His-bundle pacing in a patient with dextrocardia, severe systolic dysfunction, and complete atrioventricular block

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Introduction

There is a consensus that patients with complete atrioventricular (AV) block accompanied by significant ventricular systolic dysfunction (before or after monoventricular pacing) benefit from cardiac resynchronization therapy (CRT). However, there are cases in which effective resynchronization is particularly difficult to achieve, generally owing to anatomic or vein-access problems. Up to now, the alternative therapy in these especially difficult cases has been the epicardial approach. We present His-bundle pacing (HBP) for the first time as a clinically effective alternative in a case that was complicated by dextrocardia and persistent right superior vena cava and required CRT because of systolic dysfunction in the presence of complete AV block.

Case report

We present the case of a 70-year-old man who was diagnosed with arterial hypertension, diabetes mellitus, permanent atrial fibrillation, and dextrocardia in the context of situs ambiguus with polysplenia and persistent right superior vena cava. In 2005 a single-chamber pacemaker was implanted on his left side because of symptomatic complete AV block. During follow-up the left ventricular ejection fraction (LVEF), which was preserved before the implant, gradually deteriorated to 30%, with dyspnea on minimal exertion, despite optimal medical treatment. Cardiac catheterization showed no significant coronary lesions. The indication was "upgrade to CRT pacing."

We inserted a sheath by left axillary puncture into a very dilated coronary sinus. As it was impossible to perform an occlusive venogram, we made multiple contrast injections at various levels. A 0.35-inch guidewire was introduced in an unsuccessful attempt to find a lateral/inferolateral vein.

KEY TEACHING POINTS

- Cardiac resynchronization therapy (CRT) in patients with complex cardiomyopathy is an added difficulty for the optimal placement of the left ventricle electrode in a coronary sinus vein. The alternative in these cases is usually epicardial implantation in most centers.
- His-bundle pacing (HBP) has shown its feasibility and efficacy in prognostic terms in patients with normal left ventricular function. Small trials have also shown it to be effective in patients with left ventricular dysfunction and wide QRS complex.
- HBP for cardiac resynchronization is an alternative approach in patients with complex anatomy when conventional CRT is not possible. It provides advantages over the epicardial implant or the transventricular approach, such as the low complexity of the procedure, absence of need for indefinite oral anticoagulation, possibility of performing it in the same procedure, and a more physiological ventricular activation.
- Despite the lack of randomized studies, HBP for cardiac resynchronization should be the alternative of choice to classic CRT in centers with experience with this technique.

In view of the impossibility of cannulating a vein draining into the coronary sinus, we decided to change strategy to HBP, given our experience with this technique. We used a peelable, deflectable sheath (Attain 6227DEF, Medtronic, Minneapolis, MN) because the usual sheath (C315HIS, Medtronic Inc, Minneapolis, MN) has a septal curve in the opposite direction to the one required. Through this we introduced a 58 mm active fixation electrode (VEGA R58, Sorin Group, Milan, Italy) connected to the polygraph. We

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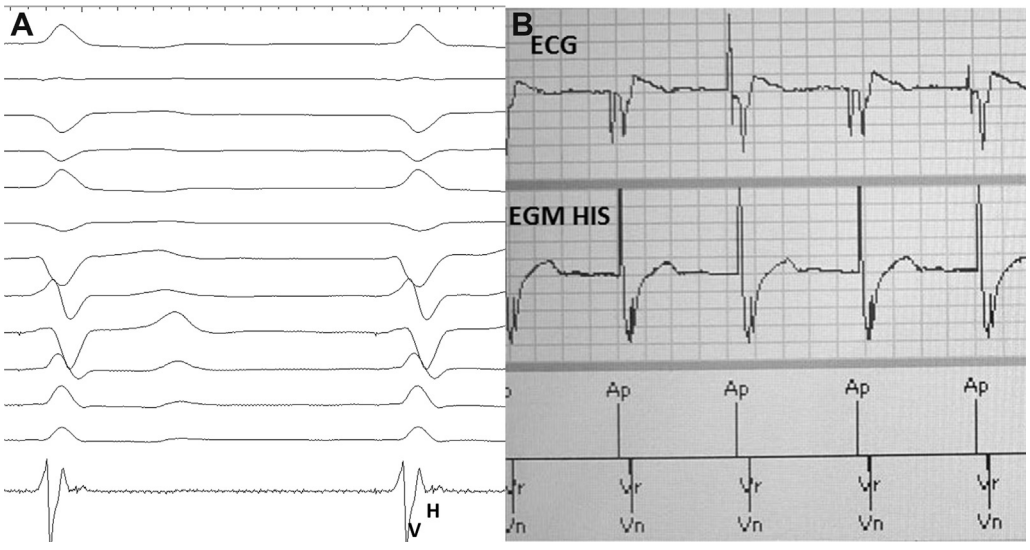

