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Clinical Research

# New-Onset Left Bundle Branch Block After TAVI has a Deleterious Impact on Left Ventricular Systolic Function

Romain Eschalier, MD, PhD,[a,b] Grégoire Massoullié, MD,[a] Youssef Nahli, MD,[a] Frédéric Jean, MD,[a] Nicolas Combaret, MD,[a] Sylvain Ploux, MD, PhD,[c] Géraud Souteyrand, MD,[a] Xavier Chabin, MD,[a] Romain Bosle, MD,[a] Céline Lambert, MSc,[d] Elodie Chazot, MSc,[a] Bernard Citron, MD, PhD,[a] Pierre Bordachar, MD, PhD,[c] Pascal Motreff, MD, PhD,[a] Bruno Pereira, PhD,[d] and Guillaume Clerfond, MD[a,b]

[a] *Department of Cardiology, CHU Clermont-Ferrand, Clermont-Ferrand, France and Université Clermont Auvergne, CHU Clermont-Ferrand, CNRS, SIGMA Clermont, Institut Pascal, Clermont-Ferrand, France*

[b] *INI-CRCT F-CRIN, Nancy, France*

[c] *Hôpital Cardiologique du Haut-Lévêque, CHU Bordeaux, Université Bordeaux, IHU LIRYC, Bordeaux, France*

[d] *Biostatistics Unit (Clinical Research and Innovation Direction), CHU Clermont-Ferrand, Clermont-Ferrand, France*

***See editorial by Muntané-Carol et al., pages 1286–1288 of this issue.***

## ABSTRACT

**Background:** Transcatheter aortic valve implantation (TAVI) has revolutionized the management of severe aortic stenosis. The development of a new-onset complete left bundle branch block (LBBB) is, however, a frequent complication. The objective of the present study was to assess the impact of a new-onset LBBB after TAVI on the evolution of left ventricular ejection fraction (LVEF).

**Methods:** Forty consecutive patients were included after the development of a new-onset LBBB after TAVI and were matched for age and LVEF with 40 patients implanted during the same period who did not develop an LBBB. The primary endpoint was evolution of the LVEF measured by echocardiography before implantation and between 6 and 12 months after TAVI.

**Results:** The development of an LBBB was associated with a 5-point decrease in LVEF [−12.5; 2.5], contrary to the non-LBBB group (1.5 [−6.5; 9.5], $P = 0.007$) at 8 months, with the persistence of the LBBB (n = 23) exacerbating this decrease (−7 [−13; 2], $P = 0.009$). When left ventricular dysfunction (LVEF < 50%) was present before TAVI, the

## RÉSUMÉ

**Introduction :** L'implantation valvulaire aortique par cathéter (TAVI) a révolutionné la prise en charge de la sténose aortique grave. Toutefois, la survenue d'un nouveau bloc de branche gauche (BBG) complet est une complication fréquente. L'objectif de la présente étude était d'évaluer les conséquences de la survenue d'un nouveau BBG après le TAVI sur l'évolution de la fraction d'éjection ventriculaire gauche (FEVG).

**Méthodes :** Nous avons sélectionné 40 patients consécutifs chez qui est survenu un nouveau BBG après le TAVI et les avons appariés selon l'âge et la FEVG à 40 patients qui ont subi une implantation durant la même période, mais qui n'ont pas eu de BBG. Le critère de jugement principal était l'évolution de la FEVG mesurée par échocardiographie avant l'implantation et de 6 à 12 mois après le TAVI.

**Résultats :** Contrairement au groupe sans BBG (1,5 [−6,5; 9,5], $P =$ 0,007) après 8 mois, nous avons associé la survenue d'un BBG à une diminution de la FEVG de 5 points [−12,5; 2,5], et à l'exacerbation de cette diminution en cas de persistance du BBG (n = 23) (−7 [−13; 2],

Calcified aortic stenosis (AS) is the most common of valvulopathies,[1] the incidence of which increases with the increasing life expectancy of the population along with better management of cardiovascular risk factors and heart diseases.[2] Percutaneous transcatheter aortic valve implantation (TAVI) has transformed the management of patients with this disease,[3] particularly those with high and intermediate surgical risk.[4-6]

Numerous advances in implantation techniques and/or in the design of prostheses (antileak paravalvular skirt, rigidity of the prostheses, reduction in the size of the introducers) have considerably limited vascular and functional complications.[7] However, atrioventricular conduction complications are highly common and remain a major

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Corresponding author: Dr Romain Eschalier, Department of Cardiology, Rue Montalembert, 63000 Clermont-Ferrand, France. Tel.: +33-473751410; fax: +33-473754730.

