Journal Pre-proof

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PII: S1936-8798(22)01710-1

DOI: https://doi.org/10.1016/j.jcin.2022.08.057

Reference: JCIN 6564

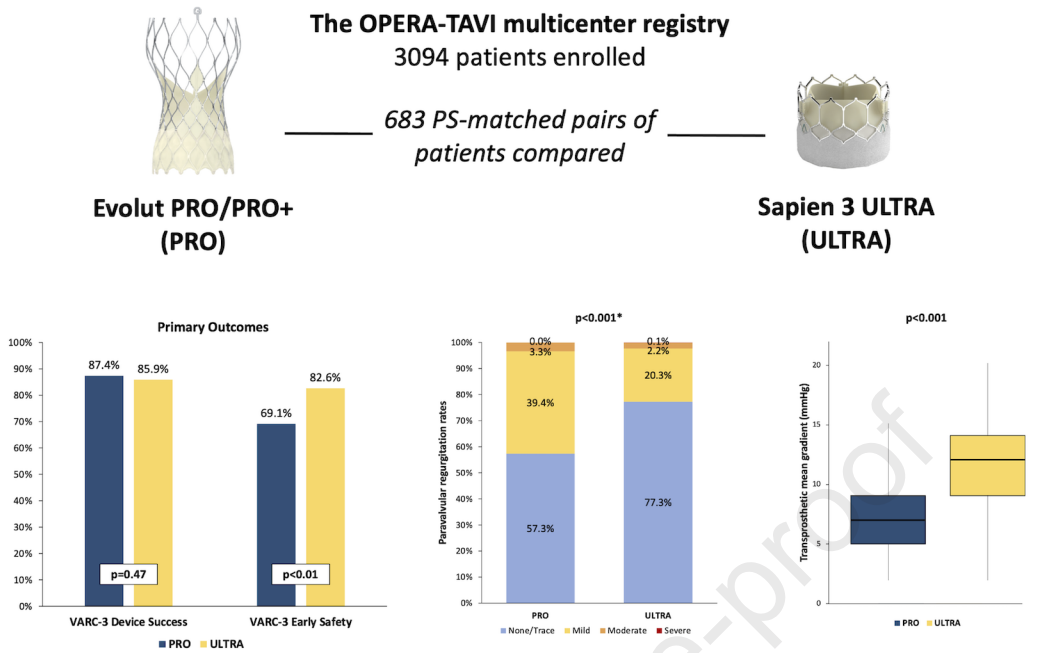
To appear in: *JACC: Cardiovascular Interventions*

Received Date: 6 July 2022

Revised Date: 25 August 2022

Accepted Date: 30 August 2022

Please cite this article as: Costa G, Saia F, Pilgrim T, Abdel-Wahab M, Garot P, Valvo R, Gandolfo C, Branca L, Latib A, Santos IA, Mylotte D, De Marco F, De Backer O, Franco LN, Akodad M, Mazzapicchi A, Tomii D, Laforgia P, Cannata S, Fiorina C, Scotti A, Lunardi M, Poletti E, Mazzucca M, Quagliana A, Hennessey B, Meier D, Adamo M, Sgroi C, Reddavid CM, Strazzieri O, Motta SC, Frittitta V, Dipietro E, Comis A, Melfa C, Thiele H, Webb JG, Sondergaard L, Tamburino C, Barbanti M, Transcatheter Aortic Valve Replacement with the Latest-Iteration Self-Expanding or Balloon-Expandable Valves: The Multicenter OPERA-TAVI Registry, *JACC: Cardiovascular Interventions* (2022), doi: https://doi.org/10.1016/j.jcin.2022.08.057.



Transcatheter Aortic Valve Replacement with the Latest-Iteration Self-Expanding or Balloon-Expandable Valves: The Multicenter OPERA-TAVI Registry

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Running title: TAVR with Latest Iteration SE or BE Valves

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Dr De Backer has received institutional research grants and/or consulting fees from Abbott and Boston Scientific.

Dr Meier is supported by the Swiss National Science Foundation (grant P2LAP3_199561).

Dr Akodad has reported receiving research funding from Medtronic, Biotronik, MUSE-Explore, Villa M, and Federation Française de Cardiologie.

Dr Sondergaard has received consultant fees and/or institutional research grants from Abbott, Boston Scientific, Medtronic, and SMT.

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Dr Abdel-Wahab has reported that his institution received speaker's honoraria and/or consultancy fees on his behalf from Boston Scientific and Medtronic.

All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ABSTRACT

Background. The latest iterations of devices for transcatheter aortic valve replacement (TAVR) have brought refinements to further improve patient outcomes.

