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Predictors of High-Degree Atrioventricular Block After TAVR with SAPIEN 3 Valve: A Single-Center Experience from CHU Amiens Sud

Facteurs prédictifs d'un bloc auriculo-ventriculaire de haut degré après une TAVR avec la valve SAPIEN 3 : expérience d'un seul centre, le CHU Amiens Sud

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Résumé

Contexte et objectif. Le bloc auriculo-ventriculaire de haut degré (BAVHD) survient parfois après le remplacement valvulaire aortique par cathéter (TAVI). L'objectif de la présente étude était d'identifier les facteurs prédictifs BAVHD après TAVI chez les patients atteints de sténose aortique sévère ayant reçu une bioprothèse SAPIEN 3. *Méthodes.* Il s'agissait d'une série analytique des cas, des patients ayant bénéficié d'un TAVI transfémoral SAPIEN 3 au CHU d'Amiens entre janvier 2020 et janvier 2022. Les facteurs prédictifs de BAVHD post-TAVI étaient recherchés, par la méthode de régression logistique multivariée. *Résultats.* Des 237 patients avec TAVI, le sexe masculin était prépondérant (67,1 %), avec un âge moyen de 78,6±7,8 ans. Parmi eux, 30,4 % étaient en surpoids, 56, 1% avaient une maladie cardiaque ischémique et 23,2 % une maladie artérielle périphérique. Les patients ont été catégorisés selon leur statut BAVHD, présent chez 60 individus (25,3 %) : bloc de branche gauche (LBBB) + bloc auriculo-ventriculaire de premier degré (BAV-1) (25,0 %), BAV pendant le TAVI (13,3 %) et BAV post-TAVI (11,7 %). L'âge ≥ 75 ans (OR 3,03 [1,67-4,78]), le haut risque chirurgical (OR 3,51 [1,92-5,47]), et la présence du bloc de branche droit complet (OR 5,54 [2,92-7,50]) et BAV pendant le TAVI (OR 4,63 [2,38-6,55]) ont émergé comme principaux facteurs associés à HDAVB. *Conclusion.* Le HDAVB post-TAVI est multifactoriel, principalement lié à l'âge avancé et aux anomalies de conduction péri- et post-procédurales. Ces résultats suggèrent la réalisation systématique d'un ECG pré-TAVI et une surveillance rapprochée de la conduction AV. Toutefois, des études prospectives multicentriques sont nécessaires.

Mots-clés : TAVI, Troubles de conduction,

Summary

Context and objective.
High degree atrioventricular bloc (HDAVB) may occur after transcatheter aortic valve replacement (TAVR). The present study aimed to identify factors predicting High-Degree Conduction Disturbances After-TAVR in patients with severe aortic stenosis who had received a SAPIEN 3 bioprosthesis. *Methods.* It was an analytical case series of consecutive transfemoral SAPIEN 3 TAVR patients attending CHU Amiens between January 2020 and January 2022. Predictors of post-TAVR HDAVB were identified using multivariate logistic regression analysis. *Results.* Among the 237 patients with TAVR, 67.1% were men, with a mean age of 78.6±7.8 years. Of these, 30.4% were overweight, 23.2% had peripheral artery disease, and 56.1% had ischemic heart disease. Patients were categorized based on their HDAVB status, which was present in 60 individuals (25.3%): left bundle brunch block (LBBB) associated to first degree atrioventricular (AVB-1) (25.0%), AVB during TAVR (13.3%), and AVB post-TAVR (11.7%). Multivariate analysis revealed a higher likelihood of HDAVB in patients aged 75 and over (OR 3.03 [1.67-4.78]), those with increased surgical risk (OR 3.51 [1.92-5.47]), and those with conduction issues such as complete right bundle brunch block (OR 5.54 [2.92-7.50]) and AVB during TAVR (OR 4.63 [2.38-6.55]). *Conclusion.* Post-TAVR HDAVB is multifactorial, chiefly linked to advanced age and peri- and postprocedural conduction abnormalities. The data support routine pre-TAVR ECG screening and close AV conduction monitoring. Prospective multicenter studies are needed.

