Jieruo Chen, Zefeng Wang, Fei Hang, Yongquan Wu
Beijing Anzhen Hospital, Capital Medical University, Department of Cardiology, Beijing, China

Comparison of Clinical Complications Between LBBAP and Traditional RVP in Long-Term Follow-Up

Background Traditional right ventricular pacing (RVP) can lead to asynchronous cardiac mechanical contractions and increase the risk of adverse cardiac events. This study aimed to compare the clinical complications between left bundle branch area pacing (LBBAP), which is both novel and physiological, and RVP in a cohort requiring ventricular pacing.

Material and methods A retrospective study was conducted on patients with initial implantation of a dual-chamber, permanent pacemaker and with ventricular pacing proportion more than 20% from January 2019 to December 2020. Patients were divided into the LBBAP or RVP group and follow-up was conducted routinely. The primary outcome was ventricular lead complications, including an increase in the ventricular lead threshold or a decrease in R-wave amplitude. Overall complications were defined as ventricular lead complications, ventricular lead dislocation, ventricular lead perforation, adverse cardiovascular events and cardiovascular death.

Results A total of 248 patients were included in the analysis (LBBAP, n=98; RVP, n=150). The pacing QRS duration in LBBAP patients was significantly shorter than in RVP patients (110.3±22.7 vs 140.0±29.3 ms, p<0.01). For a mean follow-up duration of 13 mos, the risk of ventricular lead complications was higher in the LBBAP group than in the RVP group (62.0% vs. 36.5%, p=0.03). LBBAP was comparable to RVP within one year follow-up when considering overall complications. At the one year follow-up ultrasound examinations, the LA in LBBAP group was decreased (p=0.04). Considering the larger initial left ventricular end-diastolic diameter (LVEDD) in the LBBAP group, the similarity of LVEDD values in both groups at follow-up suggested that LVEDD was reduced in patients treated with LBBAP. There was no difference in left ventricular ejection fraction (LBBAP LVEF, baseline = 61.2±8.6%) between the two groups at baseline or follow-up.

Conclusions LBBAP patients were more prone to ventricular lead threshold increase and amplitude decrease than RVP patients. The risk of overall complications in the two pacing modalities were equal in one year follow-up duration. LBBAP is safe and effective in patients with VP>20% and without seriously depressed LVEF.

Keywords Left bundle branch area pacing; physiological pacing; bradycardia; ventricular lead complications

For citations Jieruo Chen, Zefeng Wang, Fei Hang, Yongquan Wu. Comparison of Clinical Complications Between LBBAP and Traditional RVP in Long-Term Follow-Up. Kardiologiia. 2025;65(1):27–33. [Russian: Цзеруо Чен, Зефэн Ван, Фэй Ханг, Юнцюань Ву. Сравнение клинических осложнений между стимуляцией области левой ножки пучка Гиса и традиционной стимуляцией правого желудочка в долгосрочном наблюдении. Кардиология. 2025;65(1):27–33].

