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Article

Clinical Outcomes of Minimally Invasive Aortic Valve Replacement Using Sutureless Perceval Versus St. Jude Bioprosthesis

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Abstract

Background: To compare the clinical outcomes between isolated aortic valve replacement (AVR) using a conventional stented bioprosthetic valve (St. Jude, Epic™ Valve Porcine) and a sutureless bioprosthetic valve (Perceval). **Methods**: This single-center retrospective study evaluated 160 patients who underwent isolated surgical minimally invasive AVR between January 2020 and December 2024. Demographic, intraoperative, and postoperative data, as well as echocardiographic findings, were analyzed and compared. **Results**: Patients were divided into two groups: Perceval (n = 73) and St. Jude (n = 87). Patients in the Perceval group were older and had higher EuroSCORE 2 scores. The Perceval group showed significantly shorter cardiopulmonary bypass and aortic cross-clamp times (53.45 $\pm$ 24.18 vs. 68.02 $\pm$ 21.05 min; $p < 0.001$; and 40 $\pm$ 20.11 vs. 53.24 $\pm$ 17.34 min; $p < 0.001$). The intensive care unit (ICU) stay, intubation time, and hospital discharge time were significantly shorter in the Perceval group ($p < 0.05$). The requirement for inotropic support was also lower (2.8% vs. 24.1%, $p < 0.001$). At the 30-day follow-up, the perceval group had significantly lower mean and maximum transvalvular gradients. Complication rates were low in both groups, with one case of permanent pacemaker implantation and two reinterventions in the Perceval group. **Conclusion**: Sutureless AVR with a Perceval valve is a safe and effective alternative to conventional stented bioprostheses, particularly in elderly patients. It offers shorter operative times and improves early postoperative recovery without compromising the clinical or hemodynamic outcomes.

Keywords: sutureless aortic bioprosthesis; conventional aortic bioprosthesis; Perceval; St. Jude; operation time; cardiopulmonary bypass

1. Introduction

Aortic valve diseases represent one of the most prevalent valvular pathologies, a trend amplified by rising global life expectancy [1,2]. In patients with symptomatic aortic stenosis, mortality escalates dramatically; without intervention, more than 75% succumb within three years of symptom onset [2–4].

Aortic valve replacement (AVR) offers a cornerstone treatment that is achievable via conventional open surgery or transcatheter approaches for severe aortic valve disease. Both modalities are now firmly established to be safe and efficacious, delivering favorable short- and long-term outcomes [5,6].

Within surgical AVR, minimally invasive techniques such as upper mini-sternotomy and right anterior minithoracotomy have emerged as compelling alternatives to traditional full sternotomy for appropriately selected patients. Complementing mechanical and biological prostheses, sutureless bioprosthetic aortic valve grafts (SBAVGs) have increasingly entered clinical practice in recent years [7,8].

The principal benefits of SBAVGs stem from obviating the need for sutures and facilitating swifter and simpler implantation. This, in turn, shortens cardiopulmonary bypass (CPB) and aortic cross-clamp (ACC) times while curtailing overall operative duration [9–11]. Such efficiencies correlate with diminished morbidity and mortality, abbreviated hospital stays, and lower healthcare expenditures [12–15].

By dispensing with sewing rings, sutureless valve implantation enables a broader effective orifice area, potentially yielding superior hemodynamic performance [8].

This study aimed to compare the clinical outcomes of minimally invasive AVR using a conventional stented bioprosthetic valve (St. Jude Epic™ Valve Porcine, Abbott, USA) and a sutureless bioprosthetic valve (Perceval, Corcym, Milan, Italy).

2. Materials and Methods

Patient data, including demographic characteristics, intraoperative details, and postoperative clinical outcomes, were retrospectively collected from our hospital database. The methodology and reporting of this observational study were designed in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. The study was approved by the local ethics committee (Ethics Committee TOBB ETU) and the requirement for informed consent was waived because of its retrospective nature.

In this single-center retrospective study, we collected and compared the clinical, operative, and echocardiographic data of patients who underwent minimally invasive AVR using either the Perceval or St Jude bioprosthesis. Data were obtained from an institutional database of patients who underwent surgical AVR at our clinic between January 2020 and December 2024.