Stimulateur cardiaque permanent, Bloc auriculo-ventriculaire de haut degré

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Introduction

Aortic stenosis (AS) is the most common primary valvular lesion in Europe (1) and North America, with an increasing prevalence of about 4 to 5% after the age of 65 (2-3). In France, the incidence among those over 65 is between 2-7 % (4). Surgical aortic valve replacement (SAVR) is the conventional treatment for severe AS; however, Transcatheter Aortic Valve Replacement (TAVR) has become a well-accepted alternative, particularly for patients deemed inoperable or at high surgical risk, as assessed by STS-Prom (Society of Thoracic Surgery-Predicted Risk of Mortality) and EuroSCORE (European System for Cardiac Operative Risk Evaluation) metrics (5). The Placement of Aortic Transcatheter Valve (PARTNER) IA was the first trial comparing TAVR with the Edwards SAPIEN prosthesis to SAVR for high surgical risk patients (STS score > 10 and/or predicted perioperative mortality > 15%). Reporting comparable results in terms of efficacy and safety at 30 days and 1 year, PARTNER demonstrated the non-inferiority of the interventional technique versus the surgical approach on the primary criterion (overall mortality + re-hospitalization) (6). Patients at intermediate and low surgical risk benefit from this emerging technique as shown in the PARTNER 2B and 3 studies, respectively. TAVR can lead to conduction disorders like heart block and new-onset left bundle branch block (LBBB) because the placement of the new valve may interfere with the heart's electrical pathways. Although conduction disorders may regress in the early days following TAVR, they remain a significant post-procedural complication (7), occurring typically within 24-48 hours (8-9) and sometimes necessitating permanent pacemaker (PPM). Risk factors include male sex, pre-existing right bundle branch block (RBBB), complete atrioventricular block (cAVB) during the procedure, new LBBB, prolonged post-TAVR QRS duration, bradycardia and PR prolongation. Technical factors involve using self-expanding valves, over-dilating the annulus, low valve implantation, and oversized prostheses (10-12), Pacemaker implantation rates vary widely, from 2.3% to 36.1% (13) internationally with France estimating around 17.5% (10).

Our single-center study had two main goals. Firstly, we aimed to identify factors predicting post-TAVR High-Degree Conduction Disturbances after TAVR in patients with severe AS who had received a SAPIEN 3 bioprosthesis. Secondly, we sought to determine the percentage of these patients who required a PPM during their hospital stay following TAVR with a percutaneous SAPIEN 3 prosthesis.

Methods

Study design and setting

This analytical case series included consecutive patients who underwent transfemoral TAVR with a SAPIEN 3 bioprosthesis at Amiens University Hospital (CHU Amiens) between January 2020 and January 2022.

Inclusion criteria

Patients with AS considered eligible for TAVR by the Heart Team were included in the study.

Non inclusion criteria

Patients with prior valve-in-valve procedures or those with a permanent pacemaker were excluded.

Primary endpoint

Incidence of HDAVB requiring PPM within 30 days after TAVR.

Data collection:

Data were retrospectively collected from the institutional registry of all patients who underwent TAVR at the CHU Amiens between 2020 and 2022. Baseline demographic and clinical characteristics, echocardiographic parameters, electrocardiographic findings, and procedural details were extracted. Follow-up data, including the occurrence of conduction disturbances and the requirement for PPM, were obtained from the registry and verified through medical records when necessary. Data entry and verification were performed independently by two investigators to ensure accuracy and consistency. All patient information was anonymized before analysis.

Operational Definitions

- Severe Aortic Stenosis: defined as a mean left ventricle-aorta gradient ≥ 40 mmHg, maximum transvalvular velocity ≥ 4 m/s, aortic valve area < 1 cm², indexed aortic valve area < 0.6 cm², and impedance > 0.25, according to ESC guidelines.
- High-degree conduction disturbances following TAVR were defined as clinically significant conduction abnormalities that may require permanent pacemaker implantation. These include (14) :

a) HDAVB – including Mobitz type II second-degree AV block and complete (third-degree) AV block, characterized by failure of atrial impulses to propagate to the ventricles, resulting in severe bradycardia.
b) New or persistent LBBB – commonly observed after TAVR, especially with self-expanding valves, which may progress to high-degree AV block.
c) Pre-existing RBBB with aggravation – patients with RBBB are at higher risk of developing high-degree AV block post-procedure.
d) Bifascicular block – combination of RBBB and left anterior or posterior fascicular block (LAFB or LPFB), associated with high risk of progression to complete AVB.
e) Delayed or intermittent conduction disturbances – HDAVB occurring several days after TAVR, requiring prolonged ECG monitoring.

