Deep septal, distal His bundle pacing for cardiac resynchronization therapy

Pugazhendhi Vijayaraman, MD, FHRS

From the Geisinger Heart Institute, Geisinger Commonwealth School of Medicine, Wilkes Barre, Pennsylvania.

Introduction

His bundle pacing (HBP) is a physiologic form of pacing to achieve cardiac resynchronization therapy (CRT) in patients with left bundle branch block (LBBB).[1] The success rates for correcting LBBB with permanent HBP has been reported to range from 52% to 90%.[2,3] Upadhyay and colleagues[4] recently reported that intrahisian block could be demonstrated in the left His or proximal left bundle in 64% of patients with LBBB pattern on electrocardiogram (ECG). In this report, we present a case of successful deep septal distal His bundle pacing to achieve CRT in a patient with LBBB.

Case report

A 74-year-old woman with ischemic cardiomyopathy, chronic atrial fibrillation, LBBB, class III congestive heart failure, and severely reduced left ventricular (LV) ejection fraction of 30% was referred for CRT. Baseline ECG showed a QRS duration of 150 ms (Figure 1). Informed consent was obtained from the patient for CRT-defibrillator implantation with HBP. Following implantation of the right ventricular defibrillator lead, His bundle region was mapped with the SelectSecure pacing lead and C315HIS sheath (Medtronic Inc, Minneapolis, MN). The proximal, mid, and distal His electrograms could be mapped on the right side of the interventricular septum where His-ventricular (HV) intervals of 65, 60, and 50 ms were recorded, respectively (Figures 1 and 2). Despite pacing at high output, LBBB could not be corrected from these sites. Attempts to advance the lead slightly more distally (no local His electrograms) and deep into the septum to reach the distal His region was unsuccessful owing to inability to penetrate the membranous septum. The measured R waves in this location was less than 5 mV. Following this, the sheath and the lead were advanced about 1 cm distally (from distal His location with HV interval of 50 ms, Figure 2). The R waves were 6 mV at this location. There were no His electrograms recorded at this right septal site. The lead was successfully advanced deep into the septum by rapid rotations of the lead. Contrast injection along the right ventricular septum demonstrated the lead depth to be approximately 11 mm. A sharp potential-ventricle interval of 40 ms (distal HV) was recorded at this site (Figure 3). During pacing, nonselective HBP with LBBB correction was noted at 3 V, selective HBP with LBBB correction at up to 1 V, and selective HBP without LBBB correction was observed until loss of capture. An LV lead was placed in a lateral branch of the coronary sinus. Biventricular pacing utilizing the RV defibrillator lead and coronary sinus lead resulted in QRS duration of 148 ms. During HBP with LBBB correction, His-LV interval decreased from 180 ms at baseline to 140 ms, suggesting significant resynchronization and QRS duration was 118 ms, suggesting residual conduction delay. The HBP lead was connected to the atrial port of the CRT-defibrillator and His-optimized CRT was achieved by

KEY TEACHING POINTS

- Deep septal, distal His bundle pacing (HBP) overcomes many of the limitations of traditional HBP for left bundle branch block, as it can correct left bundle branch block (LBBB) at low and stable threshold.
- Distal HBP has the potential to be an effective alternative to cardiac resynchronization therapy.
- We describe an interesting case of deep septal distal HBP to correct LBBB at low output.
- His-optimized left ventricular pacing can be utilized to achieve maximal cardiac resynchronization in patients with incomplete correction of LBBB.