Corresponding author Yongquan Wu. E-mail: wuyongquan67@163.com

Introduction

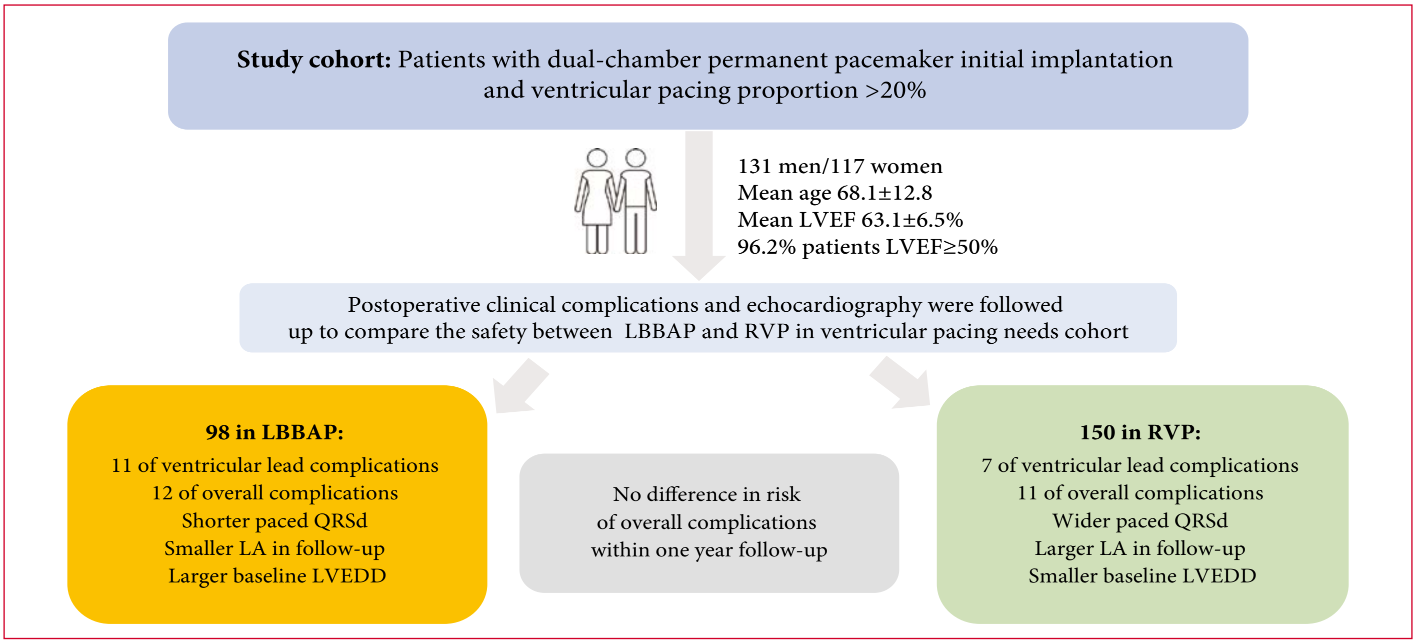
Pacing is the only effective treatment for symptomatic bradycardia. Traditional pacing methods include the placement of electrodes in the right ventricular septum or apex. The resulting, pacing-induced depolarization sequence is directionally opposite to the normal atrial conduction, and this can lead to asynchronized mechanical contractions and increased risk of atrial fibrillation (AF) [1, 2]. Left bundle branch area pacing (LBBAP) is a novel, more physiological, pacing technique. The pacing signal depolarizes the left ventricle through the normal conduction system of the LBB and its branches to achieve ideal electromechanical synchronization and electrophysiological stability [3, 4]. This technique is especially suitable for higher pacing requirements and patients with an infranodal block. Recent studies have confirmed the validity of LBBAP in various pacing indications [5–7], but there is still a lack of research related to its long-term application in patients with a high ventricular pacing proportion (VP). This retrospective study aimed to compare the safety of traditional right ventricular pacing (RVP) with that of LBBAP in patients requiring dual-chamber pacemakers.

Material and methods

Study design

This was a retrospective analysis of patients with successful implantation of a dual-chamber, permanent pacemaker for bradycardia who were treated between January 2019 and December 2020. The study was approved

Central illustration. Comparison of Clinical Complications Between LBBAP and Traditional RVP in Long-Term Follow-Up



QRSd – QRS duration, LBBAP – Left bundle branch area pacing, RVP – Right ventricular pacing, LVEF – Left ventricular ejection fraction; LVEDD – Left ventricular end-diastolic dimension; LA – Left atria.

by the institutional review committee, and the requirement for informed consent was waived.

Subject selection

Patients aged between 18 and 90 years who had pacing indications based on the current guidelines and successfully underwent dual-chamber permanent pacemaker implantation with postoperative VP≥20% [8] and at least 6 months follow-up duration were enrolled in the study. Patients with clinical heart failure and left ventricular ejection fraction (LVEF) ≤35%, requiring implantable cardioverter-defibrillator or cardiac resynchronization therapy, with valvular heart disease, a history of cardiac surgery within the past 6 mos, or those unable to cooperate in the follow-up were excluded.

Implantation definition

The enrolled patients also met the following criteria for pacing: The atrial leads were hooked to the right atrial appendage with passive wing electrodes or fixed to the right atrial appendage with active spiral electrodes, and the test parameters were satisfactory. Traditional RVP included right ventricular apical and septal pacing. The following right ventricular lead parameters had to be satisfied: 1) The pacing threshold was less than 1) V/0.4 ms. 2) The R-wave amplitude was greater than 5 mV. 3) The impedance was 300–2000 Ω. LBBAP was achieved by the "nine partition method" [9] using 3830 pacing leads (Medtronic Inc., Minneapolis, MN USA) delivered through a fixed sheath (C315 HIS, Medtronic Inc., Minneapolis, MN USA). The LBBAP was successfully accomplished based on the following criteria: 1) The electrode passed through the septum from the right ventricular surface to the left bundle branch region of the left ventricular septum, and the QRS pattern of the pacing ECG was RBBB in leads V1. 2) The left ventricular activation time (LVAT) was significantly shorter than endocardium pacing, and the time from the pacing signal to the R-wave peak of the V5 and V6 leads was ≤80 ms. This was fixed under high and low amplitudes (measurement method: postoperative pacing at 2.0V, 5.0V).