- Obesity: BMI ≥ 30 kg/m², calculated as weight (kg) divided by height (m²), according to WHO criteria (15).
- Type 2 Diabetes (T2DM): documented history of diabetes, use of antidiabetic medication, or fasting plasma glucose ≥ 126 mg/dL (7.0 mmol/L) on at least two occasions, per ADA guidelines (16).
- Arterial hypertension: documented history of hypertension, use of antihypertensive medication, or systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg on repeated measurements, according to ESC guidelines (17).
- Chronic kidney disease (CKD): eGFR < 60 mL/min/1.73 m² persisting ≥ 3 months or presence of markers of kidney damage, per KDIGO guidelines (18).
- Ischemic heart disease (IHD): documented history of myocardial infarction, coronary revascularization (PCI or CABG), or imaging evidence of coronary artery disease (19).

Statistical Analyses

Data were entered and analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± standard deviation (SD) for normally distributed variables, or as median and interquartile range (IQR) for non-normally distributed variables. The normality of quantitative variables was assessed using the Shapiro-Wilk test. Qualitative variables were expressed as numbers and percentages. To compare quantitative variables between two groups (men vs. women or patients with vs. without high-degree conduction disorders), Student's t-test was used for normal distributions, and the Mann-Whitney U test was used for non-normal distributions. Qualitative variables were compared between groups using Pearson's chi-square test or Fisher's exact test when the sample size was less than 5. A bivariate analysis was performed to identify variables associated with high-degree conduction block (HDB). Associations were expressed as odds ratios (OR) with a 95% confidence interval (95% CI). A significance threshold of $p < 0.05$ was used. Variables with a significant association ($p < 0.05$) in the bivariate analysis were entered into a multivariate logistic regression model to identify independent factors associated with HGD. Results are expressed as adjusted odds ratios (aOR) with a 95% CI, and statistical significance was set at $p < 0.05$.

Ethical clearance
This study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki. We ensured that informed consent was obtained from all participants or their legal representatives when necessary, safeguarding the rights and well-being of those involved

Results
A total of 237 patients underwent TAVR on a native valve with a SAPIEN 3 bioprosthesis between January 2020 and December 2022 at Amiens Sud University Hospital. Sixty patients developed HDAVB requiring PPM (Figure 1).

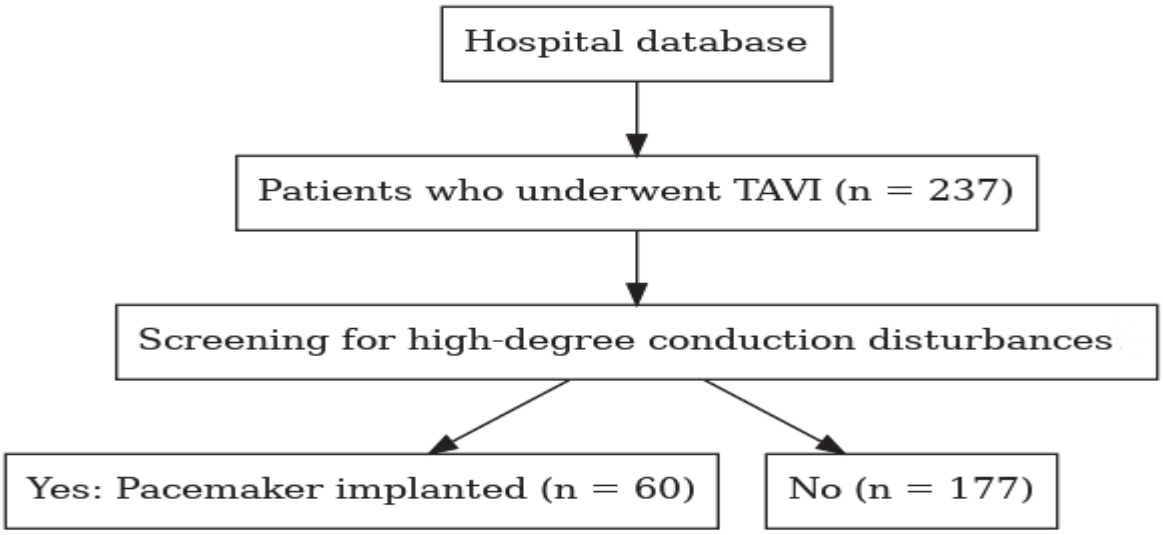

Figure 1. Participants flow chart

Table 1 summarizes the baseline characteristics of the 237 patients. The mean age was 78.6 ± 7.8 years, with a predominance of men (159, 67.1%; sex ratio 2.04). Age, BMI, and the prevalence of hypertension, obesity, diabetes, CKD, and angina were similar between sexes. Men had a higher body surface area ($p < 0.001$) and more frequent peripheral artery disease ($p = 0.005$). Women tended to have more severe symptoms (NYHA III) and higher rates of paroxysmal atrial fibrillation, while ischemic heart disease and complete AV block were more common in men, without reaching statistical significance. Peri- and post-procedural conduction disturbances and major adverse events (cardiac arrest, stroke) were rare and comparable between sexes.

