Deep septal, distal His bundle pacing to achieve low and stable capture threshold

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Introduction

His bundle pacing (HBP) is widely accepted as the most physiological type of pacing. However, HBP is mainly limited by a high pacing threshold, resulting in early depletion of the battery or a risk for lead revisions from a late increase in threshold in some patients.

We report a case of HBP complicated by a chronically elevated HBP threshold, which resulted in early depletion of the battery. This was successfully revised to deep septal HBP at the distal His bundle (HB).

Case report

A 96-year-old woman was admitted for replacement of a pacemaker generator and HBP lead revision because of an elevated HBP threshold and premature battery depletion. She had undergone HBP 5 years previously because of complete atrioventricular block with narrow QRS escape rhythms (Figure 1). The HBP threshold was 1.5 V/1 ms at implantation, but gradually increased up to 3.5 V/1 ms at 2-year follow-up. Two years later, the battery was depleted and battery replacement with HB lead revision was scheduled. Using a SelectSecure 3830 lead and a C315 delivery sheath (Medtronic Inc, Minneapolis, MN), the HB region was mapped slightly distal to the existing HBP lead. At 2 mm distal to the existing HBP lead (site 1), an excellent HBP threshold of 0.5 V/1 ms was obtained immediately after fixation. However, the HBP threshold markedly increased to 2.5 V/1 ms after pulling back the sheath into the right atrium. The lead was then unscrewed and repositioned 2 mm distal to site 1. A tiny HB potential was observed on the Medtronic Pacing System Analyzer and pacing threshold testing showed an HBP threshold of 1.5 V/1 ms. Five to 6 rapid turns of the lead were performed, but unwinding (backspin) was not observed after releasing the lead, unlike traditional HBP lead fixation (site 2). The HB potential became larger with current of injury (Figure 2). An excellent nonselective HBP with an HB threshold of 0.3 V/1 ms and high unipolar pacing impedance of 942 Ω were obtained. Sheath angiography showed that the lead tip was deeply inserted into the septal myocardium by approximately 12 mm (Figure 3). The left ventricular activation time in this HBP site was 10 ms shorter than that of site 1. The existing HBP lead was easily extracted with manual traction after unscrewing.

At 1-year follow-up, the HB pacing threshold remained stable at 0.5 V/0.4 ms.

KEY TEACHING POINTS

- Deep septal His bundle pacing (HBP) may be a promising HBP method with a low and stable pacing threshold.
- In deep septal HBP, unwinding or backspins may not be observed when releasing the lead after fixation, unlike traditional HBP.
- In deep septal HBP, high unipolar pacing impedance should be obtained.
- Further study of deep septal HBP is necessary.

Discussion

HBP is widely accepted as the most physiological form of pacing. However, even without infranodal conduction disturbance, acute or chronic elevation of the HBP threshold and resultant early depletion of the battery or lead revision are a major concern. The proximal HBP lead is generally thought to be screwed into the penetrating HB surrounded by firm fibrous tissue. One of the reasons for an acute or chronic elevation in the threshold may result from such an anatomical location. In addition to this possibility, prolapse of the lead body into the right ventricular cavity might have contributed to chronic elevation of the HB capture threshold in this case.

Deep septal left bundle branch pacing (LBBP) has emerged as a novel physiological alternative to HBP to

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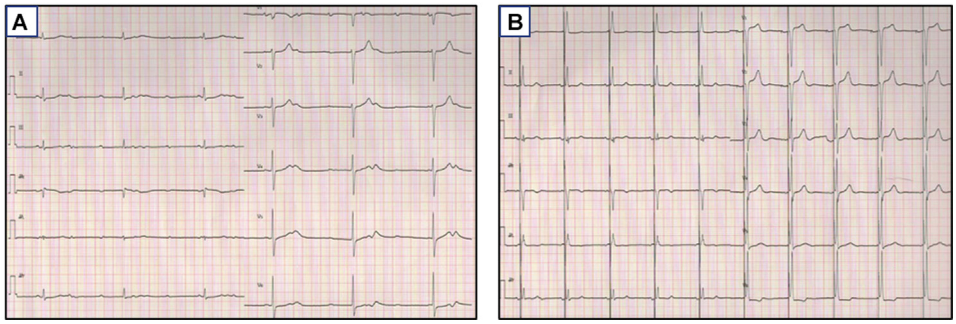

Figure 1 Twelve-lead electrocardiogram before (**A**) and after (**B**) the first pacemaker implantation. **A:** Complete heart block with a narrow escape rhythm. **B:** Nonselective His bundle pacing.

overcome such concerns about HBP.[1,2] LBBP provides a low and stable capture threshold, probably because the left bundle branch is embedded in the myocardium.

