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SELECTIVE AND NON-SELECTIVE LEFT BUNDLE BRANCH PACING

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Left bundle branch (LBB) pacing is a novel method of cardiac pacing, which can prevent development of interventricular dyssynchrony, and also could be used as a resynchronization therapy in patients with low ejection fraction and LBB block. Demonstration of the specific electrocardiographic criteria is essential to confirm LBB capture.

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Left bundle branch area pacing (LBBAP**)** is a relatively new method of cardiac pacing that allows for the prevention of interventricular dyssynchrony typically associated with conventional right ventricular pacing [1-5]. This technique may also serve as an alternative to cardiac resynchronisation therapy (CRT) in patients with heart failure and left bundle branch block (LBBB). LBBAP involves implantation of a right ventricular lead deep into the interventricular septum (IVS), extending to the subendocardial layers of the left ventricle, with the aim of establishing direct contact between the lead helix and the fibers of the left bundle branch (LBB). Successful capture of the LBB requires a sound understanding of cardiac electrophysiology as well as specific fluoroscopic equipment in the catheterization lab.

Criteria for Left Bundle Branch Area Pacing [1]

1. Transition from Non-selective to Selective LBBAP (sLBBAP) During Pacing Threshold Assessment**:** Selective LBBAP refers to the capture of only the specialised conduction system, while non-selective LBBAP involves simultaneous capture of the left bundle branch (LBB) and adjacent interventricular septal myocardium. Immediately after lead implantation, the myocardial capture threshold is typically higher than that of the conduction system. This difference may diminish within minutes post-implantation, making the transition from non-selective to selective LBBAP difficult to reproduce during subsequent pacemaker checks.

2. Electrocardiographic (ECG) Criteria

• Stimulus-to-R Wave Peak Interval in Lead V6 (St-RV6, Left Ventricular Activation Time): Normally, the time from the onset of the QRS complex to the R-wave peak in lead V6 is ≤50 ms. In the presence of LBBB, this interval typically exceeds 60 ms. Since conduction through the LBB to the distal Purkinje fibres and working myocardium takes approximately 30 ms, this value should be added to the "native" RV6 peak time when evaluating pacing-induced activation. During selective LBB pacing (sLBBP), an isoelectric interval is observed on the ECG during this conduction delay. In non-selective pacing (nsLBBP), a pseudo-delta wave may appear due to depolarisation of the adjacent septal myocardium. Thus, according to established LBB pacing criteria, the St-RV6 interval should be less than 75-80 ms.

• Interval Between R-Wave Peaks in Leads V6 and V1 (RV1-RV6): During LBB pacing, right ventricular activation is delayed relative to the left ventricle. This results in a paced right bundle branch block (RBBB) morphology, with a characteristic late R wave in lead V1. Based on accepted criteria, the RV1-RV6 interval should be at least 33 ms (and ≥44 ms according to more stringent standards).

• Prolongation of the Stimulus-to-RV1 Peak Interval (St-RV1) by >10 ms during transition from nsLBBP to sLBBAP. This criterion reflects the loss of adjacent septal myocardial capture and the subsequent delay in activation of the right ventricular lateral wall. It is essentially a composite of the previous two criteria.

• Prolongation of St-RV6 by >15 ms with Decreased Output Amplitude: This pattern indicates a transition from non-selective LBB capture to isolated septal myocardial pacing, reflecting loss of LBB capture - essentially the reverse of the phenomenon described in section A.

• St-RV6 Should Match the Intrinsic Conduction Time from the LBB Potential to the RV6 Peak: The difference between these two measurements should not exceed 10 ms.

Recording of signals from the implanted lead in the region of the LBB is an essential component of the procedure and determines the success of the implantation. The lead is connected to the electrophysiological recording system and the analyser in a unipolar configuration. To visualise the current of injury (COI), we use the following bandpass filter settings: high-pass filter - 0.5 Hz; low-pass filter - 500 Hz. The electrogram from the lead tip used to record potentials is typically filtered at 30-500 Hz.

Figure 1 presents surface ECG leads, unfiltered COI signal, and filtered LBB electrogram (LB EGM) from the tip of the implanted lead. Figure 1a shows a native QRS complex with a duration of 94 ms. Intrinsic conduction via the LBB allowed identification of the LBB potential (arrow). The interval from the LBB potential to the R-wave peak in lead V6 was 80 ms. Analysis of the COI endogram revealed an RS morphology, indicating subendocardial positioning of the ventricular lead helix. Figure 1b illustrates non-selective LBB area pacing (nsLBBP). The St-RV6 interval was 84 ms (similar to the intrinsic conduction time from the LBB potential to RV6 peak), St-RV1 was 116 ms, and the RV1-RV6 interval was 32 ms. A pseudo-delta wave is visible in leads I, V5, and V6, suggesting local capture of the adjacent interventricular septal myocardium. Figure 1c shows sLBBP achieved by reducing pacing output from 5 V to 1 V. This is evidenced by a stable St-RV6 interval of 86 ms (matching the previous 84 ms seen during nsLBBP), disappearance of the pseudo-delta wave, prolongation of the St-RV1 interval to 134 ms, an increase in the RV1-RV6 interval to 48 ms (+16 ms compared to nsLBBP).