Data collection

The clinical data collected included sex, age, height, weight, main disease, such as sick sinus syndrome (SSS) and atrioventricular block (AVB), comorbidities, and New York Heart Association classification of cardiac function (NYHA). The following blood biochemistry parameters were measured before surgery: hemoglobin (Hb), white blood cell (WBC), platelet (PLT), alanine aminotransferase (ALT), albumin (ALB), low-density lipoprotein cholesterol (LDL–C), high-sensitivity c-reactive protein (hs-CRP), prothrombin time (PT), activated partial thromboplastin time (APTT), D-dimer and estimated glomerular filtration rate (eGFR). The following ventricular pacing parameters were collected and recorded during the operation and each follow-up examinations: VP threshold (V/0.48 ms), R-wave amplitude (mV), and impedance. Recorded complications included intraoperative cardiac perforation, pericardial effusion, malignant arrhythmia, and sudden death.

The patients' baseline and follow-up echocardiography were conducted in accordance with the recommendations of the American Society of Echocardiography. Standard apical

ISSN 0022-9040. Кардиология. 2025;65(1). DOI: 10.18087/cardio.2025.1.n2809

four-chamber and two-chamber views were selected, and the left ventricular end-diastolic diameter (LVEDD) and left atrial anteroposterior diameter (LAD) were measured. Left ventricular ejection fraction (LVEF) was calculated using the modified single-plane Simpson method. The patients' baseline and follow-up ECG parameters were also collected, including QRS duration (QRSd, ms), baseline left bundle branch block (LBBB), or right bundle branch block (RBBB). ECGs were recorded at 100 mm/s. All QRS widths were measured in lead V1, and the paced QRS width was measured from the beginning of the pace signal to the end of the QRS complex.

Endpoints

The patients were followed-up every 6 mos after discharge; data for this study was collected at the follow-up examinations. The primary endpoint of the study was postoperative complications, including total and ventricular lead complications. Ventricular lead complications were defined as an increase in the ventricular lead threshold or a decrease in amplitude, which was defined as a 2-fold increase in the threshold that was greater than 1.5 V/0.48 ms at follow-up compared with the initial amplitude or a 2-fold decrease in the amplitude of less than 5 mV at follow-up compared with baseline. Overall complications included ventricular electrode complications, ventricular lead dislocation, ventricular lead perforation, adverse cardiovascular events, and cardiovascular death.

Statistical analysis

SPSS software (version 23.0) was used for the statistical analysis. The study population was divided into two groups, LBBAP and RVP. Baseline clinical characteristics of the patients were compared between the two groups. Continuous variables at baseline and follow-up (ECG and UCG indicators) were compared paired t-tests if the variables obeyed normal distributions and rank-sum tests if the variables did not obey normal distributions. The total number of complications and ventricular lead complications were counted during the follow-up, and the event rate for each group was calculated. Using the Kaplan–Meier method, the survival curve of the two surgical groups and the incidence of complication events were established, and the log-rank test was used to compare the survival time difference between the curves and to clarify the safety in the group of patients. $p<0.05$ indicated that a difference was statistically using significant.

Results

Baseline characteristics

From January 2019 to December 2020, we treated 412 patients who underwent permanent pacemaker

