Transcervical approach versus transfemoral approach for transcatheter aortic valve replacement

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ABSTRACT

Objectives: The transfemoral (TF) approach is the gold-standard access route for transcatheter aortic valve replacement (TAVR). Alternative approaches, among which the transcervical (TC) approach, are needed in some patients. We aimed to compare TC-TAVR with TF-TAVR.

Methods: All patients who underwent TAVR in our institution between 2016 and 2020, using Edwards SAPIEN family balloon-expandable transcatheter heart valves, were retrospectively included. Endpoints included 30-day all-cause mortality, procedural complications (according to the VARC-2 criteria), procedure duration, hospital length of stay (LOS) and echocardiographic outcomes. For 30-day all-cause mortality, we furthermore used a Cox proportional-hazards model to adjust for significant between-group differences in baseline characteristics as well as anesthesia modality.

Results: TAVR was performed in 306 patients, using a TF approach ($n = 255$) or a TC approach ($n = 51$). TC-TAVR was associated with significantly higher STS scores (4.06 [IQR (interquartile range), 2.05, 5.56] vs. 2.97 [IQR, 2.08, 4.88], $p < 0.001$) and higher prevalence of peripheral artery disease, history of stroke, previous cardiovascular surgery. 30-day mortality (hazard ratio, 0.87 [0.77, 9.77], $p = 0.909$) and stroke rates (2.0% vs. 1.6%, $p = 0.840$) were similar, as well as procedural duration (74.0 [53.0, 99.5] vs. 77.0 [58.0, 98.0] minutes, $p = 0.370$), LOS (6.0 [IQR, 3.0, 8.0] vs. 6.0 [IQR, 4.0, 9.0] days, $p = 0.175$) and postprocedural mean transvalvular gradient (10.00 [IQR, 8.00, 13.00] vs. 10.00 [IQR, 8.00, 12.00] mmHg, $p = 0.724$).

Conclusion: Despite a higher cardiovascular disease burden in TC patients, TC-TAVR and TF-TAVR yielded similar outcomes. TC-TAVR may be a safe alternative when TF-TAVR is contraindicated.

1. Background

First described in 2002 [1], transcatheter aortic valve replacement (TAVR) initially emerged as an alternative to surgical aortic valve replacement (SAVR) in patients who were ineligible for surgery. In the recent years, it has developed into a procedure that can now be considered in a large category of patients, including those at lower surgical risk [2,3].

Although transfemoral access is considered the default access strategy, 10–15% [4,5] of TAVR candidates are not suitable due to iliofemoral atherosclerosis, small or heavily calcified vessels, mural thrombus, extreme tortuosity or abdominal aortic aneurysms [6]. In these settings, alternative pathways have been developed and include the transapical (TA) [7], transaortic (TAo) [8], brachiocephalic (BC) [9], transcarotid (TCa) [10] and transsubclavian (TSc) [11] approaches. Each access

option must be individualized to the patient's anatomy and a deep pre-operative evaluation is of upmost importance. Previous retrospective studies suggest that the latter three might yield more favorable procedural and clinical outcomes than the transthoracic approaches (e.g. TA and TAo) and as such, may be considered as first-line alternatives to the TF approach [12–15]. However, there are only limited data comparing BC-, TCa- and TSc-TAVR (all accessible via a same transcervical [TC] approach) to TF-TAVR. We performed this single-center retrospective study to compare the TC and TF approaches with respect to procedural, safety and early clinical outcomes.

2. Methods

2.1. Patient population

The TF-TAVR program started in our institution in 2013, but TC-TAVR was introduced later, in January 2016. We included in the present study all patients who underwent TF- or TC-TAVR at Lausanne University Hospital (Centre hospitalier universitaire vaudois) using the same

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timeframe: between January 1st 2016 and May 31st 2020. In our institution, all TC-TAVR interventions were performed using balloon-expandable transcatheter heart valves (THVs) of the Edwards SAPIEN family (SAPIEN 3 and SAPIEN 3 Ultra). Therefore, in order to limit the risk of bias due to valve type, only TF-TAVR interventions using the Edwards SAPIEN family THVs were included.

