SHORT COMMUNICATION

The impact of operator experience on the success rate, time aspects, and electrocardiographic features in left bundle branch area pacing

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INTRODUCTION

Left bundle branch area pacing (LBBAP) is a novel method of cardiac pacing. LBBAP is considered a very promising method as it combines excellent and stable pacing parameters with rapid activation of the left ventricle. The term LBBAP comprises two modalities: left bundle branch pacing (LBBP) and left ventricular septal pacing (LVSP) [1, 2]. The main similarity of these methods is the transseptal location of the lead in the subendocardium of the left ventricle. The major difference is that LBBP refers to capture of both left bundle branch and the adjacent myocardium, while LVSP affects the septal myocardium without direct recruitment of the conduction system. As LBBAP has been developed recently, data on the learning curve, especially procedure time, are still limited. Therefore, this study aimed to assess the impact of operator experience on the success rate, time aspects, and electrocardiographic features in LBBAP.

METHODS

The studied population consisted of 100 consecutive patients qualified for primary implantation of a dual-chamber pacemaker for bradycardia indication from January 2021 to September 2022 (see Supplementary material, *Table S1*). Patients with left ventricular ejection fraction below 35% were not included. All procedures have been performed by a single operator with no previous experience in LBBAP, and none of the patients who fulfilled the conditions described above was excluded. LBBAP was attempted in all patients as a primary pacing approach. The general implanting experience of the operator was approximately 300 right ventricular pacing and 10 His bundle pacing procedures before starting LBBAP. The study was approved by the local bioethical commission (University of Zielona Góra). All patients provided written informed consent to participate in the study.

A lumen-less ventricular lead (SelcetSecure 3830, Medtronic) was introduced via a fixed-shape catheter (C315-HIS, Medtronic). The initial position of the lead was approximately 2 cm into the ventricle from the His bundle or the top of the tricuspid annulus in the right anterior oblique view. However, in cases of inability to obtain stable position or ineffective screwing, a wide area of the interventricular septum was used. The depth of lead penetration was monitored using the fixation beats and repeated unipolar tip pacing until a terminal R-wave in the V1 lead appeared. Then electrocardiographic and pacing measurements were performed. In the case of acceptable parameters, the delivery catheter was removed.

Successful LBBAP was defined as obtaining LBBP or LVSP. Applied criteria of LBBP (see Supplementary material, *Table S2*) were previously reported to be nearly 100% specific [3, 4]. The procedure time was measured from the injection of local anesthesia to the end of suturing the skin. The ventricular lead implantation time was measured from insertion to removal of the delivery catheter. The fluoroscopy time referred to the entire procedure. Electrocardiographic parameters were measured using high sweep speed (200 mm/s) and digital calipers. Native and paced QRS complex duration was measured from the beginning of the first to the end of

Table 1. Comparison of results in subsequent quarters of the procedures[a]

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Overall	*P*-value
Numbers of procedures	1 to 25	26 to 50	51 to 75	76 to 100	1 to 100	
LBBAP success rate	20/25 (80%)	25/25 (100%)	25/25 (100%)	25/25 (100%)	95/100 (95%)	0.001
LBBP success rate	14/25 (56%)	16/25 (64%)	18/25 (72%)	21/25 (84%)	69/100 (69%)	0.17
Procedure time, min, mean (SD)	86.6 (15.1)	67.4 (10.8)	60.8 (11.0)	62.8 (11.2)	68.6 (15.3)	< 0.001[b]
Ventricular lead implantation time, min, mean (SD)	34.3 (11.1)	22.8 (7.5)	18.0 (7.6)	18.7 (8.7)	22.9 (10.6)	< 0.001[c]
Fluoroscopy time, min, mean (SD)	6.6 (3.1)	5.2 (2.0)	5.3 (2.8)	5.9 (2.3)	5.7 (2.6)	0.25
Paced QRS duration, ms, mean (SD)	122.5 (10.7)	115.6 (12.6)	122.8 (12.4)	121.0 (10.6)	120.4 (11.9)	0.12
V6-RWPT, ms, mean (SD)	82.2 (12.0)	74.8 (11.2)	78.9 (12.6)	79.5 (10.7)	78.7 (11.8)	0.20
V6-V1, ms, mean (SD)	40.4 (9.0)	36.8 (13.2)	43.0 (16.0)	47.0 (12.2)	41.9 (13.4)	0.047[d]
Capture threshold, V, mean (SD)	0.9 (0.3)	1.1 (0.4)	1.0 (0.3)	0.9 (0.4)	1.0 (0.4)	0.25
Sensing, mV, mean (SD)	12.1 (5.0)	12.6 (6.1)	11.1 (5.5)	12.1 (6.3)	12.0 (5.7)	0.85

[a]The distribution of all quantitative variables was normal in all groups. [b]The difference was significant between the first and any other group (*P* <0.001 for all). [c]The difference was significant between the first and any other group (*P* < 0.001 for all). [d]The difference was significant between the second and the fourth group (*P* = 0.03)

Abbreviations: LBBAP, left bundle branch area pacing; LBBP, left bundle branch pacing; V6-RWPT, R-wave peak time in lead V6; V6-V1, V6-V1 interpeak interval

the last deflection. The results were compared between successive quarters of procedures.

