Editorial

Left Bundle Branch Pacing

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Cardiac pacing is the only effective therapy for patients with symptomatic bradycardia in the absence of reversible etiologies. Right ventricular pacing (RVP) has been widely used for almost 60 years. However, RVP causes electric and mechanical dyssynchrony. Due to such effects, RVP is associated with an increased risk of heart failure and atrial fibrillation development.

For these reasons, there is increasing interest in physiological pacing techniques that directly activate the specialized conduction system. There are two main methods for conduction system pacing: 1) His Bundle Pacing (HBP) 2) Left Bundle Pacing (LBP) HBP has gained prominence. Multiple studies have demonstrated the feasibility and clinical benefits of this technique.

Despite being a physiological modality of pacing, HBP has some limitations, including difficulty identifying the precise location of the His bundle, which is only approximately 1 to 2 mm; a high or unstable pacing threshold in 10% of patients;[1-3] low R-wave amplitude or large atrial signals making under-sensing or over sensing and resultant pacemaker malfunction; damage to the His bundle during implantation; heart block distal to pacing; and potential limitations in long-term performance.

In addition, higher capture thresholds at implant compared with Right ventricular (RV) pacing and concerns over increasing long-term capture thresholds, resulting in reduced battery longevity.

Moreover, the His-SYNC study showed that QRS duration cannot be normalized in almost one-half of the patients with LBBB, suggesting that block if present cannot be overcome with HBP in this subset of patients.[4]

To overcome these problems, while preserving the concept of stimulation of the cardiac conduction system, techniques for pacing the left bundle branch (LBB) have recently emerged as an alternative method of conduction system pacing to have better physiological pacing with improved stability and better long-term pacing thresholds.

The hypothesis for HBP to correct LBBB is that increased pacing output penetrates the LBBB region beyond the area of the block and hence corrects LBBB by directly exciting the LBB.[5]

Huang et al.[6] first reported direct LBB pacing (LBBP) during pacemaker implantation for HBP in a patient with heart failure and LBBB. Standard HBP at very high output (10 V) failed to correct LBBB. The pacing tip was then advanced toward the ventricle, and LBBB resolved at a low pacing capture threshold (0.5 V). In addition to a stable pacing threshold, the patient experienced a significant reduction of heart failure symptoms with pacing. The LV ejection fraction increased from 32% to 62%, and LV volume decreased.

The obvious advantage of LBBP is that the pacing site can be distal to the pathological or vulnerable region in the conduction system[6-7] (e.g., the AV node, His bundle, and proximal LBB). Moreover, the approach of the transventricular septal technique described earlier makes LBBP easier to perform compared with HBP implantation,

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with less precision needed for lead placement.[8,9] Initial investigations in LBBP raised several potential implications in pacing therapy practice. First, LBBP has the potential of being an alternative to conventional CRT via biventricular pacing in patients with heart failure with ventricular dyssynchrony, and it may be an optimal choice for patients with typical LBBB. A recent study by Zhang et al.[10] demonstrated not only LBBB correction and ventricular electric and mechanical resynchronization but also a significant improvement in clinical outcomes by LBBP in 11 consecutive CRT-indicated patients.

In patients with systolic heart failure with no pacing indication and narrow QRS intervals, CRT is deleterious. Accordingly, LBBP or HBP may be better choices because they use the native conduction system for better ventricular synchrony, whereas CRT causes ventricular dyssynchrony due to pacing at 2 non- physiological sites.[11]

Whether LBBP is equal to or better than conventional CRT via biventricular pacing needs to be confirmed in prospective randomized clinical trials. Additionally, whether LBBP plus LV epicardial pacing through the coronary sinus would be better than either LBBP alone or conventional biventricular pacing is an intriguing concept, which also needs further study.

Although the early studies of LBBP showed technical advantages and clinically promising findings, there is still much uncertainty that needs to be addressed. These include the short- and long-term safety of the procedure, efficacy, and appropriate patient selection.

The long-term safety of this technique is not adequately studied, as it has been widely used only since 2017, with no prospective registries.

There are several procedural complications that can occur with pacing in this area of the heart, such as LV perforation from advancing the pacing through the septum. If the pacing lead tip of LBBP remains in the LV chamber, the potential for thrombus theoretically exists.

Methods to prevent this complication have been proposed,[9] but more widespread use of this technique is needed to estimate the true risk. Multiple attempts at lead placement or manipulation within the septum may cause local tissue damage, RBB injury), and potential injury of the septal artery. Although lead repositioning of the RV pacing implantation is relatively common, the number of LBBP lead repositioning attempts that can be performed safely should be studied.[9]

The criteria for LBBP implantation and the specific target location are developing. As discussed previously, LBBP is well-suited as a potential alternative to CRT in patients with typical LBBB. However, it is unknown which patients with heart failure are best suited for LBBP, compared with either HBP or conventional CRT.

