JACC: CARDIOVASCULAR INTERVENTIONS VOL. ■, NO. ■, 2024

PUBLISHED BY ELSEVIER

ORIGINAL RESEARCH

Real-World Outcomes for the Fifth-Generation Balloon Expandable Transcatheter Heart Valve in the United States

Curtiss T. Stinis, MD,[a] Amr E. Abbas, MD,[b] Paul Teirstein, MD,[c] Raj R. Makkar, MD,[d] Christine J. Chung, MD,[e] Vijay Iyer, MD, PhD,[f] Philippe Généreux, MD,[g] Robert M. Kipperman, MD,[h] John K. Harrison, MD,[i] G. Chad Hughes, MD,[i] Jefferson M. Lyons, MD,[j] Ayaz Rahman, MD,[k] Nikolaos Kakouros, MD,[l] Jennifer Walker, MD,[m] David K. Roberts, MD,[n] Pei-Hsiu Huang, MD,[n] Biswajit Kar, MD,[o] Abhijeet Dhoble, MD,[o] Daniel P. Logsdon, MD,[p] Puneet K. Khanna, MD,[p] Joseph Aragon, MD,[q] James M. McCabe, MD[r]

ABSTRACT

BACKGROUND The fifth-generation SAPIEN 3 Ultra Resilia valve (S3UR) incorporates several design changes as compared with its predecessors, the SAPIEN 3 (S3) and SAPIEN 3 Ultra (S3U) valves, including bovine leaflets treated with a novel process intended to reduce structural valve deterioration via calcification, as well as a taller external skirt on the 29-mm valve size to reduce paravalvular leak (PVL). The clinical performance of S3UR compared with S3 and S3U in a large patient population has not been previously reported.

OBJECTIVES The aim of this study was to compare S3UR to S3/S3U for procedural, in-hospital, and 30-day clinical and echocardiographic outcomes after transcatheter aortic valve replacement (TAVR).

METHODS Patients enrolled in the STS/ACC TVT (Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy) Registry between January 1, 2021, and June 30, 2023, who underwent TAVR with S3UR or S3U/S3 valve platforms were propensity-matched and evaluated for procedural, in-hospital, and 30-day clinical and echocardiographic outcomes.

RESULTS 10,314 S3UR patients were propensity matched with 10,314 patients among 150,539 S3U/S3 patients. At 30 days, there were no statistically significant differences in death, stroke, or bleeding, but a numerically higher hospital readmission rate in the S3UR cohort (8.5% vs 7.7%; $P = 0.04$). At discharge, S3UR patients exhibited significantly lower mean gradients (9.2 ± 4.6 mm Hg vs 12.0 ± 5.7 mm Hg; $P < 0.0001$) and larger aortic valve area (2.1 ± 0.7 cm^2 vs 1.9 ± 0.6 cm^2; $P < 0.0001$) than patients treated with S3/S3U. The 29-mm valve size exhibited significant reduction in mild PVL (5.3% vs 9.4%; $P < 0.0001$).

CONCLUSIONS S3UR TAVR is associated with lower mean gradients and lower rates of PVL than earlier generations of balloon expandable transcatheter heart valve platforms. (J Am Coll Cardiol Intv 2024;■:■–■) © 2024 by the American College of Cardiology Foundation.

From the [a]Division of Cardiology, Scripps Clinic, La Jolla, California, USA; [b]Corewell Health East, William Beaumont University Hospital, Royal Oak, Michigan, USA; [c]Division of Cardiology, Scripps Clinic, La Jolla, California, USA; [d]Cedars-Sinai Medical Center, Los Angeles, California, USA; [e]University of Washington Medical Center, Department of Medicine, Division of Cardiology, Seattle, Washington, USA; [f]Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, New York, New York, USA; [g]Gagnon Cardiovascular Institute at Morristown Medical Center, Morristown, New Jersey, USA; [h]Atlantic Health System Morristown Medical Center, Morristown, New Jersey, USA; [i]Division of Cardiology, Department of Medicine, Duke University Hospital,

ISSN 1936-8798/$36.00 https://doi.org/10.1016/j.jcin.2024.02.015

ABBREVIATIONS AND ACRONYMS

ASD = absolute standardized difference

EOA = effective orifice area

HVD = hemodynamic valve deterioration

PVL = paravalvular leak

S3 = SAPIEN 3

S3U = SAPIEN 3 Ultra

S3UR = SAPIEN 3 Ultra Resilia

SVD = structural valve deterioration

TAVR = transcatheter aortic valve replacement

THV = transcatheter heart valve

Transcatheter heart valve (THV) design has continued to evolve with the goal of further improving valve performance and durability. The SAPIEN 3 Ultra (S3U) THV incorporates an improved sealing skirt to the 20-mm, 23-mm, and 26-mm valve sizes, which has been shown to reduce paravalvular leak (PVL) in comparison to its predecessor the SAPIEN 3 (S3) THV.[1] The SAPIEN 3 Ultra Resilia (S3UR) valve is a fifth-generation device and represents the latest iteration of balloon-expandable THV technology. The S3UR utilizes bovine pericardial leaflet tissue treated with a unique process designed to reduce structural valve deterioration (SVD) via calcification, as well as the addition of an improved outer sealing skirt to the 29-mm valve size.[2] In addition, the method by which the leaflets of the 20-mm and 23-mm valve sizes are suspended at the commissures has been redesigned to optimize hemodynamic performance (**Figure 1**).

The refinements incorporated into the S3UR THV design offer potential clinical advantages, especially as transcatheter aortic valve replacement (TAVR) shifts toward treatment of younger and lower-risk patients.[3] There is an increasing focus on lifetime management of aortic stenosis with the acknowledgment that many patients currently being treated with TAVR will live long enough to develop clinical valve failure necessitating repeat aortic valve intervention.[4] As such, a THV design that provides extended durability offers patients the potential for fewer needed lifetime aortic valve interventions. Although the S3UR THV has been in clinical use in the United States since September 12, 2022, limited data exist regarding its clinical performance in unselected patients in real-world use.[5]

The aim of the current study is to compare the clinical and echocardiographic outcomes of the S3UR THV with those of its predecessors (S3 and S3U) in a propensity-matched population of patients from the STS/ACC TVT (Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy) Registry who underwent initial TAVR for the treatment of native aortic stenosis.

METHODS

STUDY POPULATION. The TVT Registry protocol was granted a waiver of informed consent by Advarra© and Duke University Institutional Review Boards. The study included patients from the TVT Registry who underwent TAVR between January 1, 2021, and June 30, 2023, with the S3UR, or S3U/S3 valve platforms. A total of 160,853 patients who underwent TAVR with either of the SAPIEN platforms were identified after appropriate exclusions were applied. Of these, 150,539 patients had undergone TAVR with S3U/S3 and 10,314 with S3UR. Exclusions for this study included presence of a prior aortic valve prosthesis. The propensity-score matching successfully paired 10,312 patients with S3UR to patients with S3U/S3 for comparison of clinical and echocardiographic outcomes (**Figure 2**).

VALVE DESIGN AND DELIVERY SYSTEM. The 29-mm S3UR valve utilizes the same frame as the 20-mm, 23-mm, and 26-mm S3U and S3 valves, but utilizes bovine pericardial leaflets treated with a special integrity preservation technology that effectively eliminates free aldehydes, a key factor in tissue calcification, while protecting and preserving tissue. The 20-mm and 23-mm S3UR valves also utilize a revised commissural leaflet suspension method designed to maximize leaflet opening, potentially leading to improved hemodynamic performance. All S3U and S3 THVs and the majority of S3UR valves were implanted using the Commander Delivery System and eSheath (Edwards Lifesciences).[6]

