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The ACURATE neo Transcatheter Heart Valve

A Comprehensive Analysis of Predictors of Procedural Outcome

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ABSTRACT

OBJECTIVES The aim of this study was to perform a comprehensive analysis of factors that affect procedural outcomes of transcatheter aortic valve replacement using the ACURATE neo prosthesis (Symetis/Boston, Ecublens, Switzerland).

BACKGROUND Predictors of procedural outcomes using the ACURATE neo prosthesis are poorly understood.

METHODS A total of 500 patients underwent transfemoral aortic valve replacement with the ACURATE neo prosthesis. Device landing zone calcification was stratified as severe, moderate, or mild. Anatomic and procedural predictors of second-degree or greater paravalvular leakage and permanent pacemaker implantation were assessed.

RESULTS Post-procedural second-degree or greater paravalvular leakage was more frequent with increasing device landing zone calcification (mild 0.8% vs. moderate 5.0% vs. severe 13.0%; $p < 0.001$), whereas permanent pacemaker implantation was independent of device landing zone calcification. More severe periannular calcification (odds ratio [OR]: 1.007; 95% confidence interval [CI]: 1.003 to 1.010; $p < 0.001$), less oversizing (OR: 0.867; 95% CI: 0.773 to 0.971; $p = 0.014$), the presence of annular plaque protrusions (OR: 2.756; 95% CI: 1.138 to 6.670; $p = 0.025$), and aortic movement of the delivery system after full deployment (OR: 5.593; 95% CI: 1.299 to 24.076; $p = 0.02$), and sinotubular junction height (OR: 1.156; 95% CI: 1.007 to 1.328; $p = 0.04$) independently predicted second-degree or greater paravalvular leakage. Predictors of permanent pacemaker implantation were pre-existing right bundle branch block (OR: 3.122; 95% CI: 1.261 to 7.731; $p = 0.01$) and more oversizing (OR: 1.111; 95% CI: 1.009 to 1.222; $p = 0.03$).

CONCLUSIONS Successful transcatheter aortic valve replacement using the ACURATE neo device predominantly depends on careful patient selection with appropriate oversizing and taking into account the individual anatomy and calcium distribution of the aortic root. (J Am Coll Cardiol Intv 2018;11:1721–9) © 2018 by the American College of Cardiology Foundation.

Transcatheter aortic valve replacement (TAVR) has become the standard therapy for elderly patients with aortic stenosis who are at high surgical risk or inoperable (1). Moreover, recent data have demonstrated that TAVR is noninferior to conventional surgery in intermediate-risk populations (2,3), which has been recently reflected in clinical guidelines (4). The majority of improvements

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ABBREVIATIONS AND ACRONYMS

AUC = area under the curve

CI = confidence interval

CV_{Ann} = calcium volume of the annular region

CV_{DLZ} = calcium volume of the device landing zone

DLZ = device landing zone

LVOT = left ventricular outflow tract

MDCT = multidetector computed tomographic

PPI = permanent pacemaker implantation

PVL = paravalvular leakage

RBBB = right bundle branch block

STJ = sinotubular junction

TAVR = transcatheter aortic valve replacement

in the field of TAVR are related to accumulation of knowledge and experience and the development of novel devices and delivery systems. The ACURATE neo (Symetis/Boston, Ecublens, Switzerland) is a new-generation self-expanding device that is characterized by an X-shaped stent design with a unique mechanism of deployment (5). Data from the Conformité Européene mark trial and a large post-market registry demonstrate favorable outcomes with a high rate of procedural success and low 30-day and 1-year mortality (6,7). In this study, we analyzed anatomic and procedural predictors of procedural success in a large cohort of patients implanted with the ACURATE neo valve at our institution.

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METHODS

STUDY COHORT. A total of 500 consecutive patients with severe aortic stenosis undergoing transfemoral TAVR using the ACURATE neo prosthesis at our center between May 2012 and September 2017 constituted the study population. The design of the ACURATE neo prosthesis (**Figure 1**) and details of the implantation technique have been described previously (5). In brief, for stable positioning of the device, it is recommended to keep the delivery system in the outer curvature of the arch and to maintain slight forward tension. A radiopaque intersection line in the stent body, commonly referred to as the "marker band," is frequently used to indicate the correct annular position. The deployment of the device consists of step 1, in which the upper crown and the stabilization arches are released, followed by the full release of the prosthesis in step 2. The prosthesis size was selected in adherence to the recommendation of the manufacturer on the basis of the maximum area-derived effective annular diameter. The final decision was at the discretion of the operator and, particularly regarding borderline sizes, depended on additional factors, including balloon sizing, patient stature, and device landing zone (DLZ) calcification. Baseline data including demographics, comorbidities, risk scores, and echocardiographic results were drawn from a prospective database. Informed consent was obtained from each patient. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee.