The systems used for HBP or LBBP were designed for RV pacing, with no dedicated leads, delivery tools, or sheaths specifically for LBBP. Thus, from a technical perspective, to facilitate LBBP with high reliability and safety, further advances in delivery sheaths and leads are needed.[5]

Case vignette

I will present the first case of LBB pacing performed at Tehran Heart Center in 2020. A 65-year-old lady with complete heart block, normal coronary arteries, and LVEF of 45%. In the image below you can find a narrow-paced QRS complex, during the procedure RV septogram was performed in Left anterior oblique (LAO) view to make sure penetration of ventricular lead into the septum. (Figure 1 & Figure 2, Video 1). Fortunately, after the implantation, the RV lead threshold was 0.5 mv. (to get more information about the case scenario see cardiocase.com case#136).

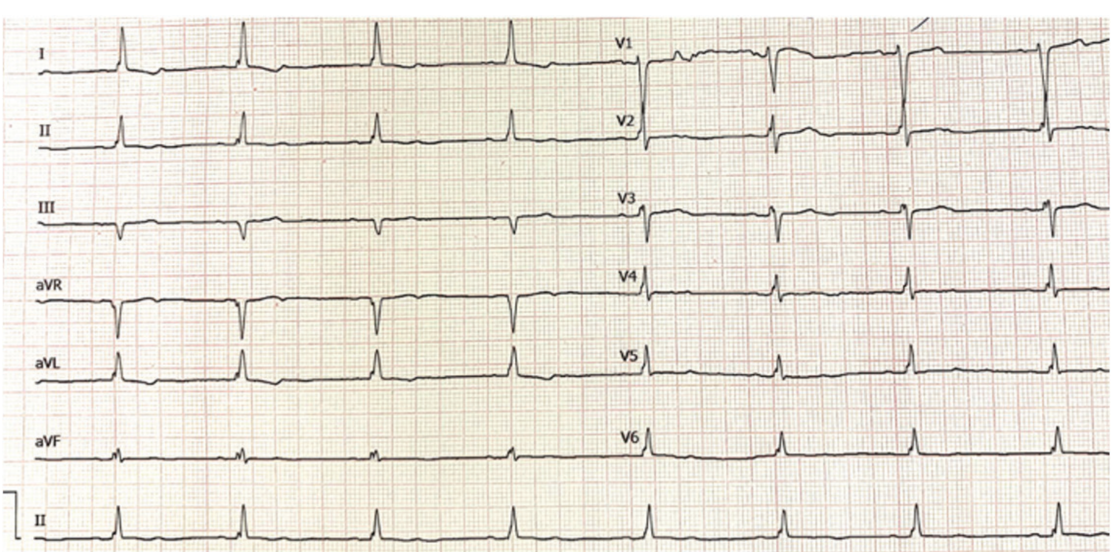

Figure 1. Electrocardiogram shows narrow-paced QRS complex

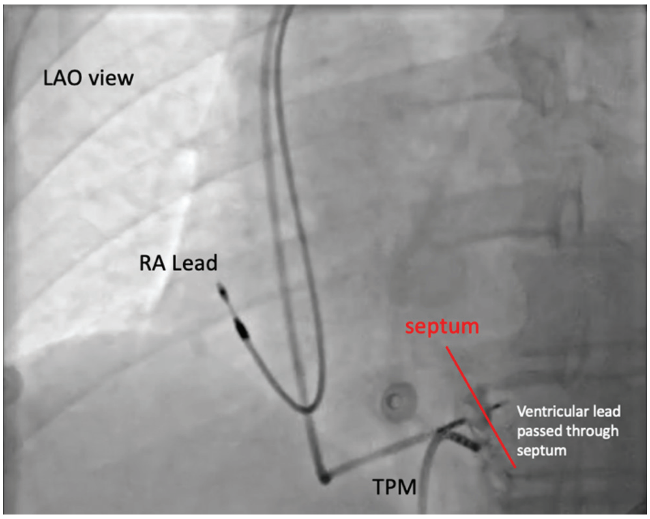

Figure 2. RV septogram in LAO view shows penetration of ventricular lead into the septum.
LAO, Left anterior oblique; RA, Right atrium; TPM, Temporary pacemaker

Conclusion

The site of LBBP bypasses the most vulnerable region in the conduction system, and LBBP usually generates a narrow-paced QRS complex and fast LV activation time, with a low, stable pacing capture threshold. As a new emerging pacing therapy, LBBP has the benefit of a physiological pacing therapy that avoids many of the limitations of HBP or RV pacing.

In the future, with more implantation of LBP, new techniques would develop and potential complications would be clarified.

To watch the following video, please refer to the relevant URL:

https://jthc.tums.ac.ir/index.php/jthc/article/view/1779/1025
Video 1. RV septogram in LAO view shows sure penetration of ventricular lead into the septum.
LAO, Left anterior oblique; RA, Right atrium; TPM, Temporary pacemaker

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