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Conduction system pacing learning curve: Left bundle pacing compared to His bundle pacing

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ABSTRACT

Introduction: Conduction system pacing (CSP), consisting of His bundle pacing (HBP) or left bundle branch area pacing (LBBAP) is a rapidly developing field. These pacing techniques result in single lead left ventricular resynchronisation. Understanding of the associated learning curve of the two techniques is an important consideration for new implanters/implanting centres.

Methods: We conducted a review of the first 30 cases of both HBP and LBBAP at The Royal Brompton Hospital. The procedural duration and fluoroscopy time were used as surrogates for the learning curve of each technique.

Results: Patient characteristics were similar in HBP and LBBAP groups; LV ejection fraction (46% vs 54%, $p = 0.08$), pre-procedural QRS duration (119 ms vs 128 ms, $p = 0.32$).

Mean procedural duration was shorter for LBBAP than for HBP (87 vs 107mins, $p = 0.04$) and the drop in procedural duration was more marked in LBBAP, plateauing and remaining low at 80mins after the initial 10 cases. Fluoroscopic screening time mirrored procedural duration (8 min vs 16 min, $p < 0.01$).

Discussion/Conclusion: Our data suggest that the CSP learning curve was shorter for LBBAP than for HBP and appears to plateaux after the first 10 cases, however the HBP learning curve is longer with continued improvement over the first 30 cases. The shorter learning curve of LBBAP in conjunction with the superior electrical parameters and simplified programming mean the establishment of a CSP program is potentially easier with LBBAP compared to with HBP.

1. Introduction

Conduction system pacing (CSP) with His bundle pacing (HBP) or left bundle branch area pacing (LBBAP) may provide single ventricular lead cardiac resynchronization and preserve systolic function (Fig. 1). Implant procedures utilise specialized sheaths and techniques to achieve the desired electrical resynchronisation. The early enthusiasm for HBP has been curbed by the concern about long-term threshold stability and implant and programming complexity. By contrast, LBBAP has recently emerged as an alternative technique that overcomes these concerns while still maintaining electrically synchronous LV activation [1]. Characterizing the learning curve associated with these novel approaches to pacing therapy may inform strategies for wider dissemination. Here, we compare the learning curve associated with establishing a conduction system pacing program with both HBP and LBBAP.

2. Methods

We evaluated the procedural characteristics of the first 30 cases of HBP (commencing 2017) and of LBBAP (commencing 2021) at The Royal Brompton Hospital. All implants included were performed with the Medtronic C315H or C304 sheath and SelectSecure 3830 lead. Procedural times, fluoroscopy time, and acute lead parameters were evaluated overall and according to operator experience over time. The

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study received local ethics board approval and was performed in accordance to the declaration of Helsinki.

3. Results

Patient characteristics were broadly similar in HBP and LBBAP groups including LV ejection fraction (46% vs 54%, p = 0.08), pre-procedural QRS duration (119 ms vs 128 ms, p = 0.32), though indication for pacing included CHB 30.0% vs 66.7% (p = 0.004). All procedures were performed under local anaesthetic and sedation only; the procedural approach for both HBP and LBBAP was as previously described and was successful in 100% of cases [2]. Vascular access was via the axillary vein in all cases; USS was used (at operator discretion) in 47% (14/30) of the LBBAP cases for vascular access and 0% (0/30) of the HBP cases. The mean procedural duration was shorter for LBBAP than for HBP (87 vs 107mins, p = 0.04) and the drop in procedural duration was more marked in LBBAP, after the first 10 cases, and remained low at 80mins for the subsequent 20 cases. Fluoroscopic screening time mirrored procedural duration being shorter for LBBAP compared to HBP (8 min vs 16 min, p < 0.01); with both CSP approaches there was a reduction in fluoroscopy time with increased experience (Fig. 2). R-waves were higher with LBBAP (12.8 vs 3.2 mV, p < 0.01) and pacing thresholds were lower (0.7 @0.5 ms vs 1.4 @1.0 ms, p < 0.01). There were no acute complications (including lead dislodgements, loss of conduction system capture and need for re-operation) observed during the study period. During follow up 20% (6/30) of HBP devices had a rise in pacing threshold of at least 1 V and one needed an additional RV lead due to poor sensing. There were no complications during the follow up of the LBBAP devices.

4. Discussion

A *meta*-analysis has demonstrated that compared to CSP, right ventricular pacing was associated with shorter procedure time, lower pacing threshold, and higher success rate [3]. However, CSP was associated with shorter QRS duration, lower rate of death, heart failure, and atrial fibrillation. Given the benefits of CSP its use is likely to increase and knowledge of the learning curve is thus essential to planning the establishment of new CSP programs.