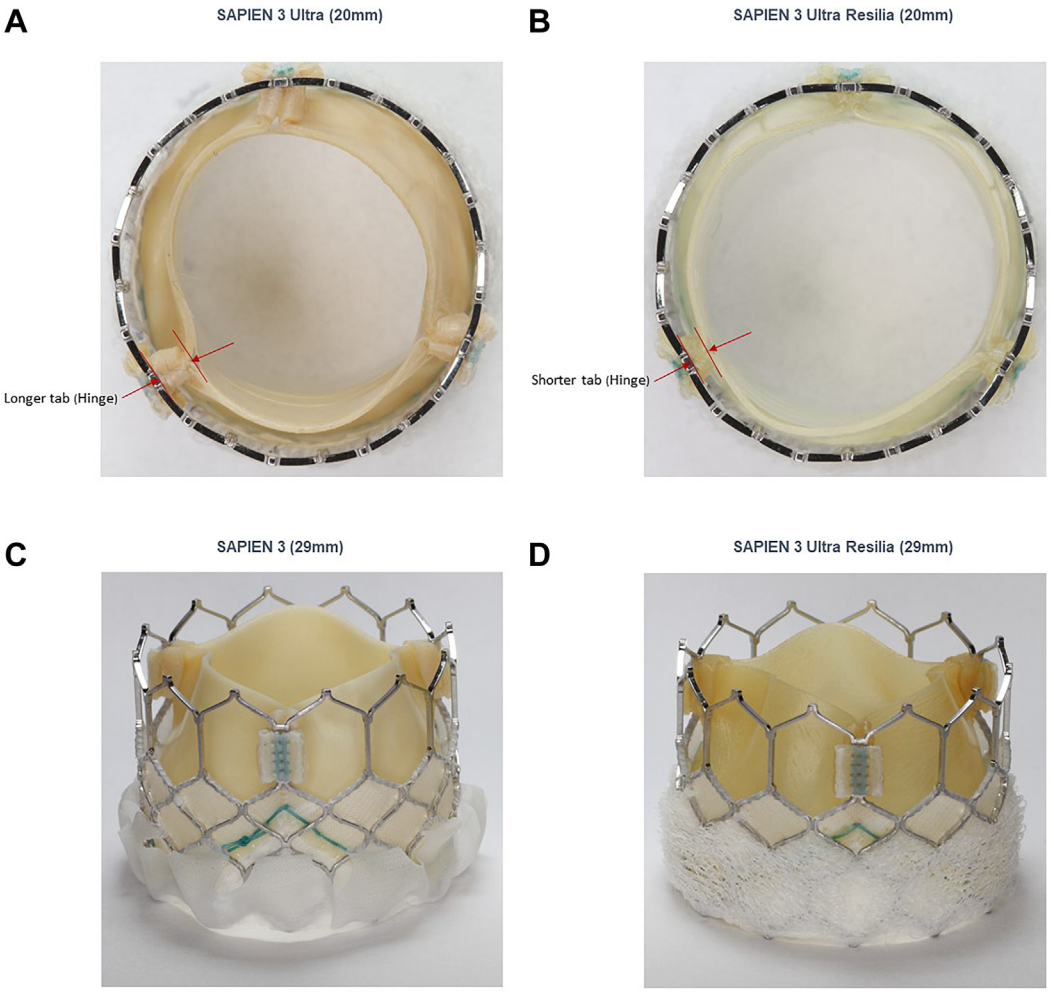
ENDPOINTS. Clinical and echocardiographic outcomes were compared between propensity-matched patients treated with S3UR and S3U/S3 at hospital discharge and at 30 days. Hemodynamic data are

Durham, North Carolina, USA; [j]OhioHealth Heart, Lung, and Vascular Surgeons, Columbus, Ohio, USA; [k]Cardiology Associates of East Tennessee, Knoxville, Tennessee, USA; [l]Division of Cardiology, University of Massachusetts School of Medicine, Worcester, MA, USA; [m]Department of Medicine, Division of Cardiology, University of North Carolina at Chapel Hill, North Carolina, USA; [n]Sutter Medical Center, Sacramento, California, USA; [o]Division of Cardiology, Department of Internal Medicine, University of Texas Health Science Center, Houston, Texas, USA; [p]Eisenhower Medical Center, Rancho Mirage, California, USA; [q]Santa Barbara Cottage Hospital, Santa Barbara, California, USA; and the [r]Division of Cardiology, University of Washington Medical Center, Seattle, Washington, USA.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received January 17, 2024; revised manuscript received February 14, 2024, accepted February 14, 2024.

FIGURE 1 Design Characteristics of the S3UR, S3U, and S3 Heart Valves

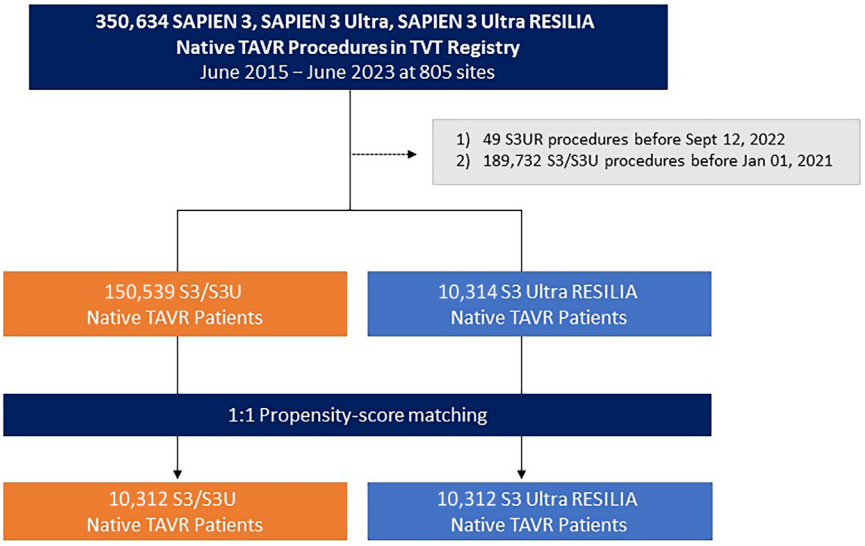


Design characteristics of the SAPIEN 3 Ultra (S3U) 20-mm (A), SAPIEN 3 Ultra Resilia (S3UR) 20-mm (B), SAPIEN 3 (S3) 29-mm, and SAPIEN 3 Ultra Resilia 29-mm transcatheter heart valves. There is a reduction in tab length at the commissures (A vs B), which may impact hemodynamic performance. Compared with the SAPIEN 3 29-mm valve (C), the S3UR 29-mm valve (D) has leaflet tissue designed to reduce structural valve deterioration via calcification and has an improved outer sealing skirt.

based upon site-reported pre- and postprocedural echocardiographic data. Endpoint criteria definitions for the TVT Registry are reported in the STS/ACC TVT Registry Data Coder Dictionary.[7]

PROPENSITY-SCORE MATCHING AND STATISTICAL ANALYSIS. Patients that underwent TAVR with S3UR were propensity-score matched against patients with S3U/S3 valve platforms using 37 covariates to eliminate potential selection bias related to differences in baseline characteristics. Covariates used for matching included age, sex, body mass index, access site, prior percutaneous coronary intervention, prior coronary artery bypass graft surgery, prior stroke, prior transient ischemic attack, carotid stenosis, peripheral arterial disease, hypertension, diabetes, chronic lung disease, immunocompromised state, porcelain aorta, atrial fibrillation/flutter, creatinine, hemoglobin level, estimated glomerular filtration ratio, aortic valve mean gradient, aortic valve area, left ventricular ejection fraction, mitral regurgitation, tricuspid regurgitation, NYHA functional class III/IV, 5-m walk test results, Kansas City Cardiomyopathy Questionnaire Overall Summary Score, Society for Thoracic Surgeons Score (STS score), dialysis status, pre-existing pacemaker, pre-existing implantable cardiac

FIGURE 2 Study Flow Chart



Study flow illustrating the derivation of unmatched and propensity-matched patient cohorts from the STS/ACC TVT (Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy) Registry. TAVR = transcatheter aortic valve replacement; other abbreviations as in Figure 1.

defibrillator, cardiogenic shock within 24 hours, aortic regurgitation, current/recent smoker, endocarditis, home oxygen, and valve size. Missing baseline values were imputed using the Markov Chain Monte Carlo method before propensity score modeling. Based on their propensity scores, each S3UR patient was matched to a S3U/S3 patient (1:1) to create 2 balanced cohorts, using a greedy matching strategy with caliper of width equal to 0.02 of the standard deviation of the logit of the propensity score. The balance between cohorts was determined by calculating absolute standardized differences (ASDs) for which a difference of <0.1 was considered achieving good balance.

Continuous variables were presented as mean ± SD or median (Q1-Q3) and were compared between groups using the 2-sample *t*-test or Wilcoxon rank sum test. Categorical variables were given as frequencies and percentages, and were compared using the chi-square or Fisher exact test. The 30-day adverse event rates were based on Kaplan-Meier estimates, and all comparisons were made using the log-rank test. All statistical analyses were performed using SAS, version 9.4 (SAS Institute), and statistical significance was set at a 2-sided $P < 0.05$ without multiplicity adjustment.

