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ADVANCED

CASE REPORT: CLINICAL CASE

Permanent Bi-Bundle Pacing in a Patient With Heart Failure and Left Bundle Branch Block

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ABSTRACT

Left bundle branch pacing (LBBP) is effective in patients with heart failure, left ventricular ejection fraction (LVEF) of ≤35%, and a widened QRS complex. LBBP leads to iatrogenic incomplete right bundle branch block (iRBBB). Bi-bundle pacing can resolve iRBBB, further narrowing the QRS duration, and may improve LVEF. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:101688) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

A 60-year-old woman with heart failure (HF) and left ventricular ejection fraction (LVEF) of 30% presented with shortness of breath. On presentation, she reported swelling of the ankles and 2-pillow orthopnea. She had a jugular venous pressure of 15 centimeters, 2+ pitting edema bilaterally up to the midshin, and mild crackles in bilateral lung bases. She was using optimal tolerated medical therapy available (carvedilol 12.5 mg twice daily, perindopril 5 mg daily, spironolactone 25 mg daily, and furosemide 40 mg daily), yet she remained in NYHA functional class III. An electrocardiogram (ECG) showed a left bundle branch block (LBBB) with a QRSd of 150 ms (Figure 1).

LEARNING OBJECTIVES

- To understand the role of bi-bundle pacing in resolving iatrogenic RBBB.
- RBBP may be beneficial in patients with broad RBBB who have conventional cardiac resynchronization therapy pacing indications.

MEDICAL HISTORY

The Patient had been an ultra-marathon runner 9 months before her initial symptoms of shortness of breath, lower extremity pitting edema, and orthopnea. She had no history of diabetes, hypertension, thyroid disease, or renal failure. Coronary angiography showed normal epicardial vessels, reduced left ventricular (LV) function (±30%), dilated LV (LVEDD = 61 mm, LVEDV = 121 mL/m^2, and LVESD = 87 mL/m^2) (Figures 2 and 3). She received a diagnosis of nonischemic dilated cardiomyopathy.

DIFFERENTIAL DIAGNOSIS

Although the patient did not describe any new or worsening symptoms, the ECG findings and reduced ejection fraction suggested interventricular desynchrony in the setting of congestive heart failure. Cardiac resynchronization therapy (CRT) was now

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ABBREVIATIONS AND ACRONYMS

BBP = bi-bundle pacing

CRT = cardiac resynchronization therapy

ECG = electrocardiogram

HF = heart failure

LBBB = left bundle branch block

LVEF = left ventricular ejection fraction

RBBB = right bundle branch block

indicated because HF was not optimized with medical therapy alone.

INVESTIGATIONS

After approval by the hospital review board and the patient's consent, a venogram was performed to elucidate the cephalic, axillary, and subclavian vein anatomy. Three guidewires were passed down to the inferior vena cava (IVC). The active fixation atrial lead was first placed at the right ventricle (RV) apex as a back-up pace lead in case of a complete heart block (CHB) during either LBBP, RBBP, or both. The RBB was localized using an intentional RBB bump to cause CHB as we had the RA lead in the RV as a back-up.

MANAGEMENT

The RBBP was achieved using the Selectra 3D 55-mm guide and the helix was fixated as per usual RV apex pacing without septal lead deployment.

The LBBP was performed as per standard reported technique and confirming LBBP versus] LV myocardial pacing. The nondeflectable guide (Selectra 3D 55-mm curve, Biotronik) was passed down over the wire within a 9-F short sheath. The guide and the guidewire were turned clockwise from the RA into the RV, the wire was removed, and the guide was turned clockwise to abut the RV septum. The lead was prepared by 8 clockwise turns and then the outer coil by 8 turns of the green stylet guide to increase the tension. The lead was then advanced to the RV septal endocardium, contrast medium being injected in the left anterior oblique 30° view to confirm that the guide was abutting the RV septum. Unipolar pacing at 5 V at 1.00 ms produced a "W" pattern in V_1, and negative and positive QRS morphologies in aVR and aVL leads, respectively. The lead was turned into the septum with pacing to confirm the LBB capture (LBBP) as evidenced by: 1) incomplete RBBB pattern (IRBBB) in V_1 with QRSd = 110 ms; 2) constant stimulus to peak V_6 stimulation to peak V_6) = 67 ms across high (5.0 V) to low (1.0 V) pacing thresholds; and 3) interpeak interval from peak V_6 to peak V_1 (r'-wave prime in V_1) = 45ms.