Objectives. This study sought to compare early outcomes of patients undergoing TAVR with the self-expanding (SE) Evolut PRO/PRO+ or balloon-expandable (BE) Sapien 3 ULTRA devices.

Methods. The OPERA-TAVI registry collected data from 14 high-volume centers worldwide on patients undergoing TAVR with SE or BE devices. After excluding patients who were not eligible to both devices, patients were compared using 1:1 propensity score matching. The primary efficacy and safety outcomes were VARC-3 device success and early safety, respectively.

Results. Among 2,241 patients eligible for the present analysis, 683 pairs of patients were matched. The primary efficacy outcome did not differ between patients receiving SE or BE transcatheter aortic valves (SE: 87.4% vs BE: 85.9%; $P = 0.47$), but BE device recipients showed a higher rate of the primary safety outcome (SE: 69.1% vs BE: 82.6%; $P < 0.01$). This finding was driven by the higher rates of permanent pacemaker implantation (PPI) (SE: 17.9% vs BE: 10.1%; $P < 0.01$) and disabling stroke (SE: 2.3% vs BE: 0.7%; $P = 0.03$) in SE device recipients. On post-TAVR echocardiography, the rate of moderate-to-severe paravalvular regurgitation was similar between groups (SE: 3.2% vs BE: 2.3%; $P = 0.41$), whereas lower mean transvalvular gradients were observed in the SE cohort (median SE: 7.0 vs BE: 12.0 mm Hg; $P < 0.01$).

Conclusions. The OPERA-TAVI registry showed that SE and BE devices had comparable VARC-3 device success rates, but the BE device had a higher rate of early safety. The higher PPI and disabling stroke rates in SE device recipients drove this composite endpoint.

KEY WORDS: TAVR, VARC-3, comparison, outcomes, Self-expanding, Balloon-expandable

CONDENSED ABSTRACT

OPERA-TAVI collected data from 14 high-volume centers worldwide on patients undergoing transcatheter aortic valve replacement (TAVR) with the self-expanding (SE) Evolut PRO/PRO+ or balloon-expandable (BE) Sapien 3 ULTRA devices. Among 2,241 eligible patients, 1:1 propensity

score matching was used to compare 683 pairs. VARC-3 device success rates were comparable, but the BE device had a higher rate of VARC-3 early safety, driven by higher rates of permanent pacemaker implantation and disabling stroke in SE device recipients. On post-TAVR echocardiography, moderate-to-severe paravalvular regurgitation rates were similar between groups, whereas lower mean transvalvular gradients were observed in the SE device cohort.

ABBREVIATIONS AND ACRONYMS

AS:	Aortic Stenosis
BE:	Balloon-expandable
CT:	Computed Tomography
LVOT:	Left Ventricular Outflow Tract
PPI:	Permanent Pacemaker Implantation
PSM:	Propensity Score Matching
PVR:	ParaValvular Regurgitation
SE:	Self-expanding
TAVR:	Transcatheter Aortic Valve Replacement
VARC:	Valve Academic Research Consortium

INTRODUCTION

Transcatheter aortic valve replacement (TAVR) has rapidly become a valuable alternative for patients affected by symptomatic, severe aortic stenosis (AS) with different surgical risk profiles (1,2). Technical advancements and increased operator experience have played an important role in outcome improvements over the past decade (3). The 2 most used transcatheter aortic valves (TAVs) worldwide are the self-expanding (SE) and the balloon-expandable (BE) platforms. In recent years, these 2 platforms have undergone remarkable changes aimed at improving the safety and efficacy of the procedure. Comparative analyses of previous generations of these devices are available (4–8). However, to date the latest iterations, the SE Evolut PRO and PRO+ (Medtronic Inc), the latter including a pericardial wrap to reduce paravalvular regurgitation (PVR), and the BE Sapien 3 ULTRA (Edwards Lifescience), have not been compared.

The aim of this international, multicenter registry was to compare the early effectiveness of SE and BE TAVR devices in a real-world practice, using the updated endpoint definitions of the Valve Academic Research Consortium (VARC)-3 criteria.

METHODS

REGISTRY DESIGN. OPERA-TAVI (Comparative Analysis of EvOlut PRO vs SapiEn 3 UltRa VAlves for Transfemoral Transcatheter Aortic Valve Implantation) is an investigator-initiated registry designed to collect data from patients undergoing transfemoral TAVR with SE or BE devices. Fourteen centers from Europe and North America contributed patient level data using a dedicated case report form (**Supplement**). Baseline demographics, clinical and echocardiographic features, preprocedural computed tomography (CT) characteristics, TAVR procedural details and follow-up data was collected by the coinvestigators at each institution. All inconsistencies were resolved directly by communication with the local investigators.