Previous studies have evaluated the learning curve of both HBP and LBBAP in isolation, but have not compared the two techniques [4,5]. Our data are concordant with previous data highlighting the superior electrical parameters of LBBAP over HBP Importantly we demonstrate that the CSP learning curve, evidenced by procedural duration, was shorter for LBBAP than for HBP.

We found that the LBBAP learning curve appears to plateaux after the first 10 cases, however the HBP learning curve is longer with continued improvement over the first 30 cases. A potential explanation for the shorter learning curve for LBBAP may be the larger area over which successful conduction system capture can be established compared to HBP.

Our results reflect the long-term safety concerns associated with HBP of rising threshold over time. Though we did not see any complications during follow up of the LBBAP devices the duration of follow up was substantively shorter as their implants occurred four years later. A further consideration for LBBAP when considering the very long-term is that of extraction of a deep septal lead. There is currently limited data due to the lack of LBBAP lead in situ for more than 5 years, but there are case reports that suggest it is no more complex or risky than extraction of traditional leads [6]. Further research is warranted to appreciate the potential issues that relate to the extraction of different lead types (stylet driven vs lumenless, fixed vs extendable helix and pacing vs combined pacing/defibrillator leads).

This study bears the inherent limitation of a small cohort prospective observation study. Operators performing LBBAP had prior experience in HBP, and so sheath familiarity was already established potentially shortening the learning curve. All operators were experienced Biventricular CRT implanters, so the use of sheath-delivered leads is part of their baseline skill-set. The nuances to the techniques are anatomical localisation of implant site and lead deployment, both of which are substantively different between HBP and LBBAP. For example, HBP requires slow lead rotation with expected lead recoil compared to LBBAP

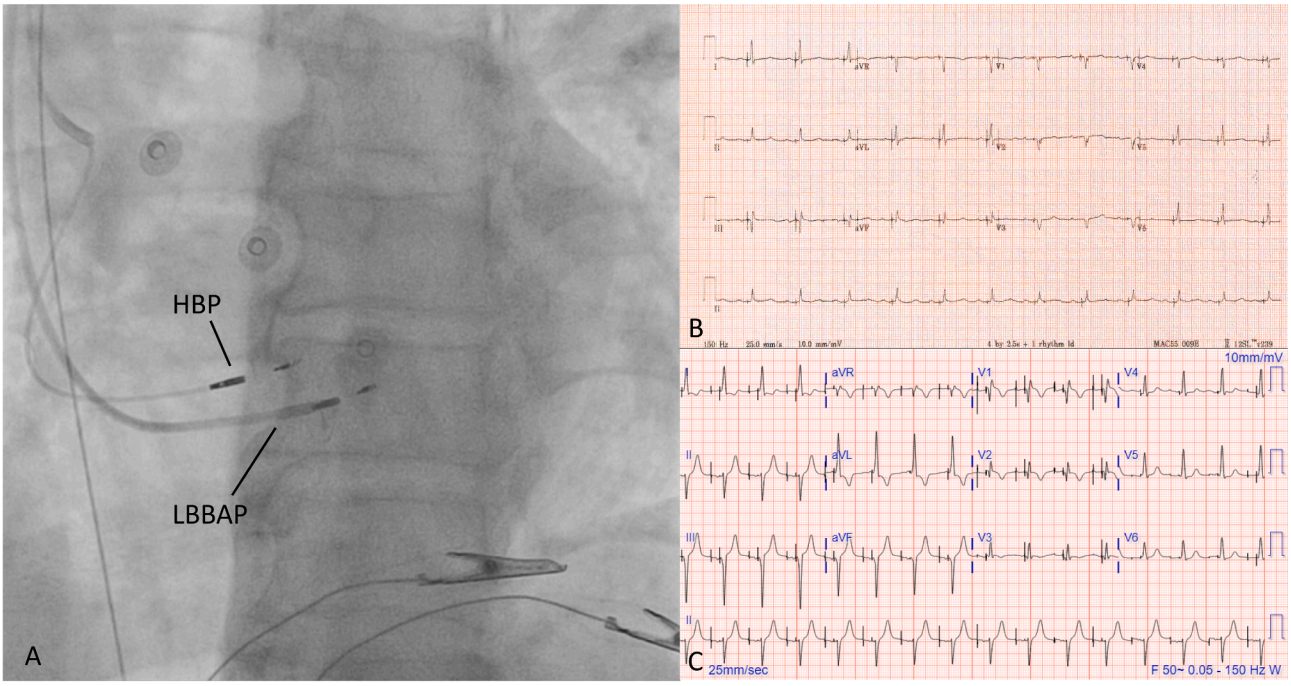

Fig. 1. Conduction system pacing lead positions and ECGs. (A) Posterior-anterior fluoroscopic image demonstrating the location of a HBP lead and LBBAP lead 15–20 mm down the septum. (B) 12-lead ECG of HBP morphology, QRS duration 108 ms. (C) 12-lead ECG of LBBAP morphology, QRS duration 110 ms. HBP – His Bundle Pacing, LBBAP – Left Bundle Branch Area Pacing.

