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Transaortic transcatheter aortic valve implantation as a first-line choice or as a last resort? An analysis based on the ROUTE registry†

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Abstract

OBJECTIVES: Transaortic transcatheter aortic valve implantation (TAo-TAVI) is a recently developed alternative to transapical (TA) or transfemoral (TF) TAVI. We aimed to analyse the effectiveness and safety of TAo-TAVI as a first line approach and to compare it to patients receiving TAo-TAVI as a last resort, which is current practice.

METHODS: ROUTE is a prospective, multicentre registry to assess the clinical outcomes of TAo-TAVI. Patients without contraindications for TA- and TF-TAVI (TAo-first) were compared to patients with contraindications for both of these access routes (TAo-last). Outcome analysis was based on VARC II defined clinical end-points.

RESULTS: Three hundred and one patients were included, of which 224 patients met TAo-first and 77 TAo-last criteria. The valve was delivered and catheter retrieved successfully in all patients. In the TAo-first group, rates of conversion to open surgery and requirement for a second valve were low and not different compared to TAo-last patients (1% vs. 3%, $P = 0.46$ and 1% vs. 3%, $P = 0.46$, respectively). This was also true for the rate of paravalvular regurgitation ($\geq$moderate: 4% vs. 3%). All-cause mortality at 30-days was 6% vs. 5% ($P = 0.76$), rates of stroke 2% vs. 0% ($P = 0.24$), pacemaker implantation (11% vs. 4%, $P = 0.093$), and life-threatening bleeding 4% vs. 3% ($P = 0.70$). Valve safety (both 85%, $P = 0.98$) and clinical efficacy (80% vs. 82%; $P = 0.73$) did not differ between groups.

CONCLUSIONS: Although comparative data to TA and TF procedures were not available in the present analysis, findings suggest that TAo may be considered not only as a last resort strategy when classical access routes are deemed unfeasible, but also as a potential first-line option, with only low rates of paravalvular regurgitation and permanent pacemaker implantation.

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Keywords: Transcatheter Aortic Valve Implantation • Transaortic • Transfemoral • Transapical • SAPIEN • TAVI

INTRODUCTION

Transcatheter aortic valve implantation (TAVI) has become an accepted alternative to open surgery for treating high-risk patients with severe aortic stenosis. Although different access routes can be used for introduction of the catheter, the common femoral artery is typically preferred due to the advantages of percutaneous access and the avoidance of a thoracic incision, especially in high-risk patients. However, the presence of peripheral vascular disease (PVD), severe vessel tortuosity, calcification, or anatomical abnormalities of the peripheral vasculature preclude its use in a proportion of patients [1]. Transapical (TA) TAVI is generally used as alternative access route in patients where transfemoral (TF) TAVI is not feasible. The recently developed transaortic (TAo) approach uses an alternative access route, and is performed via a mini-sternotomy or anterolateral mini-thoracotomy. It has been suggested for use in patients with significant pulmonary disease, severely impaired left ventricular (LV) function, or fragile apex [2] and has been used successfully in patients with contraindications to TF- and TA-TAVI [3, 4], with complications such as dissection, rupture, and bleeding shown to be rare [2, 5].

The use of TAo-TAVI in patients without contraindications to other access routes is now on the rise. This is due to surgeons being very familiar with the insertion of catheters into the ascending aorta, as used in cannulation for extracorporeal circulation. Additionally, approaching the procedure via the left ventricular apex may be considered favourable by surgeons who have experience with ventricular assist device implantation [6]. Some early studies have suggested equivalent device success and early safety when TA and TAo procedures were compared [2, 3, 7]. Although there have been no direct comparisons between TF- and TAo-TAVI, observational studies suggest equivalent rates of 30-day mortality and a lower rate of vascular complications with the TAo approach [3, 5, 7–10].

Due to the lack of data on the use of alternative TAVI access routes as a first line approach, the Registry Of the Utilisation of the Transaortic TAVI approach using the Edwards Sapien Valve (ROUTE) [11] was set up.

The aim of the present ROUTE registry analysis was to analyse the safety and efficacy of TAo-TAVI as a first line approach in patients without contraindications for TA and TF access routes, and to compare these to patients receiving TAo-TAVI as a last resort due to a lack of alternative access options, which is the current clinical practice.

MATERIALS AND METHODS

Study design

ROUTE is a multicentre, multinational, prospective, observational registry established using data from 18 centres across Europe (NCT01991431) [11]. Patients were enrolled between February 2013 and February 2015. All patients included in the registry provided written informed consent, and ethical approval was obtained from the relevant committees at each site.