E-mail: reschalier@chu-clermontferrand.fr

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**appearance of an LBBB was associated with a reduction in LVEF (−2 [−8; 2]) contrary to the non-LBBB group (20 [9; 22], $P = 0.02$).**
**Conclusions: The appearance of a new-onset LBBB after TAVI has a pejorative impact on left ventricular systolic function, particularly in patients with an initial LVEF < 50%, due to a lack of recovery of the latter, thereby potentially affecting their prognosis.**

**$P = 0{,}009$). De plus, contrairement au groupe sans BBG (20 [9; 22], $P = 0{,}02$), lorsque la dysfonction ventriculaire gauche (FEVG < 50 %) était présente avant l'intervention TAVI, la survenue d'un BBG était associée à une réduction de la FEVG (−2 [−8; 2]).**
**Conclusions : La survenue d'un nouveau BBG après le TAVI a des conséquences défavorables sur la fonction systolique du ventricule gauche, notamment chez les patients qui ont une FEVG initiale < 50 % à cause de l'absence de rétablissement de cette dernière, et de ce fait nuit potentiellement à leur pronostic.**

problem, that is, both underevaluated and poorly explored. Indeed, the anatomical proximity of the aortic ring and nodoventricular conduction pathways favour the occurrence of a left bundle branch block (LBBB) (higher incidence with self-expandable prostheses [30% to 60% vs 6% to 12%])[8] as well as severe conduction disturbances.[9] The latter are associated with increased post-TAVI morbidity and mortality.[10,11] In the presence of a new-onset LBBB, induced electrical asynchrony can lead to ventricular dysfunction or lack of improvement thereof as well as the appearance of high-grade conduction disorders in the long term. The impact of the new-onset LBBB after TAVI on left ventricular ejection fraction (LVEF) has never been assessed prospectively. TAVI in patients at intermediate surgical risk and the possible extension of this procedure to low-risk surgical populations under evaluation thus compel cardiologists to anticipate this growing issue.

In light of the above, the objective of the present study was to prospectively assess the impact of the appearance of a new-onset LBBB after TAVI on LVEF.

## Methods

This is a prospective cohort follow-up study, conducted between June 8, 2015, and August 1, 2017, as an ancillary of the LBBB-TAVI study (NCT02482844).[12] The study was approved by the local ethics committee and the National Health Authority (ANSM: 2015-AOO271-48), and the written informed consent of each patient was obtained and archived.

### Study population

Inclusion criteria were as follows: patients older than 18 years of age; implanted with TAVI according to the 2012 recommendations of the European Society of Cardiology; expected life expectancy greater than 1 year; sinus rhythm; presence of a new-onset complete LBBB after TAVI persisting for more than 24 hours.

Patients were excluded if they had a pre-TAVI pacemaker or if they had a preprocedural LBBB or lasting <24 hours after TAVI.

The first 40 patients from the LBBB-TAVI study were included (new-onset LBBB group). During the same inclusion period and within the same centre, 40 patients who did not develop an LBBB (non-LBBB TAVI group) were matched to the study population according to age and LVEF (≥50% or <50%). In both groups, patients were in sinus rhythm and did not require a pacemaker either before or during the follow-up period.

### Study design

In accordance with the LBBB-TAVI study, included patients underwent an electrophysiological study after TAVI and were implanted, depending on the outcome, with a pacemaker (His to ventricle interval [HV] ≥70 milliseconds) or an implantable loop recorder (HV < 70 milliseconds). Patients with a pacemaker, eventually only present in the LBBB group, and presenting a ventricular pacing rate greater than 5% were excluded from this ancillary study. At TAVI after procedure, patients were divided into 2 groups: patients without LBBB (non-LBBB TAVI group) and those with new-onset LBBB after TAVI (new-onset LBBB group).