Inclusion Criteria: Elective isolated minimally invasive AVR performed with either the sutureless Perceval bioprosthesis or the conventional St Jude Epic™ Valve Porcine bioprosthesis.

Exclusion Criteria: Emergency or urgent cases, bicuspid aortic valves, anatomical contraindications to the Perceval valve (e.g., aortic root dilatation, endocarditis, hypertrophic cardiomyopathy with left ventricular outflow tract obstruction), and incomplete data.

Patients with an annulus diameter $<$19 mm or $>$27 mm, an inadequate annular calcification, a history of nitinol hypersensitivity, a severe aortic root dilatation or ascending aorta aneurysm, a very low coronary ostia height, and active infective endocarditis are accepted to be contraindicated for Perceval prosthesis [2,7–9].

A total of 166 patients underwent isolated minimally invasive AVR surgery with either the Perceval or St Jude bioprosthesis at the Cardiac Surgery Department of the TOBB ETU Hospital between January 2020 and December 2024. Of these, 73 patients received the sutureless Perceval valve and 93 patients received the conventional St Jude Abbott valve. However, six patients from the St Jude group were excluded due to a lack of data. These numbers reflect only the patients who received one of the two valve types and do not represent the total number of AVR surgeries performed during this period.

Data Collection: Data collected for comparison included demographic characteristics, preoperative laboratory values, preoperative and postoperative transthoracic echocardiography (TTE) values at the 30-day follow-up, intraoperative data (e.g., CPB time, cross-clamp time, valve type, incision type), and postoperative outcomes (e.g., intubation time, intensive care unit (ICU) stay, discharge time, postoperative drainage, complications, and mortality).

Perceval Bioprosthesis Description: The sutureless percutaneous aortic bioprosthesis consists of a bovine pericardium connected to a nitinol stent. The prosthesis was initially compressed using the Perceval Collapser device and then deployed by positioning it on three guide sutures placed in the aortic valve midline. Once the valve is in position, balloon dilation is performed to ensure that the stent fits appropriately into the annulus [8].

Surgical Technique: Each case was meticulously evaluated by the institutional Heart Team, with the final determinations regarding the surgical technique and bioprosthesis selection made by the operating surgeon. All the procedures were conducted by the same experienced cardiac surgery team. Following induction of anesthesia and endotracheal intubation, the patients underwent a standardized median upper ministernotomy and were subsequently placed on cardiopulmonary bypass (CPB) via femoral cannulation. Myocardial protection was ensured through antegrade administration of cold custodiol cardioplegia, supplemented by subsequent antegrade and selective ostial cardioplegia.

A transverse aortotomy was performed approximately 2 cm above the sinotubular junction, specifically for percutaneous prosthesis implantation, whereas an oblique aortotomy was employed for the St. Jude prosthesis. The native aortic valve was excised, and annular calcifications were meticulously debrided. For conventional St. Jude valve implantation, circumferential annular sutures were placed in the standard fashion. In contrast, percutaneous implantation involved placement of three guide sutures. Following prosthesis deployment, balloon dilatation was performed at 4 atm for 30 s, and the implantation site was irrigated with warm saline to facilitate optimal positioning and hemostasis. Intraoperative assessment of the prosthesis was conducted using transesophageal echocardiography (TEE) to confirm proper function and exclude paravalvular leaks.

3. Statistical Analysis

The normality of the quantitative data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests, which confirmed that the data followed a normal distribution. Differences between the groups were evaluated using an independent *t*-test. Numerical data with normal distribution are presented as mean $\pm$ standard deviation (SD). For data that did not follow a normal distribution, values were expressed as medians (interquartile range, IQR). Comparisons between preoperative and postoperative measurements were performed using the Wilcoxon test. Categorical data are presented as frequencies and percentages (n, %), and group comparisons were evaluated using chi-square tests (χ^2). Statistical significance was set at $p < 0.05$. All analyses were conducted using IBM SPSS Statistics 22.0 (IBM Corp. Armonk, New York, USA) software.

In this study, the differences between pre-operative and postoperative left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD), and left ventricular end-systolic diameter (LVESD) values in the St. Jude and Perceval groups were evaluated. For each parameter, the intra-group change (Δ = postoperative mean – pre-operative mean) was assessed using an independent two-sample *t*-test to determine whether it was statistically significant.

