PERSPECTIVES IN CONTRAST

My preferred approach to left bundle branch area pacing: Stylet-driven leads

Jan De Pooter, MD, PhD

From the Heart Center, Ghent University Hospital, Ghent, Belgium.

Left bundle branch area pacing (LBBAP) is emerging as an attractive pacing modality, as it offers more physiologic pacing compared with standard right ventricular apical pacing and is associated with excellent pacing characteristics compared with His bundle pacing.[1–5] Left ventricular septal pacing via a transseptal route was first reported by Mafi-Rad and colleauges[1] in 2017 using a custom-made pacing lead, a modification of the lumenless SelectSecure model 3830 (Medtronic Inc, Minneapolis, MN) but with a prolonged helix of 4 mm. In the same year, Huang and colleagues[6] introduced the concept of left bundle branch capture (left bundle branch pacing) by a transseptal route using the market-released SelectSecure pacing lead 3830 delivered through a preshaped guiding sheath. Following these initial reports, several large single and multicenter studies confirmed the feasibility and safety of LBBAP using this type of lumenless pacing lead (LLL).[6–10] LBBAP using standard stylet-driven pacing leads (SDLs) was first reported in 2020 by Zanon and colleagues[11] in 2 patients as bail out after failed His bundle pacing using SDLs. A small, single-center study by our group showed that LBBAP using SDLs is feasible and yields comparable implant success, procedural times, pacing characteristics, and safety compared with LBBAP using LLLs.[12] Since then, 2 large multicenter studies have further confirmed the feasibility and safety of LBBAP using SDLs with reported implant success rates of >90%,[8,13] with a tendency to higher implant success with SDLs.[8]

The lead design of SDLs differs from LLLs, as SDLs are stylet supported and come with an extendable-retractable helix mechanism. LLLs lack an inner lumen for stylet insertion and therefore present with smaller lead body diameters (4.1F compared with 5.5F–6.0F for SDLs) and have a fixed helix design.[14] The overall implant technique for LBBAP using SDLs is quite similar to LBBAP using LLLs, although lead handling and lead behavior of SDLs might differ from LLLs due to the aforementioned differences in lead design.[14] To obtain LBBAP with SDLs, sheath and lead positioning on the right-sided septum is similar as with LLLs.[8,12–14] Deep septal lead deployment of SDLs is achieved by clockwise rotating the outer lead body with the helix extended and the stylet advanced. During screwing, attention should be made to keep the stylet fully advanced to the lead tip, as this contributes to the stability and torquability of SDLs. In our experience, even in patients with hypertrophic septa, deep septal positions with lead implant depths of 15 mm or more are easily achieved with SDLs (Figure 1A). The success of LBBAP using LLLs in patients with hypertrophic cardiomyopathy has been reported to be as low as 36%,[15] and this success rate might definitely be increased with SDLs due to easier septal penetration. The support of the stylet helps to keep position and track on the septum, even in cases in which the delivery sheath inadvertently reverses (Figure 1B and Video 1). Additionally, besides a better push on the septum, insertion of a stylet enhances the overall torquability, as rotations on the proximal outer lead body are easier transferred toward the distal lead part and helix. In cases in which septal penetration is difficult, especially in fibrotic or hypertrophic septal tissue, LLLs might get twisted in front of the delivery sheath. This phenomena does not occur with SDLs, as the stylet prevents twisting. The guiding catheters used for LBBAP with SDLs are generally wider and tend to be more supportive compared with the delivery sheaths of LLLs, which results less frequently in kinking of the guiding sheath. Advantages of using SDLs for LBBAP are summarized in Table 1.

The downside of SDLs is that clockwise rotations of the outer lead body inadvertently can result in helix retraction.[11,12,14] This helix retraction results from the outer lead body turning over the inner coil and helix and should be timely recognized during lead deployment, as a retracted helix hampers further lead progression into the septum. Helix retraction can be observed either on fluoroscopy or suspected when steep increases in unipolar pacing impedances (often >10,000 Ω) occur. Several methods to prevent helix retraction have been proposed. One method is to pretension the inner coil of the lead with stylet insertion tools or cut lead end caps.[14] With pretensioned inner coils, rotations on the outer

KEYWORDS Left bundle branch area pacing; Conduction system pacing; Stylet-driven leads; Lumenless leads; Pacing (Heart Rhythm O^2 2023;4:154–156)

