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His-Purkinje conduction system pacing and atrioventricular node ablation in treatment of persistent atrial fibrillation refractory to multiple ablation procedures: A case report

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Abstract

In patients with symptomatic atrial fibrillation refractory to optimal medical therapy, atrioventricular node ablation followed by permanent pacemaker implantation is an effective treatment option. A 66-year-old woman with symptomatic persistent atrial fibrillation refractory to multiple ablation procedures was referred to our institution. After optimal drug therapy, the patient still had obvious symptoms. Sequential His-Purkinje conduction system pacing and atrioventricular node ablation were performed. Left bundle branch pacing was used as a backup pacing method if thresholds of His bundle pacing were too high or loss of His bundle capture occurred in the follow-up. At the 6-month follow-up, the European Heart Rhythm Association classification for AF was improved, the score of the Atrial Fibrillation Effect on Quality of Life was enhanced, and the 6-Minute Walk Test was ameliorated. The present case was subjected to His-Purkinje conduction system pacing in combination with atrioventricular node ablation as treatment for a symptomatic persistent atrial fibrillation refractory to multiple ablation procedures, and this procedure alleviated symptoms and improved the quality of life in a short-term follow-up.

Keywords

Atrial fibrillation, His-Purkinje conduction system pacing, His bundle pacing, left bundle branch pacing, atrioventricular node ablation

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Introduction

The mechanisms underlying persistent atrial fibrillation (AF) are complex, and the clinical success rates of catheter ablation are limited even after various ablation approaches.[1,2] Atrioventricular node ablation is generally reserved for AF refractory over all other therapeutic options since the recipients will become pacemaker-dependent. His-Purkinje conduction system pacing (HPCSP) would be an ideal physiologic pacing option to prevent ventricular desynchrony for patients undergoing AVNA. Nowadays, His bundle pacing (HBP) and left bundle branch pacing (LBBP) are two widely used options for HPCSP in clinical practice. This report tries to reveal whether HPCSP (with both HBP and LBBP) in combination with AVNA can alleviate symptoms and improve the quality of life in a persistent AF patient refractory to multiple ablation procedures.

Case report

A 66-year-old woman with symptomatic persistent AF refractory to multiple ablation procedures was referred to our institution. She had a history of hypertension for 25 years and diabetes for 10 years. The patient received radiofrequency ablation for paroxysmal AF about 12 years ago and underwent such a procedure again about 6 years ago due to a recurrence of persistent AF. About 2 years ago, the patient had a recurrence of persistent AF; however, she refused to be treated with ablation. After successful conversion to sinus

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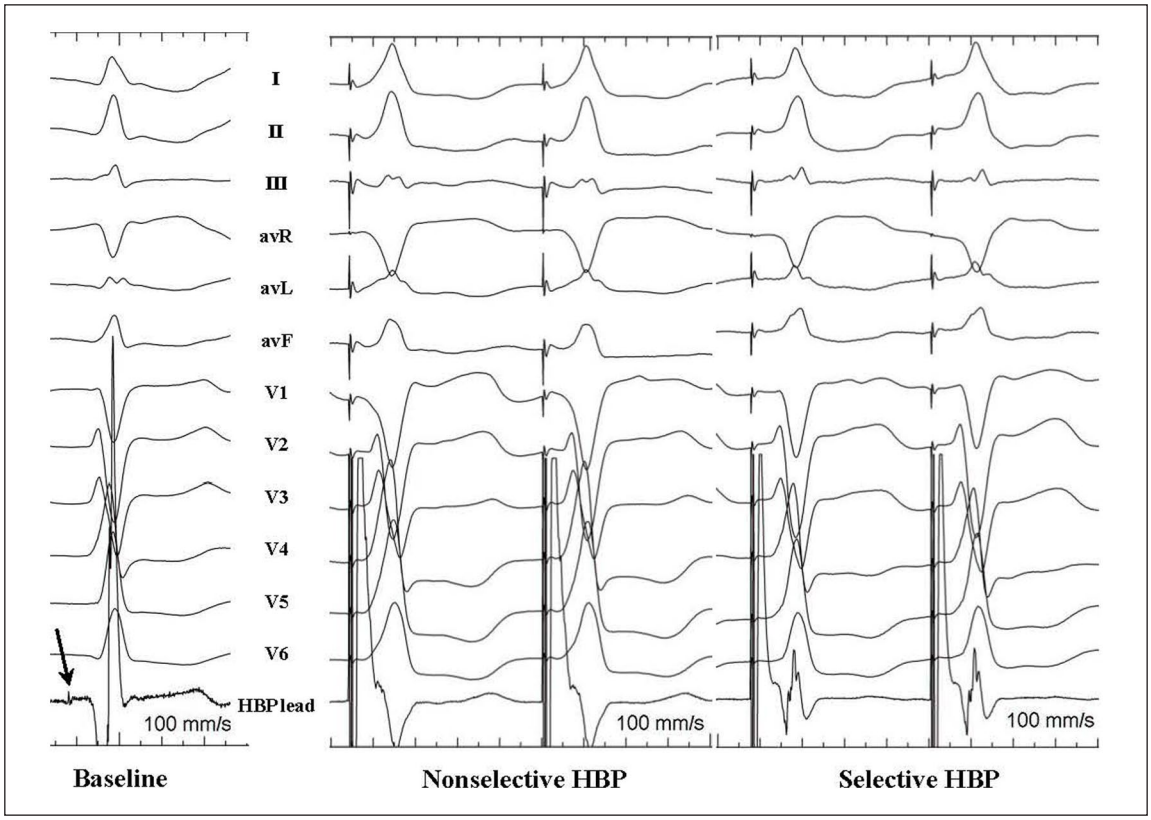