A transthoracic echocardiography was performed before the TAVI procedure as well as between 6 and 12 months after TAVI.

The primary endpoint was evolution of LVEF on transthoracic echocardiography (TTE) between before TAVI and 6 to 12 months after TAVI. The identification of LBBB was validated by 2 blinded operators.

### Definition of LBBB

LBBB on the electrocardiogram (ECG) was defined according to the American Heart Association recommendations,[13] namely by a QRS duration ≥ 120 milliseconds (in at least 1 lead); a left delay in V5-V6 and aVL leads with a wide, slurred, or notched R wave (RR'), and a fast initial ascent; a small R wave in V1-V2, followed by a wide and deep S wave, whose descent is faster than the ascent.

### Transthoracic echocardiography

The echocardiographic study before the intervention was performed during the preoperative assessment within a maximum of 1 month before the intervention and within a period of 6 to 12 months after the procedure. TTE was performed using a 2.5 to 5 MHz imaging probe connected to a Vivid 9 ultrasonic device (Vingmed-General Electric, Horten, Norway) in accordance with the recommendations of the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Image analysis was subsequently performed by 2 blinded operators. LVEF was measured from 2-dimensional 4-chamber and 2-chamber views (3 loops for each section). The measurement was performed according to Simpson's biplane method described in the recommendations.[14] Aortic regurgitation (AR) was assessed according to recommendations and Valve Academic Research Consortium (VARC)-III criteria.[15,16] AR after TAVI was considered to be significant if at least moderate.

The change in LVEF was calculated as the difference between the measurement at 6 to 12 months minus the preimplantation measurement ($\Delta LVEF = LVEF_{post\text{-}TAVI} - LVEF_{pre\text{-}TAVI}$). The variation in LVEF values is presented in LVEF percentage points. One operator's analysis were for the data acquisition. The second operator's analysis was used to evaluate interoperator reproducibility. LVEF was obtained with the best loop acquired. Data were analysed consecutively in groups of 10 patients.

### Sample size and statistical analysis

Sample size was calculated according to Cohen's definitions of effect-size bounds as follows: small (ES: 0.2), medium (ES: 0.5), and large (ES: 0.8: grossly perceptible and therefore large); we estimated that 40 patients in each group would be sufficient to detect a 5% absolute difference in LVEF for an effect size between 0.6 and 0.7 with a 2-sided type I error of 5% and a statistical power greater than 80%. Statistical analyses were performed using Stata software, Version 13 (StataCorp, College Station, TX). Tests were 2-sided, with a type I error set at $\alpha = 0.05$. Continuous data are expressed as mean ± standard deviation or median (interquartile range) according to the statistical distribution (assumption of normality assessed using the Shapiro-Wilk test). Categorical parameters (including ischemic cardiomyopathy, β-blockers, angiotensin converting enzyme inhibitors, AT1 receptors blockers, procedural access) were compared between groups (new-onset LBBB after TAVI vs non-LBBB after TAVI) using $\chi^2$ or Fisher's exact tests. Quantitative variables (including age, LVEF before TAVI) were compared between groups by Student's *t*-test or the Mann-Whitney *U* test when the assumptions of the *t*-test were not met (normality and homoscedasticity analysed using the Fisher-Snedecor test). A multivariable analysis was next conducted to determine whether LVEF after TAVI was significantly different between the 2 groups, taking an adjustment on LVEF before TAVI, in addition to other covariates fixed according to the univariable results and clinical relevance: time between TTE and TAVI implantation and presence of β-blockers. Multiple linear conditional regression models were performed, taking into account matching. Before performing a regression model with time between TTE and TAVI implantation and presence of β-blockers, we performed separate multivariable regression analyses with each parameter. Then, the 2 variables were added together in the multivariable model. Particular attention was paid to possible interaction. The normality of residuals from these models was studied using the Shapiro-Wilk test. When appropriate, a logarithmic transformation was performed to achieve the normality of dependent outcome. Particular attention was given to LVEF before TAVI, which was also considered as a categorical variable classified according to the literature as $< 50\%$ or $\geq 50\%$. Before performing subgroup analyses according to LVEF before TAVI, the interaction between groups (new-onset LBBB vs non-LBBB after TAVI) and LVEF before TAVI ($<$ or $\geq 50\%$) was studied.