4. Results

A total of 166 patients were screened, of whom six were excluded from the study. The final cohort consisted of 160 patients, with 73 (45.62%) undergoing sutureless aortic valve replacement using a Perceval bioprosthesis, and 87

Table 1. Preoperative data.

		n	mean	sd	t	*p*
Age	St Jude	87	63.93	11.83	–3.11	0.002
	Perceval	73	69.30	10.03		
BSA	St Jude	87	1.90	0.31	1.61	0.109
	Perceval	73	1.83	0.24		
EuroSCORE 2 risk score	St Jude	87	7.32	2.23	–2.736	0.007
	Perceval	73	8.27	2.14		

BSA, Body surface area.

Table 2. Preoperative data.

		St Jude		Perceval		*p*
		n	%	n	%	
Sex	Male	61	70.1%	25	34.2%	<0.001
	Female	26	29.9%	48	65.8%	
Diabetes Mellitus	–	69	79.3%	53	72.6%	0.322
	+	18	20.7%	20	27.4%	
Hypertension	–	36	41.4%	9	12.3%	<0.001
	+	51	58.6%	64	87.7%	
COPD	–	83	95.4%	72	98.6%	0.243
	+	4	4.6%	1	1.4%	
CVA	–	85	97.7%	71	97.3%	0.621
	+	2	2.3%	2	2.7%	
CKF	–	80	92.0%	72	98.6%	0.054
	+	7	8.0%	1	1.4%	
Other Diseases	–	64	73.6%	59	80.8%	0.185
	+	23	26.4%	14	19.2%	
Redo procedure	–	77	88.5%	69	94.5%	0.144
	+	10	11.5%	4	5.5%	

COPD, Chronic obstructive pulmonary disease; CFA, Cerebrovascular accident; CFK, Chronic Kidney Failure.

Table 3. Preoperative laboratory data.

		n	mean	sd	t	*p*
Haemoglobin	St Jude	87	13.57	2.13	2.491	0.014
	Perceval	73	12.82	1.60		
Haematocrit	St Jude	87	40.74	5.63	2.244	0.026
	Perceval	73	38.92	4.42		
BUN	St Jude	87	18.91	7.74	–1.042	0.299
	Perceval	72	22.64	32.26		
Creatinine	St Jude	87	1.02	0.46	1.583	0.115
	Perceval	73	0.92	0.29		
AST	St Jude	87	18.20	9.02	–0.235	0.814
	Perceval	72	18.50	6.90		
ALT	St Jude	87	18.78	14.36	0.783	0.435
	Perceval	73	17.27	8.75		
LDH	St Jude	87	200.94	45.17	–1.662	0.099
	Perceval	71	217.48	78.24		

BUN, Blood urea nitrogen; AST, Aspartate transaminase; ALT, Alanine transaminase; LDH, Lactate dehydrogenase.

Table 4. Preoperative transthoracic echocardiography data.

		n	mean	sd	t	*p*
LVEF	St Jude	87	54.08	10.31	–2.242	0.0261
	Perceval	73	57.36	7.67		
Aortic root	St Jude	34	31.71	7.30	0.143	0.8869
	Perceval	9	31.33	5.43		
LA diameter	St Jude	87	44.03	6.95	1.574	0.1182
	Perceval	47	42.17	5.72		
LVEDD	St Jude	87	54.18	7.77	3.668	0.0001
	Perceval	48	49.33	6.53		
LVESD	St Jude	87	38.39	7.87	2.957	0.0044
	Perceval	44	34.23	7.07		

LVEF, Left ventricular ejection fraction; LA, Left atrium; LVEDD, Left ventricular end-diastolic diameter; LVESD, Left ventricular end-systolic diameter.

(54.38%) undergoing conventional AVR with a St. Jude (Epic™ Valve Porcine) bioprosthesis.

The mean age was significantly higher in the Perceval group (69.3 ± 10.03 years) than in the St. Jude group (63.93 ± 11.83 years; $p = 0.003$). Regarding sex distribution, 70.4% of the patients in the St. Jude group were male, whereas the Perceval group comprised 65.8% female patients. The mean EuroSCORE 2 was significantly higher in the Perceval group (8.27 ± 2.14 vs. 7.32 ± 2.23; $p = 0.007$). Body Surface Area (BSA) values were comparable between groups (1.9 ± 0.21 in Perceval vs. 1.83 ± 0.24 in St. Jude; $p = 0.135$). Valve type was significantly associated with sex, arrhythmia, hypertension, and dyspnea ($p < 0.05$) (Tables 1,2).