The registry protocol was approved by the local institutional review board, as required by each participating center.

DEFINITIONS. All outcomes were defined according to the VARC-3 definitions (9).

Technical success was defined as 1) freedom from mortality; 2) successful access, delivery of the device, and retrieval of the delivery system; 3) correct positioning of a single prosthetic heart valve into the proper anatomical location; and 4) freedom from surgery or intervention related to the device or to a major vascular or access-related, or cardiac structural complication at exit from the procedure room.

Device success was defined as 1) technical success; 2) 30-day freedom from mortality; 3) 30-day freedom from surgery or intervention related to the device or to a major vascular, or access-related, or cardiac structural complication; and 4) intended performance of the valve (mean gradient <20 mm Hg, peak velocity <3 m/s, Doppler velocity index ≥0.25 and less than moderate aortic regurgitation.

Early safety was defined as 1) freedom from all-cause mortality; 2) freedom from all stroke; 3) freedom from VARC type 2-4 bleeding; 4) freedom from major vascular, access-related, or cardiac structural complications; 5) freedom from acute kidney injury stage 3 or 4; 6) freedom from moderate or severe aortic regurgitation; 7) freedom from permanent pacemaker implantation (PPI) due to procedure-related conduction abnormalities; and 8) freedom from surgery or intervention related to the device at 30 days.

REGISTRY OUTCOMES. The primary efficacy outcome of the study was 30-day device success. The primary safety outcome was 30-day early safety. Secondary outcomes included technical success, 30-day clinical outcomes, and VARC-3 echocardiographic device performance.

STATISTICAL ANALYSIS. Categorical variables are reported as counts and percentages. Continuous variables are reported as medians and interquartile ranges (IQRs). Continuous variables were compared with the Student's *t*-test or Mann-Whitney *U* test for paired samples, and categorical variables were compared with chi-square statistics or using Fischer's exact test for paired samples, as appropriate.

To account for the nonrandomized design of our study, adjustment with propensity score matching (PSM) was used. The propensity score was estimated using a logistic regression model according to a nonparsimonious approach.

Variables included in the PSM were sex, age, body mass index, diabetes, hypertension, peripheral artery disease, chronic obstructive pulmonary disease, renal failure (defined as estimated glomerular filtration rate < 30 mL/min/1.73 m^2), prior coronary artery bypass grafting, prior myocardial infarction (MI), prior stroke, prior pacemaker implantation, New York Heart Association classification, coronary artery disease, atrial fibrillation, baseline right bundle branch block, Society of Thoracic Surgeons (STS) mortality score, left ventricle ejection fraction, transaortic mean gradient, as well as leaflet and left ventricular outflow tract (LVOT) calcification, bicuspid aortic valve, horizontal aorta, and area/perimeter-derived aortic annulus diameter <23 mm, assessed at the preprocedural CT analysis (**Supplemental Figure 1**). One-to-one PSM with the nearest neighbor method with a caliper width of 0.1, the standard deviation of propensity score logit, was used.

Five subgroups of patients were prespecified according to key anatomical characteristics found at the preprocedural CT assessment: moderate-to-severe aortic leaflets calcifications, moderate-to-severe LVOT calcifications, area/perimeter-derived aortic annulus diameter <23 mm, horizontal aorta (defined as an angle between the horizontal plane and the aortic annulus ≥48°) and bicuspid aortic valve. The prespecified subgroups were tested for interaction considering primary and coprimary outcomes.

A sensitivity analysis for echocardiographic results was performed excluding those patients who's in-hospital data was used instead of 30-day data.

All statistical tests were performed 2-tailed, and a *P* value <0.05 was considered the threshold for statistical significance (*P* value <0.10 was the threshold for interaction tests). All statistical analyses were performed with R software version 3.6.3 (R Foundation for Statistical Computing).

RESULTS

POPULATION. A total of 3,094 patients treated from September 2017 to January 2022 were enrolled in the OPERA-TAVI registry. From the overall population, we excluded patients without available preprocedural CT data and those without follow-up data after discharge. For the purpose of the present analysis, we also excluded patients who were not eligible to receive both SE or BE devices indifferently according to the manufacturers' instructions for annular dimensions and for valve-in-valve procedures. A total of 2,241 patients receiving SE (n = 1,329, 59.3%) or BE (n = 912, 40.7%) devices with complete 30-day follow-ups were included (**Figure 1**).