## Results

### Baseline characteristics (Table 1)

Overall, 534 patients (326 [61%] with self-expandable valve and 208 [39%] with balloon-expandable valve) underwent a TAVI procedure during the inclusion period. Fifty-one

**Table 1.** Clinical characteristics according to the presence or absence of post-TAVI LBBB

| | Total (n = 80) | LBBB (n = 40) | Non-LBBB (n = 40) | *P* value |
|---|---|---|---|---|
| Clinical characteristics | | | | |
| Age, y | 82.0 ± 4.9 | 82.4 ± 4.6 | 81.5 ± 5.1 | 0.40 |
| Male gender, n (%) | 46 (57.5) | 21 (52.5) | 25 (62.5) | 0.37 |
| NYHA (III or IV) | 28 (35.0) | 12 (30.0) | 16 (40.0) | 0.35 |
| EuroSCORE II | 3.5 ± 2.3 | 3.8 ± 2.9 | 3.2 ±1.4 | 0.18 |
| EuroSCORE logistic | 12.8 ± 7.7 | 12.8 ± 8.7 | 12.8 ± 6.7 | 0.99 |
| Prior CABG, n (%) | 40 (50.0) | 3 (7.5) | 3 (7.5) | 0.99 |
| Hypertension, n (%) | 65 (81.2) | 37 (92.5) | 28 (70.0) | 0.01 |
| Diabetes mellitus, n (%) | 25 (36.3) | 13 (67.5) | 12 (30.0) | 0.81 |
| Mean aortic valve gradient, mm Hg | 43.8 ± 14.9 | 44.2 ± 15.6 | 43.4 ± 14.3 | 0.83 |
| Chronic respiratory insufficiency, n (%) | 12 (15.0) | 6 (15.0) | 6 (15.0) | 1.00 |
| Renal insufficiency (MDRD clearance < 30 mL/min) | 4 (5.0) | 3 (7.5) | 1 (2.5) | 0.62 |
| Ischemic heart disease, n (%) | 44 (55.0) | 24 (60.0) | 20 (50.0) | 0.37 |
| B-blockers, n (%) | 24 (30.0) | 14 (35.0) | 10 (25.0) | 0.33 |
| ACE inhibitors, n (%) | 34 (42.5) | 19 (47.5) | 15 (37.5) | 0.37 |
| Procedure-related characteristics | | | | |
| Medtronic Corevalve or Corevalve Evolut-R (vs Edwards Sapien, Sapien XT or Sapien 3) | 52 (65.0) | 33 (82.5) | 19 (47.5) | 0.001 |
| Diameter | | | | 0.02 |
| 23 mm | 15 (18.7) | 6 (15.0) | 9 (22.5) | |
| 26 mm | 30 (37.5) | 12 (30.0) | 18 (45.0) | |
| 29 mm | 27 (33.8) | 20 (50.0) | 7 (17.5) | |
| 31 mm | 8 (10.0) | 2 (5.0) | 6 (15.0) | |
| Access route, n (%) | | | | 0.19 |
| Femoral | 61 (76.2) | 32 (80.0) | 29 (72.5) | |
| Subclavian | 15 (18.8) | 8 (20.0) | 7 (17.5) | |
| Transapical | 4 (5.0) | 0 (0.0) | 4 (10.0) | |
| Moderate-to-severe AR after TAVI, n (%) | 8 (20) | 3 (7.5) | 5 (12.5) | 0.51 |
| Predilatation, n (%) | 35 (28) | 20 (8) | 50 (20) | 0.005 |
| Postdilatation, n (%) | 10 (8) | 12.5 (5) | 7.5 (3) | 0.071 |

ACE, angiotensin converting enzyme; AR, aortic regurgitation; CABG, coronary artery bypass graft; LBBB, left bundle branch block; MDRD, modification of diet in renal disease; NYHA, New York Heart Association; TAVI, transcatheter aortic valve implantation.

