

Reversibility of New Onset LBBB between Balloon-Expandable Valves and Self-Expandable Valves

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Abstract

Objective: LBBB is not a rare complication after TAVI. Available data on the reversibility of new-onset left bundle branch block (LBBB) after transcatheter aortic valve replacement (TAVR) in relation to valve type and other factors remain controversial. We aimed to find out factors that might be responsible for the reversibility of this complication post implantation.

Method: In this retrospective observational study, we reviewed all TAVI patients operated in our institute from July 2014 to July 2019. We included patients who developed new LBBB post TAVI and excluded patients with preexisting pacemaker, preoperative LBBB and patients requiring Permanent pacemaker post-operatively during the index hospitalization. Twelve-lead electrocardiograms at baseline, immediately after TAVI and at 30-days follow-up were evaluated. Disappearance of the LBBB in follow-up was analyzed to find out patient and procedural characteristics. Out of 1247 patients operated in this 5 years period, 299 (24%) patients developed new onset LBBB. 77 patients (26%) and 179 patients (59.8%) of these patients had complete resolution before discharge and at the 30-day follow-up respectively. 40.1% showed persistent LBBB after 30 days without the need for pacemaker due to atrioventricular block during the follow up. Only one patient received a CRT pacemaker due to persistent LBBB and severely reduced ejection fraction.

Results: Reversibility of LBBB was documented in 14.3% of patients who received Sapien balloon expandable valve, in 0% of patients with Core valves and in 66.7% patients with of Symetis valve. No patients had additional conduction abnormalities at 30-day follow-up. The patients with irreversible LBBB had a lower ejection fraction ($37.5\% \pm 7.8$ vs. $69\% \pm 4.7$, p-value 0.04), and higher proBNP (2728 ± 112 vs. 495 ± 122 , p-value 0.03). Septal hypertrophy was more prominent in patients with irreversible LBBB (14 ± 2.6 vs. 13 ± 1.4 , p-value 0.004). Annulus diameter was significantly larger in patients with irreversible LBBB (25 ± 1.5 mm vs. 22.5 ± 0.5 mm, p-value 0.001). Preimplantation valvoplasty OR (95% CI): 1.3 (1.1-1.9); p-value 0.04, Sapien valve: 2 (1.1-4); p-value 0.036 were predictive for persistence of LBBB. However, Symetis valve or (95% CI): 0.5 (0.2-0.8); p-value 0.02 and LAHB 0.3 (0.1-0.6); p-value 0.001 were independent predictors of reversible LBBB.

Conclusion: New onset LBBB after self-expandable valves has a reversible nature and resolve probably by 30 day follow-up with a relevant tendency to stabilization especially in patients without balloon predilatation and in patients who received Symetis valve.

Keywords: Trans-Catheter Aortic Valve Implantation (TAVI); Left bundle branch block; Pacemaker

Introduction

Trans-catheter aortic valve implantation (TAVI) is becoming the treatment of choice not only in high risk patients with symptomatic severe aortic stenosis (AS) but has been extended to patients with intermediate risk [1]. Due to progressive technological development, patient selection, and experiences have encouraged to expand TAVI in low risk aortic population. The development of bundle branch block (LBBB) and need for permanent pace-maker implantation (PPI) have

both been demonstrated to be a rare post TAVI complications which increase the risk of mortality and heart failure following TAVI [2]. The guidelines did not address specific recommendations towards the indications for PPI in correlation to LBBB post TAVI. In a recent expert consensus scientific panel document the indication of PPI was limited to patients with LBBB and other high risk criteria as QRS >150 millisecond or AV interval >240 millisecond [3]. The incidence of the reversibility of LBBB ranges between the fact that, not all new onset LBBB stays persistent but a big proportion are reversible, stays controversial and is not thoroughly studied. The purpose of this study was to determine the factors that might be responsible for the reversibility and persistence of LBBB after TAVI.

