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Need for long-term permanent pacemaker and its association with mortality in patients undergoing transcatheter aortic valve implantation

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Abstract

Despite two decades of experience and increased procedural success in Transcatheter Aortic Valve Implantation (TAVI), the need for permanent pacemaker implantation (PPI) is still a matter of debate. We aimed to investigate the need for PPI and the long-term impact of PPI on all-cause mortality in patients with TAVI. We included retrospectively All TAVI recipients between June 2016 and January 2021 admitted to our tertiary center. In-hospital data were retrieved from the institutional digital database and mortalities were recorded from the national E-Health application. The primary outcome was to determine the frequency of PPI requirements following TAVI. The median follow-up was 52 (12-72) months. PPI had been deemed necessary in 20 (15%) of 132 TAVI recipients. When examined according to the devices used for TAVI, PPI was necessary in 25% of Evolut R (Medtronic, CA, USA), 4% of Edwards Sapien (Edwards Lifesciences, CA, USA), 16% of Portico (Abbott Structural Heart, St Paul, MN, USA), 26% of Medtronic CoreValve (Medtronic, CA, USA), 20% of Myval THV (Meril Life Sciences, Gujarat, India), and in none of ACURATE neo™ (Boston Scientific, Marlborough, MA, USA) recipients. Mortality was similar among those with and without PPI requirements. Multiple regression revealed that hyperlipidemia and preoperative valvuloplasty significantly decreased risk for all-cause mortality, while higher CRP increased mortality risk. New-generation TAVI devices appear to decrease the need for PPI compared to older-generation devices, as reported in the literature. PPI was not associated with all-cause mortality at a median follow-up of 52 months in TAVI recipients.

Keywords: transcatheter aortic valve replacement, pacemaker, mortality, preoperative valvuloplasty

1. Introduction

Transcatheter aortic valve implantation (TAVI) was introduced in 2002 and has since been identified as a breakthrough development in interventional cardiology (1). Initially, TAVI was reserved for patients with severe, symptomatic aortic valve stenosis in whom conventional surgical aortic valve implantation (SAVR) would cause high risk. However, recent randomized, multi-center, prospective studies in patients with severe aortic stenosis indicate that, among patients deemed to be at low-risk for SAVR, the TAVI approach lowers the risks for death, stroke or re-hospitalization at one year of follow-up compared to conventional SAVR (2, 3). Current European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS) guidelines recommend TAVI in older patients (≥75 years) or those who are unsuitable for or at high-risk for surgery (STS-PROM / EuroSCORE II >8%), while SAVR is recommended for (i) those older than >75 years with an STS-PROM / EuroSCORE II of <4%, or (ii) those unsuitable for transfemoral TAVI (4).

Despite two decades of experience and increased procedural success in TAVI, there is still debate concerning long-term valve durability, advantages/disadvantages relative to SAVR, risks for periprocedural stroke, and, ultimately, the need for permanent pacemaker implantation (PPI). As a result of the anatomical proximity, conduction abnormalities constitute a major complication of TAVI due to potential injuries to conductive sites. Left bundle branch block (LBBB) accounts for 10-30% of the conduction system abnormalities after TAVI (5). The frequency of PPI in TAVI recipients ranges between 4–24% (6). However, the incidence of PPI in recipients of new-generation prostheses is unclarified and there is limited data concerning clinical factors associated with the need for PPI.

This study aimed to investigate the frequency of PPI and the long-term impact of PPI requirement on mortality in TAVI recipients.

2. Material and Methods

All consecutive patients undergoing TAVI in our institute, which is a tertiary center, between June 2016 and January 2021 were examined retrospectively. All TAVI procedures were performed via the transfemoral approach, following the final decision made by the heart team. TAVI was not performed in patients with absolute contraindications (those with life expectancy less than 1 year, patients who were not expected to experience quality of life improvement due to comorbidities, and individuals with inadequate annulus size, thrombus in left ventricle or ascending aorta, active endocarditis, or increased risk of coronary ostium obstruction) and those with relative

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contraindications (obstructive coronary artery disease, hemodynamic instability, left ventricular ejection fraction of < 20 %) did not undergo TAVI. Additionally, subjects who had previously undergone pacemaker implantation for other reasons were excluded from the study. The study was approved by the Clinical Research Ethics Committee of Haseki Training and Research Hospital.