**Table 2.** Left ventricular ejection fraction (LVEF) evolution after transcatheter aortic valve implantation according to left bundle branch block (LBBB) appearance and persistence

| | | | | | At 6 mo | | |
|---|---|---|---|---|---|---|---|
| | Total | LBBB (n = 40) | Non-LBBB (n = 40) | *P* value | No LBBB (n = 17) | Persistent LBBB (n = 23) | *P* value |
| LVEF before the procedure, mean ± SD, < 50%, n (%) | 60.0 ± 11.8, 14 (17.5) | 60.9 ± 11.6, 7 (17.5) | 59.1 ± 12.14, 7 (17.5) | 0.50, 1.00 | 59.9 ± 9.4, 3 (17.7) | 61.6 ± 13.1, 4 (17.4) | 0.63, 0.99 |
| LVEF after the procedure, mean ± SD < 50%, n (%) | 59.3 ± 11.0, 10 (12.5) | 56.7 ± 12.9, 8 (20.0) | 62.0 ± 8.1, 2 (5.0) | 0.03, 0.04 | 59.3 ± 10.9, 3 (17.7) | 54.7 ± 14.1, 5 (21.7) | 0.25, 1.00 |
| Postprocedure TTE delay, mo, mean ± SD | 8.2 ± 4.8 | 8.1 ± 4.1 | 8.3 ± 5.5 | 0.91 | 8.7 ± 4.1 | 7.7 ± 4.1 | 0.22 |
| Absolute LVEF change | | | | | | | |
| All patients | −2 [−8; 6.5] | −5 [−12.5; 2.5] | 1.5 [−6.5; 9.5] | 0.007 | −2 [−7; 6] | −7 [−13; 2] | 0.16 |
| Initial LVEF < 50% | 5.5 [−2; 21] | −2 [−8; 2] | 20 [9; 22] | 0.02 | 0 [−2; 25] | −5.5 [−10.5; −0.5] | 0.16 |
| Initial LVEF > 50% | −3 [−11; 5] | −6 [−13; 3] | −2 [−7; 7] | 0.05 | −3.5 [−12; 6] | −7 [−15; 3] | 0.32 |

SD, standard deviation; TTE, transthoracic echocardiography.

patients (9.6%, n = 51) presented new-onset LBBB after TAVI lasting > 24 hours (12.3% new-onset LBBB in patients implanted with self-expandable vs 5.3% with balloon-expandable TAVI).

A total of 80 patients were included in the present study. We included the first 40 patients of the LBBB-TAVI study. The mean age and proportion of male gender were identical in both groups (82.4 ± 4.6 vs 81.5 ± 5.1 years, $P = 0.40$ and 50% vs 60% in LBBB and non-LBBB groups, respectively; $P = 0.37$). There were no differences in terms of pre-TAVI symptoms (New York Heart Association class III or IV) (12/40 [30%] in the LBBB group vs 16/40 [40%]; $P = 0.35$). The EUROSCORE also did not differ between the 2 groups (3.8 ± 2.9 in the LBBB group vs 3.2 ± 1.4, $P = 0.18$). The same was also true for the mean aortic transvalvular gradient in pre-TAVI: 44.2 ± 15.6 mm Hg in the LBBB group vs 43.4 ± 14.3 mm Hg ($P = 0.83$). The number of patients implanted with a self-expandable prosthesis was higher in the LBBB group (82.5% vs 47.5%, $P = 0.001$).

The rate of moderate or significant AR after TAVI was similar between the 2 groups: 7.5% in the LBBB group vs 12.5% ($P = 0.51$).

## ECG characteristics

Among the patients with new-onset LBBB, 97.5% still exhibited an LBBB at hospital discharge (between days 5 and 7), with 58% at TTE follow-up assessment. The mean QRS duration of the LBBB at hospital discharge was 151 ± 17 milliseconds vs 102 ± 14 milliseconds in the non-LBBB group ($P < 0.001$). Patients who did not present a complete LBBB after TAVI had the following ECG features: 1 patient had a left anterior fascicular block, 3 had an incomplete LBBB < 120 milliseconds, 2 had a nonspecific intraventricular conduction delay, and 3 had a right bundle branch block ≥ 120 milliseconds. A total of 34 patients had a narrow QRS < 120 milliseconds.

## Evolution of LVEF (Table 2)

LVEF evaluation was performed within a mean delay of 8.1 ± 4.1 months after TAVI in the LBBB group vs 8.3 ± 5.5 months in the non-LBBB group ($P = 0.91$).