Research Methodology

In this single-center observational retrospective study, we included 299 (24%) patients developed new onset LBBB after TAVI out of 1247 patients operated between July 2014 and July 2019 at the Zentralklinik Bad Berka in Germany. We excluded patients with preexisting pacemaker, pre-operative LBBB and patients requiring Permanent pacemaker during the index hospitalization. Our multidisciplinary structural heart team entailing (Cardiac surgeon, cardiologist and anesthesia) determined and decided the appropriateness of TAVI, our institute implements.

Prosthesis size and type was determined by the Heart Team. Post procedurally, all patients were transferred to the intensive care unit and placed on continuous telemetry monitoring with serial ECGs until discharge and after 30 day. The 30 days visit was organized through our research study assistant and even data collection for patients who had follow-up outside of our institution. All baseline, in-hospital, immediate post-operative and 30-day follow-up ECGs were reviewed and retrospectively collected. Patients were divided in to two groups, group A: with irreversible LBBB at 30 days and group B: reversible LBBB at 30 days.

Statistical Analysis

All data were displayed as mean (standard deviation) for continuous variables, and as the number (percentage) of patients in each group for categorical variables. The Student t test or analysis of variance test was used to evaluate the statistical significance between continuous variables; whereas the χ^2 test was used in case of categorical variables, respectively. Odds ratios were calculated with a confidence interval of 95% for the predictors of LBBB reversibility. All of the analyses were considered significant at a 2-tailed p-value <0.05. All analysis was done using SPSS statistical software (IBM Corp. Released 2013, IBM SPSS Statistics for Windows, and Version 22.0. Armonk, NY, USA, IBM Corp).

Results

Out of 1247 patients operated in this 5 years period, 299 (24%) patients developed new onset LBBB. From this 299 patients, 77 patients (26%) and 179 patients (59.8%) of these patients had complete resolution before discharge and at the 30-day follow-up respectively. One hundred twenty patients (40.1%) showed persistent LBBB after 30 days without the need for pacemaker due to atrioventricular block. Patients' characteristics showed in Table 1. Only one patient received a CRT pacemaker due to persistent LBBB and severely reduced ejection fraction. Reversibility of LBBB was documented in 14.3% of patients who received Sapien balloon expandable valve, in 0% of patients with Core valves and in 66.7% of patients with of Symetis valves. No patients had additional conduction abnormalities at 30-day follow-up. The patients with irreversible LBBB had a lower ejection fraction ($37.5\% \pm 7.8$ vs. $69\% \pm 4.7$, p-value 0.04), and higher proBNP (2728 ± 112 vs. 495 ± 122 , p-value 0.03). Septal hypertrophy was more prominent in patients with irreversible LBBB (14 ± 2.6 vs. 13 ± 1.4 , p-value 0.004). Annulus diameter was significantly larger in patients with irreversible LBBB (25 ± 1.5 mm vs. 22.5 ± 0.5 mm, p-value 0.001). Echocardiographic and ECG data showed in Table 2. Preimplantation valvoplasty OR (95% CI): 1.3 (1.1-1.9); p-value 0.04 and Sapien valve: 2 (1.1-4); p-value 0.036 were predictive for persistence of LBBB. However, Symetis valve OR (95% CI): 0.5 (0.2-0.8); p-value 0.02 and

LAHB 0.3 (0.1-0.6); p-value 0.001, were independent predictors of reversible LBBB.