KEYWORDS Cardiac resynchronization therapy; Deep septal pacing; Heart failure; His bundle pacing; Left bundle branch block
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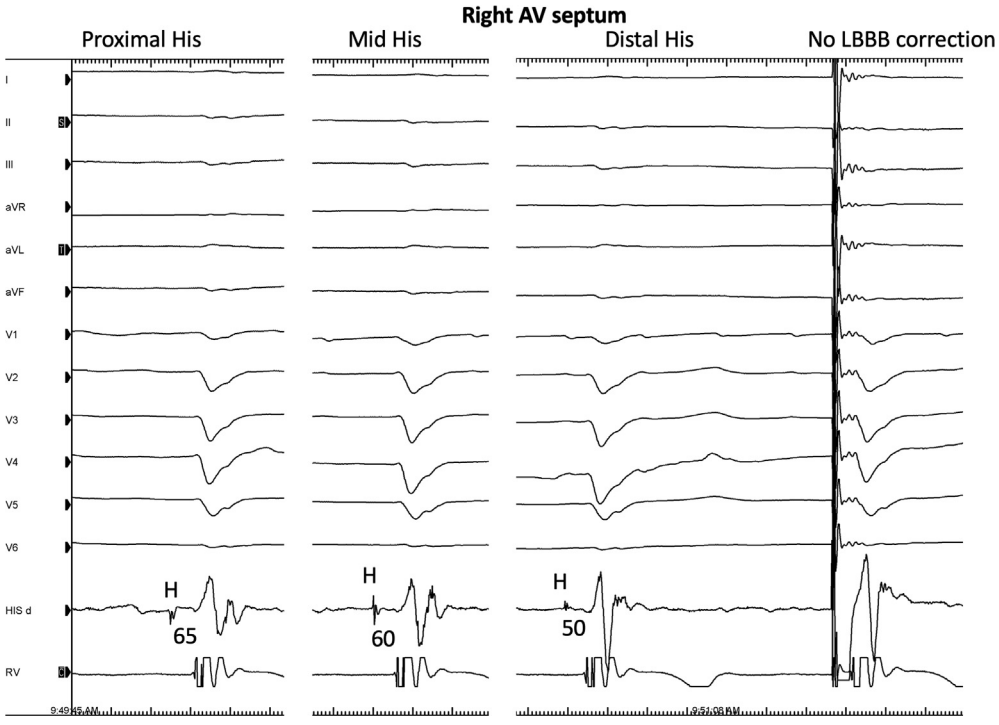

Figure 1 His bundle mapping on the right septum. Twelve-lead electrocardiogram and intracardiac electrograms from the His bundle pacing lead and right ventricle are shown. His (H) to ventricle intervals are 65, 60, and 50 ms in the proximal, mid, and distal His locations on the right side. Pacing from the distal His location did not correct the left bundle branch block (LBBB).

sequential HBP-LV pacing with a delay of 40 ms.[5] The patient's functional class improved to NYHA class II and LV ejection fraction increased to 45% at 3 months.

Discussion

This case report highlights the challenges of HBP to correct LBBB in some patients owing to distal disease. Pacing on the right side His could not correct the LBBB owing to disease in the distal His. It is very difficult to advance the lead beyond the screw in the membranous septum owing to the fibrous nature of the septum. However, it is possible to advance the lead deep into the proximal muscular septum, similar to deep septal pacing in left bundle branch pacing. In this case, the distal HV interval was 40 ms and at near-threshold outputs selective HBP without LBBB correction (QRS identical to baseline) was observed, suggesting the lead tip was positioned slightly proximal to the site of block. These findings and the lack of right bundle branch block pattern during nonselective and selective pacing suggest that the final pacing site was distal His bundle and not proximal left bundle. It is unclear if the distal His bundle can be targeted in all patients with LBBB. It is possible

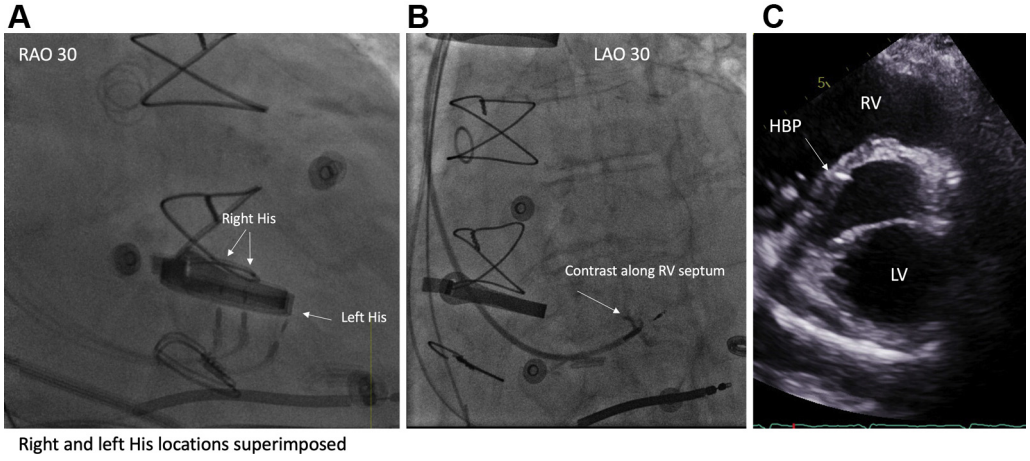

Figure 2 Fluoroscopic and echocardiographic location distal His bundle pacing (HBP). **A:** Right anterior oblique view (RAO 30°) of the mid and distal His locations on the right side are superimposed on the initial implant site of the deep septal distal HBP lead. **B:** Left anterior oblique view (LAO 30°) of the final location of the deep septal, distal HBP lead with contrast demonstrating the depth of the lead. **C:** Echocardiographic demonstration of the lead in the interventricular septum at the level of the mitral valve in short-axis view. LV = left ventricle; RV = right ventricle.

