A case of applying left bundle branch pacing combined with atrioventricular node ablation to treat atrial fibrillation-induced heart failure

Lahati HA, Li-Yun HE✉, Lei LI✉, Jiang-Li HAN, Shu-Wang LIU, Yuan ZHANG, Wei XU, Wei GAO

Department of Cardiology and Institute of Vascular Medicine, Peking University Third Hospital, NHC Key Laboratory of Cardiovascular Molecular Biology and Regulatory Peptides, Key Laboratory of Molecular Cardiovascular Science, Ministry of Education, Beijing Key Laboratory of Cardiovascular Receptors Research, Beijing, China

✉ Correspondence to: hly26@126.com; dr_lilei@126.com
https://doi.org/10.11909/j.issn.1671-5411.2021.06.010

The core treatment of rapid arrhythmia-induced heart failure (HF) is to control the ventricular rate to an optimized lower level, which is usually achieved with various anti-arrhythmic drugs. However, arrhythmias may not respond well to pharmaceutical treatment for various reasons. Iatrogenic atrioventricular (AV) node ablation needs to be performed under these extreme conditions to lower the patient’s heart rate. Moreover, the simultaneous pacing mode after AV node ablation is of great importance to the prognosis of HF. Left bundle branch pacing (LBBP) is a novel method that has been recently reported to achieve more effective ventricular resynchronization by delivering physiological pacing. Here, we report a successful case of a 62-year-old man who had recurrent atrial flutter and fibrillation and did not respond well to pharmacotherapy or radiofrequency ablation. Iatrogenic third-degree AV block and LBBP implantation were performed for patient after full consideration. At the one-month follow-up after the procedure, the patient’s clinical outcome and cardiac function by echocardiography improved significantly.

A 62-year-old man with well-controlled hypertension and type 2 diabetes mellitus was admitted because of paroxysmal palpitation for seventeen months and new-onset dyspnea for one week. Seventeen months ago, he began to feel palpitations, and his pulse rate was approximately 180 beat/min. He went to the Emergency Room (ER), and the 12-lead electrocardiogram (ECG) examination revealed atrial flutter with a rapid ventricular rate. The patient’s serum potassium and magnesium levels were normal. Coronary artery angiography later showed no stenosis in any of the main coronary arteries. Radiofrequency ablation was successfully performed, after which his symptoms were relieved, and he was discharged with oral amiodarone and metoprolol to maintain sinus rhythm.warfarin was prescribed as an anticoagulant since his CHA2DS2-VASc score was 2. Thirteen months later, the patient suffered from palpitation again, and the ECG verified atrial flutter. Electrophysiological examination confirmed typical tricuspid isthmus-dependent atrial flutter, and linear ablation on the tricuspid isthmus was successfully performed. For one year after the repeat ablation, the patient was free from palpitation. Seven days before this admission, he started to have palpitations, with a sustained pulse rate of 130–150 beat/min and chest pain lasting for 3–5 min with spontaneous remission. He gradually developed dyspnea, dizziness, and nausea after 500 meters of walking and even paroxysmal nocturnal dyspnea. The ECG performed in the ER revealed atrial fibrillation (AF) with intraventricular block (left bundle branch) and a heart rate of approximately 170 beat/min. Echo showed enlargement of both atria: left atrial area of 24 cm²; left atrial diameter of 42 mm; right atrial area of 24 cm²; left ventricle end-diastolic dimension of 45.7 mm; and left ventricle ejection fraction (LVEF) of 48%.
Physical examination on admission revealed blood pressure of 133/82 mmHg, pulse of 130 beat/min, and heart rate of 160 beat/min. Engorgement of the jugular veins and rales on the lungs were apparent; bilateral cardiac enlargement was observed, and rapid and irregular pulses and heart sounds were detected on auscultation. No edema was detected in either leg.

Blood tests showed elevated N-terminal fragment of the BNP precursor (1,862 pg/mL) and D-dimer was normal. Chest X-ray showed enlarged cardiac borders and congestion in both lungs. In view of these results, the patient was diagnosed with acute HF with arrhythmia, i.e., paroxysmal AF, and since AF with a fast ventricular rate was sustained over one week, the cause of patient’s HF was presumed to be tachycardia cardiomyopathy. Accordingly, he was given oxygen, diuretics, and nitrates to treat HF. Most importantly, to control patient’s heart rate, amiodarone, digoxin, and esmolol were given successively, yet heart rate was maintained at approximately 150 beat/min, and the symptoms of dyspnea were aggravated. Considering tachycardia to be the “culprit” of acute HF, and it did not respond to antiarrhythmic drugs, the patient was indicated for electrical conversion. After transesophageal echocardiography confirming that there was no thrombus in the left atrium or auricle, we performed 150–200 J sync direct current cardioversion three times but could not convert the patient to sinus rhythm.