After PSM, 683 matched pairs of patients receiving SE or BE devices were compared. The matched population had a median age of 81.9 years and a median STS Mortality score of 3.3%. All clinical baseline characteristics of the 2 matched groups were well-balanced after adjustment, with all standardized mean differences below 10%. Baseline characteristics of the matched and unmatched population are reported in **Table 1 and Supplemental Table 1**, respectively.

On preprocedural CT, patients receiving the SE device had larger annular dimensions (perimeter 73.9 mm for SE vs 74.9 mm for BE; $P < 0.01$), whereas SE recipients had smaller sinotubular junction (STJ) dimensions (mean diameter 28.0 mm for SE vs 28.9 mm for BE; $P < 0.01$). Aortic root CT details are reported in **Table 2**.

PROCEDURAL DETAILS. Details of TAVR procedure in the 2 matched groups are reported in **Table 3**.

Patients receiving SE devices had greater valve oversizing (perimeter oversizing18.9% for SE vs 2.4% for BE; $P < 0.01$) and higher rates of predilatation (SE: 45.6% vs BE 27.9%; $P < 0.01$) and postdilatation (SE: 29.2% vs BE: 3.9%; $P < 0.01$). The majority of the procedures were performed under local anesthesia (93.4%), with no differences between groups.

REGISTRY OUTCOMES. The primary efficacy outcome was similar between the SE and BE devices (SE: 87.4% vs BE: 85.9%; $P = 0.47$). The primary safety outcome significantly differed between groups (SE: 69.1% vs BE: 82.6%; $P < 0.01$) (**Central Illustration**).

Among secondary outcomes, technical success was achieved in a higher proportion of patients receiving the BE device (SE: 93.1% vs BE: 97.2%; $P = 0.01$). At 30 days, similar rates of all-cause death (SE: 1.9% vs BE: 1.3%; $P = 0.52$), nondisabling stroke (SE: 1.6% vs BE: 0.4%; $P = 0.06$), MI (SE: 0.3% vs BE: 0.0%; $P = 0.50$) and rehospitalization for heart failure (SE: 0.9% vs BE: 0.9%; $P = 1.00$) were reported, but SE patients had more disabling strokes (SE: 2.3% vs BE: 0.7%; $P = 0.03$) and PPI (SE: 17.9% vs BE: 10.1%; $P < 0.01$).

On post-TAVR echocardiography, SE devices had lower transvalvular mean gradients (median: 7.0 mm Hg for SE vs 12.0 mm Hg for BE; $P < 0.01$) with lower rates of a mean gradient higher than 20 mm Hg (SE: 1.0% vs BE: 8.3%; $P < 0.01$), whereas BE devices had lower rates of any grade of PVR (SE: 42.7% vs BE: 22.5%; $P < 0.01$), but similar moderate-to-severe PVR rates (SE: 3.2% vs BE: 2.3%, $P = 0.41$) (**Central Illustration)**. Primary and secondary outcomes are reported in **Table 4**. In-hospital outcomes are reported in **Supplemental Table 2**. Key characteristics of patients with moderate-to-severe PVR after TAVR and those of SE recipients experiencing disabling stroke are reported in **Supplemental Tables 3 and 4**, respectively.

SUBGROUP ANALYSIS. The primary efficacy and safety outcomes were analyzed in 5 prespecified subgroups.

The equipoise of the primary efficacy outcome between the 2 study groups was consistent in all subgroups of patients (all $P_{\text{interaction}} > 0.10$). The primary safety outcome was consistent with the main analysis in patients with small annuli ($P_{\text{interaction}} = 0.27$), whereas significant interactions were observed in patients with a horizontal aorta (SE: 63.9% vs BE: 73.4%; $P = 0.15$; $P_{\text{interaction}} = 0.07$) and in those with moderate-to-severe LVOT calcification (SE: 69.4% vs BE: 69.1%; $P = 1.00$; $P_{\text{interaction}} = 0.04$). In patients with bicuspid aortic valve, early safety was similar between study groups (SE: 75.5% vs BE: 79.6%; $P = 0.64$), but no significant interaction was detected ($P = 0.27$). Finally, in patients with moderate-to-severe leaflet calcification, a significant interaction in early safety was detected, but the difference favoring the BE device was maintained (SE: 71.5% vs BE: 81.0%; $P < 0.01$, $P_{\text{interaction}} = 0.03$).

Subgroup analyses are reported in **Table 5** and **Supplemental Figure 2**.