RESULTS

BASELINE CHARACTERISTICS. A total of 10,314 patients who underwent native TAVR with S3UR were propensity-score matched with 10,314 patients among 150,539 patients treated with S3U/S3 during the same period. Baseline and propensity-matched cohort data are shown in Table 1. Among the overall unmatched cohorts, patients treated with S3UR tended to be younger (76.7 ± 8.7 years vs 78.4 ± 8.4 years; ASD = 0.2), have a lower STS score (3.6 ± 3.5 vs 3.9 ± 3.5; ASD = 0.1), were more likely to be male (61.7% vs 60.5%; ASD = 0.02), less likely to have chronic lung disease (22.1% vs 24.5%; ASD = 0.06), less likely to have undergone previous percutaneous coronary intervention (27.6% vs 30.3%; ASD = 0.06), less likely to have undergone previous coronary artery bypass graft surgery (10.6% vs 12.7%; ASD = 0.07), less likely to have had a previous myocardial infarction (15.4% vs 16.9%; ASD = 0.04), and less likely to have had atrial fibrillation or flutter (32.8% vs 34.5%; ASD = 0.04). Following propensity-score matching, there were no significant differences in overall baseline characteristics. There were no differences in baseline echocardiographic data among the propensity score-matched cohorts.

TABLE 1 Baseline Characteristics for the Unmatched and Matched Patient Cohorts

	Unmatched Cohort			Matched Cohort		
	S3/S3U (n = 150,539)	S3U Resilia (n = 10,314)	ASD	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	ASD
Baseline characteristics						
Age, y	78.4 ± 8.4 (150,457)	76.7 ± 8.7 (10,310)	0.20	76.7 ± 8.6 (10,304)	76.7 ± 8.7 (10,308)	0.002
Male	60.5 (91,066/150,534)	61.7 (6,364/10,313)	0.02	61.3 (6,316/10,312)	61.7 (6,363/10,311)	0.009
Baseline STS score	3.9 ± 3.5 (147,774)	3.6 ± 3.5 (10,064)	0.10	3.5 ± 3.1 (10,114)	3.6 ± 3.5 (10,062)	0.02
BMI, kg/m^2	29.7 ± 10.0 (150,026)	29.8 ± 11.7 (10,285)	0.009	29.7 ± 7.5 (10,274)	29.7 ± 9.6 (10,283)	0.005
Hypertension	90.0 (135,425/150,496)	89.4 (9,212/10,300)	0.02	89.2 (9,196/10,310)	89.4 (9,210/10,298)	0.008
Immunocompromised State	6.3 (8,308/13,1842)	6.1 (556/9,097)	0.008	6.1 (549/8,994)	6.1 (555/9,095)	0.00008
Diabetes mellitus	38.5 (57,776/150,046)	39.1 (3,999/10,234)	0.01	38.3 (3,941/10,282)	39.1 (3,997/10,232)	0.02
Peripheral arterial disease	18.3 (27,354/149,903)	14.4 (1,468/10,195)	0.10	14.2 (1,460/10,276)	14.4 (1,468/10,193)	0.006
Currently on dialysis	3.5 (5,296/150,323)	3.9 (398/10,291)	0.02	3.5 (359/10,297)	3.9 (398/10,289)	0.02
Pacemaker	10.0 (14,923/149,816)	8.3 (842/10,175)	0.06	7.8 (798/10,270)	8.3 (842/10,173)	0.02
ICD	2.3 (3,408/149,728)	2.1 (209/10,163)	0.02	2.0 (205/10,264)	2.1 (209/10,161)	0.004
Cardiogenic shock within 24 h	0.9 (1,348/150,432)	1.1 (109/10,309)	0.02	1.0 (107/10,309)	1.1 (109/10,307)	0.002
Chronic lung disease	24.5 (36,684/149,988)	22.1 (2,253/10,215)	0.06	21.8 (2,245/10,282)	22.1 (2,252/10,213)	0.005
Home oxygen	6.2 (9,375/150,393)	5.7 (591/10,295)	0.02	5.7 (588/10,304)	5.7 (591/10,294)	0.001
Carotid stenosis	14.2 (21,246/149,742)	11.9 (1,213/10,181)	0.07	11.6 (1,188/10,265)	11.9 (1,213/10,179)	0.01
Prior stroke	10.3 (15,404/149,795)	10.1 (1,030/10,178)	0.005	10.0 (1,025/10,268)	10.1 (1,030/10,176)	0.005
Prior TIA	6.6 (9,856/149,787)	6.5 (663/10,172)	0.003	6.5 (668/10,270)	6.5 (663/10,170)	0.0006
Prior PCI	30.3 (45,457/149,981)	27.6 (2,815/10,206)	0.06	27.8 (2,857/10,281)	27.6 (2,815/10,204)	0.005
Prior CABG	12.7 (19,049/149,812)	10.6 (1,080/10,179)	0.07	10.3 (1,057/10,271)	10.6 (1,080/10,177)	0.01
Porcelain aorta	0.6 (965/149,703)	0.4 (41/10,163)	0.03	0.4 (45/10,265)	0.4 (41/10,161)	0.005
Endocarditis	0.3 (477/149,709)	0.4 (42/10,163)	0.02	0.3 (30/10,264)	0.4 (41/10,161)	0.02
Prior MI	16.9 (25,277/149,871)	15.4 (1,572/10,191)	0.04	15.6 (1,603/10,273)	15.4 (1,572/10,189)	0.005
<30 d	14.1 (3,560/25,268)	16.3 (256/1,572)	0.06	14.6 (234/1,603)	16.3 (256/1,572)	0.05
≥30 d	85.9 (21,708/25,268)	83.7 (1,316/1,572)	0.06	85.4 (1,369/1,603)	83.7 (1,316/1,572)	0.05
Atrial fibrillation/flutter	34.5 (51,816/150,025)	32.8 (3,350/10,215)	0.04	31.9 (3,277/10,285)	32.8 (3,349/10,213)	0.02
Current/recent smoker	12.5 (9,853/78,906)	13.2 (733/5,557)	0.02	13.3 (732/5,502)	13.2 (733/5,556)	0.003
Creatinine	1.3 ± 1.1 (149,956)	1.3 ± 1.1 (10,273)	0.007	1.3 ± 1.1 (10,270)	1.3 ± 1.1 (10,271)	0.009
Hemoglobin	12.5 ± 2.0 (149,962)	12.6 ± 2.0 (1,0273)	0.05	12.6 ± 2.1 (10,277)	12.6 ± 2.0 (10,271)	0.004
GFR	64.0 ± 25.3 (149,869)	64.9 ± 25.5 (10,268)	0.03	65.3 ± 25.0 (10,262)	64.9 ± 25.5 (10,266)	0.02
NYHA functional class III/IV	63.2 (94,259/149,142)	60.5 (6,131/10,139)	0.06	59.8 (6,107/10,207)	60.5 (6,130/10,137)	0.01
KCCQ-OS	52.0 ± 25.7 (141,855)	54.0 ± 25.9 (9,703)	0.08	53.9 ± 25.9 (9,690)	54.0 ± 25.9 (9,701)	0.005
5-m walk test, s	7.4 ± 5.6 (116,715)	7.0 ± 3.7 (8,024)	0.07	7.1 ± 3.6 (8,087)	7.0 ± 3.7 (8,022)	0.02
Echocardiographic characteristics						
EOA, cm^2	0.8 ± 0.2 (147,772)	0.8 ± 0.3 (10,105)	0.04	0.8 ± 0.2 (10,121)	0.8 ± 0.3 (10,103)	0.01
EOA, cm^2	0.7 (0.6-0.9)	0.8 (0.6-0.9)	NA	0.8 (0.6-0.9)	0.8 (0.6-0.9)	NA
Mean gradient, mm Hg	41.3 ± 13.8 (149,197)	41.0 ± 13.8 (10,214)	0.02	40.9 ± 13.5 (10,217)	41.0 ± 13.8 (10,212)	0.005
Mean gradient, mm Hg	41.0 (33.0-48.0)	40.0 (32.0-48.0)	NA	40.0 (32.0-48.0)	40.0 (32.0-48.0)	NA
LVEF	56.5 ± 12.0 (149,713)	56.9 ± 12.0 (10,257)	0.03	56.9 ± 11.9 (10,266)	56.9 ± 12.0 (10,255)	0.003
Aortic regurgitation, mod/sev	15.5 (23,121/148,946)	15.8 (1,603/10,160)	0.007	15.3 (1,564/10,208)	15.8 (1,602/10,158)	0.01
Mitral regurgitation, mod/sev	23.8 (26,804/112,806)	22.5 (1,727/7,675)	0.03	22.6 (1,708/7,552)	22.5 (1,726/7,674)	0.003
Tricuspid regurgitation, mod/sev	15.6 (23,288/149,116)	14.1 (1,434/10,202)	0.04	13.9 (1,425/10,223)	14.1 (1,433/10,200)	0.003

Values are mean ± SD (n), % (n/N), or median (Q1-Q3). An absolute standardized difference (ASD) <0.10 implies a good balance between the 2 groups.