Address reprint requests and correspondence: Dr Jan De Pooter, Heart Center, Ghent University Hospital, Corneel Heymanslaan 10, 9000 Ghent, Belgium. E-mail address: jan.depooter@uzgent.be.

https://doi.org/10.1016/j.hroo.2022.12.011

KEY FINDINGS

- Left bundle branch area pacing (LBBAP) using stylet-driven pacing leads is a safe and feasible technique.
- Implant success, pacing, and electrocardiographic characteristics of LBBAP seem comparable between lumenless and stylet-driven pacing leads.
- The stiffness and additional support of stylets might facilitate deep septal lead deployment for LBBAP, without higher risk for septal perforation.

lead body are better transferred to the inner coil and can avoid helix retraction. Alternatively, if helix retraction occurs, the helix of most SDLs can be re-extended even in mid or deep septal positions using the regular clip-on tool. Although the techniques described here can be applied to the different vendors of SDLs, vendor-specific considerations have been published in detail before.[14]

Despite the stiffer lead design of SDLs, septal perforation rates of SDLs (2%–4%)[8,13] are not higher compared with LLLs, with perforation rates between 0.5 and 5%,[9,16,17] and in one study even up to 14%.[18] Therefore septal perforation during LBBAP seems not related to lead design, but rather depends on striving of the operator to obtain conduction system capture at the left-sided septal area (left bundle branch pacing).[19] Indicators of impending perforation such as drop in unipolar impedance or decreases in current of injury should be timely recognized to avoid septal perforation, similar as with LLLs.[8,12,13,18] Of interest, pacing characteristics, in terms of R-wave amplitude and pacing thresholds, are comparable between SDLs and LLLs; however, pacing impedances might differ depending on lead length and lead design. The latter is important when monitoring unipolar pacing impedances to assess lead depth and avoid perforation. Continuous monitoring of unipolar pacing characteristics during lead deployment is easily achieved by connecting the crocodile clamp to the stylet, rather than to the lead pin (Figure 1C).[14,20] As such, lead body rotations are not hampered by the jump cable getting twisted around the lead. In a large Belgian multicenter study, lead revision rate of SDL LBBAP was only 1.4%. In the European multicenter MELOS (Multicenter European Left Bundle Branch Area Pacing Outcomes Study) registry, the dislodgment rate was 3.8 and 1.1% for SDLs and LLLs, respectively, although in that study most operators had vast experience with LLLs, rather than with SDLs. One study reported higher rates of microdislodgment, resulting in loss of conduction system capture during LBBAP with SDLs compared with LLLs.[21] To avoid early and late lead (micro)dislodgments, we routinely check the electrocardiogram for changes in paced QRS morphology, especially after releasing tension on the inner coil and when retracting stylet and sheath. Microdislodgments are easily missed on fluoroscopy, whereas the paced QRS is a more reliable marker of correct lead position. Disappearance or decrease in the terminal R-wave in V1 suggests microdislodgment and should alert the operator promptly to correct the final lead position (preferentially before slitting the delivery sheath) with 1 or more additional rotations. A few cases of SDL entanglement have been described, resulting in helix fracture, elongation, or disuse.[22,23] The extendable helix mechanism of the SDL might indeed be more fragile and prone to helix damage than the fixed helix design of LLLs, especially when attempting to reposition the lead from a deep septal position. Lead entanglement can be avoided if clockwise rotations on the lead are timely stopped upon the observation that no lead progression is made or when increasing resistance to lead body rotations is felt. In that case, a new screw attempt on a different septal location is recommended. If entanglement occurs, counterclockwise rotation with gentle traction and without retracting the helix