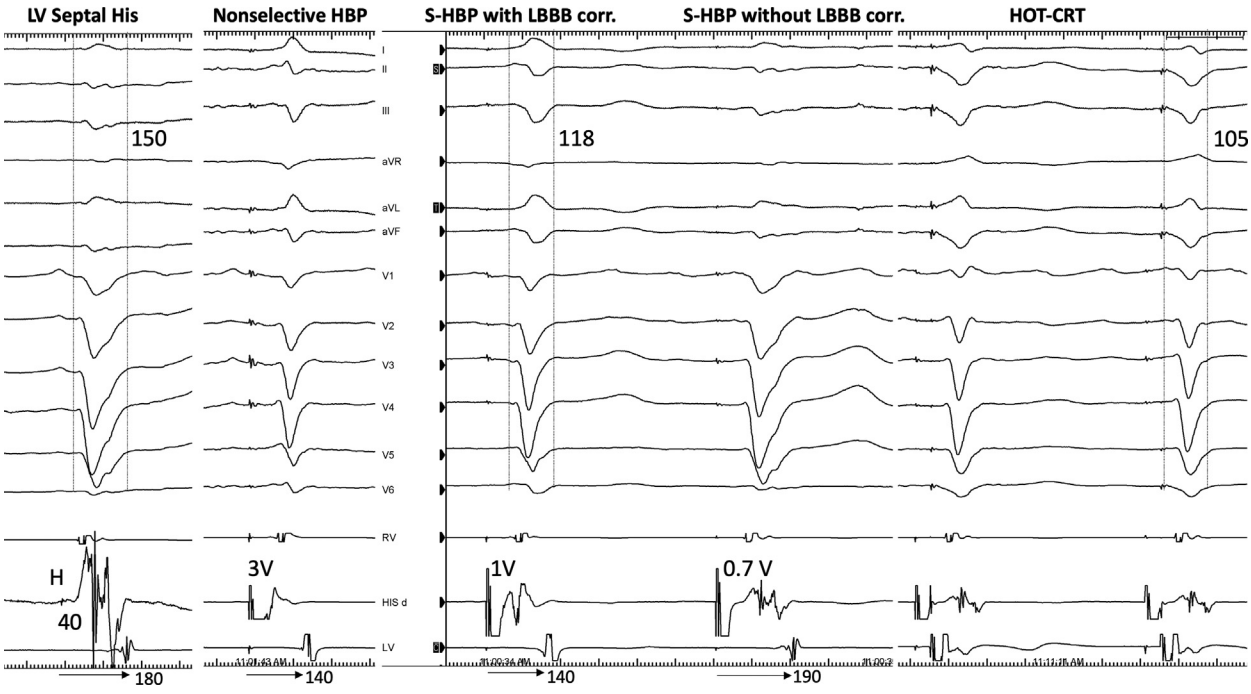

Figure 3 Deep septal, distal His bundle pacing (HBP). Twelve-lead electrocardiogram and intracardiac electrograms from the right ventricle (RV), His, and left ventricle (LV) are shown. His (H)-ventricle interval is 40 ms at the left-sided His location. During pacing at 3 V there is nonselective His capture with left bundle branch block (LBBB) correction. At 1 V, there is selective (S-)HBP with LBBB correction with reduction in QRS duration from 150 ms at baseline to 118 ms along with decrease in H-LV interval from 180 ms at baseline to 140 ms. At 0.7 V there is loss of LBBB correction. His-optimized cardiac resynchronization therapy (HOT-CRT) was achieved using sequential HBP-LV pacing at 40 ms delay with further narrowing of QRS to 105 ms.

that the course of the His bundle was long, along the left side of the muscular interventricular septum in this patient. Dedicated leads with longer screw electrode may allow routine targeting of the distal His bundle region in patients with LBBB and/or HV block, overcoming the limitations of HBP in this population.

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