Patients

Inclusion criteria were severe aortic stenosis; an indication for TAVI as decided by a consensus of cardiac surgeons and cardiologists; and eligibility for the SAPIEN XT or a SAPIEN 3 THV (Edwards Lifesciences, Irvine, CA, USA) via the TAo access route [11]. All patients included were scheduled to undergo TAVI via the TAo approach, with this access route decision made by the institutional interdisciplinary Heart Team consisting of cardiac surgeons, cardiologists and anaesthesiologists; independently from the registry.

Patients were excluded if they displayed congenital unicuspid/bicuspid aortic valves; evidence of intra-cardiac mass, thrombus, vegetation, active infection, or endocarditis; inability to tolerate anticoagulation or antiplatelet agents; or excessive calcification of the access site. Furthermore, patients who were scheduled to receive a simultaneous procedure, such as a coronary artery bypass graft (CABG) were also excluded.

The decision to use the TAo approach was generally based on one of two concepts: either (i) TAo-TAVI was the default procedure preferred by the given centre, without having first excluded the feasibility of TA and TF routes (at least one of which would have been feasible) (first choice; TAo-first); or (ii) TAo-TAVI was chosen as a last resort following the exclusion of TA and TF route feasibility, which would otherwise have been the routes of preference (neither TA nor TF feasible, last resort; TAo-last). Based on the patient and procedural variables documented, patients were stratified into two groups on a post-hoc basis: TAo-first (meeting the criteria of decision concept 1) or TAo-last (meeting the criteria of decision concept 2).

Statistical analysis

Complication rates were defined according to the Valve Academic Research Consortium (VARC)-2 criteria [12]. Statistical analysis was performed using SAS version 9.4 (SAS Institute Inc.). Continuous variables are presented as means ± standard deviations (SD). Categorical variables are presented as absolute numbers and percentages. For comparisons between the TAo-last and TAo-first groups, the chi-square test or Fisher's exact test was used for categorical variables, and the t-test for continuous variables. The risk of overall 30-day mortality and other events during the 30 days of follow-up were calculated using a logistic model, which included age, gender, hypertension at baseline, PVD or hostile PV anatomy at baseline, aortic valve peak gradient [mmHg], and comorbidities potentially interfering with the access decision as possible risk factors. No inferential testing was performed and *P*-values reported are only of a descriptive nature.

RESULTS

A total of 309 patients were enrolled in ROUTE, of which 8 did not meet the inclusion criteria (Fig. 1). Out of the remaining 301 patients, TAo-TAVI was chosen preferentially for 224 patients, despite the heart team considering TA- and/or TF-TAVI to have been feasible (TAo-first group; Table 1). Conversely, 77 patients

underwent TAo-TAVI as a last resort based on the fact that the heart team considered them ineligible for TF and TA access routes due to contraindications (TAo-last group).

Patient characteristics

Patients in the TAo-first group had a mean age of 81.8 ± 5.9 years and 56% were female (Table 1). The ejection fraction was 52.9 ± 11.7% at an aortic valve peak gradient of 69.3 ± 22.9 mmHg. Symptoms were assessed as consistent with NYHA class III in 65% and class IV in 11% of patients. Frequent comorbidities were hypertension (74%), CAD (62%), and PVD/hostile PV anatomy (47%). The mean STS score was 9.4 ± 8.3%. Cardiac and non-cardiac comorbidities were found to be comparably frequent between the two groups, with the exception of hypertension, which was reported less often in TAo-first than TAo-last patients (74% vs. 86%; $P = 0.040$).

Procedural characteristics

Ministernotomy was the preferred access route in 288 out of 300 patients (Table 2). The principal comorbidities that may potentially have affected the access route decision in either group were PVD (22% overall; 20% TAo-first; 27% TAo-last) and hostile vessel status (19% overall; 9% TAo-first; 48% TAo-last).

The most frequently chosen valve size in the TAo-first group was the 26 mm valve (48%), followed by the 23 mm (30%) and 29 mm (22%) valves, with the SAPIEN XT used in 57% of cases. Pre-dilation of the aortic valve was performed in 80% of patients (Table 3).

Compared to patients in the TAo-last group, TAo-first patients underwent BAV more often (80% vs. 57%; $P < 0.001$) and had shorter procedural durations (98.5 ± 32.7 min vs. 131.4 ± 40.4 min; $P < 0.001$) and fluoroscopy times (11.5 ± 8.2 min vs. 14.9 ± 8.8 min; $P < 0.01$).