Figure 1. This figure shows 12-lead electrocardiograms and intracardiac electrograms from the His bundle pacing (HBP) lead at baseline and from non-selective HBP (right ventricular septum + His capture) to selective HBP (His capture only). Note His potential at baseline on the pacing lead (arrow).

rhythm by electrical cardioversion, the patient continuously took anti-arrhythmic drugs. However, it was hard to maintain sinus rhythm with medications such as sotalol, amiodarone, and propafenone. The patient was subjected to electrical cardioversion to treat recurrent symptomatic AF several times in the past 2 years. About 1 month ago, the patient had a recurrence of AF again with the symptoms of palpitation, shortness of breath, and fatigue after activity. The patient was afebrile with a heart rate of 120 beats/min, respiratory rate was 20 breaths/min, and blood pressure was 124/95 mmHg. Cardiac ultrasound showed that the anteroposterior diameter of the left atrium, right atrium, the end-diastolic diameter of the left ventricle (LVEDd), and the left ventricular ejection fraction (LVEF) was 46, 54, and 49 mm, and 51%, respectively. The level of human brain natriuretic peptide (BNP) reached 245 pg/mL (reference interval 0–100), and the level of creatinine was 64.8 μmol/L (reference interval 41.0–81.0).

After optimal drug therapy, the patient still had obvious symptoms with persistent AF. The patient refused to receive ablation or electrical cardioversion but agreed to undergo AVNA. Considering the expected high percentage of ventricular pacing, a physiological modality using HPCSP was recommended.

The severity of symptoms, quality of life, and exercise tolerance were evaluated 1 day before the operation. The patient was categorized into class III according to the European Heart Rhythm Association (EHRA) symptom classification for AF.[3] The Atrial Fibrillation Effect on Quality of Life (AFEQT) Questionnaire score[4] was 50.8, and the 6-Minute Walk Test[5] (6-MWT) was 210.0 m.

HPCSP and AVNA were sequentially performed. Permanent HBP was performed as previously described,[6] and LBBP was conducted as a backup for conduction system pacing. After His bundle electrogram was mapped and recorded, an HBP test was performed, which was similar to the criteria previously described.[6,7] The threshold of selective HBP was 1.1 V@1 ms; the impedance was 561 ohms, the sensing was 5.3 mv, and the QRS duration (QRSd) was 112 ms (Figure 1).

Then LBBP was performed as previously described.[8] The lead advancement was stopped until the left bundle branch (LBB) potential was observed. The threshold of LBBP was 0.8 V@0.4 ms; the impedance was 542 ohms, the sensing was 12.7 mv, and the stimulus-QRSend duration (s-QRSend) was 144 ms (Figure 2).

The His lead was inserted into the atrial port, and the LBBP lead into the ventricular port in a dual-chamber