Because the patient underwent radiofrequency ablation twice and still experienced recurrence and echo showed enlargement of both atria, indicating that there was a good chance that he would not respond well to another ablation therapy, we ultimately decided to perform ablation of the AV node to generate iatrogenic third-degree AV block and implantation of a pacemaker. Since the patient was already experiencing HF, the traditional pacing mode might deteriorate the HF because of the anti-physiological pacing mode. In addition, the intraventricular bundle is an anatomical structure with longitudinal separation, which does not affect selective pacing. We applied novel LBBP (after-procedure parameters: QRS interval of 118 ms, QRS time to peak of 66 ms, PV interval of 32 ms, pacing threshold of ring electrode of 5V). The preprocedural ECG (Figure 1) showed AF with a rapid ventricular rate and intraventricular aberrant conduction. Implantation was achieved by the transventricular septum approach with a single electrode. During implantation, the unique transition of the paced QRS morphology and pacing parameter changes were monitored. A guidewire was sent to the right ventricular outflow tract after routine puncture of the axillary vein. First, a 3830 electrode was used to map the His bundle, as shown in Figure 2. After fluoroscopic evaluation, the electrode was then placed approximately 1–2 cm from the apex of the previously marked His bundle, at which the paced QRS complex showed a “W” pattern in lead V1 (Figure 2). Then, we fixed the lead both trans- and intra-septally by using 15–20 clockwise torque turns, and

![Figure 1 Preprocedural 12-lead electrocardiogram. Atrial fibrillation with rapid ventricular rate (100–150 beat/min) and intraventricular aberrant conduction.](http://www.jgc301.com;jgc@jgc301.com)
ECG showed that the notch at the nadir of the aforementioned “W” pattern gradually ascended up and formed an R wave and right bundle branch pacing morphology, as shown in Figure 3, confirming that the left bundle branch had been reached. Since we successfully paced the LBBB, the AV node was located fluoroscopically (Figure 4), and successful pacing after ablation was confirmed (Figure 5). The postprocedural ECG is shown in Figure 6. After the procedure, the patient recovered to a heart rate of approximately 70 beat/min, and patient’s cardiac function simultaneously improved significantly. At the one-month follow-up after the procedure, the patient’s clinical outcome had significantly improved, as the NYHA (New York Heart Association) class was enhanced from IV to I and LVEF improved to 68% by echocardiography.

In this case, the patient did not respond to first-line drugs or electric cardioversion to control the AF ventricular rate. Although it is possible to convert AF to sinus rhythm by radiofrequency ablation, the reoccurrence rate of AF is high in patients with a significantly enlarged atrium, similar to this patient. Therefore, radiofrequency ablation of the AF was not performed. According to the latest guidelines and perspectives, for patients with recurrent AF, it is recommended to apply the AV node ablation combined with pacemaker therapy. Atrial ventricular node ablation is an irreversible and destructive procedure, as after the ablation, the patient develops iatrogenic third-degree AV block and pacemaker dependency. In terms of pacing mode, since the pacing electrode of a single-chamber pacemaker is fixed on the right ventricular apex or the right ventricular outflow tract, which has deleterious effects on ventricular desynchrony, biventricular pacing is indicated. To achieve the absolute goal of biventricular pacing, it is suggested that AF patients with HF choose cardiac resynchronization therapy (CRT). Although traditional CRT can improve left and right ventricular systolic synchrony and cardiac function, its application is limited due to the high cost, long procedure time, complexity of the procedure, and comparatively higher no-response rate. At the same time, the left ventricular epicardial pacing of CRT changes the normal sequence of left ventricular electrical activation. Continuous epicardial pacing can lead to an increase in transmural dispersion of repolarization and the occurrence of malignant ventricular arrhythmias.
LBBP is technology that has emerged in the field of cardiac pacing in recent years. In 2017, Huang, et al.[7] reported the first case of direct LBBP during pacemaker implantation for a patient with HF and LBBB.

Figure 3  **Left bundle branch pacing.** Cardiac electrogram recording the notch at the nadir of the aforementioned “W” pattern ascended up and formed an R wave and right bundle branch block morphology (black arrow indicates the right bundle branch block morphology in lead V1).

