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RAPID COMMUNICATION

Left bundle branch area pacing vs. right ventricular pacing in post-transcatheter aortic valve implantation patients: a retrospective propensity-matched analysis

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Introduction

Transcatheter aortic valve implantation (TAVI) is an established treatment for severe aortic stenosis across a wide range of patients.[1] Despite technological advances, conduction disturbances remain frequent, and many patients require permanent pacemaker (PPM) implantation.[2,3] Conventional right ventricular pacing (RVP) may induce electrical and mechanical dyssynchrony, promoting left ventricular dysfunction and heart failure.[4] Left bundle branch area pacing (LBBAP) offers a more physiological activation by engaging the native conduction system.[5] Although beneficial in non-TAVI populations,[6,7] its role after TAVI is not well defined. This study compares outcomes of LBBAP vs. RVP in post-TAVI patients requiring PPM implantation.

Methods

This single-centre retrospective cohort included consecutive patients undergoing TAVI between January 2020 and December 2024 who subsequently required PPM implantation. Clinical, procedural, and follow-up data were obtained from institutional electronic records and dedicated databases. Patients with known or suspected cardiac amyloidosis were excluded *a priori*. To allow a balanced comparison between pacing strategies, propensity score matching (1:1 nearest neighbour, calliper 0.2 SD) was performed using age, sex, Society of Thoracic Surgeons (STS) score, baseline left ventricular ejection fraction (LVEF), QRS duration, and presence of left bundle branch block (LBBB) as covariates.

All procedures conformed to the Declaration of Helsinki and to the 2021 ESC/EACTS Guidelines on valvular heart disease. The study was approved by the local ethics committee. Device selection (self-expanding or balloon-expandable) was at the operator's discretion. Procedural success was defined by the VARC-3 criteria,[8] including freedom from death, major complications, or need for repeat intervention. Continuous telemetry and serial ECGs were performed for ≥48 h post-TAVI to detect conduction disturbances. Permanent pacemaker implantation followed 2021 ESC Guidelines on pacing and CRT,[9] based on persistent or symptomatic high-degree atrioventricular block or significant pauses.

In patients undergoing RVP, the lead was placed at the septal position, programmed in VVI or DDD mode. Left bundle branch area pacing was

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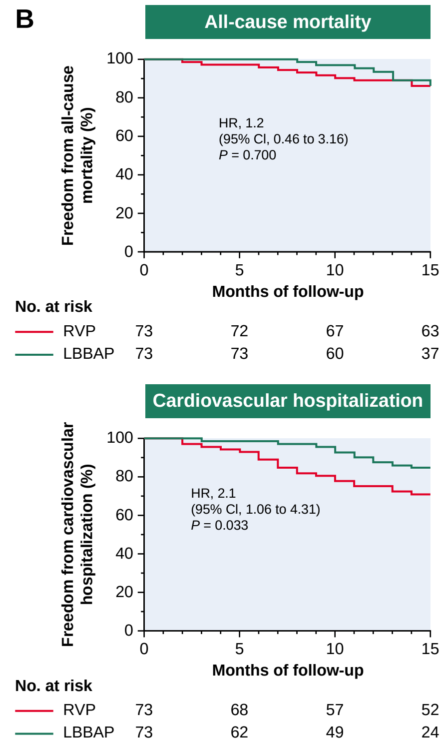
Variable	RVP (n = 73)	LBBAP (n = 73)	P-value
Age, years	78.1 ± 6.24	77.8 ± 6.38	0.811
Male, n (%)	45 (61.6%)	46 (63.0%)	0.846
Hypertension, n (%)	41 (56.2%)	30 (41.1%)	0.047
Diabetes mellitus, n (%)	16 (21.9%)	18 (24.7%)	0.712
CAD, n (%)	32 (43.8%)	30 (41.1%)	0.795
Prior cerebrovascular events, n (%)	5 (6.8%)	4 (5.5%)	0.742
CKD, n (%)	7 (9.6%)	6 (8.2%)	0.776
NYHA class III–IV, n (%)	52 (71.2%)	50 (68.5%)	0.772
Pre-TAVI LVEF, %	57.21 ± 12.38	56.87 ± 13.11	0.698
Pre-TAVI QRS duration, ms	115.24 ± 22.45	113.79 ± 23.01	0.762
Pre-TAVI LBBB, n (%)	4 (5.5%)	3 (4.1%)	0.731
Post-TAVI mean aortic gradient, mmHg	8.5 ± 3.2	8.2 ± 3.1	0.689
Post-TAVI new-onset LBBB, n (%)	20 (27.4%)	18 (24.7%)	0.692
Dual-chamber pacemaker, n (%)	63 (86.3%)	62 (84.9%)	0.812
Single-chamber pacemaker, n (%)	10 (13.7%)	11 (15.1%)	0.811
Paced QRS duration, ms	151 ± 18	122 ± 12	<0.001
PMI procedural time, min	44.6 ± 13.8	55.1 ± 21.3	<0.001
PMI fluoroscopy time, min	5.2 ± 2.7	10.3 ± 7.7	<0.001
PMI procedural success, n (%)	73 (100%)	69 (94.5%)	0.002