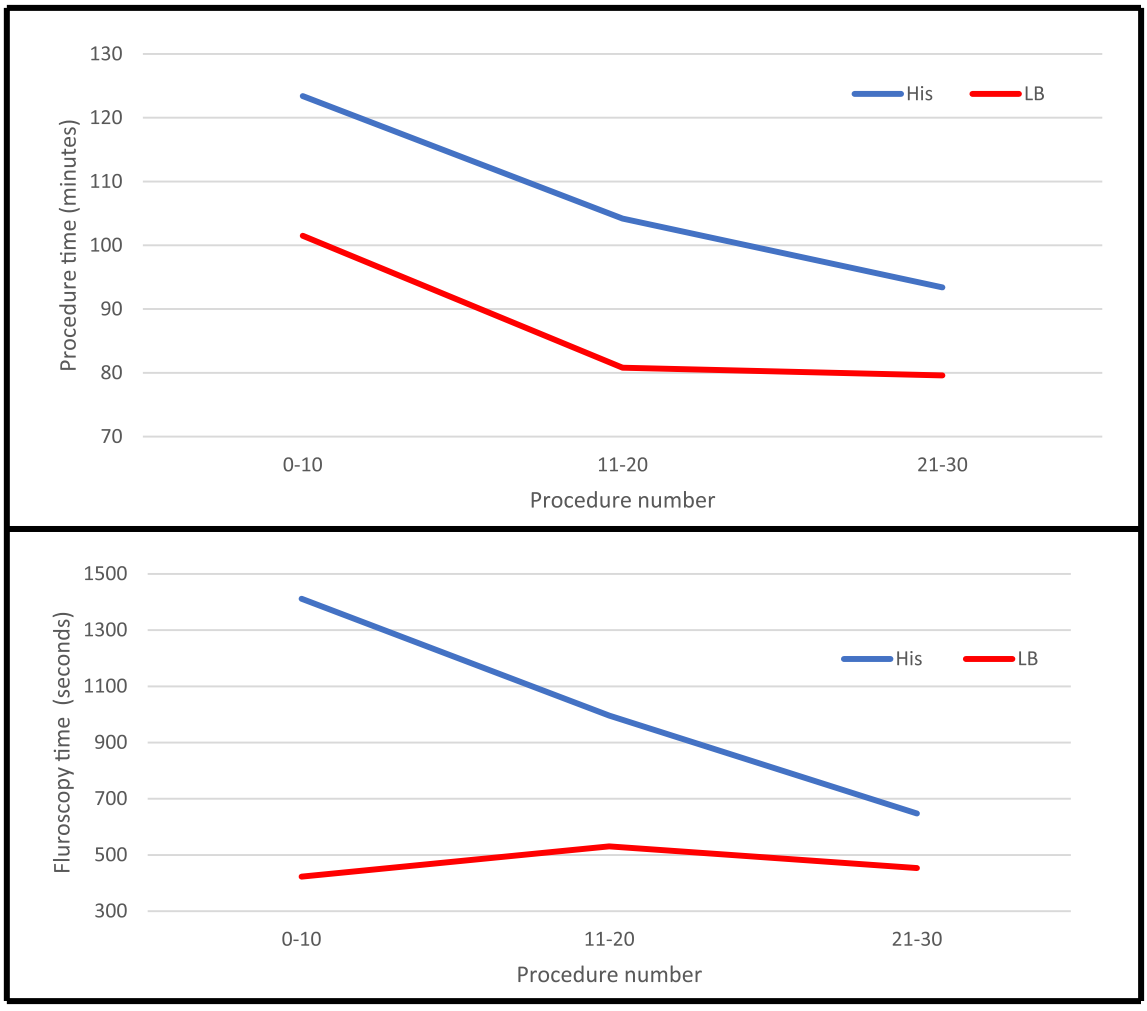

Fig. 2. Mean procedure duration (top) and fluoroscopic screening time (bottom) for the first, second and third 10 cases of both HBP and LBBAP.

which requires rapid rotations and minimal expected recoil. Nevertheless, we cannot exclude that prior experience with HBP played a role in the learning curve of LBBAP. Furthermore, we describe the learning curve for the use of the 3830 lead for CSP and our results may not be applicable to the use of extendible helix leads which require different techniques to implant.

5. Conclusion

In summary, the shorter learning curve of LBBAP in conjunction with the superior electrical parameters (larger R-wave amplitudes, lower pacing thresholds [7]) and simplified programming and follow up mean the establishment of a CSP program is potentially easier with LBBAP compared to with HBP.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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