M3 → RV               |

*The pacing configurations are displayed as LV1 → LV2 → RV. MPP: MultiPoint Pacing; LV: Left ventricular; RV: Right ventricular.

The best MPP and conventional BiV pacing configurations provided 7.7% and 7.1% increase in LV $\frac{dp}{dt_{\max}}$ relative to RV-only pacing in patient 1, and 52.8% and 46.3% increase in patient 2. Among the three tested MPP programming strategies, pacing from two of the most anatomically separated LV electrodes provided the highest hemodynamic benefit for both patients. The acute hemodynamic responses to CRT configurations were much larger in patient 2.

Our initial experiences suggested that compared with conventional BiV pacing, MPP could offer further hemodynamic benefits assessed by acute LV $\frac{dp}{dt_{\max}}$ measurement for heart failure patients with both ischemic and nonischemic diseases. Pacing from two of the most anatomically separated LV electrodes yielded the highest LV $\frac{dp}{dt_{\max}}$ among all MPP configurations tested. Compared with conventional BiV, the amount of additional benefit from MPP could vary among patients. As an attempt to improve patient selection and cost effectiveness, future studies should involve research directed at identifying factors that can predict the amount of benefit by MPP among eligible patients. In our results, the improvement in acute hemodynamic response was less significant in patient 1, which might be contributed by the fact that we were unable to pace at D1 electrode due to high capture threshold. In addition, 3D electrical activation mapping has previously demonstrated that MPP was able to recruit a greater portion of the LV than conventional BiV pacing, resulting in shorter LV activation time and less dyssynchrony. Questions about the possibility of MPP providing more benefit to patients with larger LV and/or scars remain to be answered in large randomized clinical trials.

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Nil.

**Conflicts of interest**
Chun-Lan Jiang and Fu-Jian Qu are employees of St. Jude Medical, Inc., that makes cardiac rhythm management products and they receive salary from the company.

**Authors’ contribution details**
Wei Hua (1st author) for study design, execution, and manuscript preparation and review; Li-Gang Ding for study design, execution, data collection and analysis, and manuscript preparation and review; Xi-Ming Liu for study execution, data collection, and manuscript review; Zhi-Min Liu for study execution, data collection, and manuscript review; Chun-Lan Jiang for study design, data collection and analysis, and manuscript preparation; Fu-Jian Qu for study design, data analysis, and manuscript preparation and review, and Shu Zhang (corresponding author) for study design, data quality control, and manuscript review.

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