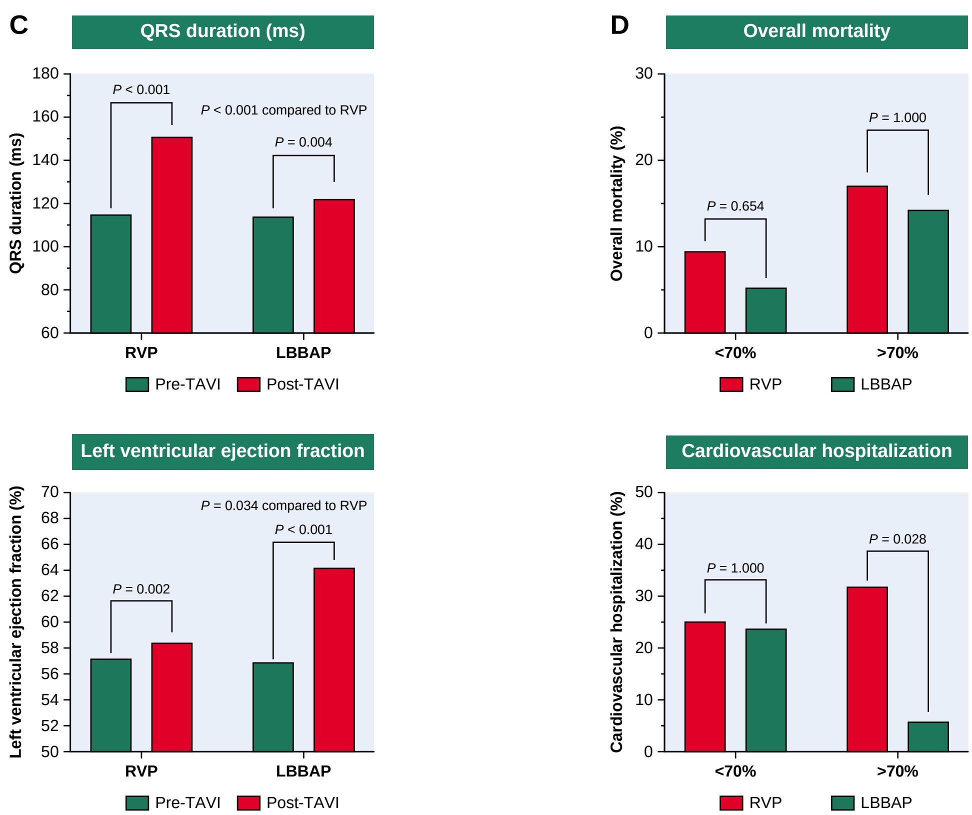


Figure 1 (*A*) Baseline, clinical, and procedural characteristics of the study population. (*B*) Kaplan–Meier survival curves for all-cause mortality (upper panel) and cardiovascular hospitalizations (lower panel) in patients who underwent LBBAP or RVP following TAVI. (*C*) Bar graphs illustrating changes in QRS duration and LVEF from baseline to follow-up in patients undergoing TAVI treated with RVP or LBBAP. (*D*) Bar graphs illustrating all-cause mortality (upper panel) and cardiovascular hospitalizations (lower panel) in patients undergoing RVP or LBBAP, classified by ventricular pacing percentage at follow-up (>70% vs. <70%). Data are reported as mean ± standard deviation or number (percentage) in case of binary variables. Abbreviations: CAD, coronary artery disease; CKD, chronic kidney disease; LBBAP, left bundle branch area pacing; LBBB, left bundle branch block; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; PMI, pacemaker implantation; RVP, right ventricular pacing; TAVI, transcatheter aortic valve implantation.

performed following current expert consensus, with the lead positioned 1–2 cm distal to the His region within the interventricular septum. Left bundle branch area pacing success required evidence of conduction system capture (Qr/qR/rSR′ pattern in V1, V6 R-wave peak time < 75 ms, or selective/non-selective capture transition). When conduction capture was not demonstrated, left ventricular septal pacing was accepted if electrical criteria were met. Acceptable thresholds were <1.5 V at 0.4 ms and R-wave amplitude > 4 mV. All devices incorporated algorithms to minimize unnecessary RVP.