DISCUSSION

Over the past decade, different studies have compared TAVR devices, aiming to investigate the potential benefit of using a specific device type (5,8,10–13). The most used TAVR platforms are the SE and the BE devices. First- and second-generation devices of these 2 TAVR platforms have been largely compared, but a head-to-head comparison between the 2 latest iterations is still lacking. The principal aim of the OPERA-TAVI registry was to compare the effectiveness of the SE and BE devices in real-world practice using the latest VARC-3 updated consensus endpoint definitions.

The main findings of this analysis were: 1) SE and BE valves showed high and comparable rates of device success; 2) The SE device had a lower rate of early safety, mainly due to higher rates of PPI and stroke; 3) Device success was consistent across all prespecified subtypes of aortic anatomies, whereas early safety differed in patients with moderate/severe LVOT calcification or a horizontal aorta; 4) Echocardiographic performance substantially confirmed the characteristics of the 2 platforms seen in previous comparisons, with lower transprosthetic gradients for the SE device and lower PVR rates for the BE device, although with similar moderate-to-severe PVR rates.
The SOLVE-TAVI RCT showed that differences in device success have been decreased in the second-generation SE and BE transcatheter valve families (5). Indeed, the first-generation SE CoreValve previously showed lower device success compared to Sapien XT in the CHOICE trial (77.5% vs 95.9%), whereas Evolut R compared favorably to Sapien 3 in the SOLVE-TAVI trial (93.6% vs 91.0%) (4,5).

In the OPERA-TAVI registry, the latest iterations of these 2 TAVR platforms confirmed comparable rates of device success (87.4% vs 85.9%) in an unselected population of TAVR candidates.

These results supported the good performance of the 2 platforms in real-world practice, even though a higher technical success at the exit of the operating room was reported in the BE group due to the lower rate of major vascular complications (SE: 5.4% vs BE: 1.9%).

Despite comparable device success, VARC-3 early safety significantly favored BE devices in our analysis (SE: 69.1% vs BE: 82.6%). This outcome was mainly driven by the higher rates of PPI and disabling stroke at 30 days reported in the SE group. Even though the OPERA-TAVI registry included recent patients treated in high-volume centers, the overall PPI rates reported in our registry are in line with those reported in previous series. It should be acknowledged that lower PPI rates following SE valve implantation have been recently reported by optimizing implantation depth by systematic use of the cusp-overlap view for valve deployment (14,15). Indeed, this technique helps to achieve greater implantation depth, minimizing the contact zone between the device frame and the cardiac conduction system located in the LVOT. Of note, recent observations showed that a higher implantation of supra-annular TAVR devices is correlated to an increased risk of coronary access impairment following TAVR and of sinus sequestration in the case of repeat TAVR procedures (16,17).

Interestingly, patients receiving SE valves had also a higher rate of disabling stroke at 30 days, which contributed to the lower early safety. We might argue that the higher postdilatation rates in the SE group played a role in this finding (18,19). However, considering the nonrandomized nature of the registry, we cannot exclude that residual unadjusted confounding variables may have affected this finding.

Comparative analysis of device success was generalizable in a large spectrum of aortic anatomies, whereas early safety showed significant differences in specific subgroups of patients. In particular, patients with moderate-to-severe LVOT calcification and those with a horizontal aorta had similar early safety when treated with SE or BE devices.

This finding supports the notion that, in these subsets of patients with intrinsically higher risk of suboptimal results and challenging procedures, the SE valve might have offset the difference

in the early safety compared with the BE valve due to the possibility of recapturing and repositioning the device when a satisfactory result was not initially achieved.

Finally, echocardiographic assessment of device performance showed similar moderate-to-severe PVR rates but higher rates of mild PVR in the SE group, whereas transprosthetic gradients were significantly lower in patients receiving SE valves.

Recent studies reported an improvement in PVR rates after TAVR with the SE and BE devices compared with their predecessors (20,21). However, we reported moderate-to-severe PVR rates similar to those reported for the earlier devices in the SOLVE-TAVI trial. We hypothesize that anatomical peculiarities (ie, valve calcium burden and distribution) and procedural challenges may play a determinative role in patients with moderate-to-severe PVR after TAVR, overcoming the potential benefit of the specific design improvements of the latest TAV iterations.