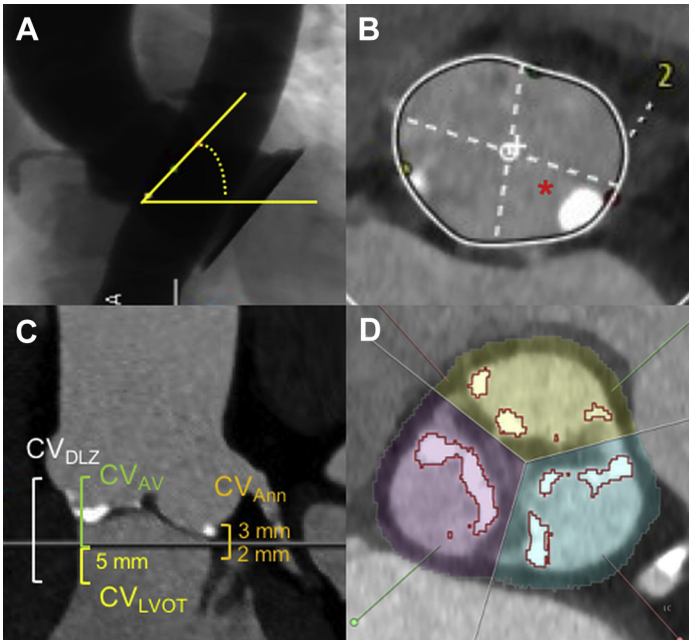
FACTORS WITH POTENTIAL IMPACT ON PROCEDURAL SUCCESS. Anatomic factors. Anatomic parameters were assessed with pre-procedural multidetector computed tomographic (MDCT) imaging, which was performed using a 64-slice or a 192-slice dual-source scanner (Somatom Definition or Force, Siemens Healthcare, Forchheim, Germany) as previously described (8). Datasets were analyzed offline using dedicated U.S. Food and Drug Administration-approved software (3mensio, Pie Medical, Amsterdam, the Netherlands) by a single reader with extensive experience in cardiac imaging who was blinded to clinical data. In addition to standard measurements, we determined the cover index (100 × [prosthesis diameter − MDCT annular size]/prosthesis diameter) for area- and perimeter-derived annulus diameter in systole and diastole, annular eccentricity (maximum/minimum annular diameter), and the aortoannular angle; we also identified annular plaques with intraluminal protrusion <4 or ≥4 mm (**Figure 2**) and noted the presence of a bicuspid aortic valve. The total calcium load of the DLZ was measured according to the Agatston method using non-contrast-enhanced MDCT imaging (9). The calcium volume of the DLZ (CV_{DLZ}) was measured on contrast-enhanced MDCT images using a scan-specific threshold as described elsewhere (10). Furthermore, we stratified according to CV_{DLZ} into groups of severe (>75th percentile), moderate (25th to 75th percentiles), and mild (<25th percentile) DLZ calcification (11). The aortic valve complex was divided into 3 regions in the craniocaudal axis for separate determination of the calcium volume of the aortic valve, calcium volume of the left ventricular outflow tract, and calcium volume of the annular region (CV_{Ann}) as specified in **Figure 2**. The calcium distribution across the 3 leaflets (left coronary, right coronary, and noncoronary) was measured for the aortic valve complex (CV_{DLZ} for the left, right, and noncoronary leaflets) and for each region (calcium volume of the aortic valve for the left, right, and noncoronary leaflets; calcium volume of the left ventricular outflow tract for the left, right, and noncoronary leaflets; and CV_{Ann} for the left, right, and noncoronary leaflets) (**Figure 2**). Asymmetrical distribution was determined by calculating the maximum absolute difference between the lowest and highest value of the calcium volume of each leaflet region (ΔCV_{DLZ}, Δ calcium volume of the aortic valve, Δ calcium volume of the left ventricular outflow tract, and ΔCV_{Ann}) (12).