Once the LBBP was confirmed during unipolar pacing, the stylet was then pulled back. The guide was then retrieved approximately 2 to 3 centimeters, and pacing stability was reconfirmed by bipolar capture. The guide was slit and removed, followed by total withdrawal of the stylet (**Figure 4**). After bi-bundle pacing, the atrial lead was repositioned from the RV apex to the RA.

ACUTE PACING PARAMETERS AND ATRIOVENTRICULAR DELAY.

1. BBP: RV wave = 9.7 mV; impedance = 690 Ω; threshold = 0.6 mV at 0.5 ms.
2. LBBP: RV wave = 7.6 mV; impedance = 672 Ω; threshold = 0.8 mV at 0.5 ms.
3. AVI = 80 ms during atrial sensing and simultaneous BBBP.

The following were the most important observations:

- LBBP resulted in RBBB morphology (V_1) QRSd of 110 ms from a baseline of 150 ms (**Figure 5**).
- RBBP showed LBBB (V_1) morphology with similar baseline morphology, but narrower QRSd (125 ms) compared with baseline LBBB-QRSd = 150ms.
- BBP depicted normal QRS morphology (V_1) with rS and QRSd of 90 ms (**Figure 6**).

FIGURE 1 Baseline Left Bundle Branch Block, QRS Duration = 150 ms