Clinical endpoints included all-cause and cardiovascular mortality, cardiovascular hospitalizations, changes in LVEF, New York Heart Association (NYHA) class, paced QRS duration, and device-related complications. Follow-up visits occurred at 3 and 12 months, then annually, with device interrogation, ECG, and echocardiography when indicated. Remote monitoring complemented in-person evaluations.

Continuous variables were expressed as mean ± SD or median (IQR) and compared with *t*-test or Mann–Whitney *U* test; categorical data were compared with χ^2 or Fisher's exact test. Kaplan–Meier and Cox proportional hazards models were used to assess survival outcomes, with hazard ratios (HR) and 95% confidence intervals (CI). The proportional hazards assumption was verified for all models. Patients were stratified according to a ventricular pacing burden of ≥70%, a threshold identifying individuals at risk of pacing-induced dysfunction. To standardize comparisons, survival analyses were censored at 15 months. Analyses were performed with R (R Foundation, Vienna, Austria) and GraphPad Prism (GraphPad Software, San Diego, CA), with $P < 0.05$ considered statistically significant.

Results

A total of 342 post-TAVI patients who underwent PPM implantation were included. Among them, 93 (27.2%) received LBBAP, while the remaining underwent conventional RVP. After 1:1 propensity score matching, 73 patients per group were analysed. Baseline, clinical, and procedural characteristics were comparable between groups (*Figure 1A*).

At 15-month follow-up, 10 patients (13.7%) in the RVP group and 7 (9.6%) in the LBBAP group had died, with no significant difference in all-cause mortality (HR 1.2; 95% CI 0.46–3.16; $P = 0.70$) (*Figure 1B*, upper panel). Cardiovascular hospitalizations occurred in 21 patients (28.8%) with RVP and 11 (15.1%) with LBBAP (HR 2.1; 95% CI 1.06–4.31; $P = 0.033$) (*Figure 1B*, lower panel).

QRS duration increased from 115 ± 22 to 151 ± 18 ms with RVP and from 114 ± 23 to 122 ± 12 ms with LBBAP ($P < 0.001$). Left ventricular ejection fraction improved from 57 ± 12 to 58 ± 8% in the RVP group and from 57 ± 13 to 64 ± 8% in the LBBAP group ($P = 0.034$) (*Figure 1C*).

In patients with a ventricular pacing burden of ≥70%, all-cause mortality was 17.1% with RVP and 14.3% with LBBAP, while cardiovascular hospitalizations were 31.7 and 5.7%, respectively ($P = 0.028$) (*Figure 1D*). No significant differences were observed among patients with <70% pacing burden.

Discussion

In this propensity-matched cohort of post-TAVI patients requiring PPM implantation, LBBAP was associated with a markedly lower rate of cardiovascular hospitalizations compared with conventional RVP, despite similar all-cause mortality at 15-month follow-up. These findings highlight the clinical relevance of preserving physiological ventricular activation through conduction system pacing.

Conduction disturbances remain frequent after TAVI, and chronic RVP is known to induce electrical and mechanical dyssynchrony, promoting progressive ventricular dysfunction.[10] By engaging the native conduction system, LBBAP restores near-physiological activation and maintains synchrony, translating into better functional outcomes. In our study, LBBAP resulted in a substantially shorter paced QRS duration and greater improvement in LVEF compared with RVP, consistent with superior electromechanical performance. Cardiovascular hospitalizations were reduced by nearly 48%, and this benefit was even more evident in patients with high pacing burden (≥70%), where RVP was associated with a six-fold higher hospitalization risk.

Our results challenge the traditional paradigm, suggesting that LBBAP may serve not only as a feasible alternative but as the preferred pacing modality in post-TAVI patients who are likely to become pacing-dependent. While biventricular pacing remains indicated in advanced heart failure or overt dyssynchrony, LBBAP offers a simpler and more physiological solution for maintaining ventricular coordination after TAVI.

The study presents some limitations, particularly related to its retrospective design and limited follow-up duration, which may have underestimated long-term differences in mortality.

Conclusions

Among post-TAVI patients undergoing PPM implantation, LBBAP was associated with fewer cardiovascular hospitalizations and superior preservation of ventricular function compared with conventional RVP. These findings support LBBAP as a more physiological and potentially preferred pacing strategy in this setting. Prospective randomized studies with extended follow-up are warranted to confirm its long-term clinical and survival benefits and to define its role relative to biventricular pacing.

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Conflict of interest: none declared.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding authors.

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