All patients referred for TAVR underwent cardiac catheterization, followed by percutaneous coronary intervention if necessary, as well as cardiac and global vascular assessment with multislice computed tomography (CT) studies. Type of prosthesis was chosen considering aortic annulus area and perimeter, Valsalva sinus size, and distance between the aortic valve annulus and coronary arteries. Patients were not considered for TF approach if they had any of the following criteria: iliofemoral atherosclerosis precluding safe arterial puncture, small or heavily calcified vessels (diameter < 6 mm), mural thrombus, extreme tortuosity or abdominal aortic aneurysms. In these cases, TC approach was considered feasible if none of the following contraindications was met: small vessel diameter (<6 mm), prior ipsilateral carotid artery intervention, heavy artery calcification and tortuosity, stenosis (>50%) or occlusion of the contralateral carotid artery. TA and Tao approaches were finally considered as last alternative in case of non-feasibility of TF and TC approaches. Carotid ultrasonography was furthermore performed for TC-TAVR patients. Brain CT-scans or magnetic resonance imaging were not routinely performed prior to TC-TAVR.

2.2. Ethical statement

Our patients belong to the SWISS TAVI Registry. Authorization to use their data for research purposes was granted by the Vaud Canton ethics commission (*Commission cantonale d'éthique de la recherche sur l'être humain*), decision CER-VD 211/13, dated 10.05.2013. All patients provided written informed consent for the use of their data. Our study conforms to the ethical guidelines of the 1975 Declaration of Helsinki.

2.3. Procedural technique course

All procedures were performed in the catheter laboratory under fluoroscopic guidance, either under general anesthesia (GA) or local anesthesia with procedural sedation (LPS). Transesophageal echocardiography was performed to assess final valve positioning and paravalvular regurgitation only in patients under GA. Temporary right ventricular pacemaker was placed through the femoral vein, and ascending aortography was performed by femoral catheterization for all patients. No cerebral embolic protection system was used, either in the TF-TAVR or the TC-TAVR group. Patients were anticoagulated with heparin targeting an activated clotting time greater than 250 s. After the intervention, patients who underwent GA were usually extubated on-table. All patients were transferred to the recovery room, and then to the surgical intermediate care unit.

2.3.1. Transcervical TAVR surgical technique

The right side is the preferred access in our institution. Through an incision of 5–7 cm, performed along the anterior border of the sterno-cleido-mastoid muscle, the common carotid artery (CCA) is dissected and exposed. The choice of the puncture site is made intraoperatively, depending on local anatomy (vessel diameters, calcification) and accessibility for repair, with the right CCA being the predominant access site, followed by the right brachiocephalic trunk and right subclavian artery. The chosen vessel should be easily clamped upstream and downstream of the puncture site to make subsequent repair easy. A CCA cross-clamping test is systematically performed for 30 s to evaluate cerebral perfusion by continuous cerebral oximetry monitoring with near infrared spectroscopy cerebral oximeter. The procedure is aborted if a significant fall of oximetry parameters (>20%) is detected. The limit of 20% is frequently used, among others, in the setting of carotid endarterectomy, with a drop >20% being associated with an increased risk of cerebral

ischemia [16]. A purse-string suture is placed around the puncture site and a 6-Fr introducer sheath is inserted through the artery, with a stiff wire positioned in the left ventricle. It is then changed to a delivery sheath after preparation of the vascular puncture site using dedicated dilatators.

After the procedure, the artery is clamped distally to avoid any embolization, and the delivery catheter, wire and sheath are removed. Eventually, the artery is reconstructed using separate stitches, and the incision is closed over a small drain.

2.4. Endpoints

Endpoints were reported according to the updated Valve Academic Research Consortium (VARC-2) definitions [17]. They include perioperative characteristics of patients (among which procedure duration, conversion to open surgery), and postoperative endpoints (among which 30-day mortality, hospital lengths of stay [LOS], stroke, life-threatening bleeding, major vascular complications, new permanent pacemaker implantation and echocardiographic evaluation of valve function. All 30-day outcomes were collected via the SWISS TAVI Registry.

2.5. Statistical analyses

Categorical variables were reported as frequencies and percentages, and were analyzed using Pearson's χ^2 test. Continuous variables were tested for normality using the Shapiro-Wilk test and are expressed as means with standard deviations (SDs), or medians with interquartile ranges (IQRs). Student's *t*-test was used to compare normally distributed continuous variables, whereas Mann-Whitney test was used to compare non-normally distributed continuous variables. The 30-day survival curves were modeled using the Kaplan-Meier method and were compared using a log-rank test. A multivariate Cox proportional-hazards regression model that included all baseline variables with a *p* value of 0.1 or less for the between-group comparison, as well as anesthesia modality (GA or LPS), was used to perform an adjusted analysis of 30-day mortality.