Procedural factors. The implantation depth, relative expansion, and coaxial position of the prosthesis were analyzed on final angiography as previously described (Online Figure 1) (13). In addition, we recorded the position of the delivery system in relation to the ascending aorta and aortic arch (outer

FIGURE 1 ACURATE neo Prosthesis

The stabilization arches enable coaxial alignment, and the upper crown captures the native leaflets and provides coronary clearance. The X shape implies a unique anchoring mechanism in the landing zone.

FIGURE 2 Anatomic Factors

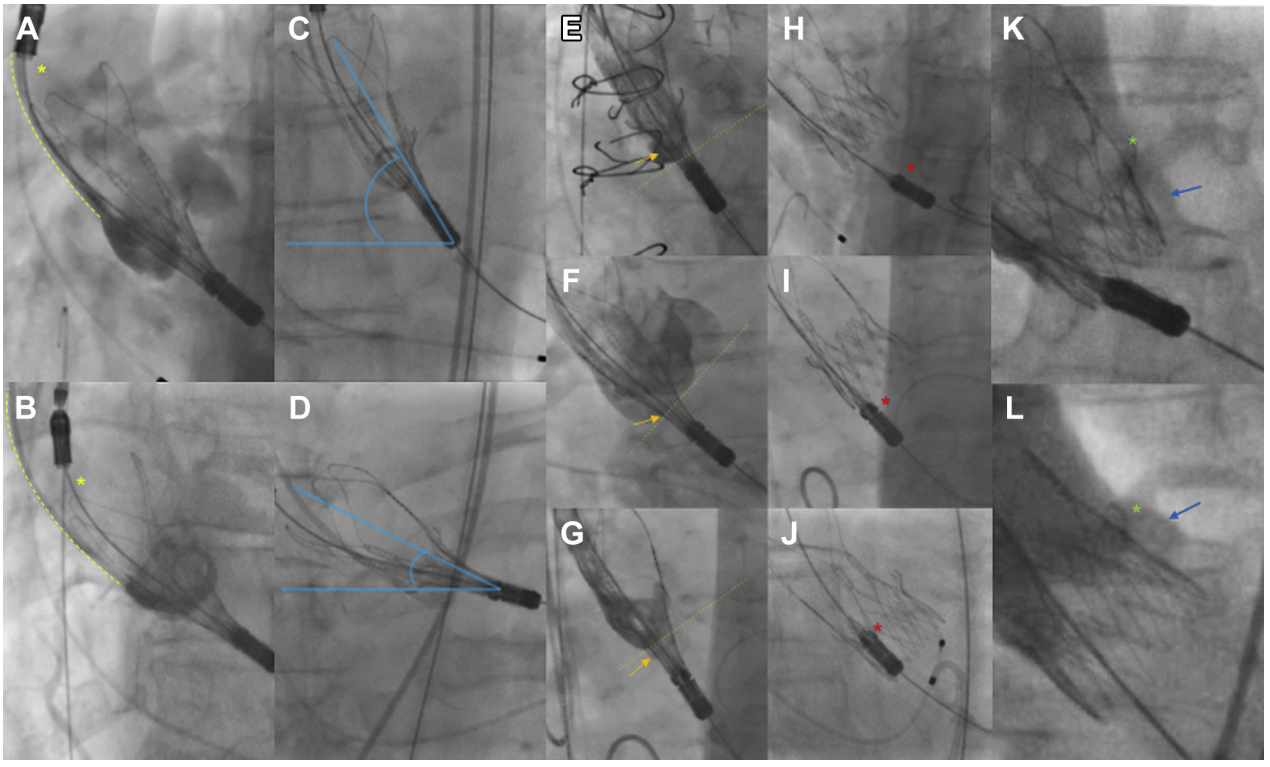


(A) Annular plaque with abluminal protrusion. **(B)** Aortoannular angle. Determination of the calcium volume of the device landing zone (CV_{DLZ}) and separately for the aortic leaflets (CV_{AV}), the left ventricular outflow tract (CV_{LVOT}), and the annular region (CV_{Ann}) in the craniocaudal axis **(C)** as well as separately for each leaflet region **(D)**.