The lower transvalvular gradients reported in the SE group confirmed the benefit of the supra-annular design of the SE platform, which has been already well-established in different comparisons (5–8). This key characteristic is particularly important in those patients with high body surface area who are at risk of a prosthesis-patient mismatch and in the setting of valve-in-valve TAVR within a degenerated bioprosthesis, but data increasingly support the long-term benefit of the supra-annular design in terms of structural valve dysfunction compared with the intra-annular design of the SE valves (22–24). Importantly, an 8-fold higher rate of an elevated (≥20 mm Hg) transprosthetic mean gradient was reported for BE recipients. Although the long-term clinical impact of this finding is still uncertain, it might be associated with worse outcomes (25). Longer-term head-to-head comparisons between these 2 platforms are necessary to investigate the impact of the hemodynamic performance differences shown in the present study.

The latest iterations of the most widely used SE and BE TAV families substantially reaffirmed the lights and shadows previously seen with their predecessors. The higher rate of PPI remains a clear drawback for the SE platform compared with the BE platform.

Further improvements and redesigns of these 2 platforms are awaited in the next years and will need ad hoc randomized clinical trials powered for assessing specific differences between the 2 platforms in the context of procedural optimization.

STUDY LIMITATIONS. This was an observational study without independent adjudication of events or independent core laboratory imaging analysis. Although PSM adjustment has resulted in 2 groups for comparison with homogeneous baseline characteristics, unmeasured confounders might remain (ie, stroke volume indexed data, ileofemoral axis characteristics) and might have affected the results due to the nonrandomized nature of the study.

Finally, the registry did not collect data regarding specific valve implantation techniques (ie, using the cusp-overlap view) or the achieved implantation height, which could have influenced the registry outcomes.

CONCLUSIONS

The OPERA-TAVI registry showed that SE and BE TAVs have comparable VARC-3 device success rates in a real-world practice, but the BE device has a higher rate of VARC-3 early safety. The higher rates of PPI and disabling stroke in patients receiving SE valves drove this composite endpoint. Early mortality was consistently low and comparable in both study groups.

CLINICAL PERSPECTIVES

WHAT IS KNOWN?

To date, the latest iterations of the SE and the BE platforms for TAVR have not been compared.

WHAT IS NEW?

Using the updated VARC-3 definitions, SE and BE TAVs showed high and comparable device success rates, but the latter had higher early safety after TAVR. The higher PPI and disabling stroke rates were the main determinants of the lower safety in SE TAV recipients.

WHAT IS NEXT?

Improvements and redesigns of these 2 platforms are awaited in the next years and will need ad hoc randomized clinical trials powered for assessing specific differences between the 2 platforms in the context of procedural optimization.

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FIGURE LEGENDS

Figure 1. Study Flow Chart. CT = computed tomography; TAVR = transcatheter aortic valve replacement.

Central Illustration. Comparison of TAVR Outcomes With SE or BE Valves in the OPERA-TAVI Registry. Box, interquartile range; central line, median; upper whisker, maximum value to quartile 3; lower whisker, quartile 1 to minimum value. *P = 0.41 comparing moderate-to-severe grades. VARC = Valve Academic Research Consortium.

Table 1. Baseline Characteristics of the Matched Population

	Overall (n = 1,366)	**SE (n = 683)**	**BE (n = 683)**	**SMD**
Age	81.9 (77.4-85.6)	81.6 (77.6-85.4)	82 (77.1-85.7)	0.012
Female sex	737 (54.0)	369 (54.0)	368 (53.9)	0.003
BMI	26.9 (23.7-30.2)	27 (23.7-30.8)	27 (23.7-30.0)	0.045
Hypertension	1,183 (86.6)	590 (86.4)	593 (86.8)	0.013
Diabetes mellitus				0.055
No	948 (69.4)	473 (69.3)	475 (69.5)	
Yes	417 (30.5)	210 (30.7)	207 (30.3)	
NA	1 (0.1)	0 (0.0)	1 (0.1)	
Renal failure*				0.074
No	1148 (84.0)	572 (83.7)	576 (84.3)	
Yes	124 (9.1)	68 (10.0)	56 (8.2)	
NA	94 (6.9)	43 (6.3)	51 (7.5)	
CAD				0.036
No	802 (58.7)	407 (59.6)	395 (57.8)	
Yes	562 (41.1)	275 (40.3)	287 (42.0)	
NA	2 (0.1)	1 (0.1)	1 (0.1)	
Prior MI				0.072

