Circulation: Arrhythmia and Electrophysiology

EDITORIAL

Intracardiac Echocardiography Guidance for Left Bundle Pacing: An Expensive Adjunct or Necessity for Optimal Lead Placement?

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The role of conduction system pacing in maintaining physiological activation and electromechanical synchrony has been established by various studies. The derived benefit is of value in patients in need of ventricular pacing, as well as those with left bundle branch (LBB) block and heart failure. His bundle pacing (HBP) was initially adopted in clinical practice albeit with the technical challenges of the implant procedure, low sensing, and elevated thresholds with potential loss of conduction system recruitment in the long term.[1] The introduction of LBB pacing (LBBP) by Huang et al[2] has rekindled interest in physiological pacing by providing a wider target zone to engage the cardiac conduction system and overcoming the inherent challenges associated with HBP.[3] An appropriately positioned deep septal pacing lead has the potential to bypass focal and more distal His bundle or proximal LBB blocks, engaging the left bundle fibers with results similar to HBP, that is, narrow QRS, short peak left ventricular (LV) activation time, and maintaining normal axis of cardiac activation. With increasing clinical experience of LBBP in patients with varying degrees of conduction system disease and electromechanical dyssynchrony, we have come to better understand the mechanisms of bundle branch correction and ventricular activation patterns.[4]

See Article by Kuang et al

The anatomical distribution of LBB may vary, but it commonly arborizes into a short, thicker left posterior fascicle and a longer, thin anterior fascicle running a subaortic route as it penetrates the interventricular septum. Not uncommonly, a septal fascicle is also present. The left bundle is the narrowest in its initial section, reaching its maximal width after extending for about 10 to 15 mm.[5,6] The ideal location for lead placement would, therefore, allow for proximal LBB capture as opposed to more distal sites that result in preferential activation of the fascicles. Proximal LBBP also results in early retrograde activation of the right bundle branch thereby reducing interventricular and intraventricular conduction delays. With conventional fluoroscopic approach, distal His bundle location and superior tricuspid annulus visualized by contrast ventriculography are commonly used as surrogate markers, placing the lead 10 to 20 mm distally on the ventricular septum. Anatomical factors such as severe atrial or ventricular dilation and septal hypertrophy may pose a significant challenge to achieving the necessary depth of implant that allows for conduction system capture. Repeated attempts at lead placement can increase the total procedure and fluoroscopy time. Mafi-Rad et al[7] originally described the technique for deep septal lead implantation for LV septal pacing in 10 patients, using a prototype lead with a 4-mm screw under the guidance of intracardiac echocardiography (ICE). After their learning experience in 8 cases, they were able to successfully implant the lead without ICE in their last 2 patients. The use of 3-dimensional electroanatomical mapping system and ICE for guiding LBBP has been reported in literature.[8,9] The 2 modalities were utilized effectively in patients with anatomical challenges including structural

Key Words: Editorials ■ bundle of His ■ intracardiac echo ■ left bundle branch pacing ■ ventricular septum

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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For Disclosures, see page 224.

Circulation: Arrhythmia and Electrophysiology is available at www.ahajournals.org/journal/circep

heart disease and advanced conduction system disease. Kuang et al[10] have previously described the feasibility of ICE guidance to facilitate LBBP with greater success.

In this issue of *Circulation: Arrhythmia and Electrophysiology*, the same authors bring forth their randomized data on the efficacy and safety of ICE-guided left bundle pacing lead placement in comparison with conventional fluoroscopic approach.[11] The study was conducted in 2 phases. A road map of the His and left bundle was created using 3-dimensional electroanatomic mapping in 20 patients undergoing ablation for premature ventricular contractions. Proximal left bundle was localized within an area of 4.5±1.1 cm^2 from the junction between noncoronary and right coronary cusp extending 10 to 20 mm from the tricuspid annulus toward the apex. As an initial step for population sampling to establish conduction patterns and distribution, this approach has been used in both normal and diseased hearts.