BMI = body mass index; CABG = coronary artery bypass grafting; EOA = effective orifice area; GFR = glomerular filtration rate; ICD = implantable cardioverter-defibrillator; KCCQ-OS = Kansas City Cardiomyopathy Questionnaire - Overall Summary Score; LVEF = left ventricular ejection fraction; MI = myocardial infarction; mod/sev = moderate/severe; PCI = percutaneous coronary; S3 = SAPIEN 3; S3U = SAPIEN 3 Ultra; S3UR = SAPIEN 3 Ultra Resilia; STS = Society of Thoracic Surgeons; TIA = transient ischemic attack.

PROCEDURAL OUTCOMES. Procedural outcomes for the propensity score-matched cohorts are shown in Table 2. Patients who underwent TAVR with S3UR as compared with patients treated with S3U/S3 were less likely to have received conscious sedation (51.6% vs 57.6%; $P < 0.0001$), had lower total procedural times (59.9 ± 33.7 minutes vs 63.7 ± 35.3 minutes; $P < 0.0001$), and had lower fluoroscopy times (13.3 ± 8.2 minutes vs 14.2 ± 10.8 minutes; $P < 0.0001$). There were no significant differences between groups in transfemoral route of access (≈97%), implantation success (≈99%), valve sizes used, or in major procedural complications, including conversion to open surgery, annular rupture, aortic dissection, coronary occlusion, or device embolization.

IN-HOSPITAL AND 30-DAY CLINICAL OUTCOMES. In-hospital and 30-day clinical outcomes for the propensity-matched cohort are shown in Table 3. Patient status at 30 days for the propensity-matched

TABLE 2 Procedural Outcomes for the Matched Cohort

	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	*P* Value
Transfemoral access	96.7 (9,974/10,312)	96.9 (9,988/10,309)	0.50
Procedure status			
Elective	90.7 (9,348/10,312)	89.1 (9,190/10,312)	0.0003
Urgent	9.0 (926/10,312)	10.5 (1,082/10,312)	0.0002
Emergency	0.3 (35/10,312)	0.3 (33/10,312)	0.81
Salvage	0.0 (3/10,312)	0.1 (7/10,312)	0.34
General anesthesia	31.0 (3,196/10,307)	33.2 (3,416/10,298)	0.0009
Conscious sedation	57.6 (5,937/10,307)	51.6 (5,317/10,298)	<0.0001
Total procedure time, min	63.7 ± 35.3 (10,307)	59.9 ± 33.7 (10,308)	<0.0001
Fluoroscopy time, min	14.2 ± 10.8 (8,704)	13.3 ± 8.2 (8,973)	<0.0001
Procedure aborted	0.0 (0/10,312)	0.0 (0/10,312)	NA
Annular rupture	0.1 (12/10,312)	0.2 (15/10,312)	0.56
Aortic dissection	0.1 (6/10,312)	0.1 (6/10,312)	1.00
Coronary compression/obstruction	0.0 (3/10,312)	0.1 (9/10,312)	0.08
Device embolization	0.1 (9/10,312)	0.1 (13/10,312)	0.39
Perforation ± tamponade	0.5 (51/10,312)	0.4 (45/10,312)	0.54
Implantation success	99.3 (10,238/10,311)	99.4 (10,250/10,312)	0.34
Conversion to open heart surgery	0.2 (23/10,304)	0.2 (17/10,301)	0.34
Annulus rupture	13.0 (3/23)	17.7 (3/17)	1.00
Ventricular rupture	4.4 (1/23)	5.9 (1/17)	1.00
Aortic dissection	4.4 (1/23)	0.0 (0/17)	1.00
Coronary occlusion	8.7 (2/23)	5.9 (1/17)	1.00
Cardiac tamponade	17.4 (4/23)	23.5 (4/17)	0.70
Device embolization	0.0 (0/23)	0.0 (0/17)	NA
Multiple	43.5 (10/23)	41.2 (7/17)	0.88
Other	8.7 (2/23)	5.9 (1/17)	1.00
Valve size			0.97
20 mm	3.3 (336/10,304)	3.3 (343/10,311)	0.79
23 mm	31.8 (3,275/10,304)	32.0 (3,302/10,311)	0.71
26 mm	42.5 (4,375/10,304)	42.3 (4,357/10,311)	0.77
29 mm	22.5 (2,318/10,304)	22.4 (2,309/10,311)	0.86
Index hospitalization length of stay, d	1.0 (1.0-2.0)	1.0 (1.0-2.0)	0.005
Discharged home	94.0 (9,696/10,312)	94.0 (9,694/10,312)	0.95

Values are % (n/N), mean ± SD (n), or median (Q1-Q2).
Abbreviations as in Table 1.

cohort is reported in Supplemental Table 1. Adverse event rates during the index hospitalization were extremely low for both groups, and there was no statistically significant difference between patients treated with S3UR compared with S3U/S3 with respect to in-hospital all-cause death (0.8% vs 0.9%), cardiac death (0.6% vs 0.7%), stroke (1.2% vs 1.1%), requirement for new permanent pacemaker (5.6% vs 5.6%), life-threatening bleeding (1.0% vs 1.2%), or major vascular complications (1.0% vs 1.1%). The median length of stay was 1 day, and 94% of patients were discharged home for both groups (**Table 2**). At 30 days, rates of major adverse events remained extremely low, and there were no statistical differences between groups with respect to all-cause death (1.4% vs 1.8%) or cardiac death (0.8% vs 1.1%), stroke (1.8% vs 1.6%), or requirement for new pacemaker (8.3% vs 7.7%). There was a numerically higher hospital readmission rate seen in the S3UR cohort (8.5% vs 7.7%; $P = 0.04$).

ECHOCARDIOGRAPHIC OUTCOMES AT DISCHARGE AND 30 DAYS: ALL VALVE SIZES. Hemodynamic outcomes for the propensity-matched cohorts were assessed via echocardiography before hospital discharge and at 30 days as shown in **Table 4** and **Figure 3**. Overall, patients treated with S3UR exhibited a significantly larger aortic valve area (2.1 ± 0.7 cm^2 vs 1.9 ± 0.6 cm^2; $P < 0.0001$) and lower mean gradients (9.2 ± 4.6 mm Hg vs 12.0 ± 5.7 mm Hg; $P < 0.0001$) than patients treated with S3/S3U at the time of hospital discharge. Rates of PVL were also significantly lower for patients treated with S3UR in comparison to S3/S3U, with a larger proportion of patients exhibiting no PVL (94.2% vs 92.6%; $P < 0.0001$) and fewer patients exhibiting mild PVL (5.6% vs 7.2%; $P < 0.0001$), whereas rates of moderate (0.2% vs 0.3%; $P = 0.77$) and severe PVL (0.0% vs 0.0%; $P = 1.00$) remained low and did not differ among the groups at the time of hospital discharge. These findings remained consistent at 30 days, with the patients treated with S3UR exhibiting lower mean gradients (10.1 ± 4.5 mm Hg vs 12.7 ± 5.6 mm Hg; $P < 0.0001$) and a larger proportion of patients exhibiting no PVL (87.9% vs 86.4%; $P = 0.006$) and fewer patients exhibiting mild PVL (11.4% vs 12.9%; $P = 0.005$), whereas the rates of moderate (0.7% vs 0.7%; $P = 0.86$) and severe (0.0% vs 0.0%; $P = 0.12$) PVL remained low and did not differ significantly between groups.