A decrease in LVEF of 5 percentage points [−12.5; 2.5] was observed in instances of new-onset LBBB in contrast to the non-LBBB group that featured an increase of 1.5 percentage points [−6.5; 9.5], $P = 0.007$. Among patients with pre-TAVI left ventricular dysfunction (LVEF < 50%), the appearance of LBBB was associated with a −2 [−8; 2] percentage points LVEF decrease as opposed to patient without a LBBB who had a increase of 20 [9; 22] percentage points ($P = 0.02$) (Figure 1).

During follow-up, LVEF of patients with persistent LBBB was reduced by −7 points [−13; 2] (n = 23), comparatively to patients who recovered from LBBB (−2 points [−7; 6]; n = 17) and those without new-onset LBBB after TAVI (1.5 [−6.5; 9.5]; n = 40, $P = 0.009$), with a regression coefficient of 10.76 [6.01; 15.52] adjusted to pre-TAVI LVEF, QRS duration, valve type, and the presence of β-blockers between persistent LBBB and non-LBBB patients (taking into account LBBB and non-LBBB groups matching).

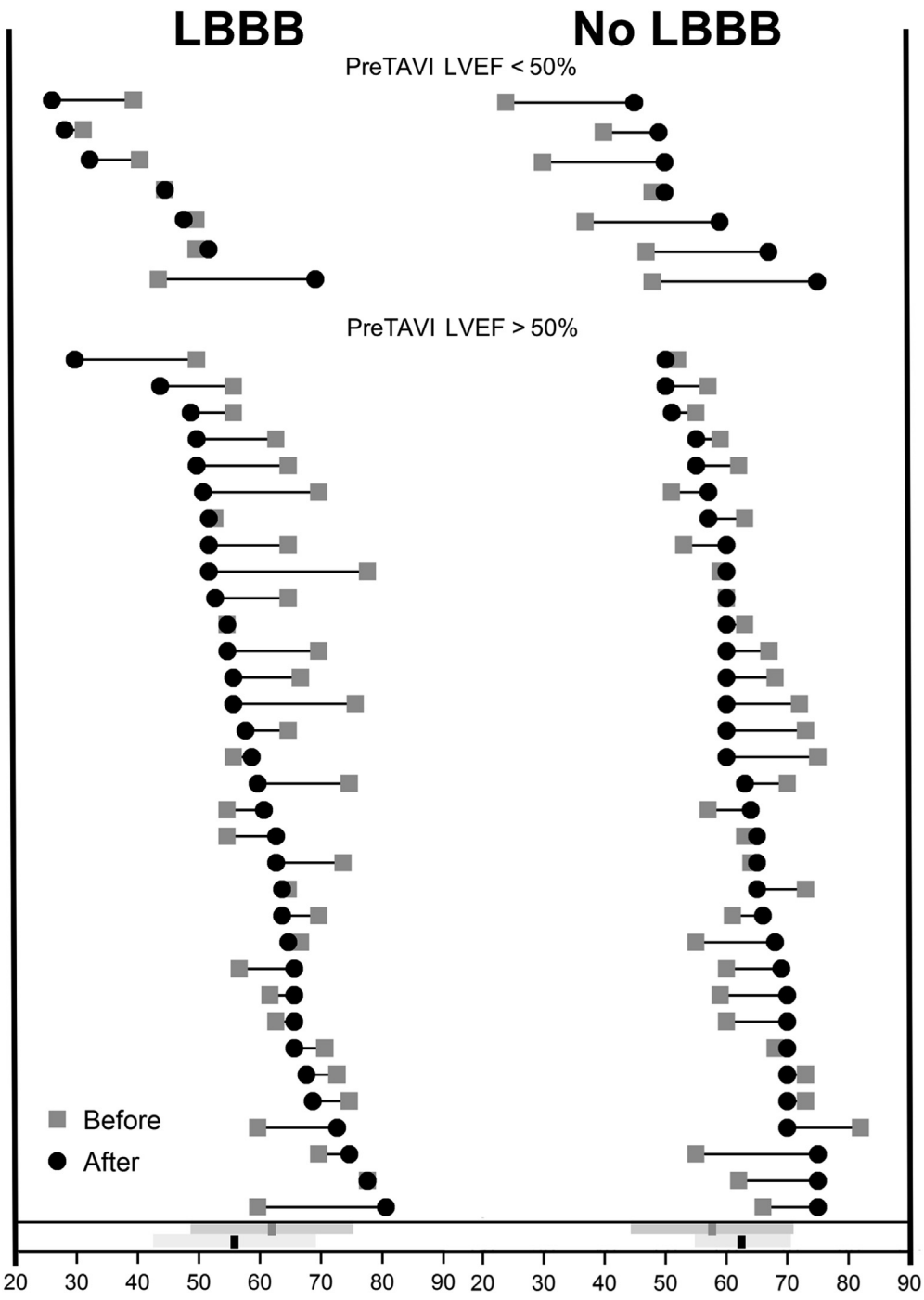


**Figure 1.** Evolution of left ventricular ejection fraction (LVEF) during follow-up in the presence or absence of post-transcatheter aortic valve implantation (TAVI) left bundle branch block (LBBB).

### Morbidity and mortality

During the 12-month follow-up, there were no differences in hospitalizations for HF in the new-onset LBBB after TAVI vs the non-LBBB groups (2/40 patients [5%] in the new-onset LBBB group vs 3/40 patients [7.5%], $P = 0.65$), as well as no difference in mortality rate (1/40 patients [3%] vs 4/40 patients [10%], $P = 0.36$).

## Discussion

This study is the first to prospectively follow the outcome of patients developing new-onset LBBB persisting for more than 24 hours after TAVI (both self-expandable and balloon-expandable valves) as well as its long-term consequences on left ventricular systolic function. The appearance of a post-TAVI LBBB was associated with a degradation in LVEF limiting the expected benefits of the intervention. The

reduction in LVEF was even more pronounced when LBBB persisted beyond 6 months and in those patients with left ventricular dysfunction (LVEF < 50%) before TAVI.