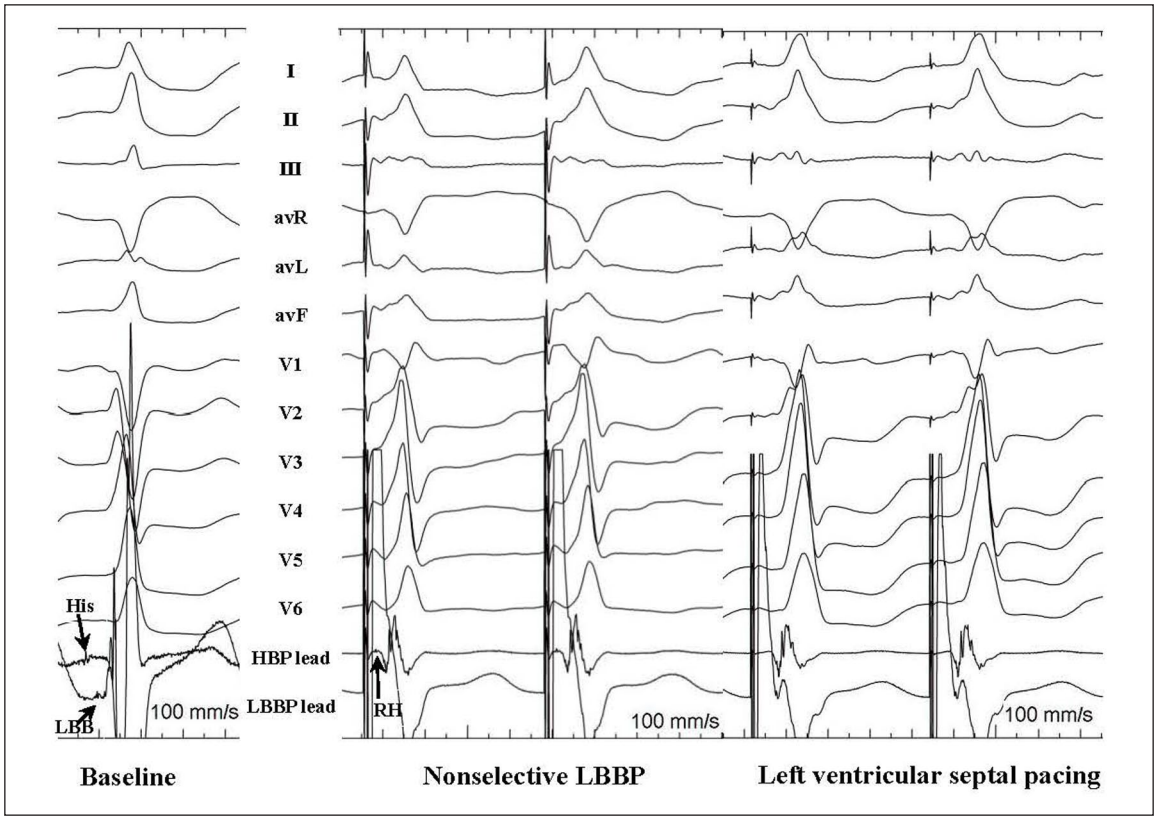

Figure 2. This figure shows 12-lead electrocardiograms and intracardiac electrograms from the left bundle branch pacing (LBBP) lead at baseline and from non-selective LBBP (left ventricular septum + LBB capture) to left ventricular septal pacing (left ventricular septum capture only). Note His and left bundle branch (LBB) potentials at baseline, retrograde His (RH) potential on HBP lead.

pacemaker generator. Temporarily DVI mode was set with a rate of 40 beats/min until the AVNA procedure was completed. AVNA was performed immediately after the successful implantation of the pacemaker (Figure 3). The success of AVNA was evidenced by a complete AV block without change in HBP parameters. The morphology of the QRS complex during HBP was the same before and after AVNA. After the ablation, the pacemaker was programmed to the DDDR mode to ensure that the backup lead would activate immediately in case of the HBP lead failure caused by lead dislodgement or an increase in the pacing threshold. Pacemaker output was adjusted with a voltage safety margin that was double the voltage of the adequate pacing threshold for both leads. Ventricular safety pacing and automatic capture management were turned off. The lower rate for permanent pacing was initially set at 80 beats/min. After the operation, amiodarone and digoxin were stopped, and metoprolol was gradually reduced. Considering this patient has little chance of returning to sinus rhythm and the financial burden, we did not place an atrial lead.

The pacing parameters were stable, and the paced QRSd remained narrow at the 6-month follow-up. The threshold of HBP was 1.4 V@1 ms; the impedance was 473 ohms, the sensing was 6.2 mv, and the QRSd was 114 ms. The threshold

