New-Onset Left Bundle Branch Block After Transcatheter Aortic Valve Implantation

— Not a Harmless Bystander —

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Transcatheter aortic valve implantation (TAVI) is a well-established alternative treatment to surgical aortic valve replacement (SAVR), and it is expected to move towards treatment of a lower risk and younger population. New-onset left bundle branch block (N-LBBB) is the most frequent clinically relevant conduction disturbances after both TAVI and SAVR.

The anatomic mechanism that causes LBBB after TAVI or SAVR can be explained by the relationship between the aortic valve and the atrioventricular conduction pathway. The atrioventricular node runs near the noncoronary sinus and the right coronary sinus (**Figure**). It is known to occur not only with mechanical stress due to radial force and longitudinal distortion of a bulky transcatheter heart valve (THV), local edema, hematoma, and ischemia, but also with the insertion of a stiff guidewire or with pre/post-balloon dilatation.

Despite advances in TAVI devices and techniques, conduction disturbance after TAVI persists as the most frequent complication of the procedure.¹ The incidence of N-LBBB after SAVR has been reported to be approximately 10%,² but the exact frequency of LBBB after TAVI differs with the THV system and the time elapsed after the procedure. The rate of new LBBB after TAVI with the balloon-expandable valve (BEV) is similar to that with SAVR; however, the incidence of N-LBBB with the self-expandable valve (SEV) is relatively higher, ranging from approximately 25% to 55% in a previous study. Although the wide range of N-LBBB rates may reflect differences in patients' characteristics, it may also be due to differences in definition and the diagnostic timing of LBBB after TAVI, which has been mostly at discharge and in a few cases immediately after the procedure (**Table**). Various definitions of N-LBBB after TAVI have been used across studies, but there is no consensus.

LBBB may induce electromechanical ventricular dyssynchrony and ventricular structural remodeling that may lead to left ventricular (LV) systolic dysfunction and heart failure (HF) with worse prognosis.³ However, the prognostic evaluation of N-LBBB after TAVI for long-term clinical outcome regarding death and re-admission for HF is controversial. N-LBBB after TAVI is known to resolve to

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a considerable extent during the clinical course. Nazif et al report that N-LBBB occurred in 121 of 1,151 patient (10.5%) at discharge and persisted in this group in 62 of 107 (57.9%) at 30 days and in 52 of 90 (57.8%) at 6 months to 1 year.⁴ Another study demonstrated that N-LBBB occurred in 150 of 476 patient (31.5%) within 24h after procedure (acute LBBB), >24h but before discharge in 4.4% (subacute LBBB), and after discharge in 0.8% (late LBBB).⁵ Transient LBBB was found in 52 of 150 patient (34.7%) in an acute LBBB group, and 12 of 21 (57.1%) in

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Table. Clinical Studies of New-Onset LBBB After Transcatheter Aortic Valve Implantation