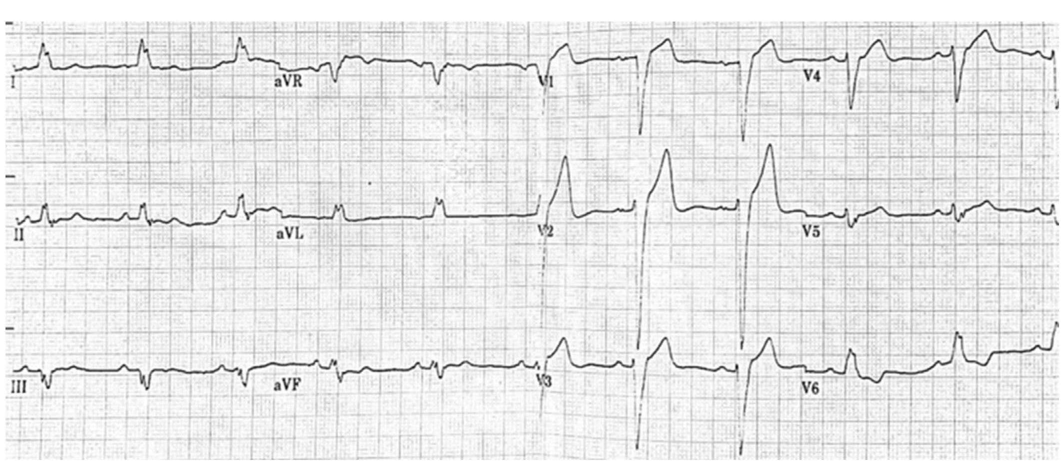

FIGURE 2 Echocardiogram Before Bi-Bundle Pacing

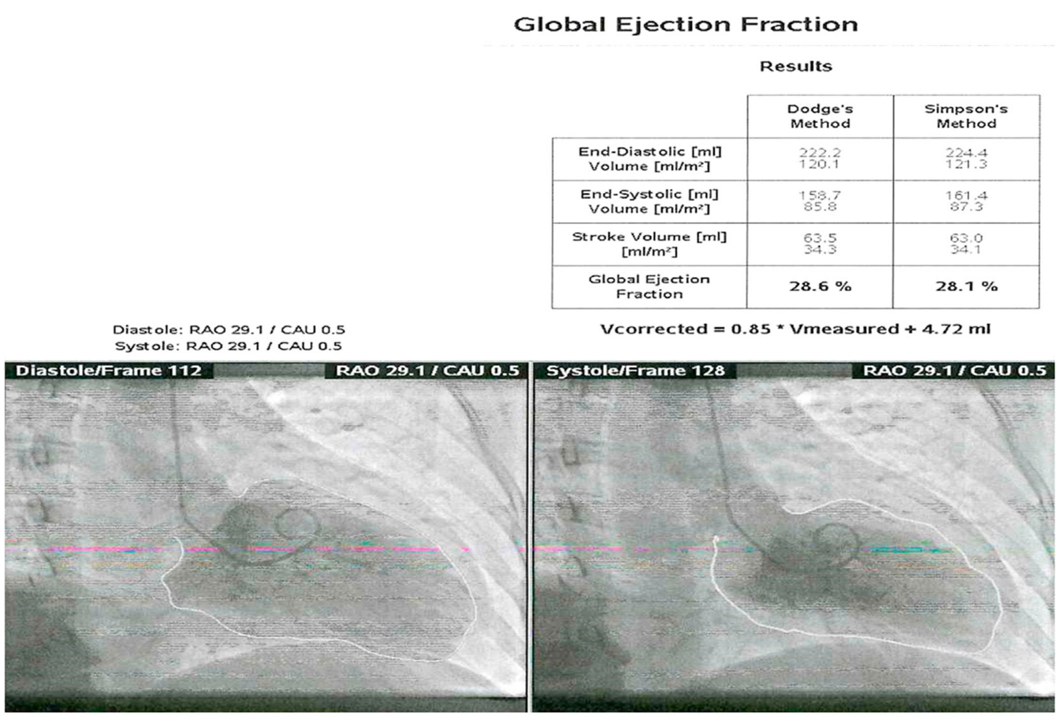

FIGURE 3 Echocardiogram After Bi-Bundle Pacing

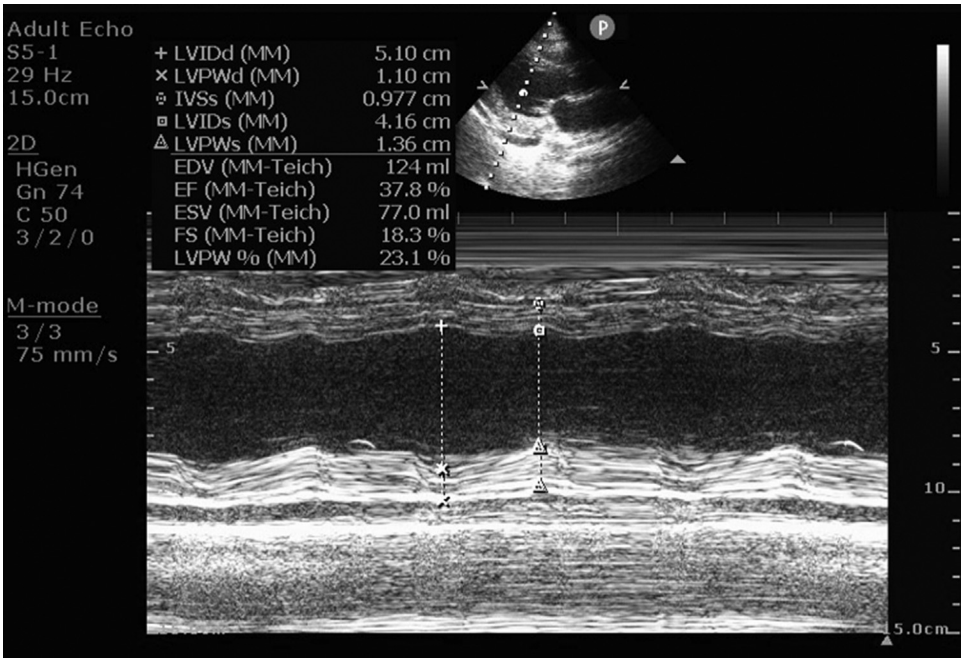

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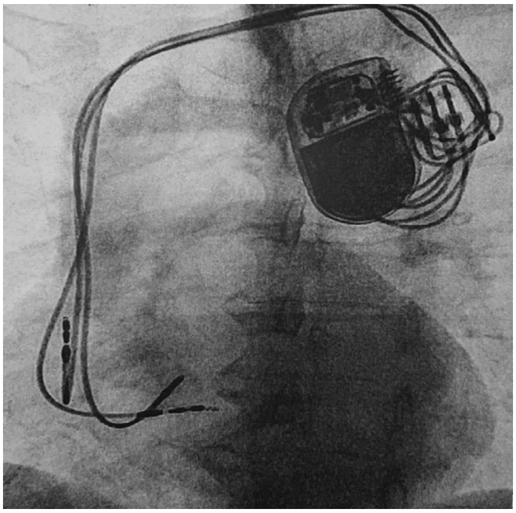
FIGURE 4 **Left Anterior Oblique View Showing Atrial, Left Bundle Branch Pacing, and Right Bundle Branch Pacing Leads**



DISCUSSION

Treatment of HF with CRT has shown a major reduction in mortality, hospitalization, and improved quality of life.[1] Despite these advantages, CRT has significant limitations, with 30% to 40% of patients not deriving the desired response depending on the prespecified clinical expectations.[2] Biventricular pacing (BVP) is not physiological and does not entirely reverse the desynchrony. Compared with His pacing, LBBP has better lead stability and a good at-implant pacing threshold.[3,4]

LBBP may be used as an alternative to conventional CRT or even as a primary option for patients with standard CRT criteria. However, LBBP does cause iatrogenic RBBB, with no data yet on the long-term outcome, for patients with HF and RBBB at baseline. The localization of RBB was done by intentional bumping of the RBB. Intentional bumping should generally be avoided; however, in this case it recovered as expected, and the RBB potential was then confirmed, although LBBP resolving the RBB delay pattern has not been proved to be superior, and masking of the RBB could also be done via anodal capture and optimizing. However, it is possible that simultaneous biventricular depolarization corrects desynchrony and may be responsible for the improvement in LVEF and left ventricular end-diastolic/systolic diameter. The narrow QRS and normal morphology may be beneficial in improving on the 30% to 40% nonresponder rates associated with standard CRT pacing. With resynchronization of LBBB or RBBB, the aim is to restore normal electrical conduction, and narrowing of the QRS is a good parameter to predict better response.[5-8]

FOLLOW-UP

The patient was seen 4 weeks after implantation. The wound healed well, and the pacing parameters remained stable. The LVEF increased from 30% to