Additionally, a local ventricular myocardial potential (arrow) becomes apparent, indicating delayed activation of the basal septal segments following conduction through the LBB, Purkinje fibres, and retrograde excitation from the apex back toward the basal regions of the septum.

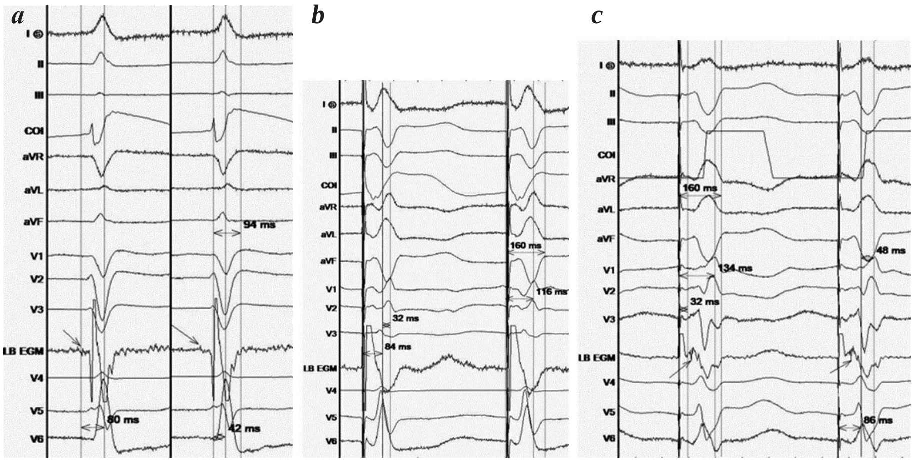

Fig. 1. Selective and Non-selective Left Bundle Branch Area Pacing (a) Native QRS complex with a duration of 94 ms. The LBB potential is indicated by an arrow; the interval from the LBB potential to the R-wave peak in lead V6 was 80 ms. (b) Non-selective LBB pacing: St-RV6 interval was 84 ms (equivalent to intrinsic conduction time from the LBB potential to RV6 peak), St-RV1 was 116 ms, RV1-RV6 interval was 32 ms. A pseudo-delta wave is visible in leads I, V5, and V6. (c) Selective LBB pacing: St-RV6 interval was 86 ms, St-RV1 increased to 134 ms, and RV1-RV6 to 48 ms. The pseudo-delta wave disappeared. A local ventricular myocardial potential is indicated by the arrow.

REFERENCES

1. urri H, Jastrzebski M, Cano O, et al. EHRA clinical consensus statement on conduction system pacing implantation: endorsed by the Asia Pacific Heart Rhythm Society (APHRS), Canadian Heart Rhythm Society (CHRS), and Latin American Heart Rhythm Society (LAHRS). *EP Europace.* 2023;25(4): 1208-36. https://doi.org/10.1093/europace/euad043.

2. Huang W, Chen X, Su L, et al. A beginner's guide to permanent left bundle branch pacing. *Heart Rhythm.* 2019;16(12): 1791-6. https://doi.org/10.1016/j.hrthm.2019.06.016.

3. Glikson M, Nielsen JC, Kronborg MB, et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: Developed by the Task Force on cardiac pacing and cardiac resynchronization therapy of the European Society of Cardiology (ESC) With the special contribution of the European Heart Rhythm Association (EHRA). *European Heart Journal.* 2021;42(35): 3427-3520. https://doi.org/10.1093/eurheartj/ehab364.

4. Wu S, Su L, Vijayaraman P, et al. Left bundle branch pacing for cardiac resynchronization therapy: non- randomized on-treatment comparison with His bundle pacing and biventricular pacing. *Canadian Journal of Cardiology*. 2020;37: 319-328. https://doi.org/10.1016/j.cjca.2020.04.037.

5. Vijayaraman P, Ponnusamy S, Cano Ó, et al. Left Bundle Branch Area Pacing for Cardiac Resynchronization Therapy: Results From the International LBBAP Collaborative Study Group. J*ACC Clinical Electrophysiology*. 2020;7(2):135-147. https://doi.org/10.1016/j.jacep.2020.08.015.