ECHOCARDIOGRAPHIC OUTCOMES AT DISCHARGE AND 30 DAYS BY INDIVIDUAL VALVE SIZE. Hemodynamic outcomes as assessed by echocardiography prior to hospital discharge and at 30 days for the propensity-matched cohorts were examined for each of the 4 available valve sizes and are presented in **Figure 4**, **Central Illustration** and Supplemental Tables 2 and 3. In comparison to patients treated with S3/S3U, patients treated with S3UR exhibited lower mean gradients and larger calculated aortic valve areas across all 4 valves sizes both at hospital discharge and at 30 days. Rates of PVL did not statistically differ among the groups treated with 20-mm, 23-mm, and 26-mm valves at the time of hospital discharge (Supplemental Table 2) or at 30 days (Supplemental Table 3), but a smaller proportion of patients treated with a 29-mm S3UR exhibited mild PVL (5.3% vs 9.4%; $P < 0.0001$) and a larger proportion with no PVL

TABLE 3 In-Hospital and 30-Day Clinical Outcomes for Matched Cohort

	In-Hospital			30-Day		
	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	*P* Value	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	*P* Value
All-cause death	0.9 (91/10,312)	0.8 (77/10,312)	0.28	1.8 (172)	1.4 (132)	0.05
Cardiac death	0.7 (70/10,312)	0.6 (57/10,312)	0.25	1.1 (106)	0.8 (77)	0.052
Stroke	1.1 (111/10,312)	1.2 (121/10,312)	0.51	1.6 (163)	1.8 (174)	0.44
New pacemaker	5.6 (581/10,312)	5.6 (580/10,312)	0.98	7.7 (771)	8.3 (814)	0.13
New-onset atrial fibrillation	2.1 (153/7,134)	1.8 (129/7,070)	0.17	3.4 (234)	3.0 (200)	0.19
Aortic valve reintervention	0.1 (11/10,312)	0.1 (11/10,312)	1.00	0.2 (16)	0.1 (13)	0.62
Any readmission	0.2 (20/10,312)	0.3 (27/10,312)	0.31	7.7 (744)	8.5 (790)	0.04
Life-threatening bleeding	1.2 (121/10,312)	1.0 (104/10,312)	0.25	1.3 (126)	1.2 (117)	0.76
Major vascular complication	1.1 (110/10,312)	1.0 (105/10,312)	0.73	1.2 (119)	1.2 (123)	0.75

Values are % (n/N) or Kaplan-Meier estimate % (n events).
Abbreviations as in Table 1.

(94.5% vs 90.1%; $P < 0.0001$) before hospital discharge and at 30 days (10.7% vs 16.4%; $P < 0.0001$ or 88.3% vs 82.5%; $P < 0.0001$, respectively) in comparison to patients treated with a 29-mm S3 (Figure 5 and Central Illustration).

DISCUSSION

The current study is the largest reported analysis of real-world clinical outcomes from the TVT Registry of the latest generation SAPIEN 3 Ultra Resilia THV platform. The key findings of this study are that: 1) the S3UR THV is associated with excellent procedural outcomes and low complication rates; 2) S3UR is associated with lower mean gradients and higher calculated aortic valve areas as determined by echocardiography in comparison to earlier generations of balloon-expandable THV platforms; and 3) the S3UR 29-mm valve size is associated with lower rates of PVL than previous 29-mm balloon-expandable THV designs.

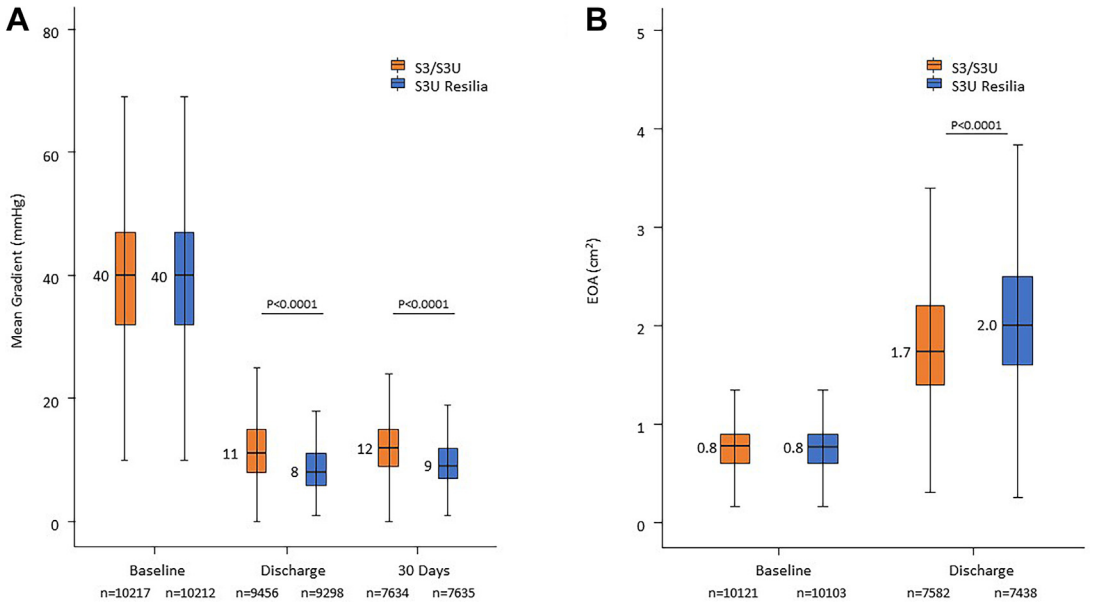
The S3UR design incorporates several innovations that have the potential to improve clinical performance, the most notable of which is a change in leaflet design. S3UR utilizes bovine pericardial leaflet tissue that has been chemically treated to reduce free aldehydes and thereby reduce the potential for leaflet calcification, which is a known driving factor of SVD.[8] Although the long-term potential for this technology to improve THV clinical durability is currently unknown, a surgically implanted valve utilizing the same tissue technology (Resilia tissue) has reported

TABLE 4 Discharge and 30-Day Echocardiographic Outcomes for Matched Cohort

	Discharge			30-Day		
	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	*P* Value	S3/S3U (n = 10,312)	S3U Resilia (n = 10,312)	*P* Value
EOA, cm^2	1.9 ± 0.6 (7,582)	2.1 ± 0.7 (7,438)	<0.0001	NA	NA	NA
EOA, cm^2	1.7 (1.4-2.2)	2.0 (1.6-2.5)	<0.0001	NA	NA	NA
iEOA, cm^2/m^2	0.9 ± 0.3 (7,551)	1.1 ± 0.4 (7,418)	<0.0001	NA	NA	NA
Mean gradient, mm Hg	12.0 ± 5.7 (9,456)	9.2 ± 4.6 (9,298)	<0.0001	12.7 ± 5.6 (7,634)	10.1 ± 4.5 (7,635)	<0.0001
Mean gradient, mm Hg	11.0 (8.0-15.0)	8.0 (6.0-11.0)	<0.0001	12.0 (9.0-15.0)	9.0 (7.0-12.0)	<0.0001
Mean gradient ≥20 mm Hg, %	8.1 (768/9,456)	2.6 (245/9,298)	<0.0001	9.6 (736/7,634)	3.6 (272/7,635)	<0.0001
Severe PPM[a]	10.9 (820/7,551)	6.2 (460/7,418)	<0.0001	NA	NA	NA
Paravalvular leak						
None	92.6 (8,412/9,088)	94.2 (8,544/9,071)	<0.0001	86.4 (6,164/7,138)	87.9 (6,301/7,169)	0.006
Mild	7.2 (651/9,088)	5.6 (505/9,071)	<0.0001	12.9 (920/7,138)	11.4 (815/7,169)	0.005
Moderate	0.3 (23/9,088)	0.2 (21/9,071)	0.77	0.7 (51/7,138)	0.7 (53/7,169)	0.86
Severe	0.0 (2/9,088)	0.0 (1/9,071)	1.00	0.0 (3/7,138)	0.0 (0/7,169)	0.12

Values are mean ± SD (n), median (IQR), or % (n/N). [a]BMI <30: severe patient-prosthesis mismatch (PPM), effective orifice area index (EOAi) <0.65; BMI ≥30: severe PPM, EOAi <0.55.
Abbreviations as in Table 1.