Data concerning demographic characteristics, comorbidities, blood type, aortic pathologies, previous surgical/non-surgical interventions (if any), pre- and post-procedural transthoracic echocardiography measurements, TAVI device size and type (brand), complications, intra-hospital PPI application and mortality were retrieved from the institutional digital database. Hyperlipidemia was defined as having a total cholesterol of >200 mg/dl or being on antihyperlipidemic medications. Also, laboratory results, including complete blood count, inflammatory indices (neutrophil-to-lymphocyte ratio; NLR, lymphocyte-to-MCV ratio; LMR, platelet-to-lymphocyte ratio; PLR, etc.), and biochemical measurements (renal function tests including glomerular filtration rate, liver function tests, lipid profile, etc.) were recorded. Data concerning mortality after discharge was obtained from the National E-Health application in which all personal health issues, including laboratory tests, imaging studies, interventions and mortality are recorded.

The primary outcome measure of this study was to address the frequency of PPI in subjects undergoing TAVI. The secondary outcome measure was identifying factors independently associated with long-term all-cause mortality.

2.1. Statistical analysis

All analyses were performed on SPSS v25 and were subject to the classical two-tailed $p < 0.05$ significance threshold (SPSS Inc., Chicago, IL, USA). We evaluated Q-Q and histogram plots to assess normal / non-normal distribution in continuous variables. Data concerning continuous variables were depicted with mean ± standard deviation in the presence of normal distribution, while median (1st quartile–3rd quartile) values were used for those with non-normal distribution. Absolute (n) and relative (%) frequency were used to depict categorical data. Comparison results for normally-distributed continuous variables were analyzed with the independent samples t-test. Non-normally distributed variables were analyzed with the Mann-Whitney U test. Categorical variable distributions were compared with chi-square tests or Fisher's exact test. Multiple logistic regression analysis (forward conditional selection) was used to determine the best factors that could independently predict mortality.

3. Results

The median follow-up period was 52 (12-72) months. Twenty (15%) of the 132 TAVI recipients had required PPI. Subjects with and without PPI were similar with respect to age, sex, comorbidities, left ventricular function, presence of additional aortic regurgitation, preoperative valvuloplasty, and TAVI prosthesis and device type. Subjects requiring PPI had lower creatinine values [0.94 (0.75 - 1.19) mg/dl vs 0.76 (0.65 - 0.91) mg/dl, $p = 0.010$] and higher GFR [68 (52 - 84) vs 86 (64 - 92), $p = 0.022$] compared to those without PPI (Table 1).

Table 1. Summary of patient characteristics and laboratory measurements with regard to permanent pacemaker need

		Permanent pacemaker		
	Total (n=132)	**Yes (n=20)**	**No (n=112)**	**p**
Age	76 (70.5 - 82)	76.5 (71 - 82)	76 (70.5 - 82.5)	0.839
Sex				
Female	82 (62.1%)	13 (65.0%)	69 (61.6%)	0.970
Male	50 (37.9%)	7 (35.0%)	43 (38.4%)	
Race				
Domestic	126 (95.5%)	19 (95.0%)	107 (95.5%)	1.000
Immigrant	6 (4.5%)	1 (5.0%)	5 (4.5%)	
Comorbidities				
Hypertension	82 (62.1%)	12 (60.0%)	70 (62.5%)	1.000
Diabetes mellitus	51 (38.6%)	4 (20.0%)	47 (42.0%)	0.108
Hyperlipidemia	76 (57.6%)	9 (45.0%)	67 (59.8%)	0.322
COPD	24 (18.2%)	3 (15.0%)	21 (18.8%)	1.000
Cerebrovascular disease	16 (12.1%)	2 (10.0%)	14 (12.5%)	1.000
Malignancy	9 (6.8%)	0 (0.0%)	9 (8.0%)	0.354
Peripheral artery disease	8 (6.1%)	1 (5.0%)	7 (6.3%)	1.000
Coronary artery disease	39 (29.5%)	8 (40.0%)	31 (27.7%)	0.397
Blood group				
A	60 (45.5%)	9 (45.0%)	51 (45.5%)	0.073
B	16 (12.1%)	0 (0.0%)	16 (14.3%)	
O	47 (35.6%)	11 (55.0%)	36 (32.1%)	