Statistical analyses were carried out using SPSS 24.0 software (SPSS Inc., Chicago, Illinois, USA).

3. Results

Between January 1st 2016 and May 31st 2020, a total of 415 TAVR interventions were performed. Among them, 255 patients who underwent TF-TAVR and 51 patients who underwent TC-TAVR using SAPIEN 3 or SAPIEN 3 Ultra were included. The remaining 109 TAVR interventions were distributed as follows: TF-TAVR using self-expandable THVs: $n = 77$, TA- and TAo TAVR: $n = 32$. Baseline demographic, clinical and echocardiographic data are presented in Table 1. Overall, patients in the TC-TAVR group had significantly higher markers of cardiovascular disease burden, namely peripheral artery disease (41.2% vs. 14.1%, $p < 0.001$) and history of stroke (21.6% vs. 11.4%, $p = 0.049$). TC-TAVR was associated with a higher prevalence of previous cardiovascular surgery (23.5% vs. 11.0%, $p = 0.015$) and higher surgical risk, illustrated by significantly higher STS scores (4.06 [IQR, 2.05, 5.56] vs. 2.97 [IQR, 2.08, 4.88], $p < 0.001$) and a trend towards higher EuroSCORE II (3.91 [IQR, 2.70, 5.92] versus 3.31 [IQR, 2.00, 5.70], $p = 0.078$). TF-TAVR was associated with slightly higher body mass indexes (BMIs) (26.04 [IQR, 23.53, 29.73] kg/m^2 vs. 24.06 [IQR, 21.87, 27.43] kg/m^2, $p = 0.006$). The two groups were similar in respect to their other baseline clinical and echocardiographic characteristics.

3.1. Perioperative outcomes

Supplementary table shows the distribution of TCa, BC and TSc accesses in the TC-TAVR group: TCa was the most used (45.2%), followed

Table 1

Baseline clinical and echocardiographic characteristics of patients undergoing transapical versus transcervical TAVR.

	TF-TAVR (n = 255)	TC-TAVR (n = 51)	p value
Clinical characteristics			
Age, years, median (IQR)	83.0 (79.0, 87.0)	83.0 (80.0, 85.0)	0.916
Male	127 (49.8)	31 (60.8)	0.152
BMI, kg/m², median (IQR)	26.04 (23.53, 29.73)	24.06 (21.87, 27.43)	0.006
EuroSCORE II, median (IQR)	3.31 (2.00, 5.70)	3.91 (2.70,5.92)	0.078
STS score, median (IQR)	2.97 (2.08, 4.88)	4.06 (3.05, 6.56)	<0.001
NYHA Functional class			
• I-II	95 (37.7)	20 (39.2)	0.792
• III-IV	160 (62.3)	31 (60.8)	
Peripheral artery disease	36 (14.1)	21 (41.2)	<0.001
Previous pacemaker	24 (9.4)	7 (13.7)	0.351
Chronic pulmonary disease	33 (12.9)	9 (17.6)	0.373
Diabetes mellitus	62 (24.3)	14 (27.5)	0.636
Dyslipidemia	134 (52.6)	33 (64.7)	0.111
Previous cardiac surgery	28 (11.0)	12 (23.5)	0.015
Coronary artery disease	133 (52.1)	32 (62.7)	0.116
Hypertension	193 (75.7)	36 (70.6)	0.444
Stroke or TIA	29 (11.4)	11 (21.6)	0.049
Moderate to severe CKD	142 (55.7)	18 (35.3)	0.383
Bicuspid aortic valve	4 (1.6)	1 (2.0)	0.832
Preoperative creatinine, μmol/l, median (IQR)	95 (80, 117)	100 (73, 132)	0.464
eGFR, using the MDRD formula, ml/min (IQR)	57 (42, 60)	57 (37, 60)	0.848
Echocardiographic characteristics			
LVEF			
• > 50%	183 (71.8)	37 (72.5)	0.909
• 30–50%	58 (22.7)	11 (21.6)	0.854
• < 30%	14 (5.5)	3 (5.9)	0.911
Mean transvalvular gradient, mmHg, median (IQR)	40.0 (29.0, 48.0)	37.0 (28.0, 45.0)	0.724
AVA, cm², median (IQR)	0.70 (0.60, 0.81)	0.70 (0.60, 0.80)	0.960