FIGURE 5 **Left Bundle Branch Pacing Only, QRS duration = 110 ms**

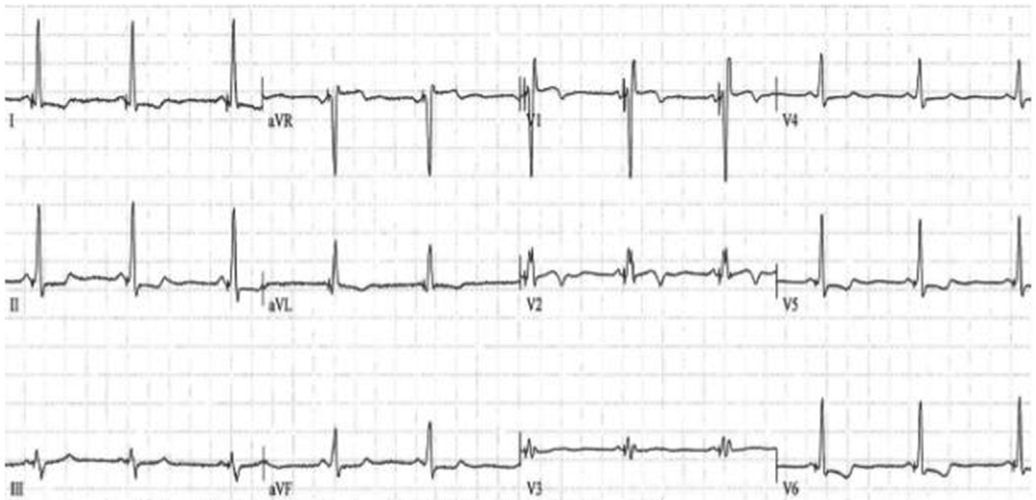
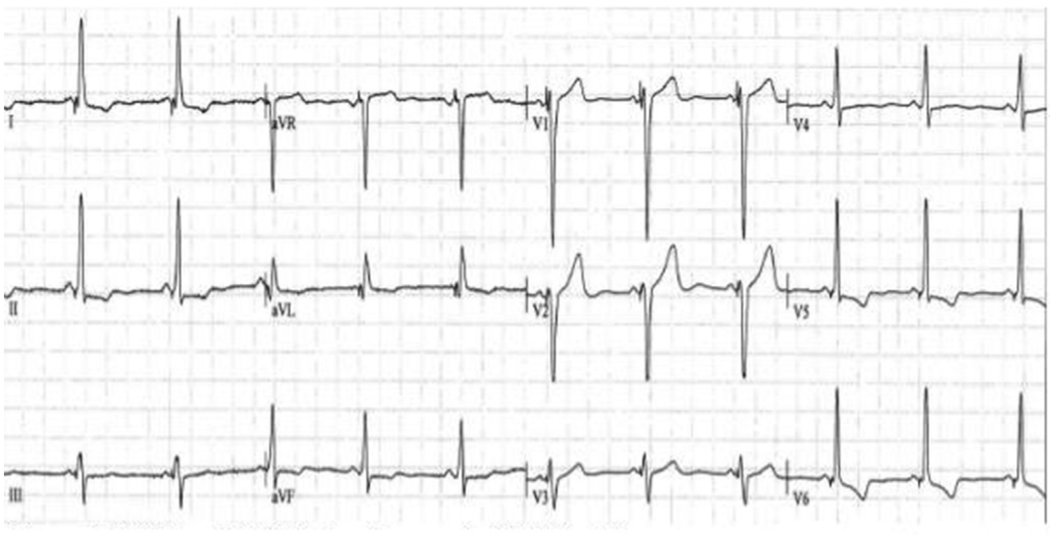


FIGURE 6 Left Bundle Branch Pacing and Right Bundle Branch Pacing Simultaneously, QRS Duration = 90 ms



38%, and left ventricular end-diastolic dimension (LVEDD) decreased from 61 mm to 51 mm (**Figures 5 and 6**). The pacing threshold parameters remained stable: LBBP, 1.2 V at 0.5 ms; RBBP, 0.8 V at 0.5 ms.

CONCLUSIONS

LBBP tends to cause iatrogenic RBBB, which can be resolved with permanent bi-bundle pacing. Resolution of iRBBB is possible using anodal capture during LBBP, but dual-lead pacing gives leverage of RBBP only as well as BBP. Programming is potentially easier with BBP with further QRSd narrowing, which may expedite LVEF improvement.

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KEY WORDS acute heart failure, cardiac resynchronization therapy, chronic heart failure, secondary prevention, systolic heart failure