Figure 1 **A:** The lower record shows the endocavitary signal sensed by electrode, showing the ventriculogram (V) and retrograde hisiogram (H). The upper records show the surface electrocardiogram (ECG). **B:** The top image shows the surface ECG; in the middle is the electrogram of the His-bundle electrode (EGM HIS); the bottom image shows the marker channel. Ap = auricular pacing; Vn = ventricular noise; Vr = ventricular refractory.

reshaped the distal end of its internal guidewire to give it a septal curvature. The patient had no spontaneous rhythm despite infusion of isoproterenol, so we decided to map the retrograde His deflection (Figure 1A). After several attempts, we achieved selective His capture with a paced QRS duration of 116 ms (basal 210 ms, Figure 2) in an area with His-bundle recording. We decided to end the procedure despite a high threshold (4.5 V at 1 ms) after 25 minutes of fluoroscopy. We positioned the existing right ventricular safety electrode connected to the ventricular channel of the dual-chamber generator (KORA 250 DR, Sorin Group) and the His electrode to the atrial channel. We programmed in DDD mode with an AV interval of 140 ms, ensuring ventricular pacing only in the event of a loss in His capture (Figure 1B).

A month after the implant the patient had clinically improved. He was in NYHA functional class I–II and the

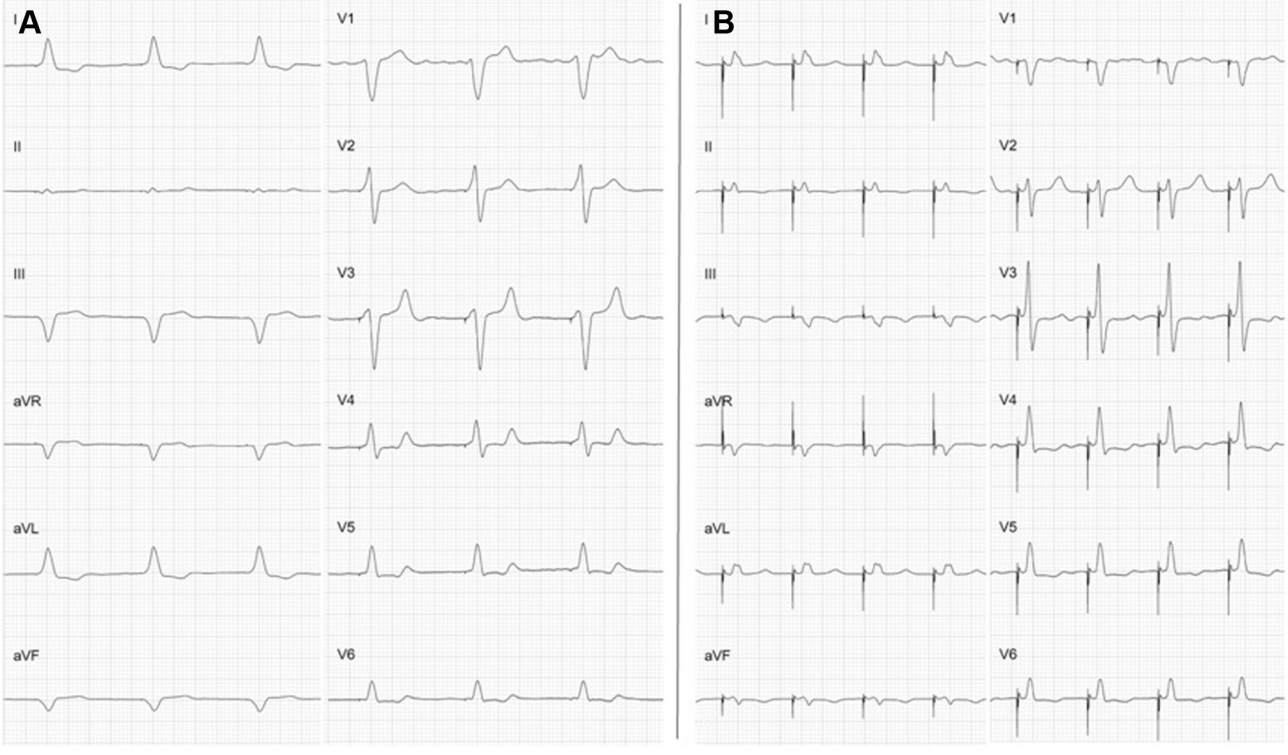

Figure 2 **A:** Atrial fibrillation with ventricular rhythm paced from the right ventricle, QRS 210 ms. **B:** Selective His-bundle pacing with narrow QRS interval, QRS 116 ms.