Table 1. General characteristics of the study population

Variable	Men	Women	All	P
	(n=159)	(n=78)	(n=237)	
Age	78.1±7.7	79.6±7.8	78.6±7.8	0.173
BMI	28.1±5.2	32.5±33.2	29.6±19.5	0.109
BSA	1.95±0.19	1.77±0.19	1.89±0.21	<0.001
Overweight	50 (31.4)	22 (28.2)	72 (30.4)	0.362
Obesity	53 (33.3)	28 (35.9)	81 (34.2)	0.401
NYHA				0.157
I	13 (8.2)	6 (7.7)	19 (8.0)	
II	86 (54.1)	34 (43.6)	120 (50.6)	
III	44 (27.7)	33 (42.3)	77 (32.5)	
IV	16 (10.1)	5 (6.4)	21 (8.9)	
Angina	15 (9.5)	8 (10.4)	23 (9.8)	0.498

Syncope	5 (3.2)	2 (2.6)	7 (3.0)	0.584
Diabetes	62 (39.0)	25 (32.1)	87 (36.7)	0.185
Hypertension	130 (81.8)	64 (82.1)	194 (81.9)	0.555
PAD	45 (28.3)	10 (12.8)	55 (23.2)	0.005
CKD	56 (35.2)	28 (35.9)	84 (35.4)	0.515
IHD	95 (59.7)	38 (48.7)	133 (56.1)	0.071

Note. Values are absolute (n) and relative (in percent) frequency BMI: Body mass index, BSA: Body surface area, NYHA: New york heart association, PAD: Peripheral artery disease, CKD: Chronic kidney disease, IHD: Ischemic heart disease

Table 2 outlines the demographic and clinical characteristics of patients divided into those with and without HDAVB. The findings indicate that older age, male gender, and certain comorbidities are linked to a higher occurrence of HDAVB. Patients with HDAVB had a higher average age of 80.3 years compared to 78.0 years in those without, with this difference being statistically significant (p=0.040). Additionally, 78.3% of the HDAVB group were aged 75 or older, compared to 67.8% in the non-HDAVB group. The HDAVB group also had a higher percentage of males at 76.7% versus 63.8% in the non-HDAVB group, with this difference reaching statistical significance (p=0.046). The average BMI was greater in the HDAVB group (33.3 kg/m²) compared to the non-HDAVB group (28.3 kg/m²), although this was not statistically significant (p=0.086). While NYHA Class III, indicating more severe heart failure symptoms, was more frequent in the HDAVB group (41.7%), it was not statistically significant.

Table 2. Baseline sociodemographic and clinical characteristics of patients according HDAVB status

Characteristics	**All (n=237)**	**No HDAVB (n=177)**	**HDAVB (n=60)**	**P**
Age mean	78.6 ± 7.8	78.0 ± 7.7	80.3±7.6	**0.04**
< 75 years	70 (29.5)	57 (32.2)	13 (21.7)	
≥ 75 years	167 (70.5)	120 (67.8)	47 (78.3)	
Gender				**0.046**
Men	159 (67.1)	113 (63.8)	46 (76.7)	
Women	78 (32.9)	64 (36.2)	14 (23.3)	
BMI Kg/m²	29.6±19.5	28.3±5.6	33.3±7.5	0.086
NYHA				0.146
I	19 (8.0)	12 (6.8)	7 (11.7)	
II	120 (50.6)	96 (54.2)	24 (40.0)	
III	77 (32.5)	52 (29.4)	25 (41.7)	
IV	21 (8.9)	17(9.6)	4 (6.7)	

Note. Values are mean ± STD, or absolute (n) and relative (in percent) frequency. Abbreviations:HDAVB: Higth Degree Atrioventricular Block, BMI: Body Mass Index, NYHA: New York Heart Association.

Table 3. presents comorbidities of participants according to HDAVB status. Overweight patients were more prevalent in the HDAVB group (40.0%) compared to non-HDAVB (27.1%), showing significance (p=0.045). Similarly, the prevalence of peripheral artery disease (PAD) was higher in the HDAVB group (35.0% vs. 19.2%, p=0.011), as was peripheral circulation issues, ischemic heart disease (IHD) (70.0% vs. 51.4%, p=0.009). The EuroSCORE II indicated similar surgical risks across groups with a slight increase in the HDAVB group, but this was not statistically significant (p=0.944).