AB	9 (6.8%)	0 (0.0%)	9 (8%)	
Rh group				
Negative	23 (17.4%)	5 (25.0%)	18 (16.1%)	0.343
Positive	109 (82.6%)	15 (75.0%)	94 (83.9%)	
LVEF				
≥ %50	91 (68.9%)	16 (80.0%)	75 (67.0%)	0.292
< %50 - ≥ %30	30 (22.7%)	4 (20.0%)	26 (23.2%)	
< %30	11 (8.3%)	0 (0.0%)	11 (9.8%)	
Aortic pathology				
Stenosis	119 (90.2%)	19 (95.0%)	100 (89.3%)	0.693
Regurgitation	2 (1.5%)	0 (0.0%)	2 (1.8%)	
Stenosis + Regurgitation	11 (8.3%)	1 (5.0%)	10 (8.9%)	
Other valvular pathology	18 (13.6%)	2 (10.0%)	16 (14.3%)	1.000
Preoperative valvuloplasty	67 (50.8%)	9 (45.0%)	58 (51.8%)	0.752
Glucose	117 (104 - 156.5)	118.5 (107 - 143.5)	116 (103.5 - 163)	0.962
Urea	42.30 (35.75 - 58.00)	39.20 (31.40 - 42.30)	43.55 (36.25 - 59.55)	**0.036**
Creatinine	0.91 (0.73 - 1.14)	0.76 (0.65 - 0.91)	0.94 (0.75 - 1.19)	**0.010**
GFR	69 (53 - 87)	86 (64 - 92)	68 (52 - 84)	**0.022**
Uric acid	6.66 ± 1.98	5.86 ± 1.70	6.81 ± 2.00	0.056
Calcium	9.06 ± 0.64	8.98 ± 0.61	9.07 ± 0.64	0.541
Total protein	64.4 (60.5 - 69)	66 (60.6 - 68.3)	64.4 (60.5 - 69.5)	0.941
Albumin	36.06 ± 4.59	36.48 ± 3.61	35.98 ± 4.76	0.659
Globulin	28.05 (26 - 32)	28.05 (24.15 - 31.5)	28.45 (26 - 32)	0.614
Total cholesterol	197.68 ± 51.85	197.06 ± 63.59	197.79 ± 49.76	0.956
HDL cholesterol	45.09 ± 11.78	44.89 ± 13.41	45.13 ± 11.53	0.936
LDL cholesterol	124.32 ± 43.63	128.89 ± 53.38	123.47 ± 41.85	0.631
Triglyceride	123 (91.5 - 163.5)	111 (95 - 140)	124 (91 - 168)	0.323
Hemoglobin	11.80 ± 1.63	12.09 ± 1.60	11.75 ± 1.64	0.394
Hematocrit	35.80 ± 4.41	36.49 ± 3.98	35.67 ± 4.49	0.451
Platelet ($x10^3$)	232.30 ± 70.47	242.25 ± 64.71	230.52 ± 71.57	0.495
MCV	84.31 ± 5.95	84.13 ± 6.55	84.34 ± 5.86	0.885
MPV	10.40 ± 1.04	10.41 ± 0.97	10.40 ± 1.06	0.957
MCHC	32.93 ± 1.42	33.09 ± 1.52	32.90 ± 1.40	0.584
WBC	7660 (6155 - 9770)	6870 (5970 - 9200)	7765 (6175 - 9930)	0.169
Lymphocyte	1715 (1300 - 2275)	1670 (1400 - 2085)	1760 (1275 - 2285)	0.975
Neutrophil	5000 (3715 - 6890)	4375 (3495 - 6135)	5220 (3845 - 7030)	0.184
Monocyte	525 (405 - 755)	465 (395 - 625)	560 (410 - 800)	0.177
Eosinophil	135 (70 - 230)	100 (55 - 225)	140 (70 - 230)	0.400
Basophile	30 (20 - 40)	30 (20 - 35)	30 (20 - 40)	0.754
Lymphocyte to MCV ratio	20.98 (15.03 - 26.95)	21.09 (16.02 - 24.63)	20.89 (14.55 - 27.46)	0.975
Neutrophil to MCV ratio	59.50 (44.79 - 84.38)	49.56 (40.24 - 70.76)	61.35 (45.76 - 85.27)	0.165
Platelet to lymphocyte ratio	128.76 (99.34 - 172.39)	137.51 (106.75 - 182.25)	128.76 (98.39 - 169.43)	0.564
Neutrophil to lymphocyte ratio	2.88 (2.05 - 4.19)	2.33 (1.97 - 3.80)	2.93 (2.06 - 4.28)	0.272
Monocyte to lymphocyte ratio	0.30 (0.22 - 0.49)	0.24 (0.21 - 0.38)	0.31 (0.22 - 0.50)	0.176
Eosinophil to lymphocyte ratio	0.07 (0.04 - 0.12)	0.06 (0.04 - 0.11)	0.07 (0.05 - 0.12)	0.429
Basophil to lymphocyte ratio	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.937
CRP	6.80 (2.95 - 16.30)	6.65 (3.25 - 16.95)	7.05 (2.81 - 16.30)	0.881
TAVI type				
Evolut R	55 (41.7%)	11 (55.0%)	44 (39.3%)	0.270
Edwards Sapien Balloon Expandable	26 (19.7%)	1 (5.0%)	25 (22.3%)	