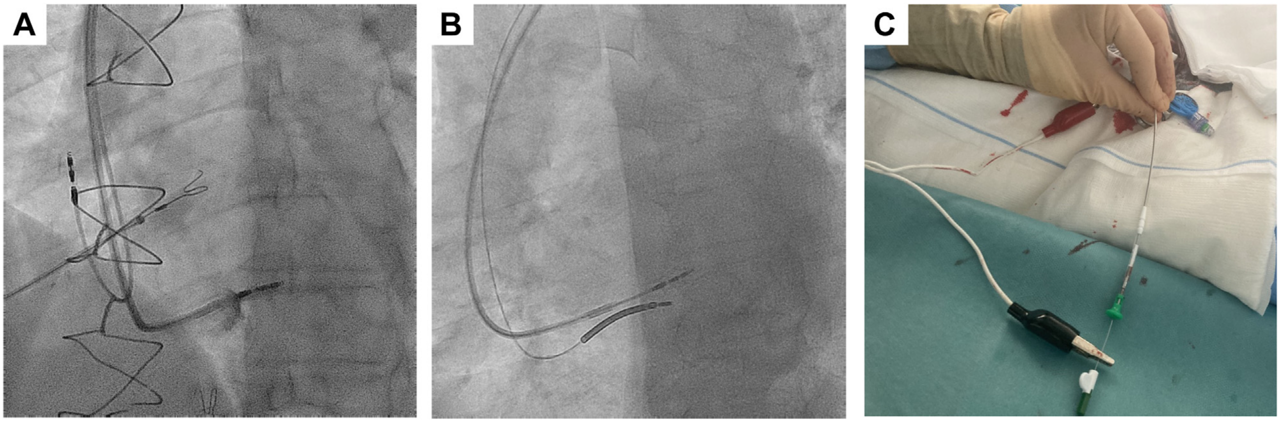

Figure 1 **A:** Deep septal lead deployment in a patient with hypertrophic septum. The stylet-driven pacing lead (SoliaS 60; Biotronik) needed an implant depth of 15–16 mm to achieve left bundle branch pacing. Contrast injections are not essential, although they can help to assess lead depth and exclude complications such as septal coronary artery fistulas. **B:** The stylet of standard stylet-driven pacing leads adds support to the lead, which facilitates to keep stable positions and track on the septum, even in case the delivery sheath reverses due to the pushing forces on the septum. **C:** Continuous monitoring of unipolar pacing characteristics during deep septal lead deployment can easily be achieved by connecting the crocodile clamps to the stylet of the pacing lead, rather than the lead pin. This way, lead rotations do not become hampered by the jump cable getting twisted around the pacing lead.

Table 1 Advantages of SDLs over LLLs in left bundle branch area pacing

Larger lead caliber allows for more grip when rotating outer lead body.
Support of the stylet increases both torquability and septal penetration performance.
Stiffness of the stylet avoids twisting of the lead in front of the delivery sheath.
Additional support of the stylet might help to keep lead position and track on the septum.
Clamps of the jumper cables can be connected to the stylet which facilitate continuous pacing while screwing.
Wider delivery sheaths of SDLs tend to be more supportive compared with the thinner delivery sheaths of LLLs with less risk of kinking.

LLL = lumenless lead; SDL = stylet-driven lead.

usually disentangles the lead without helix damage. A recent case of early conductor fracture has been reported with SDLs in a deep septal position.[24] Long-term lead performance of SDLs in deep septal positions still needs to be proven, although in a large multicenter registry of 353 patients only 1 lead fracture has been reported.[13]

LBBAP using SDLs is a safe and feasible technique with implant success as least as good as LLLs and without affecting overall safety. Several properties of current SDL lead design might be considered advantageous to achieve LBBAP, while other features might need further improvement or adaptation. From a future perspective, development of dedicated LBBAP leads should combine the advantageous lead properties of both SDLs and LLLs to further improve the implant success, safety, and overall feasibility of LBBAP.

Funding Sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosures: JDP reports speaker honoraria and consultancy fees of Biotronik, Medtronic, Boston Scientific, and Abbott.

Authorship: All authors attest they meet the current ICMJE criteria for authorship.