In laboratory parameters, hemoglobin (Hgb) and hematocrit (Hct) levels were significantly lower in the Perceval group (Hgb: 12.82 ± 1.6 vs. 13.57 ± 2.13, $p = 0.014$; Hct: 38.92 ± 4.42 vs. 40.74 ± 5.63, $p = 0.026$) (Table 3).

Preoperative TTE assessments revealed that the Perceval group had a higher mean LVEF (57.36 ± 7.67 vs. 54.08 ± 10.31; $p = 0.026$), while the St. Jude group had significantly larger LVEDD and LVESD values (LVEDD: 54.18 ± 7.77 vs. 49.33 ± 6.53, $p < 0.0001$; LVESD: 38.39 ± 7.87 vs. 34.23 ± 7.07, $p = 0.04$) (Table 4).

Intraoperatively, both cross-clamp time and CPB time were significantly longer in the St. Jude group than in the Perceval group (Cross-clamp: 53.24 ± 17.34 vs. 40 ±

Table 5. Intraoperative data.

Group		n	mean	sd	t	*p*
Total cross clamp time	St Jude	87	53.24	17.34	4.417	<0.001
	Perceval	73	40.16	20.11		
Total CPB time	St Jude	87	68.02	21.05	4.075	<0.001
	Perceval	73	53.45	24.18		

CPB, Cardiopulmonary bypass.

20.11; CPB: 68.02 ± 21.05 vs. 53.45 ± 24.18; $p < 0.001$ for both) (Table 5).

Postoperative analyses showed significantly longer discharge times, ICU stays, and intubation durations in the St. Jude group. Intubation time was 17.36 ± 10.08 hours in the St. Jude group vs. 11.9 ± 5.84 hours in the Perceval group ($p < 0.001$), and ICU stay was 7.64 ± 3.32 days vs. 5.47 ± 2.86 days, respectively ($p = 0.036$). Although the number of patients requiring ICU stay >4 days was higher in the St. Jude group (n = 6) than in the Perceval group (n = 3), the difference was not statistically significant ($p = 0.125$). The Postoperative drainage volumes were also similar ($p = 0.124$). However, the requirement for early inotropic support was significantly more common in the St. Jude group (24.1% vs. 2.8%, $p < 0.001$) (Tables 6,7).

On postoperative day 30, TTE evaluation revealed significantly lower transvalvular gradients in the perceval group. Maximal gradient was 24.22 ± 10.29 mmHg in the Perceval group vs. 29.52 ± 12.74 mmHg in the St. Jude group ($p = 0.0053$); mean gradient was 10.94 ± 4.83 mmHg vs. 14.20 ± 735 mmHg, respectively ($p = 0.0016$). LVEF, LVEDD, and LVESD were also statistically significant; however, according to the preoperative echocardiographic data, they were similar (Table 8).

On postoperative day 180, TTE evaluation was performed, and the results were quite similar to those on postoperative day 30. Maximal gradient was 23.88 ± 10.58 mmHg in the Perceval group vs. 29.27 ± 12.12 mmHg in the St. Jude group ($p = 0.0033$); mean gradient was 10.58 ± 4.52 mmHg vs. 14.10 ± 6.93 mmHg, respectively ($p = 0.0004$). LVEF, LVEDD, and LVESD were also statistically significant; however, according to the preoperative echocardiographic data, they were similar (Table 9).

Preoperative and postoperative day 30th and 180th day TEE LVEDD, LVESD, and LVEF results were statistically meaningful in favor of the Perceval group. Positive progress was observed in these parameters postoperatively. However, this progress was not statistically significant ($p > 0.88$) (Table 10).

Permanent pacemaker implantation was not required in the St. Jude group. In the Perceval group, one patient received a permanent pacemaker on postoperative day 9. Another patient in the Perceval group presented with pericardial effusion on postoperative day 27 and was found to have moderate aortic insufficiency on echocardiography; reoperation with a St. Jude valve was performed. Paravalvular leak was observed in one patient in the Perceval group at 2 months postoperatively and was surgically repaired.