Table 3. Comorbidities of patients according to HDAVB status

Characteristics	All (n=237)	No HDAVB (n=177)	HDAVB (n=60)	P
Overweight	72 (30.4)	48 (27.1)	24 (40.0)	**0.045**
Obesity	81(34.2)	63 (35.6)	18 (30.0)	0.265
Angina	23 (9.8)	18 (10.3)	5 (8.3)	0.439
Syncope	7 (3.0)	5 (2.8)	2 (3.4)	0.560
Type-2 diabetes	60 (25.3)	44 (24.9)	16 (26.7)	0.452
Hypertension	194 (81.9)	145 (81.9)	49 (81.7)	0.551
PAD	55 (23.2)	34 (19.2)	21 (35.0)	**0.011**
CKD	84 (35.4)	61 (34.5)	23 (38.3)	0.348
IHD	133 (56.1)	91 (51.4)	42 (70.0)	**0.009**
Euro score II	2.1(2.0-2.4)	2.02 (1.91-2.35)	2.50 (2.23-3.20)	0.944

Note. Values are absolute (n) and relative (in percent) frequenc. *Abbreviations: PAD: Peripheral artery disease, CKD: chronic kidney disease, IHD: Ischemic heart disease*

Table 4 displays Echocardiographic, cardiac CT scan and electrocardiographic details of participants according to HDAVB status. Patients developing HDAVB after TAVR had larger aortic annuli and sinuses of Valsalva (PLAX diameter: 28.6 ± 2.6 mm vs 27.5 ± 2.6 mm, p=0.006; PSAX diameter: 23.3 ± 2.2 mm vs 22.5 ± 2.6 mm, p=0.029), a larger CT annular area (528.9 ± 78.5 mm² vs 490.1 ± 85.3 mm², p=0.003), and slightly larger implanted valves (27.2 ± 1.8 mm vs 26.3 ± 2.0 mm, p=0.004). HDAVB occurrence was strongly associated with peri-procedure AV blocks (46.7% vs 10.3%, p<0.001), post-TAVR complete AVB (48.3% vs 0%, p<0.001), post-TAVR RBBB (40.0% vs 12.4%, p<0.001), and bifascicular block (16.7% vs 4.5%, p=0.004). Baseline left ventricular function (LVEF 55.5 ± 14.2% vs 57.2 ± 14.0%, p=0.463) and most other echocardiographic or CT parameters did not differ. These findings highlight the importance of aortic measurements and peri- and post-procedure conduction abnormalities in predicting HDAVB.

Table 4. Echocardiographic, cardiac CT scan and electrocardiographic characteristics of patients according to HDAVB status

Characteristics	No HDAVB (n=177)	HDAVB (n=60)	P
Echocardiogram mensuration			
LVEF	57.2 ± 14.0	55.5 ± 14.2	0.463
Aortic annulus			
Pick velocity	439.0 ± 69.3	428.2 ± 62.9	0.308
Mean gradient	50.6 ± 15.6	46.4 ±12.1	0.065
Valve area	0.72(0.68-0.78)	0.78(0.68-0.85)	0.802

Ao diameter PSAX	22.5±2.6	23.3±2.2	**0.029**
Ao diameter PLAX	27.5±2.6	28.6±2.6	**0.006**
TDM area	490.1±85.3	528.9±78.5	**0.003**
Perimeter, val ao	80.3±10.4	83.3±15.6	0.106
Cardiac CT scan mensuration			
Membraneous septum	5.2 (4.7-5.6)	4.2 (3.3-4.7)	**0.003**
Planimetry Ao Valv	1.10 ± 0.38	1.26 ± 0.61	**0.044**
STJ diameter	28.2 ± 3.7	29.9 ± 3.7	**0.004**
Distance LC	15.2 ± 3.2	15.1 ± 3.6	0.825
Distance RC	16.8 ±3.7	17.6 ± 3.3	0.158
Electrocardiographic mensuration			
Pre-TAVR			
AVB1	42 (23.7)	26 (43.3)	**0.004**
RBBB	**22 (12.4)**	**26 (43.3)**	**<0.001**
BFB	**8 (4.5)**	**10 (16.7)**	**0.004**
LBBB	59 (33.7)	14 (23.3)	0.089
LAFB	**40 (22.6)**	**20 (33.3)**	**0.071**
Per-TAVR			
AVB	18 (10.3)	28 (46.7)	<0.001
LBBB per	75 (42.9)	21 (35.0)	0.18
Post-TAVR			
LBBB	73 (41.5)	34 (56.7)	**0.029**
RBBB	22 (12.4)	24 (40.0)	**<0.001**
New LBBB post	54 (30.7)	25 (41.7)	0.082
AVB1	52 (29.4)	30 (50.0)	**0.003**
AVB2	3 (1.7)	6 (10.0)	**0.009**
AVBc	0	29 (48.3)	**<0.001**
LAFB	27 (15.3)	11 (18.3)	0.353
LPFB	3 (1.7)	1 (1.7)	0.734
Other events			
CRA	2 (1.1)	1 (1.7)	0.585
Exit EPL	24 (13.6)	31 (51.7)	**<0.001**
Valves details			
Valve size, n	26.3 ± 2.0	27.2 ± 1.8	**0.004**

