Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 60, No. 18, 2012
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2012.07.035

# Predictive Factors and Long-Term Clinical Consequences of Persistent Left Bundle Branch Block Following Transcatheter Aortic Valve Implantation With a Balloon-Expandable Valve

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**Objectives** This study evaluated the predictive factors and prognostic value of new-onset persistent left bundle branch block (LBBB) in patients undergoing transcatheter aortic valve implantation (TAVI) with a balloon-expandable valve.

**Background** The predictors of persistent (vs. transient or absent) LBBB after TAVI with a balloon-expandable valve and its clinical consequences are unknown.

**Methods** A total of 202 consecutive patients with no baseline ventricular conduction disturbances or previous permanent pacemaker implantation (PPI) who underwent TAVI with a balloon-expandable valve were included. Patients were on continuous electrocardiographic (ECG) monitoring during hospitalization and 12-lead ECG was performed daily until hospital discharge. No patient was lost at a median follow-up of 12 (range: 6 to 24) months, and ECG tracing was available in 97% of patients. The criteria for PPI were limited to the occurrence of high-degree atrioventricular block (AVB) or severe symptomatic bradycardia.

**Results** New-onset LBBB was observed in 61 patients (30.2%) after TAVI, and had resolved in 37.7% and 57.3% at hospital discharge and 6- to 12-month follow-up, respectively. Baseline QRS duration ($p = 0.037$) and ventricular depth of the prosthesis ($p = 0.017$) were independent predictors of persistent LBBB. Persistent LBBB at hospital discharge was associated with a decrease in left ventricular ejection fraction ($p = 0.001$) and poorer functional status ($p = 0.034$) at 1-year follow-up. Patients with persistent LBBB and no PPI at hospital discharge had a higher incidence of syncope (16.0% vs. 0.7%; $p = 0.001$) and complete AVB requiring PPI (20.0% vs. 0.7%; $p < 0.001$), but not of global mortality or cardiac mortality during the follow-up period (all, $p > 0.20$). New-onset LBBB was the only factor associated with PPI following TAVI ($p < 0.001$).

**Conclusions** Up to 30% of patients with no prior conduction disturbances developed new LBBB following TAVI with a balloon-expandable valve, although it was transient in more than one third. Longer baseline QRS duration and a more ventricular positioning of the prosthesis were associated with a higher rate of persistent LBBB, which in turn determined higher risks for complete AVB and PPI, but not mortality, at 1-year follow-up. (J Am Coll Cardiol 2012;60:1743–52) © 2012 by the American College of Cardiology Foundation

New-onset left bundle branch block (LBBB) is the most frequent conduction alteration associated with transcatheter aortic valve implantation (TAVI) (1–10). Several studies have evaluated the predictive factors of new-onset LBBB following TAVI, but most of them have focused on patients undergoing TAVI with the self-expandable system (Cor-

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Manuscript received April 22, 2012; revised manuscript received June 27, 2012, accepted July 2, 2012.

JACC Vol. 60, No. 18, 2012
October 30, 2012:1743–52

**Abbreviations and Acronyms**

**AVB** = atrioventricular block

**ECG** = electrocardiography

**LBBB** = left bundle branch block

**LVEF** = left ventricular ejection fraction

**PPI** = permanent pacemaker implantation

**TAVI** = transcatheter aortic valve implantation

eValve, Medtronic Inc, Minneapolis, Minnesota) (1,2,4–6,8). Furthermore, all studies to date have included patients with conduction disturbances prior to TAVI (including patients with prior pacemaker in some), which may indeed lead to a more difficult interpretation of the exact role of TAVI on the development of new conduction disturbances and its predictors.

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Importantly, while it has been shown that the vast majority of conduction disturbances occur during the TAVI procedure, a significant number resolve within the first days following the procedure, especially with the use of a balloon-expandable valve (9,10). However, no data exist on the factors associated with persistent (vs. transient) new-onset LBBB following TAVI and its clinical consequences. It is therefore unknown whether patients leaving the hospital with a new-onset LBBB following TAVI have a higher risk for clinical events, particularly new-onset complete atrioventricular block (AVB) and/or sudden death. The objectives of this study were therefore to: 1) determine the incidence and predictors of new-onset persistent LBBB in patients without baseline intraventricular conduction abnormalities undergoing TAVI with a balloon-expandable valve; and 2) evaluate the long-term prognostic significance of persistent LBBB in this population.