5. Discussion

Minimally invasive surgical or percutaneous approaches significantly enhance patient comfort, particularly in older patients with comorbidities. The AVR procedure, which is performed through an upper median ministernotomy instead of a full sternotomy, results in reduced pain, faster recovery, and fewer postoperative complications. Furthermore, the TAVI technique allows for valve replacement without general anesthesia, enabling discharge as early as the first postoperative day.

Among the main findings of this study, the CPB and cross-clamping times in the Perceval group were significantly reduced, as expected. The sutureless valve technique offers notable advantages, particularly because valve sutures are not required, making it easier to apply. In addition, the repositioning process is more straightforward in the case of improper seating, thus reducing the cross-clamping and CPB times. For these reasons, sutureless AVR with Perceval bioprosthesis has become a preferred option, especially in elderly patients with more comorbidities, as previously reported in the literature [8,11,14,16–19].

However, certain complications, such as incomplete removal of annular calcifications, failure to select the appropriate valve size, or inverted leaflet formation, can lead to severe paravalvular leaks or prosthesis migration after Perceval implantation [20,21]. In the present study, no instances of prosthesis migration or displacement were observed. On the other hand, central aortic regurgitation (AR) was detected in one patient in the Perceval group at the first postoperative month, requiring replacement with a St. Jude (Epic™ Valve Porcine) biological aortic valve graft. Additionally, a paravalvular leak was identified in another patient in the second postoperative month, which was subsequently surgically repaired. Both patients were discharged early without any further complications, indicating that such complications can be effectively managed with timely intervention.

The issue of postoperative permanent pacemaker (PM) implantation after sutureless AVR, particularly with the Perceval valve, has been discussed in previous studies, with reports of higher pacemaker implantation rates. The primary reasons for this include preoperative arrhythmias, calcified orifices, and the size of the resected area [22,23]. Nevertheless, with appropriate surgical techniques and implantation in experienced centers, the risk of this complication can be minimized. In our study, a permanent pacemaker was not required in the St. Jude group, while only one patient in the Perceval group required internal pacemaker implantation, which was performed on the 9th postoperative day before discharge. This finding suggests that while the risk of pacemaker implantation remains a concern

Table 6. Postoperative data.

		St Jude		Perceval		*p*
		n	%	n	%	
Positive inotropic drug support	–	66	75.9%	71	97.2%	<0.001
	+	21	24.1%	2	2.8%	
IABP	–	87	100.0%	73	100.0%	-
Recurrent Hospitalisation	–	87	100.0%	70	95.8%	0.091
	+	0	0.0%	3	4.2%	
Hemodialysis	–	85	97.7%	73	100.0%	0.298
	+	2	2.3%	0	0.0%	
CFA and Pulmonary Emboli	–	87	100.0%	73	100.0%	-
Endocarditis	–	86	98.9%	73	100.0%	0.547
	+	1	1.1%	0	0.0%	
Reintervention due to valve dysfunction	–	85	97.7%	71	97.2%	0.621
	+	2	2.3%	2	2.8%	
Mortality	–	84	96.6%	72	100.0%	0.161
	+	3	3.4%	0	0.0%	
Intensive Care Stay Time	1	73	83.9%	65	90.3%	0.125
	2	3	3.4%	4	5.6%	
	3	5	5.7%	3	4.2%	
	≥4	6	6.9%	0	0.0%	

IABP, Intraaortic balloon pump; CFA, Cerebrovascular accident.

Table 7. Postoperative data.

		n	mean	sd	t	*p*
Drainage (12 hours)	St Jude	87	276.44	126.41	–0.850	0.124
	Perceval	68	272.79	1116.31		
Departure time	St Jude	87	7.64	3.32	2.113	0.036
	Perceval	72	5.47	2.86		
Intubation time	St Jude	85	17.36	10.08	4.062	<0.001
	Perceval	72	11.90	5.84		

Table 8. Postoperative 30th day TTE data.