Note. Values are mean ± STD, or absolute (n) and relative (in percent) frequency. Abbreviations:Ao, Aorta ; AVB, Atrioventricular block; AVB1, First-degree AVB; AVB2, Second-degree AVB; AVBc, Complete AVB; CRA, Cardiorespiratory arrest ; CT, Computed tomography ; Distance LC, Left coronal distance; Distance RC, Right coronal distance; Exit-EPL, Exit with electrosystolic pacing lead; LAFB, Left anterior fascicular block; LBBB, Left bundle branch block; LPFB, Left posterior fascicular block; LVEF, Left ventricular ejection fraction ; MS, Membraneous septum; PLAX, Parasternal long axis; PSAX, Parasternal short axis; RBBB, Right bundle branch block; STJ

diameter, Sinotubular junction diameter; TAVR, Transcatheter aortic valve replacement

AVB1 pre-TAVR was the most frequent conduction disorder (68 patients, 28.7%), followed by LAFB in 60 patients and c-RBBB in 48 patients, with a male predominance. LBBB was the most frequent conduction disorder during the procedure, affecting 96 patients, followed by new LBBB in 73 and AVB in 46 patients. Post-TAVR ECG analysis revealed no significant difference in the frequency of conduction disorders between sexes. LBBB was the most prevalent post-procedure conduction disorder (107 patients), followed by first-degree AV block (82 patients) and new LBBB (79 patients).

Table 5 labeled indications of PPM implantation post TAVR. We observed a 25.3% incidence of HDAVB requiring PPM following TAVR with the SAPIEN 3 valve. AVBc accounts for 50% of the indications, representing 30 cases out of 60. The combination of LBBB with AVB1 constitute 25% of the cases, or 15 out of 60. AVB per TAVR procedure comprise 13.3%, with 8 cases while AVB post-TAVR accounts 11.7%, with 7 cases.

Table 5. Indications of permanent pacemaker implantation post TAVR

Indications	**Number (60)**	**Pourcentage**
AVBc	30	50.0
LBBB + AVB1	15	25.0
AVB per TAVR	8	13.3
AVB post-TAVR	7	11.7

Note. Abbreviations: AVBc: complete atrioventricular blok, LBBB: left bandle branch block, RBBB: right bandle branch block, PM: pacemaker, TAVR: transcatheter aortic valve replacement.

Table 6 summarizes risk factors linked with HDAVB. Multivariate analysis identified several independent predictors of HDAVB after TAVR. Age ≥75 years was associated with a 3.03-fold increased risk (95% CI: 1.67–4.78, p=0.015), indicating that advanced age is a major predictive factor. The presence of pre-procedure complete right bundle branch block (RBBB) significantly increased the risk (ORa 5.54, 95% CI: 2.92–7.50, p=0.002), confirming the importance of pre-existing conduction abnormalities. Peri-procedural AV block was also strongly associated with HDAVB (ORa 4.63, 95% CI: 2.38–6.55, p=0.013), highlighting the significance of conduction events during the procedure. The occurrence of post-procedure left bundle branch block (LBBB) contributed to the risk (ORa 1.64, 95% CI: 1.33–2.97, p=0.041), as did post-procedure 2nd-degree AV block (ORa 3.60, 95% CI: 2.86–6.41, p=0.017). These findings indicate that advanced age, pre-existing conduction abnormalities, and conduction disturbances occurring during or after the procedure are the main independent predictors of HDAVB after TAVR, and should be considered in risk stratification and post-TAVR monitoring.