Statistical analysis

The Kolmogorov-Smirnov test and Levene's test were used to check for normal distribution and equality of variances, respectively. To compare results in groups, the χ^2 test or Fisher's exact test were performed for categorical variables. In the case of continuous variables, Student's t-test was used for two groups, and analysis of variance (ANOVA) for several groups. The Tukey honestly significant difference test was applied as a *post-hoc* test. Logistic regression was conducted to assess the impact of experience on success rates. Statistical analysis was performed using PSPP software. *P*-value <0.05 was considered significant.

RESULTS AND DISCUSSION

There were no significant differences in baseline characteristics among consecutive groups of patients (Supplementary material, *Table S1*).

Success rates of LBBAP and LBBP

The overall success rate of LBBAP was 95% and was the lowest in the first quarter (Table 1). Actually, all ineffective implantations occurred in the first period, which reflects the steep learning curve. The reason for unsuccessful procedures was the inability to penetrate the interventricular septum deep enough to obtain LBBAP in several attempts (up to six). The incidence of general complications was 3% (1 pericardial effusion, 1 pneumothorax, and 1 atrial lead dislodgement). Intraprocedural perforation of the interventricular septum occurred in 6 patients without further consequences.

The overall success rate of LBBP was 69% and did not differ in consecutive quarters of implantations (*P* = 0.17). Thirty-seven patients met the criterion of V6-V1 interpeak interval >44 ms, 36 patients the criterion of V6-RWPT <75 ms, while QRS morphology transition was demonstrated in 24 patients. Logistic regression showed that the number of procedures performed was a predictor of achieving LBBP (odds ratio 1.19 per 10 implantations, 95% confidence interval [CI], 1.02–1.39; *P* = 0.03). However, operator experience did not affect the proportion of obtained LBBP and LVSP in successful LBBAP procedures (odds ratio [OR], 1.10 per 10 implantations; 95% CI, 0.93–1.30; *P* = 0.25).

These results are consistent with the findings of other researchers. LBBAP success rate varies from 92% to 96% [5–7], while LBBP success rate varies strongly in distinct studies and ranges from 41% to 97% [5, 8-10]. The explanation of such inconsistency is variability in applied criteria for diagnosing LBBP as well as strategy – aiming for LBBP or just for LBBAP. Like us, Jastrzębski et al. [5] concluded that there is no influence of operator experience on LBBP and LVSP proportions. The high success rate of LBBAP is encouraging for wide application of this method, especially when the recent study of Bednarek et al. [11] showed that LBBAP could prevent pacing-induced cardiomyopathy.

Time and electrocardiographic aspects

The mean procedure duration and ventricular lead implantation time were 86.6 and 34.3 minutes, respectively, in the first quarter, then gradually decreased to 60.8 and 18.0 minutes in the third (*P* <0.001 in both) and remained stable in the fourth quarter (Table 1). The V6-V1 interpeak interval was longer in later procedures. A significant increase was observed between the second and the fourth quarter and additionally between the first and the second half of implantations (38.4 and 45.0 ms, respectively; *P* = 0.02). We found no statistically significant differences in fluoroscopy time, V6-RWPT, and paced QRS duration in subsequent quarters of the procedures.

Heckman et al. [7] showed a decrease in the ventricular lead implantation time from 33 to 17 minutes with stabilization after 40–50 procedures, which is consistent with our results. Moreover, Wang et al. [6] also concluded that LBBAP lead implantation time could be reduced rapidly after 50 procedures. Nevertheless, they reported further shortening of ventricular lead implantation time after 150 cases.

Unlike most research, where fluoroscopy time gradually decreased [5–7], in our study it was constantly short.

During LBBAP lead implantation, we preferred electrocardiographic methods for determining the initial site (pace-mapping) as well as for monitoring lead screwing (fixation beats). This strategy probably contributed to the shorter fluoroscopy time.

The results of other studies on paced QRS duration are discordant [5, 6]. Anyway, it is significantly affected by native QRS duration (in the present study Pearson correlation coefficient = 0.50; P <0.001).

No data on the learning curve according to the V6-V1 interpeak interval are available. In our study, this parameter increased with the number of procedures performed. As it also steadily increases with the depth of lead penetration [12], our results indicate that experience helps with deeper implantation, which is crucial in LBBAP. Importantly, the V6-V1 interpeak interval is not correlated with native QRS duration [3].

Conclusions

LBBAP is a feasible method, and the learning curve is steep, especially during first 25 implantations. Operator experience influences ventricular lead implantation time, whole procedure time, success rate, and V6-V1 interpeak interval. Satisfactory and stable results could be achieved after approximately 50 procedures. LBBAP has great potential to become a widely used method of cardiac pacing. These outcomes refer to bradycardia patients and could not be applied to LBBAP procedures for heart failure indication.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

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