In the second phase, 101 patients were randomized into ICE-guided (n=50) and non–ICE-guided LBBP (n=51) predominantly for atrioventricular block of 74.3% and preserved LV ejection fraction of 63±11.5%. The patients were followed for ≈6.2±3.5 months with a transthoracic echo within a week of procedure and at 3 months. While there was no statistical difference in the success rates, there were fewer attempts required to achieve the desired results in the ICE group (1.43±0.62 versus 1.98±0.75; P=0.0002), shorter overall procedure time (26±8 versus 43±9 minutes; P<0.001), and fluoroscopy exposure (7.4±1.8 versus 10.7±2.4 minutes; P<0.001). Left bundle potential was demonstrable in 97.9% of patients using ICE guidance (90.9% in the non-ICE group) with longer left bundle-ventricle intervals. Paced QRS was significantly narrower (104±6.0 versus 110±10 ms; P=0.0007) and selective engagement of the LBB was attained more frequently in the ICE group.

Compared with HBP, the success rate of achieving LBBP as reported by various authors using fluoroscopy ranges from 85% to 98%.[12–14] These studies, however, do not distinguish between proximal and distal left bundle lead positions as long as the prespecified criteria for left bundle pacing and bundle branch correction were met.[15] Lin et al[16] demonstrated, however, that pacing of the main LBB truck was possible in only 25% of patients, whereas the remaining patients received distal LBB or fascicular pacing with resultant shift in electrical axis on ECG. In the MELOS study[17] (Multicentre European Left Bundle Branch Area Pacing Outcomes) involving 2533 patients, left bundle fascicular pacing was achieved in 69.5% of patients, while proximal LBB trunk pacing in only 9% and LV septal-only pacing in 21.5%.

Theoretically, pacing in the His bundle and proximal left bundle should achieve maximal LV electrical synchrony. However, there have been no large, randomized studies to assess the clinical outcome differences between HBP, proximal LBBP, LBB fascicular pacing, or LV septal pacing. Thus far, there is paucity of data to suggest suboptimal response based on lead location. In fact, the hemodynamic impact of LV septal pacing has been reported to be at least as good as, if not better than, traditional biventricular pacing or HBP.[18]

When proximal LBBP is indeed achieved, the entry point is close to the tricuspid annulus. The logical concerns here would be entanglement/damage to valvular apparatus resulting in or worsening tricuspid regurgitation.[11] In ICE-guided proximal LBBP (proximal left bundle trunk), Kuang et al[11] report the lead location to be 16.7±3.1 mm from the tricuspid annulus and 22.7±3.4 mm in the non-ICE group (P<0.0001), whereas the distance from the lead tip to the LV subendocardial region was 1.0±1.4 mm. Recent data comparing LBBP with right ventricular pacing suggest no difference in terms of tricuspid regurgitation risk and progression. In this study, 472 consecutive patients were enrolled (LBBP, n=269 and right ventricular septal pacing, n=203). LBBP-related tricuspid regurgitation progression was higher when the distance of electrode fixation site was 11 mm from the tricuspid annulus and mitigated when the distance exceeded 19 mm.[19] Findings from this study suggest an increased risk for tricuspid regurgitation if proximal LBBP is targeted. It is likely that aside from the reduction in fluoroscopic exposure for the operator, availability of intraprocedural echocardiography can be of value for optimal lead placement targeting the proximal LBB trunk and reducing complications including tricuspid regurgitation. The authors of the current study should be commended for performing this complex study with high success rates and low complications. Lack of significant differences in the success rates between the 2 groups in this study may be due to the highly experienced operators. Depending on the equipment availability, operator skill, and preference, ICE-guided proximal LBBP may be feasible in clinical practice but at significant cost. A case-by-case approach would perhaps be reasonable at this time as data supporting clinical advantage of proximal left bundle trunk pacing over distal fascicular or LV septal pacing are lacking.

ARTICLE INFORMATION

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Disclosures

Dr Batul received a honorarium from Medtronic. Dr Vijayaraman received a honorarium and was a consultant, researcher, and received fellowship support from Medtronic. He was a consultant for Abbott and received a honorarium from Boston Scientific and Biotronik and holds a patent for His bundle pacing delivery tool.

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