The low incidence of conduction disorders (9.6%) and the observed higher prevalence of self-expanding prostheses (82.5%) are comparable with the most recent data in the literature and the reference studies.[17] Although the prevalence of conduction abnormalities varies depending on the studies and type of valve (from 10.5% [PARTNER registry, Edwards valve] to 37% [France 2 registry, Corevalve Medtronic self-expanding valves]), such prevalence has tended to decrease with operator experience but also the use of the more recent prostheses (Medtronic Corevalve Evolut R and Edwards Sapiens XT valves).[18] The onset of these abnormalities can be delayed and transient (50% persistence at 6 months).[19] Similarly, because of its more aggressive conformation in the aortic outflow track, the self-expanding valve is likely to generate more conduction abnormalities without compromising long-term prognosis.

In instances of left ventricular dysfunction, replacement of the aortic valve for severe AS is associated with an improvement in LVEF. Whether using the percutaneous or surgical approach, LVEF recovery, including in high-risk patients, evolves towards a near normalization of the parameters depending on the degree of contractile reserve, including in the long term (TVT registry: from 35.7% ± 8.5% to 48.6% ± 11.3% [$P < 0.0001$] 1 year after TAVI and similarly from 38.0% ± 8.0% to 50.1% ± 10.8% [$P < 0.001$] after surgery). Indeed, left ventricular dysfunction is progressive and often the consequence of an elevation in afterload. Elimination of the outflow obstruction explains the improvement in LVEF in patients undergoing early aortic valve replacement. More generally, an improvement in LVEF or an absence of impairment is also expected when there is no pre-existing left ventricular dysfunction.[20]

In the present study, an LBBB after TAVI hindered this recovery. It counterbalanced the improvement expected by the reduction in afterload when LVEF was normal, and above all, it did not allow observing an improvement in LVEF in cases of left ventricular dysfunction. One explanation lies in the electromechanical effect of LBBB on left ventricular activation characteristics.[21,22] Electrical activation of the right ventricle by the nodo-Hisian pathways is preserved. On the other hand, both interventricular and intraventricular dyssynchrony (late activation of the left lateral wall) alters the quality of the cardiac contraction.[21] In the long term, it is responsible for reverse left ventricular remodelling with a reduction in LVEF and, in certain cases, heart failure.[10]