Values are expressed as percentage, n (%), unless specified otherwise. TAVR: transcatheter aortic valve replacement, IQR: interquartile range, BMI: body mass index, STS score: Society of Thoracic Surgeons score, CABG: coronary artery bypass graft, NYHA: Hew York Heart Association, TF: transfemoral, TC: transcarotid, TIA: transient ischemic attack, CKD: chronic kidney disease, eGFR: estimated glomerular filtration rate, MDRD: Modification of Diet in Renal Disease, LVEF: left ventricle ejection fraction, AVA: aortic valve area.

by BC (37.2%) and TSc (17.6%). The right side was used for all but one case of TC-TAVR. TC-TAVR was aborted in 1 patient because of a significant drop of cerebral oximetry parameters.

Perioperative outcomes are presented in Table 2. The main difference was the use of GA, significantly higher in the TC-TAVR group compared to TF-TAVR (98.0% vs. 49.4%, p < 0.001). Other characteristics, including prostheses size, procedure duration, volumes of contrast medium and the rates of valve-in-valve procedures were not significantly different between the two groups.

3.2. Postoperative outcomes

Postoperative and 30-day outcomes are reported in Table 3. There were no significant differences between TF-TAVR and TC-TAVR regarding all-cause 30-day mortality (respectively 0.4% vs. 2.0%, p = 0.141) and hospital LOS (6.0 [IQR, 3.0, 8.0] days vs. 6.0 [IQR, 4.0, 9.0] days, p = 0.175). Kaplan-Meier survival curves are represented in Supplementary Figure. When the significantly different baseline variables

Table 2

Perioperative characteristics of patients undergoing transapical versus transcervical TAVR.

	TF-TAVR (n = 255)	TC-TAVR (n = 51)	p value
Prosthesis size, mm			
	5 (2.0)	3 (5.9)	0.109
• 20 mm	93 (36.5)	15 (29.4)	0.336
• 23 mm	108 (42.3)	24 (47.1)	0.384
• 26 mm	60 (23.5)	9 (17.6)	0.746
• 29 mm			
General anesthesia	126 (49.4)	49 (96.1)	<0.001
Valve malposition	6 (2.4)	2 (3.9)	0.522
Valve-in-valve TAVR	4 (1.6)	3 (5.9)	0.060
Periprocedural MI	0 (0.0)	0 (0.0)	NA
Procedure duration, min, median (IQR)	77.0 (58.0, 98.0)	74.0 (53.0, 99.5)	0.370
Contrast medium volume, ml, median (IQR)	110.00 (85.75, 150.00)	105.00 (80.00, 145.00)	0.157

Values are expressed as percentage, n (%), unless specified otherwise. TAVR: transcatheter aortic valve replacement, MI: myocardial infarct, IQR: interquartile range.

and anesthesia modality were included in the Cox regression analysis (Table 4), the hazard ratio for 30-day mortality in the TF-TAVR group vs. TC-TAVR group was 0.85 (95% CI, 0.07 to 9.99; p = 0.897). Interestingly, the rates of neurovascular complication at 30 days (stroke or transient ischemic attack [TIA]) were not significantly different (1.6% vs. 2.0%, p = 0.840). Likewise, no other significant difference was found for the other postoperative complications. Finally, there were no significant differences between TF-TAVR and TC-TAVR regarding mean transvalvular gradient (10.00 [IQR, 8.00, 13.00] mmHg vs. 10.00 [IQR, 8.00, 12.00] mmHg, p = 0.724) and the incidence of more than mild paravalvular aortic regurgitation (PAR) (3.9% vs. 3.9%, p = 1.000).

4. Discussion

The main findings of this study can be summarized as follows: between the 2 populations, (1) the 30-day all-cause mortality rates and LOS were similar; (2) the incidence of periprocedural and postoperative complications was not statistically different; (3) postoperative clinical and echocardiographic variables were similar. These results were

Table 3

Postoperative endpoints of patients undergoing transapical versus transcervical TAVR, according to the VARC-2 criteria.