curvature vs. midluminal) immediately before full deployment, a horizontal alignment of the prosthesis (<30° against the vertical plane), the annular position of the marker band, any movement of the stent holder right after full deployment (toward the left ventricle, no movement, toward the ascending aorta), the stability of the device position upon full release (stable vs. upward movement), and the position of the upper crown in relation to the native leaflet calcification (adjacent vs. remote) (**Figure 3**). The use of pre-dilatation, which was omitted in selected patients (13), and operator experience were also taken into consideration. An operator was defined as experienced after a minimum of 50 TAVR procedures with any device as first operator. The learning curve of the center was analyzed by comparison of the first 100 with the last 100 patients treated with the ACURATE neo device.

OUTCOMES OF INTEREST. The primary endpoints were predictors of second-degree or greater paravalvular leakage (PVL) and permanent pacemaker implantation (PPI), respectively. The secondary endpoints were 30-day mortality and device success according to the Valvular Academic Research Consortium 2 criteria (14). PVL was evaluated postprocedurally after deployment of the prosthesis and post-dilatation when necessary, but before any secondary measures such as implantation of a second valve or surgical valve replacement, and at discharge. For the assessment of PVL, transthoracic echocardiograms were independently reviewed by 2 experienced cardiologists, who were blinded to clinical data, with mutual consent in the case of disagreement, according to established criteria (15). On discharge echocardiography, we also localized the

FIGURE 3 Procedural Aspects



Position of the delivery system **(yellow asterisk)** before step 2 **(A)** in the outer curvature **(yellow dashed line)** and **(B)** midluminal; normal **(C)** and horizontal position of the device in the ascending aorta. High **(E)**, optimal **(F)**, and low **(G)** position of the device ("marker band" indicated by **yellow arrows**) in relation to the annular plane **(yellow dashed line)** before step 2. Movement of the stent holder **(red asterisk)** into the left ventricle **(H)**, no movement **(I)**, or toward the ascending aorta **(J)**. Remote **(K)** or adjacent **(L)** position of the upper crown **(green asterisk)** to the native leaflet **(blue arrows)**.

number and position of PVL in a short-axis view and measured the minimum and maximum diameter of the stent prosthesis for calculation of its eccentricity in diastole (Online Figure 2). Follow-up data were obtained at outpatient visits or via telephone interview.

STATISTICAL ANALYSIS. Continuous variables are expressed as median and interquartile range; categorical data are presented as numbers and percentages. Comparison of continuous data was performed using the Mann-Whitney signed rank test for paired data and the Mann-Whitney *U* test for unpaired data. For categorical data, the 2-sided Fisher exact test was applied. A stepwise logistic regression analysis (forward logistic regression) was carried out to specify independent predictors of second-degree or greater PVL and PPI; after exclusion of multicollinear covariates with variance inflation factors >5, appropriate variables that showed associations in the univariate analysis with p values ≤0.10 were included. A 2-sided p value < 0.05 was considered to indicate statistical significance. Statistical analyses were carried out using SPSS version 22.0 (IBM, Armonk, New York).

RESULTS

PATIENTS AND PROCEDURAL RESULTS. Baseline characteristics of the study population are summarized in **Table 1**. The median age was 82.1 years (interquartile range [IQR]: 78.8 to 85.3 years), 65.2% were women, and the Society of Thoracic Surgeons score was 4.4% (IQR: 3.1 to 6.6). DLZ calcification was severe, moderate, and mild in 124, 252, and 124 patients, respectively. **Figure 4** illustrates that second-degree or greater PVL was more common in patients with more severe DLZ calcification, whereas PPI was independent of DLZ calcification. An overview of procedural data is provided in **Table 2** and in Online Table 1. Device success was achieved in 89.6%. All-cause 30-day mortality was 3.4%.