Kawashima and Sato[3] described that 50% of the distal HB emerging from the penetrating HB courses in the right half of the ventricular septum, just below the membranous septum; 30% of the distal HB is in the left half of the ventricular septum; and 20% of the distal HB is subendocardial "naked" HB without overlying myocardium. Except for cases of naked HB, deep septal HBP at such an intramyocardial portion may achieve a low and stable capture threshold because of the absence of surrounding firm fibrous tissue, unlike traditional HBP at the penetrating HB. In our case, while the existing HBP lead and site 1 were considered to be located at the penetrating HB, site 2 was located at the distal HB. The distal HB might have deeply coursed in the left-sided ventricular septum, considering the insertion depth of the lead.

When the lead is released after fixation of the HB lead, unwinding or backspin is usually observed, which is considered to be a good sign of lead fixation.[4] However, at site 2, this phenomenon was not observed, which might have indicated penetration of the lead body into the septum, as is the case with performing LBBP. Further, a high unipolar impedance also suggests deep penetration into the septum.

In our case, distal His-ventricular interval was 45 ms, and selective HBP was observed below 0.7 V/1 ms with narrow QRS similar to baseline (Supplemental Figure S1).

Based on these findings, the final site 2 was considered to be the distal HB and not the proximal left bundle. It is reported that proximal LBBP may also result in normal-looking QRS without right bundle branch block owing to rapid conduction retrogradely into the right bundle.[5] In such cases, it may be difficult to accurately discriminate between distal HBP and proximal LBBP.

Deep septal HBP, such as in our case, has rarely been reported in the literature.[6] Recently, Vijayaraman[7] reported an interesting case of deep septal, distal HBP.

However, the methodology of deep septal HBP has not been established, unlike LBBP. It is difficult to predict the course of the distal HB in the proximal muscular septum below the membranous septum. In our case, the final successful site was fortunately achieved by screwing from the parahisian muscular septum. However, dedicated leads with longer helix might allow routine targeting of the distal HB.[7]

Deep septal HBP may eliminate the concern for elevation of the threshold during follow-up, as observed in traditional HBP, because the surrounding anatomy is similar to that of LBBP. Further, for atrioventricular block with a narrow

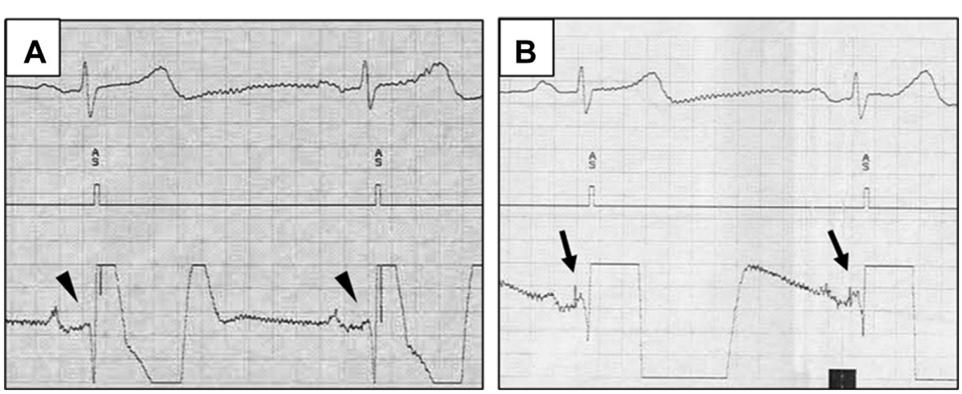

Figure 2 Intracardiac electrocardiogram recorded from the deep septal His bundle pacing lead before (**A**) and after (**B**) fixation. Note that the initially tiny His bundle potential (*arrowheads*) became larger with current of injury (*arrows*) after fixation.