	TF-TAVR (n = 255)	TC-TAVR (n = 51)	p value
All-cause 30-day mortality	1 (0.4)	1 (2.0)	0.141
Hospital LOS, days, median (IQR)	6.0 (3.0, 8.0)	6.0 (4.0, 9.0)	0.168
Permanent pacemaker implantation	32 (12.5)	6 (11.8)	0.877
New-onset atrial fibrillation or atrial flutter	21 (8.2)	8 (15.7)	0.097
Stroke or TIA at 30 days	4 (1.6)	1 (2.0)	0.840
Postoperative acute kidney injury	3 (1.2)	0 (0.0)	0.436
Cardiac tamponade	4 (1.6)	3 (5.9)	0.060
Life-threatening bleeding	6 (2.4)	3 (5.9)	0.173
Major vascular complication	13 (5.1)	2 (3.9)	0.722
Echocardiographic variables			
Mean transvalvular gradient, mmHg, median (IQR)	10.00 (8.00, 13.00)	10.00 (8.00, 12.00)	0.724
PAR			
• None and mild	245 (96.1)	49 (96.1)	1.000
• More than mild	10 (3.9)	2 (3.9)	

Values are expressed as percentage, n (%) unless specified otherwise. TAVR: transcatheter aortic valve replacement, LOS: length of stay, IQR: interquartile range, TIA: transient ischemic attack, PAR: paravalvular aortic regurgitation.

Table 4
Multivariable predictors of all-cause mortality at 30 days.

Variable	HR (95% CI)	p value
TC-TAVR vs. TF-TAVR	0.87 (0.77, 9.77)	0.909
STS score	1.12 (0.88, 1.43)	0.351
EuroSCORE II	0.98 (0.75, 1.27)	0.859
Peripheral artery disease	0.64 (0.06, 7.22)	0.715
BMI	1.06 (0.85, 1.34)	0.593
Previous cardiac surgery	0.52 (0.04, 6.93)	0.619
Stroke or TIA	0.13 (0.02, 1.10)	0.060
General anesthesia	0.68 (0.06, 7.62)	0.756

HR: hazard ratio, CI: confidence interval, TAVR: transcatheter aortic valve replacement, TF: transfemoral, TC: transcervical, BMI: body mass index, STS score: Society of Thoracic Surgeons score, TIA: transient ischemic attack.

obtained despite higher baseline surgical risk and morbidity associated with TC-TAVR. Overall, our study suggested the safety and feasibility of TC-TAVR.

The TC pathway allows the surgeon to choose between the TCa, BC and TSc accesses. The TCa access has been previously compared to the TF access: Watanabe and colleagues, in an unadjusted analysis comparing 83 TCa-TAVR and 643 TF-TAVR interventions, found similar 30-day mortality (respectively 8.4% and 5.0%, $p = 0.189$) and stroke rates (2.6% vs. 1.2%; $p = 0.428$), despite a higher surgical risk profile in TCa-TAVR patients (EuroSCORE II of 8.2 ± 6.7 vs. 6.4 ± 5.5; $p = 0.007$) [18]. In a retrospective study comparing 127 TCa and 399 TF interventions using a multivariate logistic model, Junquera and colleagues found respective 30-day mortality rates of 4.8% and 2.8% ($p = 0.26$) and 30-day stroke rates of 2.4% and 3.3% ($p = 0.81$). TCa patients had a higher prevalence of diabetes, chronic obstructive pulmonary disease, coronary artery disease, and peripheral vascular disease [19]. Amer and colleagues, in a retrospective study comparing TCa-TAVR and TSc-TAVR, found no difference between the two groups with regard to 30-day mortality (respectively 0% vs. 3%, $p = 0.355$), stroke (3% vs. 8%, $p = 0.393$), and vascular complications (3% vs. 4%, $p < 0.840$) [20]. Concerning the BC access, Philipsen et al. reported a 30-day mortality rate of 5%, with no stroke, major vascular complication or life-threatening bleeding at 30 days [9].

Overall, although our mortality rate was lower than previously reported, our data are in line with the precited studies in that the mortality and complication rates were not significantly different between TC-TAVR and TF-TAVR. Moreover, the higher baseline surgical risk and cardiovascular disease burden of the TC-TAVR group did not translate into longer LOS. This is in accordance with previous reports [18,19] and is also of relevance because a reduction of LOS is a critical element of current strategies to lower costs associated with TAVR.