Accurate Neo	12 (9.1%)	0 (0.0%)	12 (10.7%)	
Portico	18 (13.6%)	3 (15.0%)	15 (13.4%)	
Medtronic Corevalve	15 (11.4%)	4 (20.0%)	11 (9.8%)	
Mywall	5 (3.8%)	1 (5.0%)	4 (3.6%)	
None	1 (0.8%)	0 (0.0%)	1 (0.9%)	
TAVI device size, mm	27 (26 - 29)	28 (26 - 29)	26 (26 - 29)	0.820
Other complication	37 (28.0%)	5 (25.0%)	32 (28.6%)	0.954
Mortality	50 (37.9%)	7 (35.0%)	43 (38.4%)	0.970

Data are given as mean ± standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables.

With respect to device type, PPI was required in 25% of patients with Evolut R (Medtronic, CA, USA), 4% of patients with Edwards Sapien (Edwards Lifesciences, CA, USA), 16% of patients with Portico (Abbott Structural Heart, St Paul, MN, USA), 26% of patients with Medtronic CoreValve (Medtronic, CA, USA), 20% of patients with Myval THV (Meril Life Sciences, Gujarat, India), and none of the patients with the ACURATE neo™ (Boston Scientific, Marlborough, MA, USA) device (Table 1). Device size was similar between patients with and without PPI.

The mortality rate was similar among patients who did and did not undergo PPI. Comparison of survivors and non-survivors revealed that non-survivors had higher age, creatinine, uric acid, NLR and CRP levels, while they had lower hemoglobin, total protein and albumin levels compared to survivors. Subjects with mortality had more frequently received the ACURATE neo™ (BostonScientific, MA, USA) and Portico™ (Abbott Vascular Solutions, CA, USA) devices (Table 2).

Table 2. Summary of patients characteristics and laboratory measurements with regard to mortality

