Hyper-response to cardiac resynchronization with permanent His bundle pacing: Is parahisian pacing sufficient?

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Introduction

The feasibility of resynchronizing ventricular activation by permanent pacing of the His bundle region has been previously described, and has clinical advantages over traditional right ventricular (RV) apical pacing.[1–4] The physiologic benefit of permanent His bundle pacing (HBP) is the ability to stimulate the ventricles through the intrinsic His-Purkinje system, which results in synchronous electrical and mechanical activation. It also has theoretical advantages over cardiac resynchronization therapy (CRT) using a coronary sinus lead, which is associated with limited coronary venous anatomy and complications that include coronary sinus dissection, venous perforation, and the potential for proarrhythmia.

Hyper-response, typically described as a patient showing functional recovery and left ventricular ejection fraction (LVEF) $\geq$50%, has been reported with CRT[5,6] and similar recovery has been seen with HBP, after restoration of normal intrinsic conduction.[7–9] In the latter 3 patients, there was normalization of ventricular activation with HBP, and QRS durations ranged from 80 to 100 ms in these patients.

In this report, we present a case of a hyper-responder to HBP (LVEF 15%–55%) with parahisian capture that resulted in incomplete normalization of the QRS complex. We review the putative mechanisms of HBP, and the necessity of complete normalization of the QRS complex to achieve resynchronization with HBP.

KEYWORDS Pacing; Cardiac resynchronization; His bundle

ABBREVIATIONS **CRT** = cardiac resynchronization therapy; **HBP** = His bundle pacing; **LBBB** = left bundle branch block; **LV** = left ventricular; **LVEF** = left ventricular ejection fraction; **RV** = right ventricular

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Case report

A 74-year-old woman with hypertension, hypercholesterolemia, diabetes mellitus, symptomatic severe aortic valve stenosis (valve area 0.8 cm^2, peak velocity 4.9 m/s), and asymmetric septal hypertrophy (thickness 1.5 cm) underwent aortic valve replacement (23 mm Carpentier-Edwards pericardial bioprosthesis) and septal myomectomy to relieve exertional symptoms of chest pain and shortness of breath. The surgical procedure was complicated by postoperative complete heart block with a ventricular escape (40 beats/minute), with subsequent recovery of atrioventricular conduction on postoperative day 5 and development of left bundle branch block (LBBB). Her LVEF immediately after surgery remained at 60%.

Over the ensuing 6 months, the patient developed progressively worsening dyspnea, initially on exertion and subsequently at rest. She developed signs of volume overload, and presented for medical evaluation. She exhibited NYHA class III–IV symptoms, and an LVEF of 20% was seen on echocardiography. She was started on diuretics and medical therapy for heart failure with a beta blocker, angiotensin receptor blocker, and aldosterone antagonist. Despite these interventions, her LVEF remained severely depressed (15%, Simpson's biplane method), although her symptoms stabilized at NYHA class III. A coronary angiogram demonstrated no significant coronary lesions.

After 3 months of optimal medical therapy, given her depressed LVEF, LBBB (QRS duration of 198 ms), and NYHA class III symptoms, she was referred for consideration of resynchronization therapy and defibrillator. Magnetic resonance imaging was performed, which did not show any regions of delayed enhancement.

The patient was consented for resynchronization therapy and owing to the high clinical suspicion that her systolic dysfunction was induced by left bundle dyssynchrony, both HBP and implantation of a standard left ventricular (LV) lead were discussed in detail. The patient opted for an attempt at HBP prior to LV lead placement. During the procedure, a diagnostic His catheter (CRD2; St Jude Medical,

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KEY TEACHING POINTS

- His bundle pacing allows for physiologic activation of the ventricles and is feasible for cardiac resynchronization in patients with left bundle branch block.
- The absence of myocardial scar as seen in this case may predict the best response to His bundle pacing for systolic function recovery.
- Pure His capture may not be necessary to achieve cardiac resynchronization as the hyper-response observed in this case resulted from parahisian or nonselective capture of the His bundle.