References

1. Mafi-Rad M, Luermans JG, Blaauw Y, et al. Feasibility and acute hemodynamic effect of left ventricular septal pacing by transvenous approach through the interventricular septum. Circ Arrhythm Electrophysiol 2016;9:e003344.
2. Sharma PS, Patel NR, Ravi V, et al. Clinical outcomes of left bundle branch area pacing compared with right ventricular pacing: results from the Geisinger-Rush Conduction System Pacing Registry. Heart Rhythm 2022;19:3–11.
3. Teigeler T, Kolominsky J, Vo C, et al. Intermediate-term performance and safety of His-bundle pacing leads: a single-center experience. Heart Rhythm 2021;18:743–749.
4. Vijayaraman P, Rajakumar C, Naperkowski AM, Subzposh FA. Clinical outcomes of left bundle branch area pacing compared with His bundle pacing. J Cardiovasc Electrophysiol 2022;33:1234–1243.
5. Zanon F, Abdelrahman M, Marcantoni L, et al. Long term performance and safety of His bundle pacing: a multicenter experience. J Cardiovasc Electrophysiol 2019;30:1594–1601.
6. Huang W, Su L, Wu S, et al. A novel pacing strategy with low and stable output: pacing the left bundle branch immediately beyond the conduction block. Can J Cardiol 2017;33:1736. e1731–e1733.
7. Huang W, Chen X, Su L, Wu S, Xia X, Vijayaraman P. A beginner's guide to permanent left bundle branch pacing. Heart Rhythm 2019;16:1791–1796.
8. Jastrzębski M, Kielbasa G, Cano O, et al. Multicenter European Left Bundle Branch Area Pacing Outcomes Study (MELOS). Eur Heart J 2022;43:4161–4173.
9. Su L, Wang S, Wu S, et al. Long-term safety and feasibility of left bundle branch pacing in a large single-center study. Circ Arrhythm Electrophysiol 2021;14:e009261.
10. Vijayaraman P, Subzposh FA, Naperkowski A, et al. Prospective evaluation of feasibility, electrophysiologic and echocardiographic characteristics of left bundle branch area pacing. Heart Rhythm 2019;16:1774–1782.
11. Zanon F, Marcantoni L, Pastore G, Baracca E. Left bundle branch pacing by standard stylet-driven lead: preliminary experience of two case reports. HeartRhythm Case Rep 2020;6:614–617.
12. De Pooter J, Calle S, Timmermans F, Van Heuverswyn F. Left bundle branch area pacing using stylet-driven pacing leads with a new delivery sheath: a comparison with lumen-less leads. J Cardiovasc Electrophysiol 2021;32:439–448.
13. De Pooter J, Ozpak E, Calle S, et al. Initial experience of left bundle branch area pacing using stylet-driven pacing leads: a multicenter study. J Cardiovasc Electrophysiol 2022;337:1540–1549.
14. De Pooter J, Wauters A, Van Heuverswyn F, Le Polain de Waroux JB. A guide to left bundle branch area pacing using stylet-driven pacing leads. Front Cardiovasc Med 2022;9:844152.
15. Zhu H, Wang Z, Li X, et al. The initial experience of left bundle branch area pacing in patients with hypertrophic cardiomyopathy. Pacing Clin Electrophysiol 2022;45:1065–1074.
16. Padala SK, Master VM, Terricabras M, et al. Initial experience, safety, and feasibility of left bundle branch area pacing: a multicenter prospective study. J Am Coll Cardiol EP 2020;6:1773–1782.
17. Shali S, Wu W, Bai J, et al. Current of injury is an indicator of lead depth and performance during left bundle branch pacing lead implantation. Heart Rhythm 2022.
18. Ponnusamy SS, Basil W, Vijayaraman P. Electrophysiological characteristics of septal perforation during left bundle branch pacing. Heart Rhythm 2022;19:728–734.
19. Burri H. Complications with left bundle branch area pacing. Heart Rhythm 2022;19:735–736.
20. Gillis K, O'Neill L, Wielandts JY, et al. Left bundle branch area pacing guided by continuous uninterrupted monitoring of unipolar pacing characteristics. J Cardiovasc Electrophysiol 2022;33:299–307.
21. Tan ES, Lee JY, Boey E, et al. Predictors of loss of capture in left bundle branch pacing: a multicenter experience. Heart Rhythm 2022;19:1757–1758.
22. le Polain de Waroux JB, Wielandts JY, Gillis K, et al. Repositioning and extraction of stylet-driven pacing leads with extendable helix used for left bundle branch area pacing. J Cardiovasc Electrophysiol 2021;32:1464–1466.
23. Tan ESJ, Lee JY, Boey E, et al. Use of extendable helix leads for conduction system pacing: differences in lead handling and performance lead design impacts conduction system pacing. J Cardiovasc Electrophysiol 2022;33:1550–1557.
24. Thaler R, Sinner MF, Joghetaei N, Fichtner S. Early sudden distal conductor fracture of a stylet-driven lead implanted for left bundle branch area pacing. HeartRhythm Case Rep 2023;9:28–30.