FIGURE 3 **Echo-Based Gradients and EOA: Baseline Through Discharge or 30 Days**



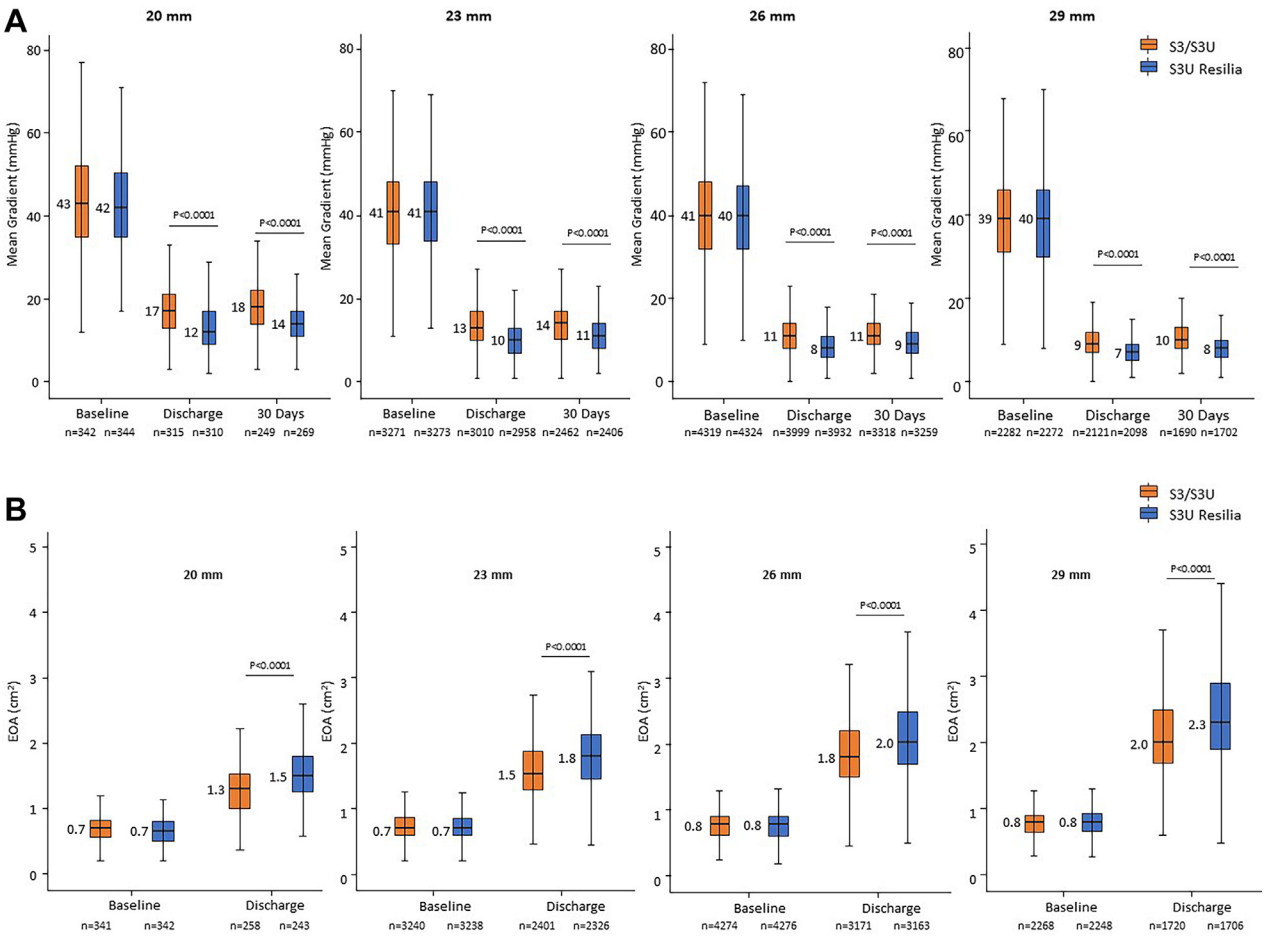
Box plot of aortic valve mean gradient (A) and effective orifice area (EOA) (B) at baseline, discharge, and at 30 days by valve type. Values are displayed as median (box midline), IQR (lower and upper box limits), and whiskers represent 1.5 × IQR. Abbreviations as in Figure 1.

promising results with only 1 patient of an aggregate of nearly 3,000 patients developing SVD within 5 years.[9] As TAVR expands to include younger and lower-risk patients, there is an increased emphasis on lifetime management of aortic valve disease with the understanding that many patients currently being treated will survive long enough to require repeat aortic valve intervention.[3] Thus, initial treatment with a THV offering enhanced durability may reduce the total number of lifetime aortic valve interventions.

In addition to the change in tissue treatment, the method by which the leaflets are suspended within the frame of the 20-mm and 23-mm S3UR valve sizes has also been altered in comparison to its predecessors. This design modification minimizes the adhesive surface area of the leaflets and thereby facilitates a larger orifice opening and a reduction in mean gradient. Okuno et al[10] were the first to report lower mean gradients and larger effective orifice areas (EOAs) as assessed by echocardiography for patients treated with 23-mm and 26-mm S3UR in comparison to 23-mm and 26-mm S3 in a single-center analysis of the OCEAN-TAVI (Optimized Transcatheter Valvular Intervention-Transcatheter Aortic Valve Implantation) registry. Our current and much larger real-world multicenter study of >20,000 patients from the TVT Registry is the second such report and is consistent with these prior findings, but also expands upon them by demonstrating a lower mean gradient and larger EOA for S3UR in comparison to S3/S3U for all 4 available valve sizes. Interestingly, the leaflet suspension design modification is only incorporated into the 20-mm and 23-mm S3UR valves. However, all 4 sizes of the S3UR demonstrated lower echocardiographic gradients and larger aortic valve areas, implying that the Resilia tissue itself may create different flow dynamics during systole manifesting as differential echocardiographic hemodynamics despite no change in leaflet geometry for the 26-mm and 29-mm valve sizes.

Echocardiography is the primary recommended method by which THVs are assessed for hemodynamic performance. The Valve Academic Research Consortium-3 (VARC-3) emphasizes an echocardiographic approach to the assessment of SVD, placing an emphasis on changes in mean gradient as well as other parameters to determine whether hemodynamic deterioration (HVD) is present.[11] Although echocardiography is used as a primary assessment tool post-TAVR, multiple studies have reported substantial discordance between Doppler-derived gradients and gradients obtained through direct pressure measurement during left heart catheterization. In a

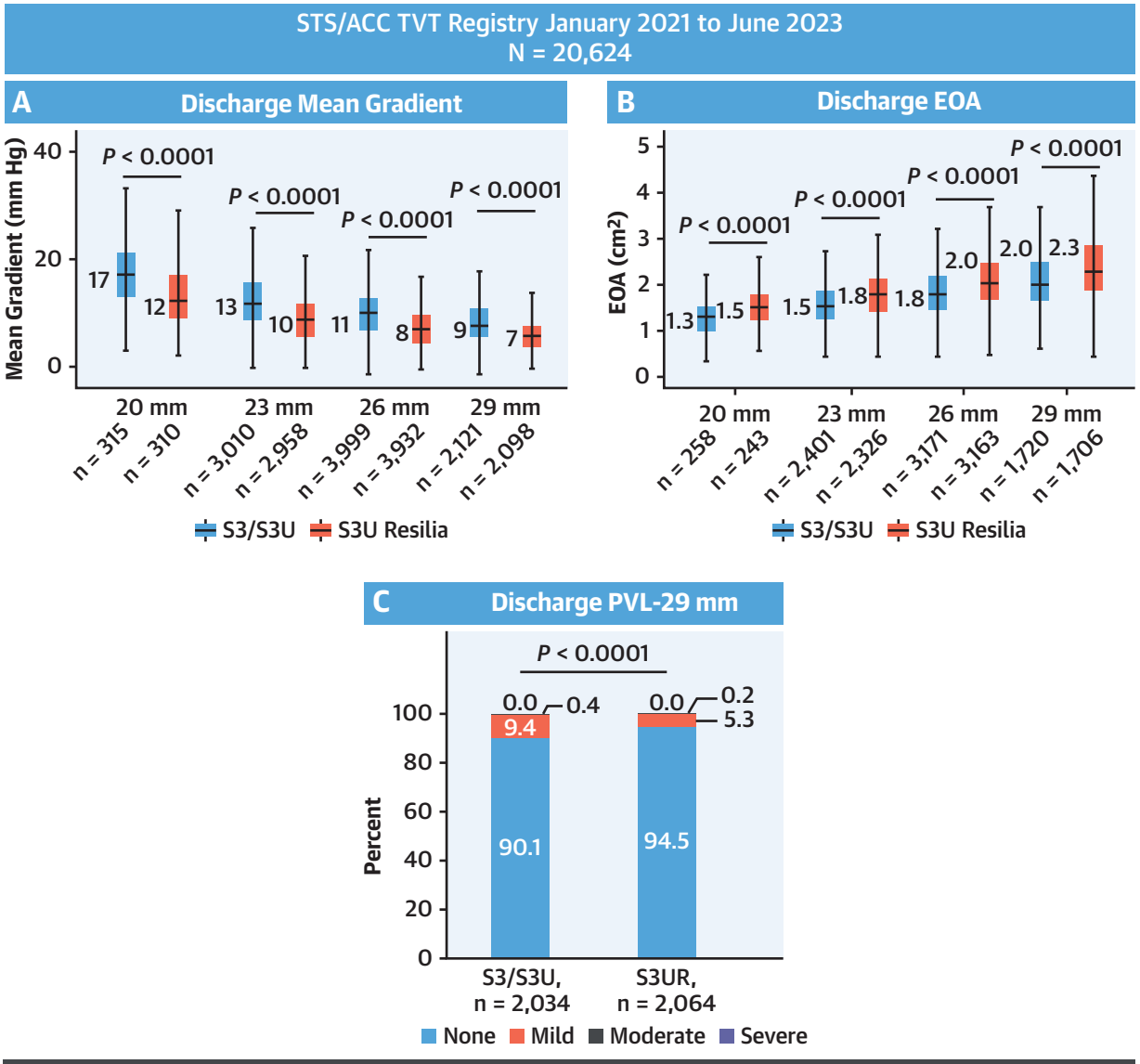
FIGURE 4 Echo-Based Gradients and EOA by Valve Size: Baseline Through Discharge or 30 Days