Minneapolis, MN) was placed to serve as a fluoroscopic landmark. The AH interval and HV intervals were 88 ms and 64 ms, respectively. The patient underwent implantation of standard atrial lead and RV defibrillator lead (single coil). A Medtronic Select Secure lead (Model number 3830) was advanced through a Medtronic C315HIS sheath to the region of the His bundle. The lead was connected to an analyzer, and the high septal region adjacent to the site marked by the CRD2 catheter was mapped for a His bundle electrogram. The lead was fixated to a site with a near-field His recording (Figure 1A and B) with an acute capture threshold at this site of 2 V at 0.6 ms pulse width. With His bundle pacing, the QRS narrowed from 198 ms to 123 ms (with paced "HV" interval of 52 ms) (Figure 2). The His lead was placed into the LV port of the CRT device and because the device could not be programmed to pace the LV port only, it was programmed with a zero LV→RV offset with RV pacing output below the RV capture threshold to prevent fusion between RV pacing with HBP The patient tolerated the procedure well, and was discharged home the following day.

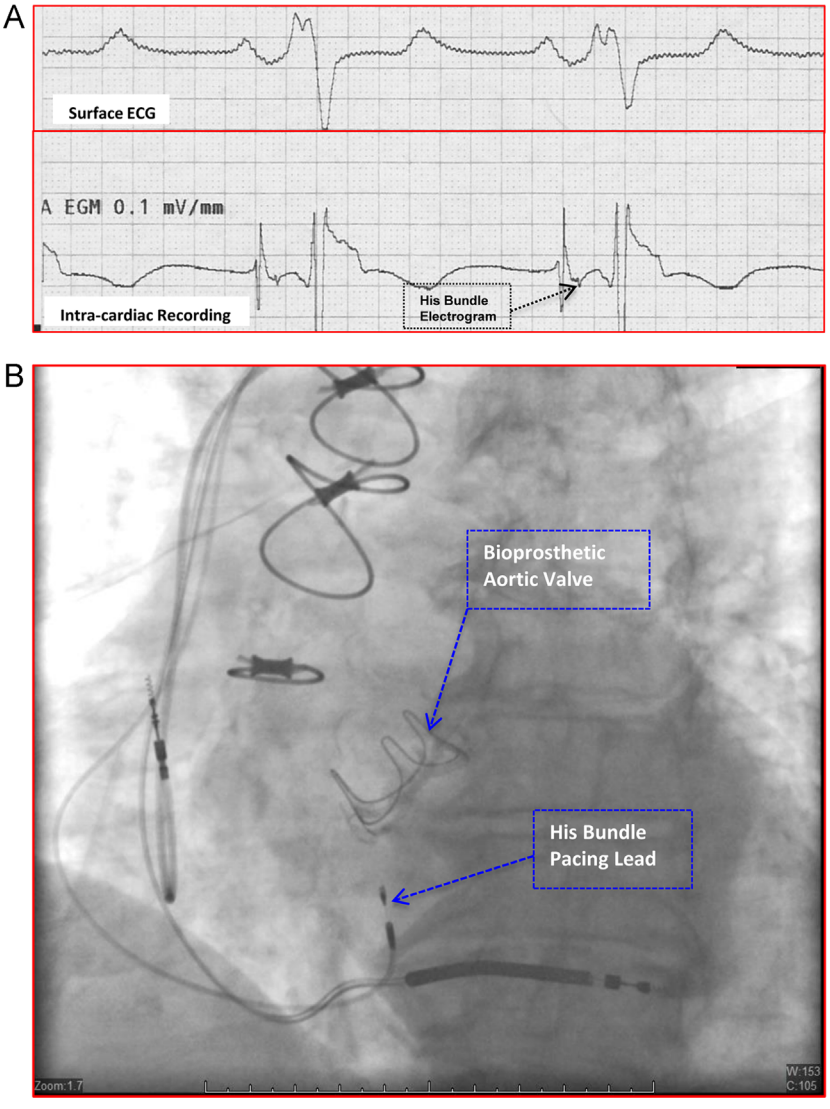

Figure 1 Intracardiac recording and fluoroscopic appearance of parahisian pacing site. **A:** Intracardiac electrograms (lower tracing) obtained at a site in the high septum where the His bundle pacing lead was deployed. The His bundle electrogram is indicated by the arrow. The surface electrocardiogram (ECG; upper tracing) is also shown. **B:** Fluoroscopic appearance of the final position of the permanent His bundle pacing lead and the atrial and ventricular leads in a shallow right anterior oblique projection.