No	1,217 (89.1)	614 (89.9)	603 (88.3)	
Yes	148 (10.8)	69 (10.1)	79 (11.6)	
NA	1 (0.1)	0 (0.0)	1 (0.1)	
Prior CABG	87 (6.4)	45 (6.6)	42 (6.1)	0.018
Prior PM	118 (8.6)	60 (8.8)	58 (8.5)	0.010
PAD	158 (11.6)	77 (11.3)	81 (11.9)	0.018
AF				0.059
No	1,012 (74.1)	502 (73.5)	510 (74.7)	
Yes	353 (25.8)	180 (26.4)	173 (25.3)	
NA	1 (0.1)	1 (0.1)	0 (0.0)	
Prior stroke	131 (9.6)	68 (10.0)	63 (9.2)	0.025
COPD				0.019
No	1,212 (88.7)	608 (89.0)	604 (88.4)	
Yes	146 (10.7)	71 (10.4)	75 (11.0)	
NA	8 (0.6)	4 (0.6)	4 (0.6)	
NYHA				0.039
I	66 (4.8)	32 (4.7)	34 (5.0)	
II	493 (36.1)	251 (36.7)	242 (35.4)	
III	722 (52.9)	357 (52.3)	365 (53.4)	

IV	78 (5.7)	40 (5.9)	38 (5.6)	
NA	7 (0.5)	3 (0.4)	4 (0.6)	
Prior RBBB				0.024
No	1,158 (84.8)	582 (85.2)	576 (84.3)	
Yes	99 (7.2)	48 (7.0)	51 (7.5)	
NA	109 (8.0)	53 (7.8)	56 (8.2)	
STS Mortality Score	3.3 (2.2-4.8)	3.37 (2.3-4.7)	3.11 (2.1-4.9)	0.015
Echocardiographic parameters				
LVEF	60 (55-65)	60 (55-65)	60 (55-65)	0.018
Aortic peak gradient	71 (58-84)	70 (58-84)	71 (59-84)	0.012
Aortic mean gradient	44 (35-52)	44 (35-53]	44 (36-51)	0.009
AVA	0.7 (0.5-0.8)	0.7 (0.6-0.8]	0.7 (0.5-0.8)	0.055

Values are n (%) or median (IQR).

*Defined as estimated glomerular filtration rate <30 mL/min

AF = atrial fibrillation; AVA = aortic valve area; BE = balloon-expandable; BMI = body mass index; CAD = coronary artery disease; CABG = coronary artery bypass graft; COPD = chronic obstructive pulmonary disease; IQR = interquartile range; LVEF = left ventricular ejection fraction; MI = myocardial infarction; NA = not available; NYHA = New York Heart Association; PAD = peripheral artery disease; PM = pacemaker; RBBB = right bundle branch block; SAVR = surgical aortic valve replacement; SE = self-expanding; SMD = standardized mean difference; STS = Society of Thoracic Surgeons.

Table 2. CT Characteristics of the Matched Population

	SE (n = 683)	**BE (n = 683)**	***P* Value**
Annulus area, mm^2	420.0 (360.1-464.7)	426.5 (382.0-473.6)	0.003
Annulus perimeter, mm	73.9 (69.1-77.4)	74.9 (70.9-78.7)	<0.001
LM height, mm	14.0 (12.0-16.0)	14.0 (11.7-16.0)	0.992
RCA height, mm	16.0 (13.7-18.1)	16.0 (13.0-18.2)	0.802
Leaflet calcifications			0.218
Absent/trace	25 (3.7)	24 (3.5)	
Mild	200 (29.3)	207 (30.3)	
Moderate	230 (33.7)	192 (28.1)	
Severe	212 (31.0)	240 (35.1)	
LVOT calcifications			0.117
Absent/trace	435 (63.7)	473 (69.3)	
Mild	134 (19.6)	100 (14.6)	
Moderate	36 (5.3)	29 (4.2)	
Severe	26 (3.8)	26 (3.8)	
STJ mean diameter, mm	28.0 (25.8-30.0)	28.9 (27.0-31.0)	<0.001
SoV mean diameter, mm	31.0 (28.8-33.5)	31.37 (29.0-34.00	0.076

Horizontal aorta	119 (17.4)	109 (16.0)	0.713
Bicuspid aortic valve	49 (7.2)	54 (7.9)	0.881

Values are n (5) or median (IQR)

CT = computed tomography; LM = left main coronary artery; LVOT = left ventricular outflow tract; RCA = right coronary artery; SoV = sinus of Valsalva; STJ = sinotubular junction. Other abbreviations as in **Table 1**.