Table 6. Factors associated with high-degree atrioventricular block.

Variables	**Bivariate analysis**		**Multivariate analysis**	
	P	OR (CI 95%)	P	aOR (CI 95%)
Age ≥75 years	0.012	2.46 (1.79-3.68)	0.015	3.03 (1.67-4.78)
Male gender	0.047	1.86 (1.50-3.65)	0.207	1.77 (0.73-4.26)
Overweight	0.025	1.79 (1.30-3.31)	0.211	1.69 (0.74-3.84)
Chirurgical Risk	0.01	3.73 (1.37-10.16)	0.007	3.51(1.92-5.47)
PAD	0.014	2.27 (1.18-4.33)	0.19	1.93 (0.72-2.74)
IHD	0.013	2.21(1.18-4.12)	0.798	1.12 (0.48-2.57)
AVB-1	0.004	2.46 (1.33-4.56)	0.863	1.09 (0.40-3.03)

RBBBc	<0.001	5.39 (2.73-10.62)	0.002	5.54 (2.92-7.50)
BFB	0.004	4.23 (1.58-11.28)	0.738	1.31 (0.28-1.99)
AVB-Per	<0.001	7.63 (3.78-15.43)	0.013	4.63 (2.38-6.55)
LBBB-post	0.043	1.85 (1.02-3.34)	0.041	1.64 (1.33-2.97)
RBBB-post	<0.001	4.70 (2.37-9.30)	0.48	1.67 (0.40-2.89)
AVB-1 Post	0.004	2.40 (1.32-4.38)	0.586	1.31 (0.50-3.46)
AVB-2 Post	0.01	3.44 (1.56-6.63)	0.017	3.60 (2.86-6.41
Exit-EPL	<0.001	6.82 (3.51-13.24)	0.347	1.74 (0.55-2.50)

Note. Abbreviations: OR, Odds ratio; Ora, adjusted odds ratio; CI, Confidence intervals; AVB-1: first-degree atrioventricular block; AVB-2: second-degree AVB post-TAVR; AVB-per: AVB per-TAVR; BFB: bifascicular block; Exit-EPL: exit with electrosystolic pacing lead; IHD: ischemic heart disease; LBBB-post: left BBB post-TAVR; PAD: peripheral artery disease; RBBB-post: right BBB; RBBBc: complete RBBB; TAVR: transcatheter aortic valve replacement.

Discussion

The occurrence of HDAVB following TAVR is a significant concern due to its impact on patient outcomes and the subsequent need for PPM. Our study focused on identifying predictors of HDAVB in patients with severe AS who received a SAPIEN 3 bioprosthesis. Additionally, we sought to determine the rate at which these patients required a PPM during their hospital stay after TAVR with the SAPIEN 3 prosthesis. This study reveals that being at least 75 years old, surgical risk, as well as certain electrocardiographic parameters such as baseline RBBBc, AVB per-TAVR, LBBB-post and AVB2-post TAVR show a strong association with a higher risk of HDAVB post-TAVR, even after adjustment.

Sociodemographic and clinical characteristics

The results highlight age as a crucial factor in the development of HDAVB, with older individuals showing greater susceptibility. The significant age difference between the groups suggests that age-related physiological changes might play a role in the onset of HDAVB (20).

This finding is consistent with existing research linking advanced age to heightened cardiovascular risks. The increased occurrence of HDAVB among males suggests a possible gender-related vulnerability.

While the HDAVB group had a higher average BMI, the lack of statistical significance indicates that BMI alone may not fully account for HDAVB development. The complex interplay of comorbidities, especially in older adults, requires further exploration to better understand their combined impact on HDAVB.

Incidence of HDAVB post-TAVR procedures and commorbidies

Our study underscored a link between PAD and IHD and HDAVB post-TAVR. PAD serves as a robust indicator of widespread atherosclerosis, which significantly elevates the risk of heart attack and stroke. HDAVB is a rare yet serious complication that can occur in the context of non-ST-elevation myocardial infarction, often requiring the implantation of a PPM. The relationship between PAD, IHD, and HDAVB is intricately linked through the common thread of atherosclerosis, which exacerbates ischemic conditions leading to cardiac electrical disturbances. According to ACC/AHA guidelines, an ischemia-guided strategy is recommended for managing HDAVB (21-22).