Variables	No resolution of LBBB 120 (40.1%)	Resolution of LBBB 179 (59.9%)	Total 299 (100%)	p-value
Male n (%)	52 (43%)	79 (44%)	131 (44%)	0.9
Age mean \pm SD	80 \pm 4	79 \pm 4.1	79.5 \pm 5.8	0.2
EURO II median (IQR)	14 \pm 2	17.6 \pm 5.1	15 \pm 4.1	0.1
BMI n (%)	27.4 \pm 3	26.6 \pm 2.9	26.8 \pm 2.8	0.7
Stroke n (%)	15 (12.5%)	19 (10.6%)	34 (11.%)	0.2
Redo n (%)	17 (14.1%)	20 (11.1%)	37 (12%)	0.8
PCI n (%)	34 (28%)	45 (25%)	79 (26%)	0.6
GFR	60 \pm 12	46 \pm 14.6	53 \pm 12	0.7
proBNP pg/ml	2728 \pm 112	495 \pm 122	16111 \pm 89	0.03
IDDM n (%)	18 (15%)	24 (13.4%)	42 (14%)	0.4

Note: BNP: Brain Natriotic Peptide; GFR: Glomerular Filtration Rate; IDDM: Insulin Dependent Diabetes Mellitus; LVEF: Left Ventricular Ejection Fraction; N: Number; PCI: Percutaneous Coronary Intervention; SD: Standard Deviation.

Table 1: Pre-operative patients' characteristics.

Variables	No resolution of LBBB 120 (40.1%)	Resolution of LBBB 179 (59.9%)	Total 299 (100%)	p-value
EF	37.5 \pm 7.8	69 \pm 4.7	53 \pm 7	0.04
MG AV mmHg \pm SD	36 \pm 11	56.1 \pm 6.2	53 \pm 24	0.02
LVEDD mm	55.5 \pm 2.6	48.5 \pm 8.8	52 \pm 7.3	0
SWT	14 \pm 2.6	13 \pm 1.4	13.5 \pm 1.1	0.004
PWT	12 \pm 2.5	13 \pm 2.4	12.5 \pm 2.2	0.09
Annulus (mm)	25 \pm 1.5	22.5 \pm 0.5	2.7 \pm 1.3	0.001
QRS msc	102 \pm 2	94 \pm 6.2	98 \pm 6.1	0.3
QRS msc at discharge	155 \pm 5.2	130 \pm 10	142 \pm 15	0.6
QRS msc at FU	150 \pm 20	120 \pm 20	135 \pm 21	0.001

Note: EF: Ejection Fraction; MG: Mean Gradient; AV: Aortic Valve; LVEDD: Left Ventricle End Diastolic Diameter; SWT: Septal Wall Thickness; PWT: Posterior Wall Thickness; FU: Follow Up.

Table 2: Difference between the two groups as regard echocardiographic and ECG parameters.

Discussion

To our knowledge, this study is the first retrospective analysis of the reversibility versus persistence of new onset LBBB after TAVI. Our institute is considered to be a high volume TAVI center with average

350 cases per year with 3 different valve types (Edwards sapien 3, Evolut Medtronic and Symetis from Boston scientific). Collectively with more than 2500 cases in the past 10 years, this enabled us to have a huge pool of archived patients and easily producing this study with a competitively large number of patients. Our institute is contributing in 4 prospective studies with all consequent scheduled follow up visits and calls which allowed us to pick up our 30 day ECGs easily from the follow up files.

Our choice of this pathology is related to the relative non rarity of this complication post TAVI rather than RBBB and this could be explained anatomically by the close proximity of the left fascicles to the aortic annulus [4-6]. Persistent LBBB beyond 6 months affected negatively the LVEF in a study performed by Eschaliere et al. and published in May 2019. This fact aroused our attention to compare the factors responsible for reversibility and persistence of new onset LBBB after TAVI [7].

In our study, the presence of pre-operative moderate aortic regurgitation was a predictor of persistence of LBBB. This could be interpreted through the fact that patients with moderate degree of regurgitation in a stenotic calcified valve might have more extensive calcification than patients without regurgitation. This extensive calcification leads to regurgitation through extra rigid and hypomobile cups and increases the risk of conduction injury as well. These 2 theories add for the favor of persistence of LBBB after TAVI. Our choice of new onset and reversibility/persistence in 30 days approves the theory of technical mechanical acute injury during implantation as for size of balloon, depth of deployment and size of prosthesis. This coincides with Moreno et al. who demonstrated hemorrhage and edema involving the His bundle during post-mortem analysis of a patient who developed CHB following TAVI [8]. Direct trauma or compression of the AV node and LBB during valvoplasty leads to AV block and LBBB due to peri-procedural edema of the left ventricular outflow [9].