Table 3. Procedural Characteristics of the Matched Population

	SE (n = 683)	**BE (n = 683)**	***P* Value**
General anesthesia	49 (7.2)	41 (6.1)	0.446
Area oversizing, %	46.1 (36.7 to 56.1)	8.9 (2.8 to 16.1)	<0.001
Perimeter oversizing, %	18.9 (15.3 to 23.1)	2.4 (-0.6 to 5.7)	<0.001
Valve type			
SE			
23 mm	9 (1.3)	-	-
26 mm	204 (29.9)	-	-
29 mm	323 (47.3)	-	-
SE with pericardial wrap			
23 mm	8 (1.2)	-	-
26 mm	49 (7.2)	-	-
29 mm	84 (12.3)	-	-
34 mm	6 (0.9)	-	-
BE			
20 mm	-	13 (1.9)	-
23 mm	-	356 (52.1)	-
26 mm	-	314 (46.0)	-

Concomitant PCI	23 (3.4)	24 (3.5)	0.883
Predilatation	289 (45.6)	172 (27.9)	<0.001
Postdilatation	186 (29.2)	25 (3.9)	<0.001
TAV recapturing/repositioning*			-
1 attempt	84 (17.7)	-	
2 attempts	2 (0.4)	-	
3 attempts	2 (0.4)	-	
2 TAVs implanted	7 (1.0)	4 (0.6)	0.547
Annular rupture	1 (0.1)	6 (0.9)	0.124
Coronary obstruction	2 (0.3)	0 (0.0)	0.500
Contrast dye, mL	123.0 (90.0 to 170.0)	99.0 (75.0 to 150.3)	<0.001

Values are n (%) or median (IQR).

*Data available on 475 patients receiving the SE valve without the pericardial wrap.

PCI = percutaneous coronary intervention; TAV = transcatheter aortic valve. Other abbreviations as in **Table 1**.

Table 4. Primary and Secondary Outcomes of the Matched Population.

	SE (n = 683)	**BE (n = 683)**	***P* Value**
Primary outcomes			
VARC-3 device success	597 (87.4)	587 (85.9)	0.47
VARC-3 early safety endpoint	472 (69.1)	564 (82.6)	<0.01
Secondary outcomes			
VARC-3 technical success	636 (93.1)	664 (97.2)	<0.01
All-cause death	13 (1.9)	9 (1.3)	0.52
Disabling stroke	16 (2.3)	5 (0.7)	0.03
Nondisabling stroke	11 (1.6)	3 (0.4)	0.06
MI, n (%)	2 (0.3)	0 (0.0)	0.50
Permanent pacemaker implantation	122 (17.9)	69 (10.1)	<0.01
Rehospitalization for heart failure	6 (0.9)	6 (0.9)	1.00
Echocardiographic device performance			
Transprosthetic mean gradient, mm Hg,	7.00 (5.00-9.00)	12.00 (9.00-15.00)	<0.01
Transprosthetic mean gradient ≥20 mm Hg	7 (1.0)	57 (8.3)	<0.01
PVR			<0.01
None/trace	383 (57.3)	521 (77.3)	

Mild	263 (39.4)	137 (20.3)	
Moderate	22 (3.3)	15 (2.2)	
Severe	0 (0.0)	1 (0.1)	
Moderate to severe PVR	22 (3.2)	16 (2.3)	0.41

Values are n (%) or median (IQR)

PVR = paravalvular regurgitation; VARC = Valve Academic Research Consortium. Other abbreviations as in **Table 1**.

Table 5. Subgroup Analysis of Primary and Secondary Outcomes.

	SE	BE	*P* Value	$P_{interaction}$
Moderate-to-severe leaflet calcifications	N = 442	N = 432		
VARC-3 device success, n (%)	391 (88.5)	372 (86.1)	0.31	0.35
VARC-3 early safety, n (%)	316 (71.5)	350 (81.0)	<0.01	0.13
Moderate-to-severe LVOT calcifications	N = 62	N = 55		
VARC-3 device success, n (%)	52 (83.9)	42 (76.4)	0.36	0.40
VARC-3 early safety, n (%)	43 (69.4)	38 (69.1)	1.00	0.04
Horizontal aorta	N = 119	N = 109		
VARC-3 device success, n (%)	101 (84.9)	94 (86.2)	0.85	0.90
VARC-3 early safety, n (%)	76 (63.9)	80 (73.4)	0.15	0.07
Annulus diameter <23 mm	N = 297	N = 299		
VARC-3 device success, n (%)	250 (84.2)	253 (84.6)	0.91	0.32
VARC-3 early safety, n (%)	204 (68.7)	253 (84.6)	<0.01	0.27
Bicuspid aortic valves	N = 49	N = 54		
VARC-3 device success, n (%)	45 (91.8)	46 (85.2)	0.37	0.39
VARC-3 early safety, n (%)	37 (75.5)	43 (79.6)	0.64	0.27

Abbreviations as in **Tables 1, 2, and 4.**