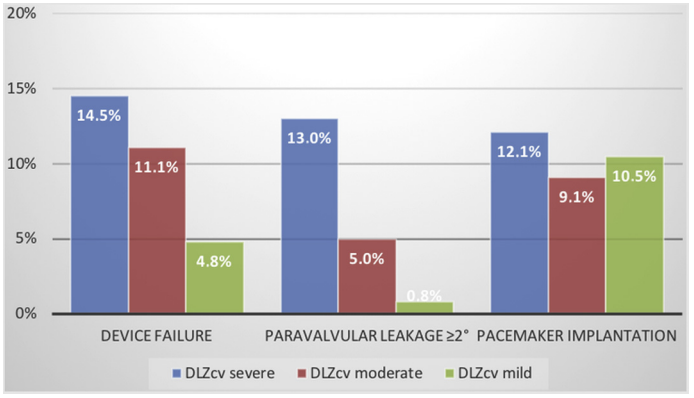
TABLE 1 Baseline Characteristics (n = 500)

Age, yrs	82.1 (78.8-85.3)
Female	326 (65.2)
Logistic EuroSCORE I, %	18.3 (11.9-26.6)
STS PROM, %	4.4 (3.1-6.6)
Body mass index, kg/m^2	26.8 (23.9-30.4)
eGFR, ml/min/1.73 m^2	64.0 (44.3-84.1)
Hypertension	474 (94.8)
Diabetes	176 (35.2)
COPD	169 (33.8)
Coronary artery disease	284 (56.8)
Prior stroke	52 (10.4)
Atrial fibrillation	197 (39.4)
Previous pacemaker	59 (11.8)
Ejection fraction, %	65.0 (55.0-65.0)
P_{mean}, mm Hg	42.0 (32.0-53.0)
Aortic valve area, cm^2	0.7 (0.6-0.8)

Values are median (interquartile range) or n (%).

COPD = chronic obstructive pulmonary disease; eGFR = estimated glomerular filtration rate; EuroSCORE = European System for Cardiac Operative Risk Evaluation; P_{mean} = mean transaortic gradient; PROM = Predicted Risk of Mortality; STS = Society of Thoracic Surgeons.

FIGURE 4 Outcomes in Relation to Device Landing Zone Calcification



Second-degree or greater paravalvular leakage and device failure (Valve Academic Research Consortium 2 [VARC-2]) increase with more severe device landing zone (DLZ) calcification, whereas permanent pacemaker implantation is independent of DLZ calcification. DLZcv = calcium volume in the device landing zone.

A comparison of the first 100 and the last 100 cases revealed that over time, patient selection for this device changed, with more distinct oversizing and less calcified DLZs in the last 100 cases with coincident declines in 30-day mortality, device failure, and second-degree or greater PVL (Table 3).

PARAVALVULAR LEAKAGE. Post-procedure, none or trace, mild, moderate, and severe PVL was noted in 193 (38.8%), 273 (54.8%), 29 (5.8%), and 3 (0.6%) of 499 patients, respectively. Discharge or final echocardiography was available in 499 subjects, with none or trace, mild, and moderate PVL in 199 (39.9%), 276 (55.2%), and 24 (4.8%), respectively. The circumferential distribution of PVL in the short-axis view is illustrated in Online Figure 3. Patients with moderate PVL more frequently had ≥2 leaks, and the leaks were most commonly located at the site of the left coronary cusp.

Predictors of second-degree or greater PVL. Online Table 2 lists the factors that were significantly associated with post-procedural second-degree or greater PVL.

In the multivariate analysis, increased CV_{Ann}, less oversizing (cover index for perimeter-derived annular diameter in diastole), presence of annular plaque protrusions, aortic movement of the delivery system after full deployment, and increased sinotubular junction (STJ) height were identified as independent predictors of post-procedural second-degree or greater PVL (Table 4).

The threshold for prediction of second-degree or greater PVL on the basis of CV_{Ann} was 97.0 mm^3 (area under the curve [AUC] = 0.773; 95% confidence interval [CI]: 0.702 to 0.845; $p < 0.001$), with sensitivity and specificity of 78.1% and 78.1%, respectively. In terms of oversizing, second-degree or greater PVL was discriminated by cover index for perimeter-derived annular diameter in diastole with a threshold of 4.4% (AUC = 0.647; 95% CI: 0.531 to 0.762; p = 0.009; sensitivity 75.1%, specificity 55.6%) or by cover index for perimeter-derived annular diameter in systole with a threshold of 2.5% (AUC = 0.645; 95% CI: 0.535 to 0.755; p = 0.01; sensitivity 79.9%, specificity 46.4%).

In the subgroup with severe DLZ calcification, independent predictors of second-degree or greater PVL were the presence of annular plaque protrusions, increased periannular calcification (ΔCV_{Ann}), and increased STJ height (Online Table 3).