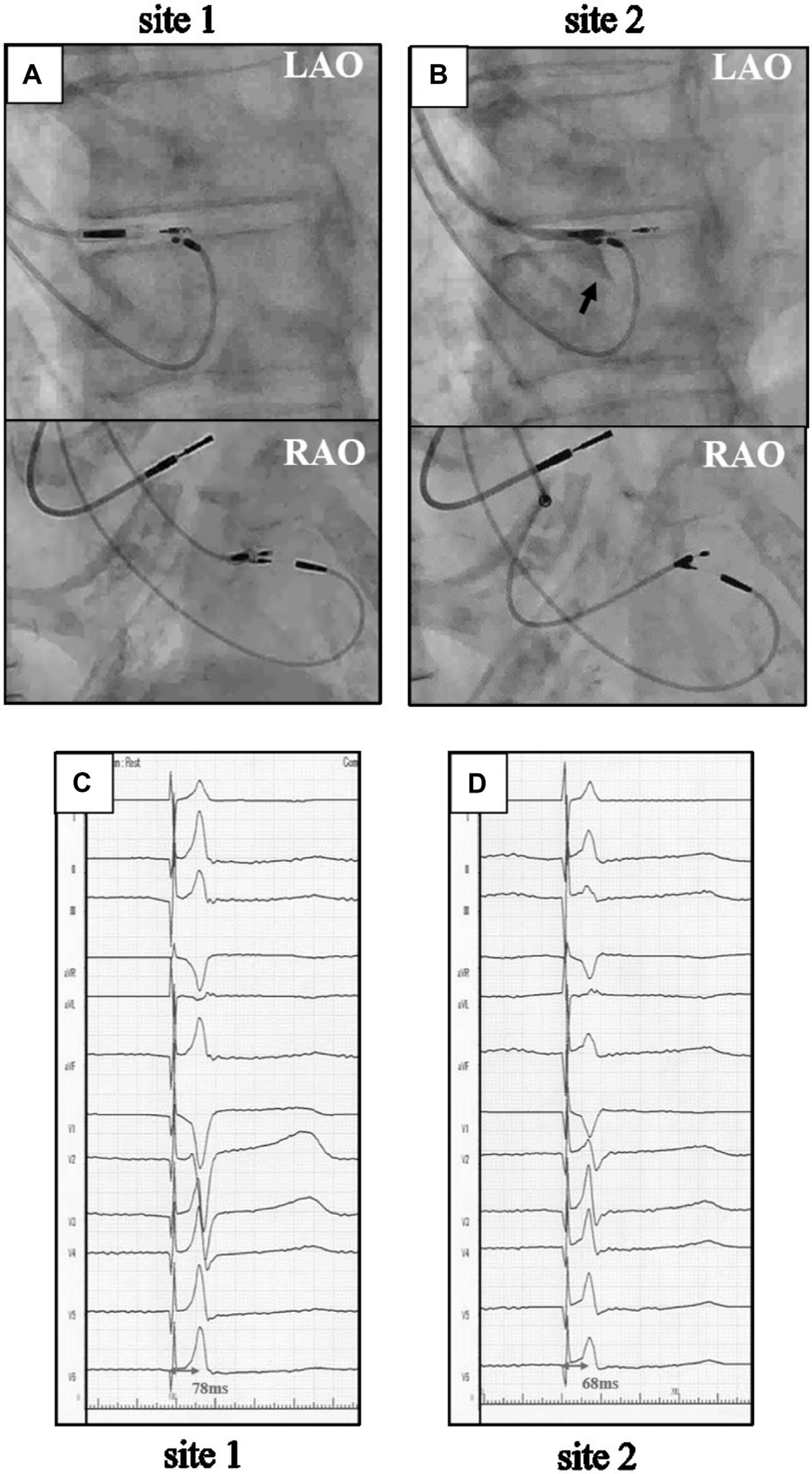

Figure 3 Fluoroscopic images (left anterior oblique [LAO] and right anterior oblique [RAO] views) during His bundle pacing (HBP) lead revision and corresponding pacing electrocardiograms. **A:** First fixation site (site 1) approximately 2 mm distal to the existing His bundle lead. **B:** Final fixation site (site 2) with deep insertion of approximately 12 mm into the ventricular septum, with contrast showing the depth of the lead (*arrow*). Note the existing HBP lead body prolapsing into the right ventricle. **C:** Nonselective HBP at site 1 showing a left ventricular activation time (LVAT) of 78 ms and QRS duration of 120 ms. **D:** Nonselective HBP at site 2 showing LVAT of 68 ms and QRS duration of 110 ms.

QRS, deep septal HBP may be preferable to LBBP in view of maintaining complete interventricular synchronization. Further study of deep septal HBP is necessary.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://10.1016/j.hrcr.2020.10.005.

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