Box plot of aortic valve mean gradient (A) and EOA (B) by individual valve size and type at baseline, discharge, and at 30 days. Values are displayed as median (box midline), IQR (lower and upper box limits), and whiskers represent 1.5 × IQR. Abbreviations as in Figure 1.

recent large multicenter study, Abbas et al[12] reported that echocardiography-derived gradients exhibited significant discordance with catheter-derived gradients post-TAVR, that echocardiography-derived gradients were often overestimated in comparison to catheter-derived gradients, and that this finding was most pronounced with smaller balloon-expandable valves. Moreover, elevated mean gradients as measured by echocardiography were not associated with an increase in mortality at 2 years in this study. Similarly, Eng et al[13] examined real-world outcomes of the 20-mm S3 and S3U valves in comparison to their respective 23-mm, 26-mm, and 29-mm valve sizes in a propensity-matched analysis and found that although the 20-mm valve size was associated with the highest echocardiography-derived mean gradient and a higher rate of patient-prosthesis mismatch, the clinical outcomes at 1 year were no different. Barker et al[14] reported the findings of a prospective study utilizing a standardized protocol with core lab adjudication to assess hemodynamics in patients who met VARC-3 criteria for ≥stage 2 HVD by echocardiography and found that none of these patients exhibited HVD by catheter-based hemodynamic assessment. The ongoing prospective multicenter DISCORDANCE TAVR (Standardized Invasive Hemodynamics for Elevated Gradients Post TAVR) study aims to further examine the role of catheter-derived gradient assessment in the classification of HVD post-TAVR.[15] These and other studies bring into question the clinical relevance of the absolute value obtained by echocardiography for the mean gradient post-TAVR. Thus, although current studies observed lower mean echocardiography-derived gradients for S3UR across

CENTRAL ILLUSTRATION **Outcomes of SAPIEN 3 Ultra Resilia vs Predecessor Platforms**

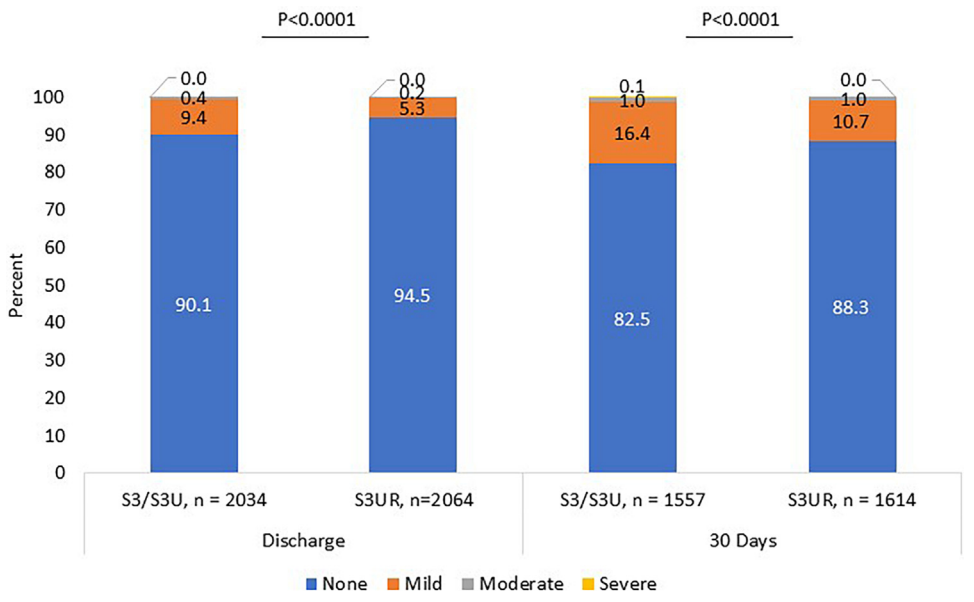


- S3UR is associated with lower mean gradients and higher aortic valve areas compared to S3/S3U
- S3UR 29-mm valve size is associated with lower rates of PVL compared to S3 29-mm valve size
- 30-day mortality and stroke rate for S3UR did not significantly differ from those of predecessor platforms
- S3UR cohort had higher hospital readmission rate (8.5% vs 7.7% for S3/S3U cohort, $P = 0.04$)

Stinis CT, et al. J Am Coll Cardiol Intv. 2024;■(■):■-■.

A and B show box plots for aortic valve mean gradient (A) and effective orifice area (EOA) (B) at discharge by valve type. C shows the incidence and severity of paravalvular leak (PVL) at discharge for propensity-matched patients undergoing transcatheter aortic valve replacement (TAVR) with the SAPIEN 3 Ultra Resilia (S3UR) 29-mm and SAPIEN 3 (S3) 29-mm valves. Values are displayed as median (box midline), IQR (lower and upper box limits), and whiskers represent 1.5 × IQR. ES3U = SAPIEN 3 Ultra; STS/ACC TVT = Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy.

FIGURE 5 Echo-Based PVL: Discharge Through 30 Days for 29-mm Valve Size



Incidence and severity of paravalvular leak (PVL) at discharge and 30 day for propensity-matched patients undergoing TAVR with the SAPIEN 3 Ultra Resilia 29-mm and SAPIEN 3 29-mm valves. Abbreviations as in Figures 1 and 2.

all valve sizes in comparison to its predecessors, the ultimate clinical significance of these findings remains unclear.

Previous studies have found that the improved sealing skirt design of S3U is associated with a significant reduction in PVL when compared with S3.[1] However, the S3U design did not include a 29-mm valve size. The S3UR THV incorporates the improved sealing skirt design of S3U and also includes a 29-mm valve size. The present study demonstrates a significant reduction in PVL for the 29-mm S3UR valve size in comparison to the previous generation 29-mm S3 valve, which is undoubtedly due to the incorporation of the Ultra sealing skirt design. Importantly, this reduction in PVL was accomplished without any obvious tradeoffs with respect to hemodynamic performance, permanent pacemaker rates, or other procedural complications in this large real-world population. The importance of PVL as a marker for increased mortality and reintervention was identified as far back as the original PARTNER (Placement of Aortic Transcatheter Valves) 2 cohort A study, with multiple subsequent studies reporting that PVL greater than mild is associated with poorer clinical outcomes.[16] In a large propensity-matched analysis from the TVT Registry of S3U compared with S3, Nazif et al[17] reported that 85.7% of patients treated with S3U had no PVL at 30 days, 13.8% had mild PVL, and 0.6% had moderate/severe PVL. The findings of the present study are consistent with these prior results with very low rates of PVL overall and specifically a significant reduction in PVL at 30 days for the 29-mm S3UR compared with the 29-mm S3, with 88.2% of patents exhibiting no PVL, and only 10.7% of patients exhibiting mild PVL. This reduction in PVL represents an important advance and offers a potential clinical advantage for patients with larger annuli being considered for TAVR.