PERMANENT PACEMAKER IMPLANTATION. A pre-existing right bundle branch block (RBBB), a higher degree of oversizing (cover index for perimeter-derived annular diameter in systole), and more aggressive pre-dilatation (higher ratio of balloon to annulus size) were significantly associated with the need for PPI (Online Table 4). In the multivariate analysis, independent predictors of PPI were pre-existing RBBB and cover index for perimeter-derived annular diameter in systole. The threshold for prediction of PPI on the basis of cover index for

TABLE 2 Procedural Outcomes and Complications (n = 500)

Device success (VARC-2)	448 (89.6)
All-cause 30-day mortality	16/483 (3.3)
Post-procedural ejection fraction, %	65.0 (60.0–65.0)
Post-procedural P_{mean}, mm Hg	8.0 (6.0–11.0)
Post-procedural AVA, cm^2	1.6 (1.4–1.9)
Second-degree or greater PVL (post-procedure)	32/499 (6.2)
Second-degree or greater PVL (at discharge)	24/499 (4.8)
Pacemaker implantation	51 (10.2)
Second valve	9 (1.8)
Conversion to sternotomy	9 (1.8)
Device embolization	6 (1.2)
Aortic root injury	0
Aortic dissection	1 (0.2)
Ventricular septum defect	1 (0.2)
Ventricular perforation	6 (1.2)
Coronary obstruction	0
Major bleeding	38 (7.6)
Major vascular complication	46 (9.2)
Major stroke	1 (2.0)
AKI stage 2 or 3	15 (3.0)

Values are n (%) or median (interquartile range).

AKI = acute kidney injury; AVA = aortic valve area; P_{mean} = post-procedural mean gradient, PVL = paravalvular leakage; VARC-2 = Valve Academic Research Consortium 2.

perimeter-derived annular diameter in systole was 3.6% (AUC = 0.594; 95% CI: 0.518 to 0.669; p = 0.03), with sensitivity of 81.6% and specificity of 37.0%.

SIZING RECOMMENDATION. Given that official sizing recommendations of the manufacturer have not been validated with clinical data, we elaborated a modified sizing chart that takes into account the required minimum oversizing to avoid post-procedural second-degree or greater PVL (Table 5). The new recommendations are based on the thresholds of cover index for perimeter-derived annular diameter in diastole and in systole with minimum oversizing of 4.4% and 2.5%, respectively.

DISCUSSION

We present a comprehensive analysis of anatomic and procedural factors that affect periprocedural outcomes based on the largest single-center transfemoral TAVR cohort treated with the self-expanding ACURATE neo device. Key findings were as follows. 1) Overall, the best outcomes were achieved in mild to moderate DLZ calcification (Figure 4). Second-degree or greater PVL was more common in patients with more severe DLZ calcification, whereas PPI was independent of DLZ calcification. 2) Predictors of second-degree or greater PVL were more severe periannular calcification (CV_{Ann}), less oversizing, the presence of annular plaque protrusions, increased STJ height, and aortic movement of the stent holder at full release of the prosthesis. 3) Predictors of PPI were pre-existing RBBB and more oversizing.

PROCEDURAL OUTCOMES. The device success of 89.6% noted in the present series is slightly lower than in previous reports (7). This may reflect not only real-world data but also the fact that this patient cohort includes many of the earliest patients treated globally with the ACURATE neo prosthesis, as illustrated in Table 3.

PARAVALVULAR LEAKAGE. Moderate or severe PVL following TAVR has been linked to worse outcomes, which is why there are sustained efforts to minimize this common complication of transcatheter valve therapy. Post-procedure, the frequency of second-degree or greater PVL was somewhat high (6.4%), but after second measures, including the implantation of a second valve or surgical valve replacement, it was reduced to 4.8% at discharge, which is in line with previous results (7,16). As stated earlier, we additionally noted a learning-curve effect, with substantial improvement over time (rate of second-degree or greater PVL of 11.0% in the first 100 cases vs. 3.0% in the last 100 cases, p = 0.03), which may be attributed largely to more oversizing and better patient selection, with less DLZ calcification, but also to a modified implantation technique.