## Methods

**Study population.** Of 348 consecutive patients (Quebec Heart & Lung Institute: n = 263; Vall d'Hebron hospital: n = 85), who underwent TAVI with a balloon-expandable valve (Sapien or Sapien XT, Edwards Lifesciences, Irvine LLC, California); 146 patients were excluded because of the following reasons: prior pacemaker (n = 57), prior intraventricular conduction abnormalities (complete or incomplete right or left bundle branch block, n = 83), death, or conversion to open heart surgery before the first ECG (4 and 2 patients, respectively). The final study population consisted of 202 patients. Details about the TAVI procedure have been previously reported (11). All baseline, procedural, and post-operative data were prospectively recorded. Periprocedural complications were defined according to the Valve Academic Research Consortium criteria (12). The degree of native aortic valve calcification was measured (in Agatston units) in all patients who had noncontrast ECG-gated computed tomography prior to the procedure (n = 131; 65%). Patients underwent transthoracic echocardiography at baseline, at hospital discharge, and at 6- to 12-month follow-up. The position of the transcatheter valve after implantation was evaluated by transesophageal echocardiography (long-axis view) as previously described (9).

**ECG data and criteria for pacemaker implantation.** ECG tracings were recorded at baseline (within 24 h prior to the procedure), immediately after the procedure, and then every 24 h until hospital discharge. Furthermore, patients were on continuous ECG monitoring during the entire hospitalization period following the procedure. All ECG tracings were analyzed by a cardiologist blinded to the clinical data. The diagnosis of intraventricular conduction abnormalities was based on recommendations from the Amer-

**Table 1** Baseline and Procedural Characteristics of the Study Population (n = 202)

| | |
|---|---|
| **Baseline characteristics** | |
| Age (yrs) | 80 ± 8 |
| Female | 121 (59.9) |
| Body mass index (kg/m$^2$) | 27 ± 5 |
| Comorbidities | |
| Hypertension | 178 (88.1) |
| Diabetes mellitus | 67 (33.2) |
| COPD | 50 (24.8) |
| CAD | 118 (58.4) |
| eGFR (ml/min) | 56.8 ± 23.0 |
| Baseline treatment | |
| Beta-blockers | 94 (46.5) |
| Calcium channel blockers | 58 (28.7) |
| Amiodarone | 13 (6.4) |
| STS-PROM score (%) | 7.5 ± 3.7 |
| ECG (ms) | |
| PR interval | 174 ± 38 |
| QRS duration | 92 ± 10 |
| Echocardiography | |
| LVEF (%) | 57 ± 12 |
| Mean gradient (mm Hg) | 47 ± 18 |
| Aortic valve area (cm$^2$) | 0.64 ± 0.22 |
| Computed tomography | |
| Aortic valve calcification (Agatston units) | 3227 ± 2121 |
| **Procedural variables** | |
| Success | 190 (94.1) |
| Approach, n (%) | |
| Transapical | 117 (57.9) |
| Transfemoral | 85 (42.1) |
| Ratio valve prosthesis size/aortic annulus | 1.17 ± 0.07 |
| Prosthesis ventricular depth* (mm) | 1.87 ± 2.62 |
| In-hospital outcomes | |
| Death | 14 (6.9) |
| Stroke | 4 (2.0) |
| Myocardial infarction | 2 (1.0) |
| Major bleeding | 23 (11.4) |
| Major vascular complications | 7 (3.5) |
| Pacemaker implantation | 14 (6.9) |
| Length of stay (days) | 7 (5–10) |

Values are mean ± SD, n (%), or median (interquartile range). *Distance between the hinge point of the mitral valve and the ventricular end of the valve prosthesis frame (transesophageal echocardiography [TEE], long-axis view).

CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; ECG = electrocardiography; eGFR = estimated glomerular filtration ratio; LVEF = left ventricular ejection fraction; STS-PROM = Society of Thoracic Surgeons predicted risk of mortality.