Figure 4  **Atrioventricular node ablation.** Cardiac electrogram recording successful left bundle branch pacing after atrioventricular node ablation.
which involved locating and implanting the pacing electrode on the left bundle branch. The pacing site fully conforms to the physiological characteristics of cardiophysiology, which makes it one of the most “electrophysiologically friendly” pacing sites. Another significant advantage of LBBP is that the pacing site can be distal to the pathological or vulnerable region in the conduction system, which makes it a safer option for patients without AV block. At the same time, in patients with poorly controlled AF, as in our case, LBBP bypasses the pathological region in the iatrogenic AV block after ablation. LBBP has a lower and stable capture threshold because of the pacing site in septal tissue compared with His bundle pacing, which greatly increases the longevity of the pacemaker. Last, the procedure of LBBP implantation is simpler and faster than that of His bundle pacing because of its fascicular distribution. A recent single-center retrospective study by Li, et al. proved the feasibility, safety, and acute effect of LBBP in AV block patients. In a recent report by Su, et al., 632 consecutive pacemaker patients with attempted LBBP were followed up for a mean time of 18.6 ± 6.7 months, and the left bundle branch capture thresholds were 0.65 ± 0.27 mV at 0.5 ms at implantation and 0.69 ± 0.24 mV at 0.5 ms at two-year follow-up. The QRS duration dropped significantly in patients with left bundle branch block, and postimplantation LVEF improved in patients with QRS ≥ 120 ms, which was also confirmed in this reported case. This observational study suggests that LBBP is a promising pacing mode with high success rates and low complication rates during long-term follow-up and is expected to be a reliable method for physiological pacing for patients with HF pacing indications. However, more randomized controlled multicenter trials need to be performed to confirm the long-term safety and efficacy of this procedure.

In conclusion, we successfully attempted LBBP combined with AV node ablation to treat AF with a rapid ventricular rate and provided a promising method to treat severe AF that does not respond well to pharmacotherapy or radiofrequency abla-

Figure 5  Atrioventricular node ablation. The X-ray shows tip of the pacing lead located at the left bundle branch area (white arrow) and the ablation wire located at the atrioventricular node (black arrow) under the LAO 45° view of the X-ray. LAO: the left anterior oblique position.

Figure 6  Postprocedural 12-lead electrocardiogram. Cardiac electrogram recording III° atrioventricular block and successful pacing of the left bundle branch at a rate of 70 beat/min.
tion, especially for a HF patient at this age. Although it is not a first-line therapy because this is an iatrogenic procedure, individualized treatment should be considered under complex circumstances. However, future studies should be performed to demonstrate the long-term outcomes of this application.

ACKNOWLEDGMENTS

This study was supported by the National Natural Science Foundation of China (No.31700674). All authors had no conflicts of interest to disclose.

REFERENCES

[1] Chung MK, Refaat M, Shen WK, et al. Atrial fibrillation: JACC council perspectives. *J Am Coll Cardiol* 2020; 75: 1689–1713.

[2] January CT, Wann LS, Calkins H, et al. 2019 AHA/ACC/HRS focused update of the 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society in Collaboration With the Society of Thoracic Surgeons. *Circulation* 2019; 140: e125–e151.

[3] Bank AJ, Gage RM, Burns KV. Right ventricular pacing, mechanical dyssynchrony, and heart failure. *J Cardiovasc Transl Res* 2012; 5: 219–231.

[4] Prabhu S, Taylor AJ, Costello BT, et al. Catheter ablation versus medical rate control in atrial fibrillation and systolic dysfunction: the CAMERA-MRI study. *J Am Coll Cardiol* 2017; 70: 1949–1961.

[5] Doshi RN, Daoud EG, Fellows C, et al. Left ventricular-based cardiac stimulation post AV nodal ablation evaluation (The PAVE study). *J Cardiovasc Electrophysiol* 2005; 16: 1160–1165.

[6] Öztan EE, Szilagyi S, Sallo Z, et al. Comparison of the effects of epicardial and endocardial cardiac resynchronization therapy on transmural dispersion of repolarization. *Pacing Clin Electrophysiol* 2015; 38: 1099–1105.

[7] 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.e1–1736.e3.

[8] Zhang S, Zhou X, Gold MR. Left bundle branch pacing: JACC review topic of the week. *J Am Coll Cardiol* 2019; 74: 3039–3049.

[9] Li X, Li H, Ma W, et al. Permanent left bundle branch area pacing for atrioventricular block: feasibility, safety, and acute effect. *Heart Rhythm* 2019; 16: 1766–1773.

[10] 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.

Please cite this article as: HA L, HE LY, LI L, HAN JL, LIU SW, ZHANG Y, XU W, GAO W. A case of applying left bundle branch pacing combined with atrioventricular node ablation to treat atrial fibrillation-induced heart failure. *J Geriatr Cardiol* 2021; 18(6): 492–497. DOI: 10.11909/j.issn.1671-5411.2021.06.010

http://www.jgc301.com; jgc@jgc301.com

497