All of the studies specifically related to the impact of LBBB have reported the degradation or, at the very least, the absence of improvement of LVEF in instances of new-onset LBBB (LVEF at 6 months, narrow QRS 58.1% vs LBBB 52.8%, $P < 0.001$ PARTNER study; LVEF at 6 months, narrow postprocedure QRS +4.6 ± 7.8 vs LBBB-TAVI −2.1% ± 6.9%, $P = 0.002$, Dobson et al.,[23] and 7.39% ± 9.05% vs −0.46% ± 5.63%, $P < 0.001$, Carrabba et al.[24]). However, these studies, although akin to LBBB-TAVI, mainly focused on either 1 type of prosthesis (balloon-expandable[24] or self-expandable[25]) or without a matching of their population.[23] Moreover, these studies were the result of retrospective data and in many instances performed before the advent of last-generation valves (in contrast to the Evolut R and Sapiens XT valves included in the present study) and whose haemodynamic and structural characteristics tended to modify their behaviour *in vivo*.[19,26,27] In addition, there are very sparse data on the long-term evolution of LVEF.[19,24,26,27]

In the long term, the impact of the reduction in LVEF and of a new-onset LBBB on morbidity and mortality remains nevertheless controversial.[26,28-31] The haemodynamic repercussions of LBBB may be less well tolerated by the remodelled and hypertrophied left ventricle of a patient who is often elderly and with a prior history of AS.

These considerations are essential, given that patients with severe AS with left ventricular dysfunction account for approximately 10% of the population with AS[32] (17.5% in the present study) and the reduction in post-TAVI LVEF appears to be associated with a higher mortality and hospitalization rate in those patients with more severe heart failure.[33,34]

Further studies enabling to stratify the management of these patients exhibiting new-onset LBBB is necessary with regard to the rhythmic and haemodynamic outcome of these patients. Indeed, although the LBBB disappears in nearly half of the affected patients, there are currently no predictive elements with regard to the persistence of new-onset LBBB after TAVI. Its persistence may ultimately warrant prevention of LVEF dysfunction appearance by biventricular pacing in these patients presenting new-onset LBBB and a left ventricular dysfunction even of moderate grade (eg, LVEF < 50%). On the other hand, adaptation of the type of valve to be implanted in patients with left ventricular dysfunction could represent an appealing avenue given the notable differences highlighted between self-expandable and balloon-expandable valves.[8] This point is of particular importance in that the newer valves being developed are seemingly more conducive to conductive disorders, albeit with a near zero rate of AR.[35,36]

The study has some limitations, mainly the observational design and small sample size. However, the groups were matched on age and LVEF and the sample size seems relevant to meet the primary objective. Because of the relative small population, only large effects could be highlighted, notably to study the secondary objectives and the subgroup analyses. Residual confounding remains a possibility and there remains a risk of bias, despite the conservative regression analysis. The present study remains the first study conducted prospectively in this frequent population and whose outcome remains uncertain. It moreover represents one of the largest cohorts established to date and will help to gain a greater understanding of the underlying mechanisms at play in these patients with new-onset LBBB. Other parameters assessing systolic function such as the Tei index, the measurement of the S' velocity of the mitral annulus at the septal and lateral levels, or as recently described, the study of myocardial deformation or speckle tracking could be more effective and will need to be evaluated.[37] Notwithstanding the latter, LVEF remains the indispensable measurement parameter currently used[38] in cardiology for the assessment, management, and stratification of patient risk, and remains a strong and reproducible marker of left ventricular systolic function. None of the patients in our study were screened for the presence of a contractile reserve (stress echocardiography, magnetic resonance imaging). The worsening or lack of improvement of

LVEF could be attributable to a reduction in contraction reserve. However, the opposite evolution of LVEF at 6 months in patients without LBBB or who had recovered from LBBB would suggest a minor impact of this particular parameter.

## Conclusions

The development of new-onset LBBB after TAVI, particularly when persisting beyond 6 months, has a pejorative impact on left ventricular systolic function, especially in patients with an initial LVEF < 50%. Complementary studies aimed at decreasing the rate of new-onset LBBB after the TAVI procedure but also at guiding the management strategy of such patients are necessary.

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The authors have no conflicts of interest to disclose.

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