From a technical standpoint, although the use of auto-expandable and balloon-expandable THVs has been reported for both TCa- [14] and TSc-TAVR [21], the balloon-expandable Edwards SAPIEN family THVs were exclusively used for TC-TAVR as well as all other non-TF-TAVR interventions in our institution. Furthermore, although both right and left sides have been used for TC-TAVR [13], we had a preference for the right side because, in our experience, using the right CCA, brachiocephalic trunk or subclavian artery provided an easier manipulation of the THV and its delivery system due to shorter distances between the access site and the aortic annulus, and a better alignment with the aortic root.

The choice of the best anesthesia modality in TF-TAVR (GA or LPS) is subject to debate and has changed in recent years, with GA being preferred during the early TAVR experience, and LPS becoming more popular. A study by Muller et al., which included 2007 GA and 4338 LPS patients from the SWISS TAVI Registry, suggested GA might be associated with less favorable clinical outcomes compared with LPS, with a higher 30-day all-cause mortality rate (HR: 1.46; 95% CI: 1.16 to 1.85) and a higher risk of life-threatening bleeding complications (HR: 1.60; 95% CI: 1.12 to 2.27) [22]. In our study, approximately one out of two

TF-TAVR interventions was not performed under GA, reflecting a change in practice during the course of our study period, as most interventions were performed under GA before 2018 while, with gained experience, LPS was started from 2018 on. No association between the type of anesthesia and 30-day mortality was found, possibly because of a limited population sample size. In contrast, most TC-TAVR interventions (96.1%) were performed under GA. LPS and GA have both been described in TCa, BC and TSc accesses. Some authors suggest favoring LPS because of a lower risk of respiratory complications [21], and because neurological monitoring may be easier [23].

The higher burden of cardiovascular diseases in TC-TAVR patients was expected, as these patients have a higher chance of presenting contraindications to the TF pathway. Some data suggest the atherosclerotic process may preferentially affect the femoral arteries, more than the carotid arteries [24]. Independently of a higher global atherosclerotic burden, TC-TAVR may be expected to have a higher risk of neurovascular complications, in particular when using the TCa and the BC accesses, due to direct injury to the carotid artery or to transient reduction in blood flow during surgery. However, this was not the case in our study, in which the incidence of stroke (2%) was actually lower than those reported in the multicenter French Transcarotid TAVR registry, as well as in previous other studies [14,18,19]. This is all the more important because stroke remains one of the most feared complications after TAVR. Our lower rate of neurological complications might have been influenced by several factors, which all remain speculative: (1) all patients undergoing TC-TAVR were carefully screened for CCA atherosclerotic plaques before intervention; (2) the functional integrity of the circle of Willis was systematically intraoperatively assessed using the CCA clamping test; (3) at the end of interventions, the access artery was reconstructed using interrupted sutures, thus allowing purging of intravascular debris by back-bleeding. Continuous monitoring of cerebral oximetry throughout the procedure and clinical monitoring in case of local anesthesia are paramount. Although embolic protection systems have been studied in TF-TAVR, literature in the setting of TC-TAVR is very scarce. Their role in the patients undergoing TC-TAVR requires further investigations to determine efficacy in the reduction of the risk of stroke [25]. In our study, the unique case of stroke in the TC group manifested as sudden left hemiplegia less than 24 h after TAVR, with a neurovascular CT-scan showing right CCA dissection, at the site of puncture. The patient underwent urgent resection of the dissected arterial segment and replacement with a prosthesis. At 30 days, the patient had persistent left hemispatial neglect.

5. Limitations

Our study was non-randomized and retrospective in nature, with two non-similar groups. However, a prospective randomized trial cannot in theory be performed to compare TC- and TF-TAVR as TC patients, by definition, have contraindications to TF-TAVR. Instead, we used a Cox proportional-hazards model that included all different patient characteristics at baseline and anesthesia modality in the 30-day mortality analysis. Furthermore, we only included interventions using the balloon-expandable Edwards SAPIEN family THVs, thus accounting for a potential important bias related to the type of valve. The results presented here are those of a single tertiary high-volume Swiss tertiary center and may not be applicable to other centers.

6. Conclusion

Despite higher surgical risk profile and cardiovascular burden, TC-TAVR provided similar results in terms of mortality, incidence of neurovascular complications, LOS and improvement in aortic valve function, compared with TF-TAVR. Our data support the recommendation that a TC approach may be considered a first-line alternative to TF-TAVR in patients with challenging femoral or aorto-iliac anatomy.

Further prospective trials are needed to confirm the safety and efficacy of TC-TAVR compared with other alternative approaches.

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Declaration of Competing Interest

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