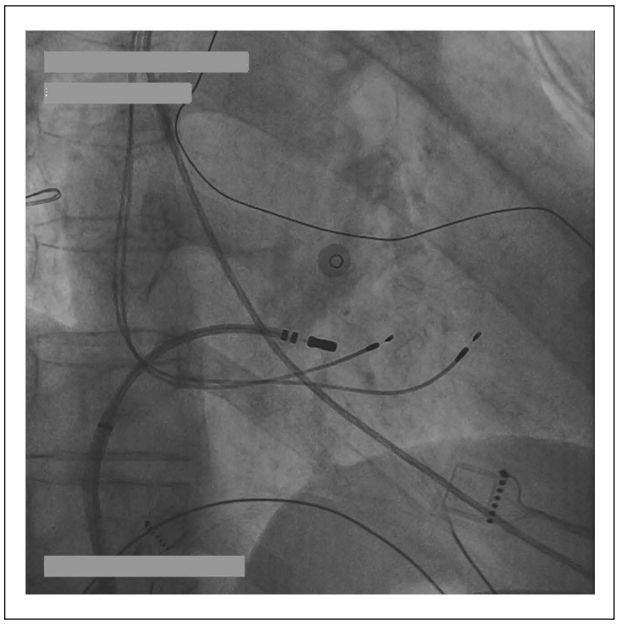

Figure 3. This figure shows the atrioventricular node ablation site and the distance to the tip of His bundle pacing lead (arrow) using fluoroscopic images in the right anterior oblique projection 30°.

of LBBP was 0.7 V@0.4 ms; the impedance was 418 ohms, the sensing was 13.9 mv, and the s-QRSend was 146 ms.

The cardiac ultrasound, BNP, and creatinine levels were tested again at the 6-month follow-up. The level of BNP decreased to 152 pg/mL (reference interval 0–100), and the creatinine level was 74.3 μmol/L (reference interval 41.0–81.0). Cardiac ultrasound showed that the LVEDd was 50 mm and the LVEF was 65%.

The symptoms were released after the operation. At the 6-month follow-up, the EHRA classification was improved to class I, the AFEQT score was enhanced to 73.3, and the 6-MWT was ameliorated to 430.0 m.

At the 1.5-year follow-up, the threshold of HBP elevated to 1.7 V@1 ms; however, the threshold of LBBP remained low at 0.7 V@0.4 ms. There were no complications, such as device infections, dislodgement, and loss of capture during the follow-up. We did not observe sinus rhythm at any point during the follow-up.

Discussion

The present case was subjected to HPCSP in combination with AVNA as treatment for a symptomatic persistent AF refractory to multiple ablation procedures, and this procedure alleviated symptoms and improved quality of life in a short-term follow-up. The mechanism underlying the improvements of AFEQT score, ERHA classification, plasma BNP concentration, and 6-MWT observed at 6-month follow-up are likely multifactorial and may include: maintaining regular ventricular rhythm, improving heart rate control by AVNA, and reducing or withdrawing negative inotropic drugs such as β-blocks.

Although it was possible to convert AF to sinus rhythm by radiofrequency ablation or electrical cardioversion, the recurrence rate of AF was high in this patient, since she had a significantly enlarged atrium, was refractory to multiple ablation procedures, and had a history of failure to maintain sinus rhythm even after several times of electrical cardioversion. In addition, the patient refused to be treated with ablation again. After all, AVNA followed by permanent pacemaker implantation was considered as a last-resort treatment for this patient. HPCSP would be an ideal physiologic pacing option to prevent ventricular desynchrony for this patient, who would become pacemaker-dependent after AVNA. A previous report has shown that permanent HBP post-atrioventricular node ablation significantly improved echocardiographic measurements and New York Heart Association classification and reduced diuretics use for heart failure management in AF patients with narrow QRS who suffered from heart failure with preserved or reduced ejection fraction.[9]

HBP has long been considered the most physiologic pacing method; however, it has some drawbacks. For example, the success rate of HBP remains unsatisfactory,[10] and HBP is limited by increases in pacing thresholds over time. It has been reported that 15% of patients experienced His bundle capture threshold increase by ⩾1 V during long-term follow-up.[11] Another report has shown that more than 5% of patients receiving HBP require lead revision secondary to high thresholds or loss of capture during follow-up.[12] LBBP appears to overcome some limitations of HBP, as a recent large study has shown that LBBP was successful in 618/632 (97.8%) patients, and it had low and stable capture thresholds over long-term follow-up.[13] The advantage of combined primary HBP and backup LBBP is that the backup LBBP lead can still maintain physiologic pacing in case of HBP failure in the future. A further advantage of LBBP is that the lead is close to the ventricular septal myocardium providing backup ventricular septal pacing in case of loss of LBB capture if more distal conduction system disease develops. A previous study reported that combined HBP and LBBP is a feasible approach as a pace and ablate strategy for AF refractory to medical therapy[14]; However, this report did not relate to the quality of life. Although LBBP overcomes the main limitations of HBP, it can bring about right ventricular activation delay, which means it is not as physiologic as HBP. Several questions remain unanswered regarding the long-term safety, lead performance, feasibility of lead extraction, and, most importantly, the long-term clinical outcome of LBBP. A previous report has shown that, in symptomatic AF patients with reduced LVEF and narrow QRS, HPCSP modalities showed superior symptomatic and echocardiographic improvement compared with biventricular pacing after AVNA.[15] Because of these, the authors still consider HBP as the most physiologic pacing method and apply it to this patient. If the implantation of an HBP lead failed in this case, we would consider placing an LV lead for backup. If the cardiac function deteriorates in the future, upgrading the pacing system to LBB-optimized cardiac resynchronization therapy will be considered.