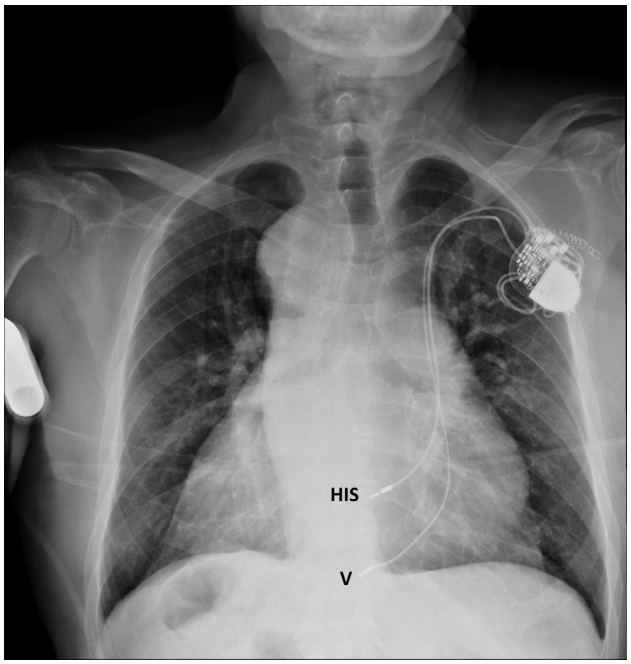

Figure 3 Chest radiograph: His-bundle electrode (HIS) above, right ventricular electrode (V) below.

LVEF had improved to 45%, with a reduction in left ventricular telediastolic diameter from 62 mm to 56 mm. The pacing threshold was maintained at 4.5 V at 0.6 ms, programming the output to 5 V at 1 ms pulse width, with an estimated battery life of 3 years. The chest radiograph (Figure 3) showed electrodes in the normal position and an absence of complications arising from the implant.

Discussion

For years, CRT has been part of the treatment of patients with heart failure, left ventricular dysfunction, and bundle branch block, with the main objective of narrowing the QRS interval and correcting asynchrony and left ventricular dysfunction.

Although the percentage success rate of implantation is high (between 75% and 95%, depending on the series),[1] placing the electrode in a suitable coronary sinus vein poses an additional challenge and can reduce the efficacy to 70%.[2] Our case represents this difficulty in the context of congenital heart disease, and as far as we know it is the first case of HBP in a patient with dextrocardia. Although it has proved its superiority over right ventricular pacing in patients with normal LVEF in prognostic terms,[3] there is currently no study that has evaluated which is the best resynchronization technique when implantation of an electrode in a coronary sinus vein is not possible. Classically, such patients are subjected to epicardial implantation of an electrode in the left ventricle. This alternative has the disadvantage of requiring a surgical intervention with thoracotomy, which is not without risks and complications, as well as the reduced longevity of the electrodes and the difficulty of placing them in inferolateral regions.[4,5] Recently the ventricular transseptal approach has been described,[6] with few cases reported in the literature; it has the advantage of more physiological endocardial pacing. However, it has limitations, such as the high complexity of the procedure, which represents an added risk because of ventricular transseptal puncture, combined with the need for indefinite oral anticoagulation. In addition, implementing this technique may require a second procedure and in some cases even general anesthesia.

Several recent studies[7,8] have shown the efficacy of HBP in patients who are candidates for CRT and are not eligible for the standard procedure, achieving significant narrowing of the QRS interval and improvement in LVEF, similar to conventional CRT. Even so, this approach has certain drawbacks, mainly owing to higher pacing thresholds, something we observed in our patient. Furthermore, this technique, like the transventricular approach, requires a high degree of specialization, particularly when there are additional anatomic difficulties, as in the case we present here with dextrocardia and persistent right superior vena cava. These disadvantages were offset, in our case, by the excellent outcome, with an improvement in functional class and LVEF and without the need for further intervention at a second stage to perform another, more aggressive procedure.

Another added difficulty is mapping the His deflection in pacemaker-dependent patients. In these cases isoprenaline infusion is recommended to stimulate escape rhythms, as well as pace mapping in the anatomic area of the bundle of His if it is not achieved.[9] In our case these 2 strategies were not effective, but we did manage to record a retrograde His signal with the pacemaker's ventricular pacing, which enabled us to position the electrode in the correct position in the region. This resulted in the narrowing of the QRS interval. As far as we know, this mapping technique has not been described in the literature, although in our case it was very effective.

Conclusion

We consider that in complex patients (such as the one presented here) for whom conventional CRT is not possible, HBP is an alternative worth considering. It is preferable to surgical or transventricular implantation, given that it is less aggressive, it does not require permanent anticoagulation therapy, and it can be performed in the same procedure. We still await prospective studies that support the use of this technique over the other alternatives in patients who are not candidates for conventional CRT.

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