Occurrence of HDAVB following TAVR necessitating PPM

In our study conducted at CHU Amiens Sud, we observed a 25.3% incidence of HDAVB requiring PPM following TAVR with the SAPIEN 3 valve. This rate exceeds those reported in larger registries and multicenter studies such as the FRANCE TAVR (10–17.5%) (23), the PARTNER trials (8% to 12%) (24), and both the U.S. TVT and CONDUCT registries (8–15%) (25). Several factors might explain the higher incidence in our study, including a tendency to select older, higher-risk patients, specific procedural techniques unique to our center, or more thorough post-TAVR rhythm monitoring. While our study, along with the TVT and CONDUCT trials, used the SAPIEN 3 valve, the FRANCE TAVR study employed a balloon-expandable valve, and the PARTNER study utilized the SAPIEN/Edwards valve. These variations in valve type could also contribute to differences in outcomes (26).

Determinants of HDAVB necessitating PPM following TAVR

In our study, age of 75 and older emerged as an robust independent predictor for HDAVB after TAVR. This age-related influence is well documented, likely due myocardial fibrosis and conduction system frailty of the conduction system in elderly patients, which heightens their susceptibility to conduction disturbances following valve implantation (26). As we age, there is a reduction in pacemaker cells and an increase in fibrosis, leading to a greater risk of arrhythmia post-TAVR. Additionally, fibrosis resulting from AS causes changes in LV, disrupting the heart's normal electrical pathways (27).

Moreover, patients categorized as high surgical risk exhibit a higher propensity for HDAVB post-TAVR because these patients often present with a complex clinical profile. This includes multiple comorbidities, such as renal insufficiency and diabetes, alongside cardiovascular impairments like LV dysfunction and BBB. These conditions, coupled with compromised cardiovascular function, heighten their vulnerability to the mechanical stresses of the TAVR procedure (28).

From an electrocardiographic standpoint, our findings highlight several conduction abnormalities, such as cRBBB**,** periprocedural HDAVB (AVB-Per) post-procedural disturbances like LBBB and AVB-2, as strong predictors of HDAVB. These results corroborate the literature, which consistently identifies pre-existing conduction disorders (especially RBBB) and the occurrence of new conduction abnormalities post-TAVR as the strongest predictors of PPM (29).

In particular, pre-existing RBBB has been recognized as the most robust risk factor in large cohorts and meta-analyses (27,29). In our study, this factor increased the risk of AVB more than five-fold, in perfect agreement with international data. Moreover, conduction abnormalities arising immediately after the procedure (LBBB, AVB-2, AVB-Per) should be regarded as major warning signals for close monitoring and early pacemaker implantation (10).

Interestingly, our study did not find significant associations with factors such sex, obesity, and coronary artery disease, or isolated AVB-1 in multivariate analyses, suggesting potential inter-population variability and the influence of confounding factors (30,31). This highlights the necessity for personalized predictive models that incorporate clinical, electrocardiographic, and electrophysiological data to better anticipate and manage the risk of HDAVB post-TAVR, ultimately enhancing patient care and outcomes.

Limitations and strengths

The study faces several limitations that warrant consideration. Firstly, the short in-hospital follow-up period means that long-term pacing requirements were not studied, potentially missing insights into the extended effects and recovery post-TAVR. Additionally, the study lacks detailed data on device positioning, such as implantation depth and valve oversizing, which are crucial procedural variables that can influence outcomes. The absence of electrophysiological testing before discharge also limits the ability to fully assess conduction system disturbances. Moreover, as a single-center, retrospective study, its findings are less generalizable and may not apply broadly.

Despite these limitations, the study boasts several strengths that enhance its contribution to the field. It offers a focused examination of predictors for HDAVB after TAVR with the SAPIEN 3 valve, providing valuable insights for patient selection and monitoring. The use of robust statistical analysis, specifically multivariate logistic regression, strengthens the validity of its conclusions. Additionally, the study features comprehensive data collection, including detailed clinical and ECG information, which supports its findings. Importantly, the study's results align well with existing literature on known predictors, reinforcing its credibility and relevance.

Conclusion

HDAVB after TAVR is multifactorial; major drivers include advanced age and peri- and postprocedural conduction disturbances. These findings support routine pre-TAVR ECG evaluation and close AV conduction monitoring, particularly in patients with RBBB. Prospective multicenter studies are warranted.

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Disclosures

None

Author's contribution

Study design: NBB, LL, SQ, ESL.
Data collection: JH, ESL.
Results' interpretation: ANN.
Data analyses: ANN.
Manuscript penning: All authors
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Competing Interest

The authors declare no competing interests.

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