Anatomic factors with impact on second-degree or greater PVL. The association between DLZ calcification and oversizing in relation to second-degree or greater PVL has been extensively investigated in recent years and was confirmed in the present cohort. Ours is the first demonstration, however, that for this specific device, increased calcification in the periannular region enables the best discrimination of post-procedural second-degree or greater PVL, with a threshold of 97.0 mm^3. Periannular calcification is commonly located at the base of the leaflets and may not be shifted aside as well as calcium deposits at the edge of the leaflets; hence, deposits at the base are likely to impair proper expansion of the ACURATE neo prosthesis given its relatively low radial force. The same mechanism accounts for the presence of annular plaque protrusions which were highly predictive of second-degree or greater PVL. The lower threshold of minimally required oversizing to prevent second-degree or greater PVL was 4.4% when using cover index for perimeter-derived annular diameter in diastole and 2.5% when using cover index for perimeter-derived annular diameter in systole. In

most previous studies, the cover index is reported to be higher, depending on the type of implanted prosthesis and the applied modality of annular measurement (17,18). The causal association between STJ height and PVL is not clear but may be related to a suboptimal anchoring mechanism of this device in a larger aortic root anatomy.

Procedural factors with impact on second-degree or greater PVL. Among procedural factors, only the displacement of the stent holder in aortic direction after full release of the prosthesis independently predicted second-degree or greater PVL, which would indicate tensile stress on the delivery system when during positioning of the prosthesis the final movement was in the aortic direction. This in turn might hamper a tight anchoring of the upper crown within the native leaflets, which itself was significantly associated with less second-degree or greater PVL and seems to be required for a better paravalvular sealing.

Interestingly, positioning the delivery system in the outer curvature of the arch and the position of the marker band in relation to the annular plane, both of which are recommended by the manufacturer, had no significant impact on the rate of second-degree or greater PVL rate. This does not necessarily devalue these recommendations, because particularly keeping the delivery system in the outer curvature and maintaining a certain forward tension on the delivery system in the moment of full device release may increase stability during deployment and minimize the risk for aortic movement. However, excessive forward pressure on the delivery system should be avoided because of the risk for device migration into the left ventricle, which occurred in a single case in the present series.

The seemingly paradoxical finding that patients who did not have pre-dilatation performed had a lower rate of post-dilatation is attributable to the fact that pre-dilatation was generally omitted in cases with mild or moderate DLZ calcification. Finally, in contrast to other self-expanding transcatheter heart valves (19), a horizontal position of the prosthesis did not affect the PVL rate, which can be attributed to the principle of top-down deployment and better coaxial alignment due to the stabilization arches.

SECOND-DEGREE OR GREATER PVL IN SEVERE DLZ CALCIFICATION. The high rate of second-degree or greater PVL, at 13% in the group with severe DLZ calcification, would not generally preclude these patients from treatment with the ACURATE neo prosthesis. Among subjects with severe DLZ calcification, the presence of annular plaque protrusions, an asymmetrical distribution of calcification in the periannular region (ΔCV_{Ann}) and increased STJ height predicted second-degree or greater PVL in this specific subgroup, meaning that in the absence of these risk factors, the use of the ACURATE neo may be considered despite of severe DLZ calcification.

TABLE 3 Center Experience and Learning Curve

	First 100 Cases	Last 100 Cases	p Value
Cover index, %			
Area-derived systolic	6.0 (4.0–8.1)	7.5 (5.3–9.7)	0.001
CV_{DLZ}, mm^3	648.0 (456.0–1,016.0)	547.0 (284.0–866.0)	0.006
Rapid pacing during deployment	82.0	0	<0.001
DS position during deployment			0.004
Outer curvature	81/99 (81.0)	63/99 (63.6)	
Midluminal	18/99 (18.0)	36/99 (36.4)	
Stent holder movement			0.16
None/left ventricular	99/99 (100.0)	97/99 (98.0)	
Aortic	0	2/99 (2.0)	
Marker band position			<0.001
Annular/infra-annular	31/99 (31.3)	77/99 (77.8)	
Supra-annular	68/99 (68.7)	22/99 (22.2)	
THV movement at full release	26.3	18.0	0.17
Upper crown adjacent to leaflet	76.0	90.0	0.005
All-cause 30-day mortality	5.0	1.3	0.18
Device success	86.0	94.0	0.06
Second-degree or greater PVL post-procedure	11.0	3.0	0.03

Values are median (interquartile range), %, or n/N (%).