STUDY LIMITATIONS. This study is a retrospective analysis of registry data and is therefore subject to the limitations inherent in such a study. The TVT Registry relies on site-reported data that are not independently adjudicated. Echo-based hemodynamics were not measured by an independent core lab. Although propensity matching was performed, there exists the possibility that differences in the populations compared could still be present that could confound the findings. Patient-specific computed tomography data are not available as part of the TVT Registry, thus specific patient anatomical features including annulus size, calcium burden and distribution, and the presence or absence of left ventricular outflow tract calcium, which could affect valve performance and outcomes, are unknown. Finally, the study follow-up period was limited to 30 days, thus

longer-term studies will be required to determine long-term clinical outcomes.

CONCLUSIONS

In this large, real-world propensity-matched analysis of data from the TVT Registry, TAVR with the SAPIEN 3 Ultra Resilia valve was associated with significantly lower echocardiography-derived mean gradients and larger calculated EOAs for all 4 available valve sizes, as well as lower rates of PVL for the 29-mm valve size in comparison with previous generation SAPIEN valves. There were no differences in procedural outcomes, complications, or in 30-day clinical outcomes.

ACKNOWLEDGMENTS The authors would like to thank Angila Sewal, PhD, Edwards Lifesciences, for ensuring the technical accuracy of the manuscript and for assisting with tables and figures for the manuscript, and Ke Xu, PhD, Edwards Lifesciences, for statistical support. They were not compensated for their contributions uniquely for this article.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Stinis has received consulting fees from Edwards Lifesciences, Medtronic, Boston Scientific, and Shockwave Medical; and serves on an advisory board for Boston Scientific. Dr Abbas has received research grants and consulting fees from Edwards Lifesciences. Dr Teirstein has received research grant and honoraria from Abbott, Boston Scientific, Cordis, and Medtronic; and serves on advisory boards for Boston Scientific and Medtronic. Dr Makkar has received grant support/research contracts from Edwards Lifesciences and St. Jude Medical; and has received consultant fees/honoraria and served on the Speakers Bureaus of Abbott Vascular, Cordis Corporation, and Medtronic. Dr Généreux has been a consultant for Abbott Vascular, Abiomed, BioTrace Medical, Boston Scientific, CARANX, Cardiovascular Systems Inc (for the PI Eclipse Trial), Edwards Lifesciences, GE Healthcare, iRhythm Technologies, Medtronic, Opsens, Pi-Cardia, Puzzle Medical, Saranas, Shockwave, Siemens, Soundbite Medical Inc, Teleflex, and 4C Medical (for the PI Feasibility study). Dr Huang has received speaker honoraria from Abbott Vascular; and has received consulting fees from Edwards Lifesciences. Dr Aragon received has consultant fees from Edwards Lifesciences. Dr McCabe has received fees from Edwards Lifesciences, Boston Scientific, and Teleflex outside the submitted work. Statistical analyses were performed by Edwards Lifesciences. The views or opinions presented here do not represent those of the American College of Cardiology (ACC), Society of Thoracic Surgeons (STS), or the STS/ACC TVT Registry. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Curtiss T. Stinis, Division of Cardiology, Scripps Clinic, 9898 Genesee Avenue, AMP-200, La Jolla, California 92037, USA. E-mail: STINIS.CURTISS@SCRIPPSHEALTH.ORG.

PERSPECTIVES

WHAT IS KNOWN? SVD is of increasing consideration given that the transcatheter aortic valve replacement indication has recently shifted to younger and lower-risk patients. The Resilia tissue used in the S3UR heart valve demonstrably remained free of SVD at 5 years owing to an improved anticalcification coating, but S3UR THV data have been limited because the S3UR valve has only been in clinical use in the United States since September 2022.

WHAT IS NEW? Patients who underwent TAVR with the S3UR valve have significantly lower echocardiography-derived mean gradients, larger effective orifice areas, and lower rates of PVL in comparison with previous generations of SAPIEN valves at 30 days with no difference in clinical outcomes.

WHAT IS NEXT? Continued follow-up is needed to assess long-term outcomes and valve durability.

REFERENCES

1. Solomonica A, Choudhury T, Bagur R. Newer-generation of Edwards transcatheter aortic valve systems: SAPIEN 3, Centera, and SAPIEN 3 Ultra. *Expert Rev Med Devices*. 2019;16:81–87.

2. Bartus K, Bavaria JE, Thourani VH, Xu K, Keuffel EL. Structural hemodynamic valve deterioration durability of RESILIA-tissue versus contemporary aortic bioprostheses. *J Comp Eff Res*. 2023;12:e220180.

3. Russo G, Tang GHL, Sangiorgi G, et al. Lifetime management of aortic stenosis: transcatheter versus surgical treatment for young and low-risk patients. *Circ Cardiovasc Interv*. 2022;15:915–927.

4. Basman C, Pirelli L, Singh VP, et al. Lifetime management for aortic stenosis: planning for future therapies. *J Cardiol*. 2022;80:185–189.

5. Edwards Sapien 3 Ultra Resilia Valve Approved and Launched in United States. Cardiac Interventions Today. Accessed January 17, 2024. https://citoday.com/news/edwards-sapien-3-ultra-resilia-valve-approved-and-launched-in-united-states

6. Chatfield A, Sathananthan J, Wood DA, Webb JG. Next-generation balloon-expandable transcatheter heart valve: the SAPIEN 3 Ultra valve. *Future Cardiol*. 2021;17:811–816.

7. STS/ACC TVT Registry. Data Collection; Version 3.0 Coder's Data Dictionary. Accessed January 17, 2024. https://www.ncdr.com/WebNCDR/tvt/publicpage/data-collection

8. Schoen FJ, Levy RJ. Bioprosthetic heart valve calcification: clinicopathologic correlations, mechanisms, and prevention. In: Aikawa E, Hutcheson JD, eds. *Cardiovascular Calcification and Bone Mineralization*. Cham, Switzerland: Springer International Publishing; 2020:183–215.

9. Bavaria JE, Griffith B, Heimansohn DA, et al. Five-year outcomes of the COMMENCE trial investigating aortic valve replacement with

RESILIA tissue. *Ann Thorac Surg*. 2023;115:1429–1436.

10. Okuno T, Terauchi K, Kai T, et al. Enhanced hemodynamic performance of a new-generation 23-mm balloon-expandable transcatheter heart valve. *J Am Coll Cardiol Intv*. 2024;17(3):454–456. https://doi.org/10.1016/j.jcin.2023.10.056

11. Généreux P, Piazza N, Alu MC, et al. Valve Academic Research Consortium 3: updated endpoint definitions for aortic valve clinical research. *J Am Coll Cardiol*. 2021;77:2717–2746.

12. Abbas AE, Mando R, Kadri A, et al. Comparison of transvalvular aortic mean gradients obtained by intraprocedural echocardiography and invasive measurement in balloon and self-expanding transcatheter valves. *J Am Heart Assoc*. 2021;10(19):e021014. https://doi.org/10.1161/JAHA.120.021014

13. Eng MH, Abbas AE, Hahn RT, et al. Real world outcomes using 20 mm balloon expandable SAPIEN 3/ultra valves compared to larger valves (23, 26, and 29 mm)–a propensity matched analysis. *Catheter Cardiovasc Interv*. 2021;98:1185–1192.

14. Barker M, Abbas AE, Webb JG, et al. Standardized invasive hemodynamics for management of patients with elevated echocardiographic gradients post-transcatheter aortic valve replacement at midterm follow-up. *Circ Cardiovasc Interv*. 2022;15:e011243.

15. ClinicalTrials.gov. Standardized Invasive Hemodynamics for Elevated Gradients Post TAVR (DISCORDANCE TAVR). Accessed January 17, 2024. https://clinicaltrials.gov/study/NCT04827238

16. Leon MB, Smith CR, Mack MJ, et al. Transcatheter or surgical aortic-valve replacement in intermediate-risk patients. *N Engl J Med*. 2016;374:1609–1620.

17. Nazif TM, Cahill TJ, Daniels D, et al. Real-world experience with the SAPIEN 3 Ultra transcatheter heart valve: a propensity-matched analysis from the United States. *Circ Cardiovasc Interv*. 2021;14:e010543.

KEY WORDS bioprostheses, heart valve prosthesis, propensity score, transcatheter aortic valve replacement

APPENDIX For supplemental tables, please see the online version of this paper.