

# Long-Term Results of His Bundle Pacing



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## KEYWORDS

• His bundle pacing • Right ventricular pacing • Heart failure hospitalization • Long-term outcomes

## KEY POINTS

- His Bundle Pacing (HBP) is safe and feasible in the short-term.
- Long-term studies are few regarding HBP.
- Lead performance and clinical outcomes show promise in the long term.

## INTRODUCTION

The number of patients requiring permanent pacemaker therapy has increased over the past several decades. The adverse effects of the early single-chamber pacemakers were quickly realized with regard to hemodynamics, and pacemakers that maintained atrioventricular (AV) synchrony were developed shortly afterward. Physiologic ventricular activation was then addressed with the advent of cardiac resynchronization therapy (CRT). His Bundle Pacing (HBP) is an alternative technique in pacing the ventricles “physiologically” that has shown promise in implant success and short-term follow-up,<sup>1–3</sup> especially with the advent of new lead technology and delivery mechanisms.

## LONG-TERM OUTCOMES

The studies involving long-term outcomes of HBP are relatively few. A summary of the studies is published in [Table 1](#). The first study that looked at HBP in humans involved patients with dilated cardiomyopathy and permanent atrial fibrillation (AF) by Deshmukh and colleagues.<sup>4</sup> HBP was performed in conjunction with AV node ablation.

Using a mapping catheter from the groin, His bundle pacing was performed to identify feasibility of selective capture. A fixed nonretractable screw-in lead was then advanced to that spot using “J”-shaped stylets and secured there. Eighty-six percent of these patients had successful HBP. Lead dislodgement was seen in 2 patients, one the day after and the other 2 months after implantation. Over a mean follow-up of 23 months, the investigators were able to show maintenance of HBP in 11 of 12 patients. Thresholds ranged from  $2.4 \pm 1.0$  V at implant and increased to  $3.9 \pm 2.5$  V at follow-up. Echocardiographic data also were measured in this study. Left ventricular ejection fraction (LV EF) and left ventricular end-diastolic diameter (LV EDD) improved in follow-up.

The same group of investigators published a study a few years later looking at a larger group of patients over a longer period of time.<sup>5</sup> Fifty-four patients who had permanent AF, dilated cardiomyopathy, and New York Heart Association (NYHA) Class III or IV were studied. Once again, a mapping catheter was used from the groin and a custom lead with a longer fixed helix was advanced using “J” stylets into the annulus area identified as the His region. Seventy-two percent

Disclosure: F.A. Subzposh - speaker (Medtronic); P. Vijayaraman – speaker, consultant, research (Medtronic), consultant (Abbott), advisory board (Boston Scientific).

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Card Electrophysiol Clin 10 (2018) 537–542

<https://doi.org/10.1016/j.ccep.2018.05.011>

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**Table 1**  
**Summary of His bundle pacing studies with medium to long-term follow-up**

Author	No. of Patients	Success, %	Follow-up Duration, mo	Threshold, V	Sensing, mV	Impedance, ohms	Paced QRS, ms	LV EF, %
Deshmukh et al, <sup>4</sup> 2000	18	86	23	2.4 → 3.9	1.7 → 2.2	488 → 723	92 → 104	18 → 28
Deshmukh et al, <sup>5</sup> 2004	54	72	42	—	—	—	—	23 → 33
Occhetta et al, <sup>1</sup> 2006	18	89	12	0.9 → 1	6.9 →	614 →	121 → similar	52 → 53
Kronburg et al, <sup>6</sup> 2014	34	84	24	1.0 → 1.5	—	—	—	—
Vijayaraman et al, <sup>7</sup> 2015	100	84	19	1.4 → 1.6	5.3 → 6.4	577 → 437	—	—
Huang et al, <sup>8</sup> 2017	52	80	21	1.1 → 1.2	3.5 → 3	—	—	44 → 64
Vijayaraman et al, <sup>9</sup> 2017	42	95	19	1 → 1.6	6 → 5.1	544 → 459	127 → 127	43 → 50
Vijayaraman et al, <sup>10</sup> 2017	20	—	70	1.9 → 2.5	5.9 → 6.1	516 → 484	117 → 118	50 → 55
Vijayaraman et al, <sup>11</sup> 2016	10	—	48	1.4 → 1.9	—	—	132 → 132	—
Zanon et al, <sup>12</sup> 2017	369	83	76	—	—	—	—	56 → 60
Vijayaraman et al, <sup>13</sup> 2018	94	80	60	1.4 → 1.6	6.8 → 7.2	639 → 463	122 → 126	55 → 57

Abbreviation: LV EF, left ventricular ejection fraction.

of patients were able to achieve selective HBP. Over a mean follow-up of 42 months, 10 patients died, and 2 generator replacement procedures were performed. Electrophysiological data were not reported. Patients showed improvement of their EF from  $23\% \pm 11\%$  to  $33\% \pm 15\%$ . Twelve of the patients had a His and right ventricular (RV) pacing lead placed and underwent cardiopulmonary testing that showed higher  $O_2$  uptake with HBP compared with RV pacing from the apex. In 2006, Occhetta and colleagues<sup>1</sup> reported on the clinical advantage of para-Hisian pacing compared with RV pacing in 16 of 18 patients undergoing AV node ablation in a randomized, 6-month, crossover study. In this study, para-Hisian pacing resulted in improved interventricular mechanical delay, NYHA functional class, quality of life, 6-minute walk, and mitral and tricuspid regurgitation.

Kronburg and colleagues<sup>6</sup> randomized 34 patients to HBP or RV pacing for a period of 12 months each and followed them clinically in a double-blind, crossover study. All patients had AV block with approximately 99% ventricular pacing. The EF with RV pacing was significantly lower

than with HBP. Thresholds rose significantly from 1.0 V to 1.5 V and 1 patient developed exit block after 15 months.

In 2015, Vijayaraman and colleagues<sup>7</sup> published a study involving 100 patients with advanced AV block followed over a mean of 19 months. Success rate of HBP was 84% using the Select Secure (Model 3830, Medtronic Inc, Minneapolis, MN) lead delivered through a fixed curve sheath (C315 His, Medtronic Inc). Pacing thresholds at implant were reported as  $1.4 \pm 1.0$  V and increased to  $1.6 \pm 1.0$  V at follow-up. Impedance values and sensed R waves remained stable in the follow-up period. Five percent of patients had a significant increase in their pacing threshold requiring revision or replacement. This occurred in 2 weeks in 2 patients and between 2 months and 6 months in the remaining 3 patients. Patients were further divided into those with AV nodal block (normal QRS) and those with infranodal block (wide QRS). The 2 groups had similar outcomes in follow-up.

In 2017, Huang and colleagues<sup>8</sup> published a study looking at HBP in patients with symptomatic AF requiring AV nodal ablation. Fifty-two patients

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