In this report, the threshold of HBP was elevated in this patient during follow-up; in contrast, the threshold of LBBP remained stable and low. It is promising that even if the threshold of HBP is elevated too high in the future, LBBP could still guarantee a conduction system pacing. The benefits and safety profile of the described therapy should further be evaluated in large-scale clinical trials with longer follow-up periods.

Conclusion

This report demonstrated that HPCSP (with primary HBP and backup LBBP) in combination with AVNA alleviated symptoms and improved the quality of life in a short-term follow-up in a persistent AF patient refractory to multiple ablation procedures. Further research is needed to confirm our findings.

Declaration of conflicting interests

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Ethics approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed consent

Written informed consent was obtained from the patient for their anonymized information to be published in this article.

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References

1. Scherr D, Khairy P, Miyazaki S, et al. Five-year outcome of catheter ablation of persistent atrial fibrillation using termination of atrial fibrillation as a procedural endpoint. *Circ Arrhythm Electrophysiol* 2015; 8(1): 18–24.
2. Schreiber D, Rostock T, Fröhlich M, et al. Five-year follow-up after catheter ablation of persistent atrial fibrillation using the stepwise approach and prognostic factors for success. *Circ Arrhythm Electrophysiol* 2015; 8(2): 308–317.
3. Kirchhof P, Auricchio A, Bax J, et al. Outcome parameters for trials in atrial fibrillation: recommendations from a consensus conference organized by the German Atrial Fibrillation Competence NETwork and the European Heart Rhythm Association. *Europace* 2007; 9(11): 1006–1023.
4. Spertus J, Dorian P, Bubien R, et al. Development and validation of the Atrial Fibrillation Effect on QualiTy-of-Life (AFEQT) Questionnaire in patients with atrial fibrillation. *Circ Arrhythm Electrophysiol* 2011; 4(1): 15–25.
5. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med* 2002; 166: 111–117.
6. Vijayaraman P, Dandamudi G, Zanon F, et al. Permanent His bundle pacing: recommendations from a multicenter His bundle pacing collaborative working group for standardization of definitions, implant measurements, and follow-up. *Heart Rhythm* 2018; 15(3): 460–468.
7. Burri H, Jastrzebski M and Vijayaraman P. Electrocardiographic analysis for his bundle pacing at implantation and follow-up. *JACC Clin Electrophysiol* 2020; 6(7): 883–900.
8. Huang W, Chen X, Su L, et al. A beginner's guide to permanent left bundle branch pacing. *Heart Rhythm* 2019; 16(12): 1791–1796.
9. Huang W, Su L, Wu S, et al. Benefits of permanent His bundle pacing combined with atrioventricular node ablation in atrial fibrillation patients with heart failure with both preserved and reduced left ventricular ejection fraction. *J Am Heart Assoc* 2017; 6: e005309.
10. Zanon F, Ellenbogen KA, Dandamudi G, et al. Permanent His-bundle pacing: a systematic literature review and meta-analysis. *Europace* 2018; 20: 1819–1826.
11. Beer D, Subzposh FA, Colburn S, et al. His bundle pacing capture threshold stability during long-term follow-up and correlation with lead slack. *Europace* 2021; 23: 757–766.
12. Vijayaraman P, Naperkowski A, Ellenbogen KA, et al. Electrophysiologic insights into site of atrioventricular block: lessons from permanent His bundle pacing. *JACC Clin Electrophysiol* 2015; 1(6): 571–581.
13. 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(2): e009261.
14. Nam MCY, O'Sullivan P, Tonchev I, et al. His bundle combined with deep septal left bundle branch area pacing for atrial fibrillation prior to atrioventricular node ablation. *J Arrhythm* 2023; 39(1): 27–33.
15. Ivanovski M, Mrak M, Meznar AZ, et al. Biventricular versus conduction system pacing after atrioventricular node ablation in heart failure patients with atrial fibrillation. *J Cardiovasc Dev Dis* 2022; 9: 209.