	Status		
	Alive (n=82)	**Exitus (n=50)**	**p**
Age	74.5 (69 - 80)	78 (73 - 84)	**0.010**
Sex			
Female	51 (62.2%)	31 (62.0%)	1.000
Male	31 (37.8%)	19 (38.0%)	
Race			
Domestic	78 (95.1%)	48 (96.0%)	1.000
Immigrant	4 (4.9%)	2 (4.0%)	
Comorbidities			
Hypertension	57 (69.5%)	25 (50.0%)	**0.040**
Diabetes mellitus	34 (41.5%)	17 (34.0%)	0.503
Hyperlipidemia	57 (69.5%)	19 (38.0%)	**0.001**
COPD	14 (17.1%)	10 (20.0%)	0.849
Cerebrovascular disease	9 (11.0%)	7 (14.0%)	0.809
Malignancy	6 (7.3%)	3 (6.0%)	1.000
Peripheral artery disease	6 (7.3%)	2 (4.0%)	0.710
Coronary artery disease	29 (35.4%)	10 (20.0%)	0.093
Blood group			
A	38 (46.3%)	22 (44.0%)	0.720
B	9 (11.0%)	7 (14.0%)	
O	28 (34.1%)	19 (38.0%)	
AB	7 (8.5%)	2 (4.0%)	
Rh group			
Negative	18 (22.0%)	5 (10.0%)	0.129
Positive	64 (78.0%)	45 (90.0%)	
LVEF			
≥ %50	61 (74.4%)	30 (60.0%)	0.215
< %50 - ≥ %30	15 (18.3%)	15 (30.0%)	
< %30	6 (7.3%)	5 (10.0%)	

Aortic pathology			
Stenosis	75 (91.5%)	44 (88.0%)	
Regurgitation	1 (1.2%)	1 (2.0%)	0.805
Stenosis + Regurgitation	6 (7.3%)	5 (10.0%)	
Other valvular pathology	13 (15.9%)	5 (10.0%)	0.491
Preoperative valvuloplasty	49 (59.8%)	18 (36.0%)	**0.014**
Glucose	119.5 (103 - 153)	116 (104 - 175)	0.811
Urea	40.1 (32.3 - 54.6)	46.95 (39.9 - 64.8)	**0.004**
Creatinine	0.82 (0.70 - 1.11)	0.93 (0.80 - 1.19)	**0.026**
GFR	78 (55 - 90)	61 (51 - 77)	**0.004**
Uric acid	6.32 ± 1.77	7.25 ± 2.21	**0.011**
Calcium	9.12 ± 0.58	8.96 ± 0.72	0.185
Total protein	66 (61 - 72)	63.2 (60.2 - 66)	**0.026**
Albumin	37.00 ± 4.49	34.49 ± 4.38	**0.002**
Globulin	28 (25 - 32)	29 (26.1 - 32)	0.646
Total cholesterol	203.86 ± 48.39	185.16 ± 56.85	0.069
HDL cholesterol	46.15 ± 11.67	42.92 ± 11.87	0.166
LDL cholesterol	127.04 ± 40.46	118.82 ± 49.56	0.344
Triglyceride	131.5 (98 - 175)	110.5 (69 - 136)	**0.011**
Hemoglobin	12.05 ± 1.58	11.40 ± 1.66	**0.027**
Hematocrit	36.43 ± 4.40	34.76 ± 4.27	**0.035**
Platelet ($x10^3$)	224.44 ± 66.23	245.18 ± 75.84	0.101
MCV	84.53 ± 5.51	83.95 ± 6.64	0.592
MPV	10.32 ± 1.04	10.53 ± 1.04	0.271
MCHC	33.05 ± 1.38	32.73 ± 1.46	0.212
WBC	7500 (6140 - 9360)	8455 (6180 - 10390)	0.089
Lymphocyte	1775 (1330 - 2200)	1560 (1270 - 2490)	0.577
Neutrophil	4800 (3620 - 6240)	5625 (4200 - 7710)	**0.039**
Monocyte	560 (400 - 740)	520 (430 - 760)	0.899
Eosinophil	150 (80 - 230)	110 (50 - 230)	0.160
Basophile	30 (20 - 40)	30 (20 - 40)	0.824
Lymphocyte to MCV ratio	21.37 (15.62 - 26.76)	18.79 (13.97 - 30.17)	0.673
Neutrophil to MCV ratio	56.37 (42.61 - 76.81)	66.25 (46.51 - 92.22)	**0.033**
Platelet to lymphocyte ratio	121.70 (102.63 - 155.63)	140.44 (94.46 - 196.30)	0.168
Neutrophil to lymphocyte ratio	2.66 (1.98 - 3.75)	3.28 (2.31 - 5.12)	**0.035**
Monocyte to lymphocyte ratio	0.30 (0.22 - 0.39)	0.31 (0.21 - 0.58)	0.622
Eosinophil to lymphocyte ratio	0.08 (0.05 - 0.13)	0.07 (0.04 - 0.11)	0.236
Basophil to lymphocyte ratio	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.520
CRP	4.9 (2.4 - 11.1)	11.4 (6 - 24)	**0.002**
TAVI type			
Evolut R	30 (36.6%)	25 (50.0%)	
Edwards Sapien XT	14 (17.1%)	12 (24.0%)	
Accurate Neo	11 (13.4%)	1 (2.0%)	
Portico	15 (18.3%)	3 (6.0%)	**0.046**
Medtronic Corevalve	8 (9.8%)	7 (14.0%)	
Mywall	4 (4.9%)	1 (2.0%)	
None	0 (0.0%)	1 (2.0%)	
TAVI device size, mm	27 (26 - 29)	26 (26 - 29)	0.706
Permanent pacemaker	13 (15.9%)	7 (14.0%)	0.970