These abnormalities theoretically may resolve over time and this motivated us to study and analyze this finding. From the manufacture point of view, it's well-known that the greater length of S3 valve (3-4 mm longer than XT valve) in the LVOT and septum consequently increases the probability of AV block and other conduction disorders [10]. However, during the valve deployment, the stent shortens from the ventricular end, resulting in higher position and less damage of the AV node and low incidence of PPI [11].

We found out that self-expandable valve Symetis had higher incidence of reversible LBBB after 30 days. This could be explained through two theories; either because we implant self-expandable valves in our institute without rapid pacing and hence lower incidence of bundle edema and less trauma of the myocardium or because; to our imagination; the Symetis valves may slightly loose degree of its radial strength over time and hence decreasing the tension over the bundle and consequently leading to disappearance of LBBB. The loss of this radial strength over time was also in discussion through the PVL study of symetis valve which showed slight progressive increase in PVL in a number of patients in 30 days follow up and was interpreted through loss of radial strength.

Numerous studies were conducted in this domain in relation to valve type. Piazza et al. included only self-expanding Medtronic Core-Valve prosthesis and reported persistence of LBBB at 6 months of follow-up [12]. This coincides with our results which showed the in 100% of core valve patients the LBBB was irreversible. On the other hand, Leire et al. investigated 59 patients operated by S3 and showed

relatively high incidence of new-onset LBBB up to 39% with equal incidence of persistence and disappearance of LBBB [13]. This opposes our study in various aspects. Our follow up analysis period was up to 30 days and on the other hand he followed up his patients until hospital discharge and this adds an extra strength of our results. The other factor is our study population which is bigger than his study allowing us to conclude statistically relevant data.

It was observed that patients with persistent LBBB had depressed ejection fraction which was stable during the follow up without further deterioration. Klæboe et al. showed that the classical dyssynchronous LBBB contractions were absent in most patients with new-onset post-TAVI LBBB. Furthermore, the follow up was too short to detect the deterioration of the LV function.

Dolci et al. stated that the disappearance of new onset LBBB was encountered in 17% in patients with Sapien 3 [14]. Moreover he could not conclude any predictive factors for the persistence of LBBB. Our results showed higher incidence of disappearance of LBBB especially in self-expandable valves. Our results in this domain coincide with Kebler et al. However it's worth noting that in our institute, patients are operated by 3 different operators which would have encouraged more incidence of LBBB due to the minute technical differences between operators as for depth of deployment and duration of rapid pacing. But the same learning pathway and experience abolished any operator dependent complications. We should also confess that our institutional protocol for implantation of balloon expandable valves applies a relatively planned higher position of implantation and this follows the current recommendations for implantation to minimize the damage to the AV node and left bundle branch.

Predilatation irrespective to balloon size was observed to be done less frequently in the group who showed disappearance of LBBB and this could be related to less irritation and less damage of the left bundle during implantation. The greater the size of LVOT, the higher the incidence of disappearance of LBBB after 30 days. This could be easily interpreted anatomically by the fact that a wider LVOT offers extra space for the lower curtains of the prosthesis with tension forces [15].

Limitations

This study has several limitations. First, this is an observational retrospective study with all its known selection biases and unmeasured confounders. Second, being a single center study behaves as an obstacle against generating a generalized conclusive result. Third, we included valve-in-valve procedures in our cohort group which were all operated by sapien 3.

Conclusion

New onset LBBB after self-expandable valves has a reversible nature and resolve probably by 30 day follow-up with a relevant tendency to stabilization especially in patients without balloon predilatation and in patients who received Symetis valve.

Conflict of Interests

The authors declare no conflicts of interest.

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