Table 1. Clinical characteristics of the patients in the two surgical groups

Clinical Characteristics	LBBAP Group (n=98)	RVP Group (n=150)	p
General features			
Age, yrs	67.12±12.51	69.28 ± 12.22	0.19
Male	55 (56.1)	76 (50.7)	0.30
Systolic pressure, mmHg	138.93 ± 17.37	137.58 ± 18.57	0.58
Diastolic pressure, mmHg	74.01 ± 9.82	71.48 ± 10.28	0.06
BMI, kg/m²	25.4 ± 3.6	25.2 ± 3.8	0.62
Smoking	9 (9.2)	18 (12.0)	0.49
Alcohol	5 (5.1)	12 (8)	0.38
Comorbidities			
Diabetes	28 (28.6)	32 (21.3)	0.19
Hypertension	57 (58.2)	90 (60.0)	0.77
Coronary heart disease	17 (17.3)	20 (13.3)	0.27
Cerebral infarction	5 (5.1)	4 (2.67)	0.32
Bradycardia type			
SSS	19 (19.4)	49 (32.7)	0.02
AVB			0.33
First-degree	2 (2.0)	4 (2.7)	
Second-degree type I	1 (1.0)	0 (0.0)	
Second-degree type II	15 (15.3)	23 (15.3)	
High-grade	48 (49.0)	57 (38.0)	
Third-degree	18 (18.4)	32 (21.3)	
Use of ACEI/ARB	18 (18.4)	30 (20.0)	0.75
NYHA			0.01
NYHA I	82 (83.7)	142 (94.7)	0.02
NYHA II	13 (13.3)	5 (3.2)	0.003
NYHA III-IV	3 (3.1)	3 (2.0)	0.91
Electrocardiogram			
RBBB	14 (14.3)	30 (20.0)	0.25
LBBB	16 (16.3)	19 (12.7)	0.42
Baseline QRSd (ms)	104.2 ± 29.4	103.7 ± 27.3	0.91
Paced QRSd (ms)	110.3 ± 22.7	140.0 ± 29.3	<0.01
Hematology and Biochemistry			
WBC (10^9/l)	7.0 ± 3.3	7.5 ± 6.2	0.44
Hb (g /l)	138.0 ± 21.4	137.1 ± 17.8	0.74
PLT (109 /l)	213.8 ± 52.0	209.1 ± 70.1	0.56
ALT (U /l)	25.8 ± 34.0	24.3 ± 37.4	0.74
ALB (g /l)	43.3 ± 4.1	43.5 ± 4.3	0.79
eGFR (ml/min·1.73 m²)	87.9 ± 21.2	82.0 ± 19.4	0.04
LDL-C (mmol/l)	2.5 ± 0.76	2.5 ± 0.80	0.56
hs-CRP (mg/l)	2.6 ± 4.4	2.5 ± 4.7	0.93
PT (s)	12.1 ± 3.4	11.9 ± 2.3	0.69
APTT (s)	31.5 ± 4.0	31.0 ± 3.8	0.27
D-dimer (ng/ml)	157.0 ± 138.9	179.5 ± 166.6	0.27
BNP (pg/ml)	185.8 ± 220.3	213.0 ± 317.5	0.48

Values are mean ± SD or number (%). LBBAP – Left Bundle Branch Area Pacing; RVP – Right Ventricular Pacing; BMI – Body Mass Index; RBBB – Right Bundle Branch Block; LBBB – Left Bundle Branch Block; SSS – Sick Sinus Syndrome; AVB – Atrioventricular Block; VP – Ventricular Pacing; AF – Atrial Fibrillation; ACEI – Angiotensin-Converting Enzyme Inhibitor; ARB – Angiotensin II Receptor Blocker; NYHAF – New York Heart Association classification of functional capacity; WBCF – White Blood Cell; HbF – Hemoglobin; PLTF – platelet; ALTF – Alanine Aminotransferase; ALBF – Albumin; eGFRF – Estimated Glomerular Filtration Rate; LDL–CF – Low-Density Lipoprotein Cholesterol; hs-CRPF – High-sensitivity C-reactive protein; PTF – Prothrombin time; APTTF – Activated Partial Thromboplastin Time; BNPF – Brain Natriuretic Peptide.

Figure 1. Flowchart of screened patients in the study according to the inclusion and exclusion criteria