		n	mean	sd	25th Percentile	75th Percentile	t	*p*
LVEF	St Jude	84	51.95	10.82	50.00	60.00	–3.88	0.0002
	Perceval	72	57.61	6.46	56.75	60.00		
Max gradient	St Jude	84	29.52	12.74	21.00	33.25	2.98	0.0053
	Perceval	72	24.22	10.29	17.00	28.25		
Mean gradient	St Jude	84	14.20	7.35	10.00	16.00	3.21	0.0016
	Perceval	72	10.94	4.83	7.00	13.00		
LVEDD	St Jude	84	51.06	6.55	48.00	52.25	3.59	0.0004
	Perceval	72	47.47	4.55	45.00	50.00		
LVESD	St Jude	84	37.13	7.32	32.00	38.00	4.05	0.0001
	Perceval	72	32.82	3.68	31.75	34.00		

TTE, transthoracic echocardiography; LVEF, Left ventricular ejection fraction; LVEDD, Left ventricular end-diastolic diameter; LVESD, Left ventricular end-systolic diameter.

with sutureless valves, it can be mitigated by careful surgical practice.

Long intubation periods, particularly in elderly patients with multiple comorbidities, can complicate the weaning process and contribute to various nosocomial infections such as pneumonia, endocarditis, and wound infections. Prolonged antibiotic use may also lead to organ dysfunction, including liver and kidney failure, further exacerbating the postoperative complications. The need for positive inotropic support and the potential for arrhythmias and hemodynamic disturbances increase both morbidity and mortality. Additionally, extended hospital stays im-

Table 9. Postoperative 180th day TTE data.

		n	mean	sd	25th Percentile	75th Percentile	t	*p*
LVEF	St Jude	84	51.90	10.81	50.00	60.00	–4.13	0.0001
	Perceval	72	57.77	6.55	56.75	60.00		
Max gradient	St Jude	84	29.27	12.12	21.00	33.25	2.98	0.0033
	Perceval	72	23.88	10.58	16.75	28.25		
Mean gradient	St Jude	84	14.10	6.93	10.00	16.00	3.61	0.0004
	Perceval	72	10.58	4.52	7.00	12.00		
LVEDD	St Jude	84	50.98	6.96	48.00	52.25	3.44	0.0007
	Perceval	72	47.56	4.57	45.00	50.00		
LVESD	St Jude	84	37.04	7.45	32.00	38.00	4.04	0.0001
	Perceval	72	32.86	3.85	31.75	34.00		

TTE, Transthoracic echocardiography; LVEF, Left ventricular ejection fraction; LVEDD, Left ventricular end-diastolic diameter; LVESD, Left ventricular end-systolic diameter.

Table 10. Preoperative and postoperative day 180 TTE data progress comparison.

Group	Parameter	Δ (Post - Pre)	t	*p*
St. Jude	LVEF	–0.05	–0.0300	0.9761
St. Jude	LVEDD	–0.06	–0.0562	0.9552
St. Jude	LVESD	–0.09	–0.0790	0.9371
Perceval	LVEF	+0.16	+0.1481	0.8825
Perceval	LVEDD	+0.09	+0.1188	0.9056
Perceval	LVESD	+0.04	+0.0639	0.9491

TTE, Transthoracic echocardiography; LVEF, Left ventricular ejection fraction; LVEDD, Left ventricular end-diastolic diameter; LVESD, Left ventricular end-systolic diameter.

pose financial burdens on healthcare institutions due to increased costs [24–26]. In our study, when comparing intensive care unit (ICU) stay, intubation duration, and discharge times, the Perceval group demonstrated better outcomes despite the higher EuroSCORE 2 risk score and average age. This suggests that the sutureless valve technique contributes to faster recovery and fewer complications even in high-risk patients. In contrast, the St. Jude group had longer ICU stays, more extended intubation periods, and a greater need for positive inotropic support postoperatively.

At 30 and 180 days postoperatively, the TTE evaluations demonstrated significant differences between the two groups with respect to the maximum and mean prosthetic valve gradients. The Perceval group exhibited significantly lower gradient values than the St. Jude group, a finding consistent with previous reports suggesting that sutureless valves provide superior hemodynamic performance. Such reductions in transvalvular gradients may positively influence the long-term clinical outcomes and contribute to the extended functional lifespan of biological valves. Analysis of the preoperative TTE data revealed statistically significant differences in LVEF, LVESD, and LVEDD parameters within the St. Jude group. Although slight improvements in these parameters were observed at both 30 and 180 days postoperatively, the changes were not statistically significant. Therefore, longer follow-up periods are warranted to obtain more reliable insights into ventricular remodeling and functional recovery.