CV_{DLZ} = calcium volume of the device landing zone; DS = delivery system; PVL = paravalvular leakage; THV = transcatheter heart valve.

PERMANENT PACEMAKER IMPLANTATION. The rate of PPI of 10.2% was within the range of previous data (7,16). Our findings that pre-existing RBBB and a higher degree of oversizing were predictors of PPI are consistent with what has been reported for other transcatheter heart valves (20). Theoretically, a cover index for perimeter-derived annular diameter in systole between 2.5%, as a minimum requirement to prevent moderate PVL, and 3.6%, as the upper limit

TABLE 4 Independent Predictors of More Than Mild Paravalvular Leakage

Multivariate Analysis	Odds Ratio	95% CI	p Value
CV_{Ann}, per mm^3	1.007	1.003–1.010	<0.001
Cover index for perimeter-derived annular diameter in diastole, per %	0.867	0.773–0.971	0.014
Plaque protrusion at annular level	2.756	1.138–6.670	0.025
Stent holder movement aortic	5.593	1.299–24.076	0.02
Sinotubular junction height, per mm	1.156	1.007–1.328	0.04

CI = confidence interval, CV_{Ann} = periannular calcium volume.

TABLE 5 Modified Sizing Recommendation

ACURATE neo Size	Annular Range According to Official Sizing Recommendation (mm)	Perimeter-Derived Annulus in Diastole (mm) (Oversizing)	Perimeter-Derived Annulus in Systole (mm) (Oversizing)
Small	21.0–23.0	20.0–22.0 (13.0%–4.4%)	20.0–22.4 (13.0%–2.6%)
Medium	23.0–25.0	22.1–23.9 (11.6%–4.4%)	22.5–24.3 (10.0%–2.8%)
Large	25.0–27.0	24.0–25.8 (11.1%–4.4%)	24.4–26.3 (9.6%–2.6%)

The modified sizing recommendations are based on perimeter-derived effective annular sizes with minimum oversizing of 4.4% for diastolic measurements and minimum oversizing of 2.5% for systolic measurements.

to protect against an increasing frequency of PPI, may represent an ideal range. The only procedural factor that was associated with a higher PPI rate was more aggressive pre-dilatation. Because this approach did not show any benefit with respect to PVL, less aggressive pre-dilatation may reduce PPI rates without affecting the occurrence of PVL, as demonstrated recently (21). In contrast to other THVs, we found no association between implantation depth and the need for PPI, which may be explained by the minimal protrusion into the left ventricular outflow tract and the relatively low radial force of the ACURATE neo.

STUDY LIMITATIONS. Apart from limitations inherent to a retrospective study, a key limitation is the fact that PVL was not adjudicated in a core laboratory. Furthermore, results from this single-center analysis may not be broadly generalizable; however, such a standardized and comprehensive in-depth investigation of factors that determine procedural outcome would have been difficult in a retrospective multicenter setting. With regard to the modified sizing recommendation, a residual bias attributable to interobserver and intraobserver variability of annular measurements must be taken into account, although with the use of dedicated software applications divergences are usually minimal (22). Nonetheless, validation in a separate cohort would be necessary to further confirm our findings.

CONCLUSIONS

Procedural success of transfemoral implantation of the ACURATE neo device requires careful patient selection with appropriate oversizing and recognition that best outcomes may be achieved in cases with only mild to moderate DLZ calcification. Less aggressive pre-dilatation may help reduce PPI rates, and maintaining forward pressure on the delivery system during deployment may decrease the likelihood of post-procedural PVL.

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PERSPECTIVES

WHAT IS KNOWN? The ACURATE neo is a self-expanding device with good clinical outcomes but with room for improvement.

WHAT IS NEW? The findings of the present study may help identify patients with aortic root anatomies that are suitable for the ACURATE neo device and help practitioners in refining implantation techniques to improve results.

WHAT IS NEXT? The selection of the appropriate type and size of a prosthesis tailored to patients' individual anatomic characteristics will become more important in transcatheter valve therapies. For future investigations, the focus should be shifted from mere prevention of severe complications to pursuing optimal outcomes, hence, to identify patients with an anatomy that is particularly suitable for a specific device.

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KEY WORDS aortic stenosis, aortic valve calcification, self-expandable, TAVR

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