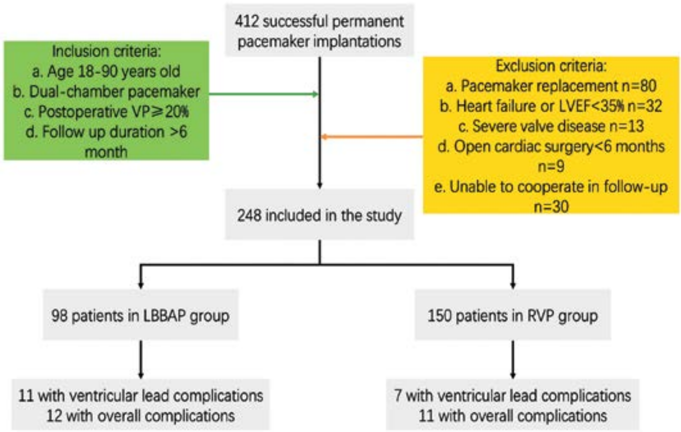
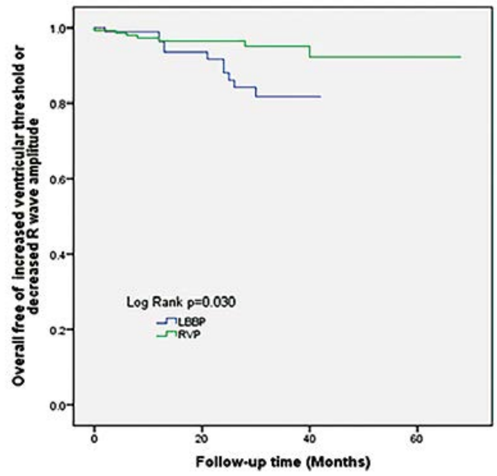


Figure 2. Kaplan-Meier survival curves for ventricular lead complications based on the groups of LBBAP and RVP

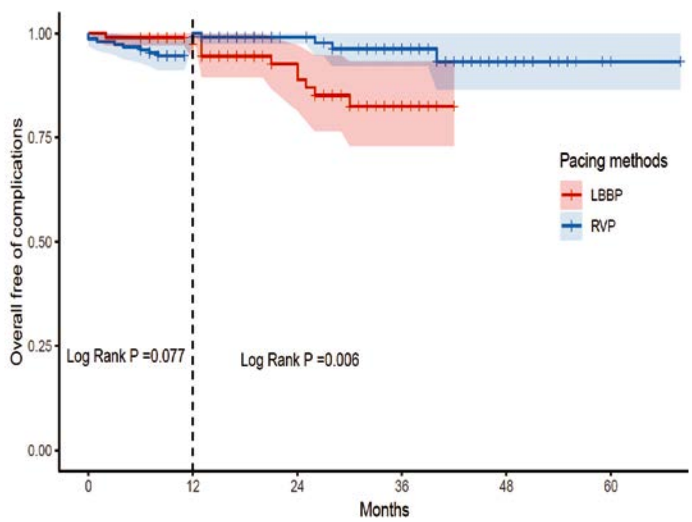


implantation. Based on the inclusion and exclusion criteria, 248 patients were enrolled in this study (Figure 1). Table 1 shows the basic clinical characteristics of the study population. The age of the total population was between 20 and 90 yrs, with an average age of 68.1±12.8 years, and 131 (52.8%) were male. According to the different surgical modalities, the selected patients were divided into the LBBAP (n=98, 39.5%) and RVP (n=150, 60.5%) groups. Patients diagnosed with SSS were more often treated with RVP, whereas patients with AVB were treated with either LBBAP or RVP in a similar proportion, and the difference was statistically significant. Patients in NYHA class I were mostly treated with RVP, while those in classes II were mostly treated with LBBAP. Furthermore, baseline eGFR levels were relatively high in the LBBAP population. The baseline QRSd of the two groups was approximately the same (104.2±29.4 vs 103.7±27.3 ms, p=0.91), and the paced QRSd of the LBBAP group was significantly shorter than that of the RVP group (110.3±22.7 vs 140.0±29.3 ms, p<0.01). There were no significant differences between the two groups with respect to general characteristics, such as age, sex, medicinal therapy, and laboratory indicators.

Comparison of complications between the two surgical approaches

During 6–58 mos of follow-up (median=13 mos), 18 (7.2%) of LBBAP patients experienced an event of increased ventricular threshold or decreased ventricular amplitude, and the incidence of adverse events of ventricular electrodes in the LBBAP group was 11.2%. Eight patients had an increase in ventricular threshold during follow-up, of which seven patients were in the LBBAP group. The threshold increased from 0.73±0.06 V/0.48 ms during the procedure to 1.91±0.14 V/0.48 ms at 21.4±2.6 months of follow-up in the LBBAP group, with an average increase of

Figure 3. Kaplan-Meier survival curves for overall complications based on the groups of LBBAP and RVP



1.18±0.11 V/0.48 ms. One patient with RVP had an elevated threshold increase from 0.5 V/0.48 ms during the procedure to 2.0 V/0.48 ms at the 28-mon follow-up. A total of 10 patients, including four in the LBBAP group, experienced a decrease in R-wave amplitude during follow-up. The four patients' amplitudes decreased from 8.4±1.7 mV during the procedure to 3.3±0.2 mV at 13±4.5 mos of follow-up, with an average decrease of 5.1±1.7 mV. In the other 6 patients with RVP, their amplitudes decreased from 8.5±1.5 mV to 3.6±0.3 mV at follow-up, with an average decrease of 5.0±1.4 mV, which occurred approximately 11.7±5.9 mos after the procedure.