Unlike prior comparative studies that primarily evaluated sutureless valves within heterogeneous cohorts or mixed access approaches, our analysis focuses exclusively on isolated minimally invasive AVR, thereby providing a more homogeneous comparison of Perceval versus conventional stented bioprostheses. These findings enrich the existing literature by demonstrating that the operative and early hemodynamic advantages of the Perceval valve persist even when both prostheses are implanted through the same standardized minimally invasive technique.

6. Study Limitations

This study had several limitations that warrant consideration. First, its retrospective design may introduce selection bias, as the choice of valve type was determined by the surgical team and potentially influenced by patient characteristics or surgeon preference. Second, the sample size, which is adequate for detecting significant differences in operative times and early outcomes, may be underpowered to detect subtle differences in long-term clinical or hemodynamic outcomes, particularly for rare complications, such as paravalvular leaks or permanent pacemaker implantation. Third, the lack of individual patient-level paired data precluded the use of a paired *t*-test for pre- and postoperative echocardiographic comparisons, leading to the use of a more conservative independent two-sample *t*-test, which may have reduced the sensitivity of detecting statistically significant changes in LVEF, LVEDD, and LVESD. Fourth, the follow-up period was limited to 180 days, which may be insufficient to fully evaluate the long-term valve durability, ventricular remodeling, or late complications. Fifth, the study was conducted at a single center, which potentially limits the generalizability of the findings to other institutions with varying surgical expertise or patient populations. Finally, preoperative differences in patient characteristics, such as age and EuroSCORE 2 scores, may have influ-

enced the outcomes despite statistical adjustments. Future multicenter prospective studies with larger cohorts, longer follow-up periods, and paired statistical analyses are recommended to validate these findings and to further elucidate the long-term benefits of sutureless versus conventional bioprosthetic valves.

7. Conclusion

This study demonstrates that minimally invasive aortic valve replacement (AVR) using the Perceval sutureless bioprosthetic valve significantly reduces cardiopulmonary bypass (CPB) and aortic cross-clamp (ACC) times compared with the conventional St. Jude stented bioprosthetic valve. These operative advantages translate into shorter intubation durations, reduced intensive care unit (ICU) stays, and faster hospital discharge times, particularly in higher-risk elderly patients with elevated EuroSCORE 2 scores. Postoperative transthoracic echocardiography (TTE) at 30 and 180 days revealed significantly lower transvalvular gradients in the perceval group, suggesting superior hemodynamic performance, which may contribute to improved long-term clinical outcomes and extended bioprosthetic valve durability. Although both valve types exhibited comparable morbidity and mortality rates, the Perceval group required less inotropic support, underscoring its potential for enhanced early recovery. However, slight improvements in the left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD), and left ventricular end-systolic diameter (LVESD) observed postoperatively were not statistically significant, indicating the need for long-term follow-up to comprehensively assess ventricular remodeling and functional recovery. These findings support the Perceval sutureless valve as a safe and effective alternative to conventional stented bioprostheses in appropriately selected patients, particularly those who benefit from reduced operative times and optimized hemodynamic outcomes.

Availability of Data and Materials

The de-identified participant data, including individual metadata and a data dictionary, are openly available in the Zenodo repository at https://doi.org/10.5281/zenodo.18088460. These data correspond to the clinical findings and laboratory results reported in this study.

Author Contributions

KA contributed substantially to the conception and design of the study, participated in data acquisition and interpretation, drafted the manuscript, and critically revised it for important intellectual content. BK was responsible for data collection, performed the statistical analyses, contributed to data interpretation, and assisted in critical manuscript revisions. BEO made significant contributions to the conception and design of the study, participated in the interpretation of findings, and critically revised the manuscript. TA contributed to the study's conception and design, provided expert interpretation of the results, and critically revised the manuscript for essential intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The investigation is officially registered, adheres to the stipulations outlined in the Declaration of Helsinki (revised in 2013), and the study was approved by the Ethics Committee TOBB ETU (KAEK-25 28.05.2025). Due to its retrospective nature, the requirement for informed consent was waived.

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Conflict of Interest

The authors declare no conflict of interest.

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