Impacts of Left Bundle/Peri-Left Bundle Pacing on Left Ventricular Contraction

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Background: His-bundle pacing is an emerging routine technique that avoids pacing-dependent side effects. However, the success rate of His-bundle pacing is not 100%.

Methods and Results: Left bundle pacing or peri-left bundle pacing (LBP/peri-LBP) are recently developed techniques that directly capture the left bundle or ventricular tissue near the left bundle. We evaluated the success rate of LBP/peri-LBP in patients whose treatment with His-bundle pacing failed. In addition, we evaluated left ventricular contraction and desynchrony after LBP/peri-LBP.

Conclusions: LBP/peri-LBP is an alternative ventricular pacing method in atrioventricular block in patients with failure of His-bundle pacing.

Key Words: His-bundle pacing; Left bundle branch pacing; Left bundle pacing; Peri-left bundle pacing
**Figure.** (A) Lead position for left bundle pacing (LBP)/peri-LBP. The pacing lead for LBP/peri-LBP is located between the temporary pacing lead located in the right ventricular apex and the His-bundle electrogram recorded site (the other pacing lead is temporarily located as a marker of the His-bundle pacing available site). (B) Morphological changes in pacing waves during screwing-in towards the left bundle from the right ventricular septum. The notch in V1 is the target morphology when the pacing lead for LBP/peri-LBP is located in an appropriate site in the right ventricular septum before screw-in (Middle bottom panel). Screwing-in for the left bundle is performed under continuous burst pacing to ensure its pacing morphology, which can reflect the depth of the lead within the ventricular septum. During screwing-in of the lead, this notch gradually moves upward and becomes an r' wave and forms the rSr' pattern (Right bottom panel). (C) Electrograms pre- and post-LBP (case 1) and peri-LBP (case 2). (D) Speckle-tracking echocardiography (bull’s eye plots display time to peak longitudinal strain) at the intrinsic and pacing beats during LBP. LBP did not provoke left ventricular dyssynchrony in the non-LBBB case (case 1). Peri-LBP recovered left ventricular dyssynchrony in the LBBB case (case 2). LAO, left anterior oblique; LBBB, left bundle branch; RAO, right anterior oblique.
(Figure B, Right panel). Once these ECG changes were observed, screwing-in was stopped to avoid exceeding the left ventricular endocardium. Thus, a narrow QRS complex with rSR’ wave in V1 was achieved (LBP/peri-LBP).

HBP was successful in approximately 64% of cases of AVB, and the high ventricular pacing ratio predicted (≥40%) cases (n=92). However, in 21 patients, HBP was abandoned and treatment switched to LBP/peri-LBP because of the high pacing threshold of the HB or specific cases of non-selective HBP-like high pacing threshold of the ventricular septum even if the pacing threshold of the HB was acceptable. These strict judgments, whether HBP was safe for AVB cases or not, were performed to avoid loss of ventricular capture. Successful LBP/peri-LBP was achieved in 17 of 21 patients (success rate 81%), resulting in maintaining narrow QRS pacing (from 116±8.3 ms to 108±4.2 ms, P=0.41). In particular, a significant narrowing of the QRS complex was achieved in 4 patients with CLBBB among all patients with successful LBP/peri-LBP (n=17), from 151±4.0 ms to 122±6.7 ms (P=0.01).

Procedure time is an important factor in terms of new implantation methods. We perform the implantation of the HBP/LBP lead as follows. We first try to implant the HBP lead. The average implantation time of HBP lead is within 15 min in most of the successful cases. We do not spend more than 30 min trying to implant the HBP lead. More than this, we abandon HBP and immediately switch to implanting LBP/peri-LBP using the same lead. The procedure time of LBP implantation was within 15 min in all cases. As a result, the total implantation times for the LBP lead (<15 min) are shorter than for the HBP lead (<30 min). There were no complications, including cardiovascular perforation, tricuspid valve injury, or loss of ventricular capture during the perioperative period.

Just after implantation, the mean LB/peri-LB capture threshold was 0.77±0.07 V/0.4 ms and the LBBB correction threshold in the CLBBB cases was 0.89±0.14 V/0.4 ms. At 6 months after LBP/peri-LBP lead implantation, mean LB/peri-LB capture thresholds and R wave amplitude had not deteriorated (pacing threshold from 0.75±0.07 V/0.4 ms (1 week after implantation) to 0.83±0.06 V/0.4 ms (6 months after implantation), R wave amplitude from 9.1±1.4 mV to 8.3±1.9 mV). The pacemaker checks were performed 1 week, 1 month and 6 months after implantation. There were no complications, including cardiovascular perforation, tricuspid valve injury, loss of ventricular capture, or dislodgement of the leads, in the late phase. Therefore, the procedure of LBP/peri-LBP and long-term stability (≤6 months) might be acceptable even if the numbers in this study were small.

We evaluated LV synchrony under LBP/peri-LBP using speckle-tracking echocardiography in 2 representative patients with BBB (case 1: CRBBB; case 2: CLBBB). Case 1 was a 74-year-old female with 2:1 AVB in whom implantation of the HBP lead had failed because of its high pacing threshold and she was switched to LBP/peri-LBP. In patients with successful LBP/peri-LBP, including in this case, LB potential with an intrinsic rhythm could be observed in some of the patients without LBBB. In this case, LB potential was recorded from the lead tip during intrinsic rhythm (Figure C, Upper panel), and nonselective left bundle capture was achieved at this site. The interval from LB potential to ventricular activation (V wave) was shorter than the His potential–V interval. Case 2 was a 61-year-old male who presented with advanced AVB with CLBBB. His ECG waveform changed from a CLBBB pattern to a RBBB pattern after peri-LBP (Figure C, Lower panel). Even in patients in whom the LB potential could not be observed because of LBBB or no intrinsic junctional rhythm in AVB, the same narrow QRS complex was often established (we call this phenomenon "peri-LBP").

Speckle-tracking echocardiography revealed no obvious deterioration of LV global longitudinal strain during LBP/peri-LBP compared with intrinsic rhythm (IR) (Case 1 IR: −23.1%, LBP/peri-LBP: −23.2%; Case 2 IR: −16.4%, LBP/peri-LBP: −15.4%). Impairment of LV synchrony by LBP/peri-LBP was not observed in case 1 (CRBBB) (Figure D). In CLBBB (case 2), recovery of activation delay in the anterior wall was observed by peri-LBP (Figure D).

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Conflicts of Interest
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