Other complication	25 (30.5%)	12 (24.0%)	0.545

Data are given as mean ± standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution, and as frequency (percentage) for categorical variables.

We performed multiple logistic regression analyses to determine the factors independently associated with mortality. Patients with hyperlipidemia had a lower risk of death than those without (OR: 0.258, 95% CI: 0.117 - 0.569, p = 0.001). Preoperative valvuloplasty decreased the risk of death (OR: 0.358, 95% CI: 0.161 - 0.792, p = 0.011). Also, patients with higher CRP were found to have a higher risk of death (OR: 1.035, 95 % CI: 1.007 - 1.064, p = 0.014). Other variables included in the model, age (p = 0.269), hypertension (p = 0.789), urea (p = 0.175), creatinine (p = 0.678), GFR (p = 0.142), uric acid (p = 0.451), total protein (p = 0.226), albumin (p = 0.075), triglyceride (p = 0.089), hemoglobin (p = 0.059), hematocrit (p = 0.052), neutrophil (p = 0.362), neutrophil-to-MCV ratio (p = 0.229), NLR (p = 0.730) and TAVI type (p = 0.305) were found to be non-significant (Table 3).

Table 3. Significant predictive factors of the mortality, multiple logistic regression analysis

	Odds ratio	95.0% CI for Exp (β)	p
Hyperlipidemia	0.258	0.117 – 0.569	0.001
Preoperative valvuloplasty	0.358	0.161 – 0.792	0.011
C-reactive protein	1.035	1.007 – 1.064	0.014
Constant	1.317		0.461

Dependent variable: Mortality; Nagelkerke R^2=0.256; Correct prediction=68.2% CI: Confidence interval

4. Discussion

In our series, PPI was required in 15% of TAVI recipients, which is compatible with the literature. The mortality rate was similar in subjects with and without PPI. Higher age, creatinine, uric acid, NLR and CRP levels, and lower hemoglobin, total protein and albumin levels were noted in subjects with mortality. Blood urea nitrogen and creatinine were lower in subjects undergoing PPI. However, neither blood urea nitrogen nor creatinine were associated with mortality. Except for higher CRP levels, none of these parameters, including device type, were independently associated with a higher likelihood of mortality.

TAVI has become a highly reliable and safe therapeutic option for patients with severe aortic stenosis since its introduction in 2002 (7). TAVI was initially reserved for patients with severe aortic stenosis and high surgical risk; however, currently, TAVI represents the standard of care in treating severe aortic stenosis among patients older than 70 years of age. The two predominant device types used for TAVI are balloon-expandable and self-expandable valve systems. While self-expandable systems have the advantage of a larger effective orifice area and lower gradient, the likelihood of PPI is reported to be elevated with this kind of device compared to balloon-expandable devices (8, 9). New-onset conduction abnormalities are reported in 35% of patients undergoing TAVI, with LBBB being the most common type (10). Development of conduction abnormalities after TAVI or SAVR result from the proximity between the aortic valve and the conduction system of the heart. Another important point to note is that around 22% of patients undergoing TAVI develop atrioventricular block; however, these cases are demonstrated to resolve in about half of these patients within the first 24 hours (11).