Author	Year	n	Type of THV	New-onset LBBB and timing	Results
Houthuizen et al ⁹	2012	679	SEV 57%/BEV 43%	233 (34.3%) at discharge	All-cause death was higher in the LBBB group (88 [37.8%] vs. 107 [24.0%]; P=0.002)
Franzoni et al ¹⁰	2013	237	SEV 36.7%/BEV 63.7%	63 (26.5%) after procedure 41 (17.2%) at discharge	LBBB persisted in 8.6% of ESV (n=13) and 32.2% of MCRS (n=28) (P=0.001). Persistent new-onset LBBB at discharge was not associated with overall (log-rank P=0.42) or cardiovascular (log-rank P=0.46) death
Testa et al ¹¹	2013	818	SEV 100%	354 (43.3%) after procedure 224 (27.4%) at discharge	LBBB was not associated with higher all-cause death, cardiac death, or hospitalization for heart failure at 30 days or 1 year. At 30 days, but not at 1 year, persistent LBBB group had a significantly higher rate of pacemaker implantation
Nazif et al ⁴	2014	1,151	BEV 100%	121 (10.5%) at discharge or 7 days	New LBBB was not associated with significant differences in 1-year death, cardiovascular death, repeat hospitalization, stroke, or myocardial infarction. It was associated with increased PPI during hospitalization (8.3 vs. 2.8%, P=0.005) and from discharge to 1 year (4.7 vs. 1.5%, P=0.01)
Houthuizen et al ⁵	2014	476	SEV 46.8%/BEV 53.2%	150 (31.5%) in 24 h 107 (22.7%) at discharge	Persistent LBBB was associated with a significant increase in death as compared with no LBBB and temporary LBBB combined (HR 1.49, 95% CI: 1.10–2.03; P=0.01)
Urena et al ¹²	2014	668	BEV 100%	128 (19.2%) after procedure 79 (11.8%) at discharge	No differences between the new-onset LBBB and no new-onset LBBB groups regarding mortality rate (adjusted HR: 0.87 [95% CI: 0.55–1.37]; P=0.54), cardiovascular death (P=0.82), sudden death (P=0.87), rehospitalization (P=0.11), or heart failure (P=0.55)
Schymik et al ¹³	2015	634	SEV 19.2%/BEV 80.8%	197 (31.1%) at discharge	At 30 days and 1-year, the all-cause mortality rate was higher in patients with persistent new-onset LBBB (6.1% and 20.8%) than in patients without new-onset LBBB (3.3% and 13.0%; P=0.014 and P=0.010 for the 2 time points)
Nazif et al ¹⁴	2019	1,179	BEV 100%	179 (15.2%) at discharge	At 2 years, new LBBB was associated with increased rates of all-cause death (19.3% vs. 10.8%, P=0.002), cardiovascular death (16.2% vs. 6.5%, P<0.001), rehospitalization, and new PPI. New LBBB was also associated with worse left ventricular systolic function at 1 and 2 years
Chamandi et al ¹⁵	2019	1,020	SEV 46.1%/BEV 51.6%	212 (20.8%) at discharge	No differences between new-onset LBBB and no new-onset LBBB groups in all-cause death (45.3% vs. 42.5%; adjusted HR: 1.09; 95% CI: 0.82–1.47; P=0.54), cardiovascular death (14.2% vs. 14.4%; adjusted HR: 1.02; 95% CI: 0.56–1.87; P=0.95), or heart failure rehospitalization (19.8% vs. 15.6%; adjusted HR: 1.44; 95% CI: 0.85–2.46; P=0.18).

BEV, balloon-expandable valve; CI, confidence interval; ESV, Edwards SAPIEN valve; HR, hazard ratio; LBBB, left bundle branch; MCRS, Medtronic CoreValve Revalving System; PPI, permanent pacemaker implantation; SEV, self-expandable valve; THV, transcatheter heart valve.

a subacute LBBB group; however, there was no conduction improvement in the late LBBB cases.⁵

In this issue of the Journal, Sasaki et al⁶ report a cohort study of N-LBBB after TAVI defined as a notable criterion in a single high-volume center in Japan. N-LBBB was defined as any new LBBB occurring after TAVI, which was further classified into 2 groups at the 1-month follow-up: (1) LBBB disappearing before 1-month (transient N-LBBB: TN-LBBB) and (2) LBBB persisting at 1-month (persistent N-LBBB: PN-LBBB); furthermore, patients without N-LBBB and the TN-LBBB group were combined (No/TN-LBBB). The main findings of the study were: (1) the overall incidence of N-LBBB post-TAVI was 39% (90/230), and it persisted at 1-month follow-up in 32.2% (29/90); (2) the only predictor of PN-LBBB was SEV implantation (31% vs. 10%, odds ratio: 4.39, 95% confidence interval: 1.69–11.41, P=0.002); and (3) PN-LBBB did not increase the risk of overall or cardiovascular death or need for late permanent pacemaker implantation, but was associated with a higher incidence of HF rehospitalization.

In this study, LVEF in the PN-LBBB group did not significantly improve throughout the follow-up period, in

contrast with that of the No/TN-LBBB group. Furthermore, mild LV dilatation was observed after TAVI in the PN-LBBB group. These results are consistent with previous reports.⁷

Early intervention with cardiac resynchronization therapy (CRT) for patients with mild HF symptoms, LV dysfunction, and LBBB has been associated with a significant long-term survival benefit and nonfatal HF events.⁸ Nevertheless, the effectiveness of CRT for LBBB after TAVI remains obscure. N-LBBB after TAVI is a not so harmless bystander because of its high incidence and potential adverse effects on clinical efficacy. In addition to the development of novel devices and techniques with a low incidence of LBBB post-TAVI, establishment of the appropriate follow-up observation and treatment for patients with N-LBBB after TAVI is required.

Disclosures

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Conflict of Interest Statement

S.H. received remuneration from Medtronic Japan Co., Ltd.

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