In addition, one patient had RV electrode perforation, the original lead was located in the RV apex, two patients had RV electrode dislocation at 1 wk and 3 mos after the procedure, and the original electrodes were both located in the RV septum. Acute myocardial infarction occurred in two patients 1 yr and 1.5 yrs after the operation; the patients

ISSN 0022-9040. Кардиология. 2025;65(1). DOI: 10.18087/cardio.2025.1.n2809

Table 2. Clinical characteristics of patients with ultrasound analysis at baseline and follow-up

Clinical Characteristics	LBBAP group (n=92)	RVP group (n=80)	p
General characteristics			
Age, yrs	66.7 ± 11.5	71.7 ± 11.4	0.05
Male	54 (58.7)	40 (50.0)	0.50
Systolic pressure, mmHg	137.4 ± 17.2	136.6 ± 20.8	0.86
Diastolic pressure, mmHg	73.3 ± 9.1	68.9 ± 12.8	0.07
BMI, kg/m²	25.3 ± 3.4	25.7 ± 5.0	0.72
Smoke	6 (6.5)	10 (12.5)	0.34
Alcohol	6 (6.5)	10 (7.5)	0.86
Comorbidities			
Diabetes	26 (28.3)	16 (20.0)	0.37
Hypertension	48 (52.2)	48 (60)	0.47
Coronary heart disease	16 (17.4)	12 (15.0)	0.89
Cerebral infarction	6 (6.5)	4 (5.0)	0.76
Bradycardia type			
SSS	16 (17.4)	28 (35.0)	0.06
AVB	-	-	0.18
First-degree	0	0	-
Second-degree type I	16 (17.4)	6 (7.5)	-
Second-degree type II	48 (52.2)	30 (37.5)	-
High to Third-degree	14 (15.2)	18 (22.5)	-
Use of ACEI/ARB	5 (10.9)	8 (20.0)	0.24
NYHA			0.048
I	72 (78.3)	76 (95.0)	0.038
II	18 (19.6)	2 (2.5)	0.012
III-IV	2 (2.2)	2 (2.5)	0.94
Biochemistry			
Hb (g/l)	137.5 ± 24.8	132.3 ± 22.8	0.33
ALT (U/l)	20.9 ± 11.8	23.1 ± 19.2	0.56
ALB (g/l)	43.1 ± 4.4	43.6 ± 5.6	0.67
eGFR (ml/min·1.73m²)	88.2 ± 18.7	87.0 ± 15.2	0.77
LDL-C (mmol/l)	2.5 ± 0.83	2.5 ± 1.0	0.70
D-dimer (ng/ml)	135.4 ± 130.5	193.1 ± 176.3	0.11

Values are mean ± SD or number of subjects (%). LBBAP – Left Bundle Branch Area Pacing; RVP – Right Ventricular Pacing; BMI – Body Mass Index; RBBB – Right Bundle Branch Block; LBBB – Left Bundle Branch Block; SSS – Sick Sinus Syndrome; AVB – Atrioventricular Block; VP – Ventricular Pacing; AF – Atrial Fibrillation; ACEI – Angiotensin-Converting Enzyme Inhibitor; ARB – Angiotensin II Receptor Blocker; NYHA – New York Heart Association classification of functional capacity; WBC – White Blood Cell; Hb – Hemoglobin; PLT – platelet; ALT – Alanine Aminotransferase; ALB – Albumin; eGFR – Estimated Glomerular Filtration Rate; LDL–C–Low-Density Lipoprotein Cholesterol; hs-CRP – High-sensitivity C-reactive protein; PT – Prothrombin time; APTT – Activated Partial Thromboplastin Time; BNP – Brain Natriuretic Peptide.

had LBBAP or RVP, respectively. One patient died of sudden cardiac death 7 mos after the RVP operation. Thus, 23 complications occurred, accounting for 9.3% of the study population.