A meta-analysis of 41 studies reported a PPI rate ranging between 2% and 51% following TAVI (12). The need for PPI was much more common in patients receiving the self-expanding Medtronic CoreValve (25-52.8%) device compared to subjects receiving the balloon-expandable Edwards Sapien/Sapien XT valve (5-7%). Latest-generation devices have reduced the need for PPI, as demonstrated by frequencies between 2.3% and 36.1% (6). This is illustrated by the PPI frequencies reported for different generations. For instance, with the Evolut R, the frequency (14.7-26.7%) is lower compared to the early generation CoreValve device (16.3–37.7%), but is higher than that of the new-generation Sapien 3 device (4-24%). The reported frequency of PPI with ACURATE neo is quite low, around 8.3%, as reported by the study of Möllmann et al., which included 1000 patients (13). In Portico devices, the corresponding frequencies have been reported as 21.9% and 27.7% in two different studies (14, 15). In a recent registry comparing the Myval device with alternative devices, a PPI frequency of 7.4% was described (16).

In our study, PPI was required in 25% of patients with Evolut R, 4% of patients with Edwards Sapien XT, 16% of those with Portico, 26% of those with Medtronic CoreValve, and 20% of those with Myval devices. None of the patients receiving ACURATE neo required PPI. The frequencies reported in our study are compatible with previous data except for the Myval and ACURATE neo devices; however, these devices were used in only 5 and 12 patients, respectively; thus, data is limited in this respect.

The prognostic impact of PPI following TAVI is another point of concern. Unfavorable consequences of PPI following TAVI have been reported in large-scale trials. Undergoing PPI after TAVI has been shown to be associated with a 31% increase in 1-year mortality (17). Additionally, another study by Sharobeem et al. showed that PPI during follow-up was associated with an increased risk of hospitalization for heart failure (18). A recent meta-analysis of 31 studies, including 51,069 TAVI recipients, demonstrated that PPI was associated with a risk of all-cause death and re-hospitalization for heart failure as measured at a mean follow-up duration of 22 months (19). However, in some studies, it was stated that there was no difference between these two groups in terms of mortality, and there is no definite consensus on this issue (20-23). Therefore, it is recommended to conduct more comprehensive studies evaluating the results of long-term follow-up in order to guide

the treatment approach in line with the results. Similar to the conflicting literature, our study also found no significant differences in mortality between patients with and without PPI who had been followed for a median of 52 months. Multiple logistic regression revealed that PPI did not significantly predict long-term mortality after TAVI.

Considering our results together with contemporary literature, we can feasibly suggest that new-generation TAVI devices have reduced PPI requirements. Additionally, our study found that PPI was not associated with all-cause mortality at a median follow-up of 52 months.

This study has some limitations to be mentioned. The retrospective design and extraction of post-discharge mortality data from the National E-Health application rather than outpatient clinic visits are among its primary limitations. Sample size can also be considered relatively small to reach clear conclusions regarding the relationships between new-generation devices and PPI and/or mortality, especially in devices used less frequently. Nevertheless, our relatively long follow-up period provides valuable data concerning the relationship between PPI and mortality.

In conclusion, our results revealed that PPI was required after 20 (15%) of the 132 TAVI procedures performed between June 2016 and January 2021 at our center. When taken together with the literature, our study shows that new-generation TAVI devices may be associated with reduced PPI requirements compared to older-generation devices. Having received a permanent pacemaker was not associated with mortality; however, higher CRP was associated with increased likelihood for all-cause mortality, while having received preoperative valvuloplasty was associated with decreased mortality likelihood among TAVI recipients who were followed up for a median of 52 months.

Conflict of interest

The authors declared no conflict of interest.

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None to declare.

Authors' contributions

Concept: O.O., M.M.C., Design: O.O., M.M.C., Data Collection or Processing: O.O., M.M.C., Analysis or Interpretation: O.O., M.M.C., Literature Search: O.O., M.M.C., Writing: O.O., M.M.C.

Ethical Statement

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Clinical Research Ethics Committee of Haseki Training and Research Hospital (Decision no: 08-2022, Decision date: 19.01.2022).

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