Comparing the risks of postoperative complications between the two groups, the LBBAP group had a higher risk of ventricular lead complications than the RVP group, and the log-rank test result was significant (62.0% vs. 36.5%, p=0.03) (Figure 2). However, landmark analysis showed in Figure 3 that there are no significant differences in overall complications between the two groups within one year follow-up. LBBAP patients had a higher risk of overall complications than RVP (p=0.006) in follow-up duration between 12 and 58 months.

Subgroup analysis: Echocardiographic changes of the two pacing methods

A total of 235 (95.2%) patients completed preoperative echocardiographic examinations; 228 (97.0%) had an LVEF ≥50%, and the mean LVEF was 63.1±6.5%. Owing to the impact of the COVID-19 epidemic, only 172 patients underwent ultrasonography at the one-year follow-up after surgery. These patients were divided into the LBBAP and RVP groups, and the baseline clinical characteristics of the two groups were compared, as shown in Table 2. Compared with RVP, the LBBAP group had less NYHA grades I and more NYHA II, and the differences were statistically significant (p=0.048).

Changes in echocardiography of patients at baseline and one-year follow-up were compared, as shown in Table 3. There was no significant difference in the LA anteroposterior diameter between the two groups at admission. However, at follow-up, the LA in the LBBAP group was smaller than that in the RVP group (37.1±6.7 vs. 40.1±8.9 mm, p=0.04). The LVEDD of the two groups was similar during follow-up, but the LVEDD of the LBBAP group was generally larger at admission, suggesting that LVEDD was reduced in patients treated

Table 3. Comparison of baseline and follow-up echocardiography of patients with different surgical groups

Echocardiography	LBBAP group (n=92)	RVP group (n=80)	p
Baseline LVEF (%)	61.2 ± 8.6	63.4 ± 5.0	0.19
Follow-up LVEF(%)	61.7 ± 8.7	62.7 ± 7.3	0.57
Baseline LVEDD (mm)	51.9 ± 5.1	48.2 ± 5.4	<0.01
Follow-up LVEDD (mm)	48.5 ± 5.2	48.6 ± 8.0	0.98
Baseline LAD (mm)	38.5 ± 4.0	38.2 ± 5.5	0.79
Follow-up LAD (mm)	37.1 ± 6.7	40.1 ± 8.9	0.04

Values mean ± SD. LVEF – Left Ventricular Ejection Fraction; LVEDD – Left Ventricular End-Diastolic Dimension; LAD – Left Atrial Diameter.

with LBBAP. There were no statistically significant differences in LVEF between the two groups at baseline or follow-up.

Discussion

Some important conclusions can be drawn from this study. Patients undergoing LBBAP had an elevated risk of ventricular lead complications compared with patients undergoing RVP. Regarding overall complications, such as ventricular lead dislocation, perforation, and adverse cardiovascular events, the risks of the two pacing modalities were equal within one year follow-up, while higher risk of LBBAP patients encountered with overall complications in follow-up duration between 12 and 58 months. This risk discrimination based on follow-up duration of one-year was probably mainly attributed to higher risk of increased ventricular threshold or decreased ventricular amplitude in LBBAP patients. The results indicated that LBBAP patients requiring ventricular pacing are prone to an increase in ventricular lead threshold and a decrease in amplitude than RVP patients.

Studies have found that, compared with His bundle pacing (HBP), LBBAP, which has been increasingly used in recent years, is relatively easier to perform and achieves a higher success rate [8, 10, 11]. LBBAP has been demonstrated to have better pacing parameters and to be not inferior to HBP in terms of cardiac electromechanical synchronization. These advantages could be primarily related to the unique anatomical structure of the LBB [12]. The His bundle is surrounded by fibrous tissue of the membranous atrioventricular septum, so the pacing lead cannot be deeply screwed in this area, whereas the lead tip can reach the subendocardium of the left ventricular septum and contact the LBB and Purkinje fiber network in the LBBAP procedure. Therefore, implanting a lead tip in this area can easily achieve a lower pacing threshold and higher impedance than HBP. Moreover, because of the electrode location on the distal ventricular side of the tricuspid annulus, the R-wave amplitudes recorded in the LBBAP were significantly higher than those in the HBP.

Previous studies [2, 13, 14] have shown that LBBAP can be successfully performed in various populations and have demonstrated its reliability in terms of long-term efficacy and safety. Su et al. [13] conducted a large observational study of LBBP in 632 consecutive pacemaker patients for two-year follow-up. The results suggested that LBBP had high success rates and low complication rates during the two years. The study also reported attention to sensed R-wave amplitude, pacing impedance, and thresholds in the entire cohort, which remained stable. A multi-center, large-samples, observational study from Jastrzebski, M. [14] reported that the capture threshold (0.77V) and sensing (10.6 mV) of LBBAP were stable during mean follow-up of 6.4 months. And the complication rate of LBBAP was 11.7%. In the present study, although LBBAP was prone to adverse events of ventricular lead thresholds and R-wave amplitude compared with RVP, there was no difference between the two approaches in terms of total complications within one year follow-up, suggesting that LBBAP is not inferior to traditional RVP in terms of short-term pacing safety. Additionally, we suggest that more attention should be given to the changes in lead parameters during long-term follow-up and that the frequency of the follow-up period should be increased, especially in patients with a high VP. According to the 2021 ESC guidelines on cardiac pacing and cardiac resynchronization therapy [15], HBP may be considered an alternative to RVP in patients with AVB and LVEF >40% who are anticipated to have >20% VP. The results of the present study indicate that patients with VP >20% and LVEF ≥35% can also chose LBBAP. This alternative choice is mainly reflected in the fact that LBBAP does not carry a higher risk of implantation complications than traditional RVP, such as lead dislocation, perforation, and adverse cardiovascular events.

Some patients were examined by ultrasound at baseline and at one year in the current study. The results confirmed the above studies [2, 13, 14] to a certain extent, suggesting that LBBAP has a preserved effect on the left atrium and left ventricle compared to RVP. This is similar to the conclusion of Zhu et al. [16], who found that LBBAP was associated with a decrease in LADand resulted in a more stable LVEF compared to RVP during a mean follow-up of 13.6±7.8 mos. No statistically significant difference in LVEF between the two pacing approaches was observed in our study. This could be attributed to the small sample size of the included patients, which might have underpowered our study to reveal any differences in ventricular mechanical function. Most of our study cohort patients were relatively healthy, had normal cardiac function, and had few cardiovascular complications. The NYHA class I–II population accounted for a high proportion in the study, which means the bradycardia was not long enough to cause significant changes in left ventricular systolic function. A long-term analysis of LBBAP was conducted on patients after transcatheter aortic valve implantation (TAVI) followed-up for 5 yrs [17]. The results indicated that there was greater improvement of LVEF over time in the LBBAP patients compared to RVP (p=0.046 for LVEF changes over time between groups). This long-term study showed that LBBAP improved long-term clinical outcomes compared with RVP in patients after TAVI as indicated by lesser hospitalization for heart failure and greater improvement in LVEF. In addition, there was no difference in the intrinsic QRSd between the two groups in the present study, but the pacing QRSd in the LBBAP

ISSN 0022-9040. Кардиология. 2025;65(1). DOI: 10.18087/cardio.2025.1.n2809

group was significantly shorter than that in the RVP group, suggesting that the LBBAP can provide improved ventricular electrical synchronization.

This study had some limitations. It was a single-center, retrospective cohort analysis. The proportion of patients with incomplete follow-up was relatively high. Although the study analyzed the differences in the risk of end-points between the two groups by time interval, the large variation in follow-up periods (6–58 mos) might have affected the outcomes. Randomized controlled studies are required to validate the conclusions of the current study and to further guide clinical applications.

Conclusions

Compared with RVP, patients with LBBAP were prone to encounter an increase in the ventricular lead threshold or a decrease in R-wave amplitude. No differences were observed within one year follow-up between the LBBAP and RVP groups for overall complications, including increased ventricular threshold or decreased ventricular amplitude, ventricular lead dislocation, ventricular lead perforation, adverse cardiovascular events, and cardiovascular death. LBBAP is safe and effective in patients with VP>20% and without seriously depressed LVEF.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Anzhen Hospital. The ethical approval number is 2024133X. Cause the study only used existing medical records, did not involve the identity or privacy of the subjects, and did not cause any risk or harm to the subjects. After obtaining the consent of the ethics committee, informed consent was exempted.

Funding

The study was funded by the Center Clinical Medicine Development project of Beijing Municipal Hospital Management as "Sail" program XMLX202112.

No conflict of interest is reported.

The article was received on 08/11/2024

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