Procedural outcomes

In TAo-first patients, the valve was successfully delivered and the catheter retrieved in all patients (100%), with 99% of procedures considered to have been device successes (including absence of procedural mortality, correct positioning of a single bioprosthetic heart valve, and absence of moderate or severe paravalvular regurgitation or residual stenosis with a mean gradient above 20 mmHg) (Table 4). Periprocedural complications such as conversion to open surgery (1% vs. 3%; $P = 0.46$; adjusted OR: 0.5; 95% CI: 0.0–6.2), requirement for a second valve (1% vs. 3%; $P = 0.46$; adjusted OR: 0.4; 95% CI: 0.0–3.5), and permanent pacemaker implantation (5% vs. 1%; $P = 0.30$; adjusted OR: 6.2; 95% CI: 0.7–54.4;) were low and not associated with the type of access decision (first vs. last) according to multivariate analysis. The same was true for the rate of paravalvular regurgitation (3% vs. 2% ≥moderate, respectively). One patient in the TAo-last group with severe paravalvular leakage required reoperation in open surgery nine days after TAo-TAVI.

Post-procedure, the aortic valve peak pressure gradient in the TAo-first group had fallen significantly relative to baseline (from 69.3 ± 22.9 to 17.5 ± 7.7 mmHg; $P < 0.001$) and was similar to that of TAo-last patients (18.0 ± 7.9 mmHg; Fig. 2). There was a trend towards a greater peak pressure reduction in the TAo-last group (-59.6 mmHg vs. -51.8 mmHg; $P = 0.055$).

Overall, patients receiving TAo-TAVI were hospitalized for 9.9 ± 8.5 days with a mean stay in an intensive care unit (ICU) of 2.9 ± 5.7 days. No differences were seen between TAo-first compared to TAo-last groups in terms of length of hospitalization (9.6 ± 8.1 vs. 10.9 ± 9.7 days, respectively; $P = 0.27$) or ICU stay (3.0 ± 6.4 vs. 2.8 ± 2.6 days, respectively; $P = 0.80$).

30-day follow-up

Rate of all-cause mortality at 30 days was 6% in the TAo-first group, with a stroke rate of 2%, and life-threatening bleeding in 4% of patients (Table 5). Corresponding rates in the TAo-last

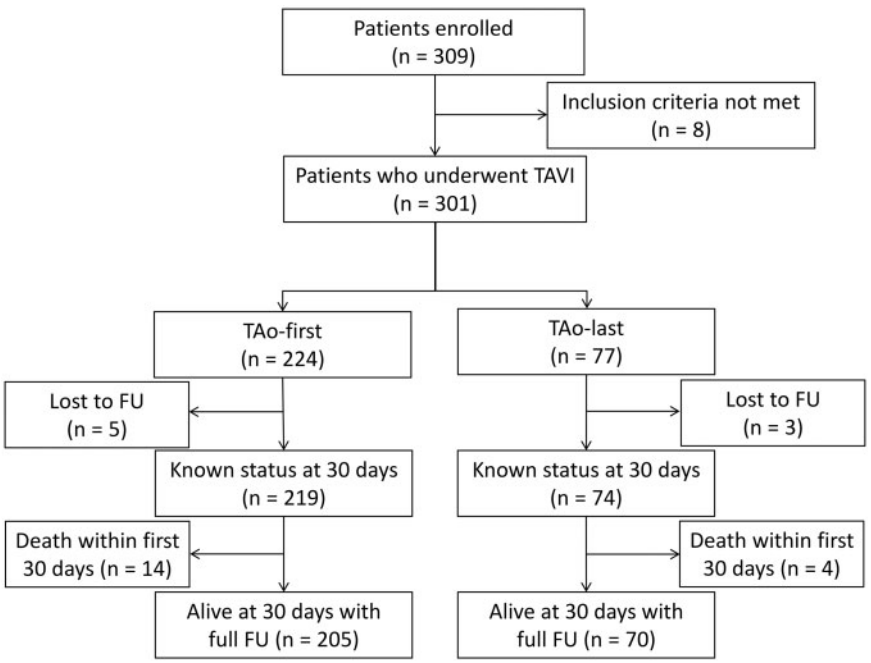

Figure 1: Patient flow chart. TAVI: transcatheter aortic valve implantation; TAo: transaortic; FU: follow up.

Table 1: Patient characteristics

	TAo-first choice $N = 224$ (mean [SD] or *n* [%])	TAo-last resort $N = 77$ (mean [SD] or *n* [%])	*P*-value (last vs. first)
Age [years]	81.8 ± 5.9	81.6 ± 6.1	0.82
Gender [% female]	125/224 (56)	37/77 (48)	0.24
Height [cm]	164.7 ± 10.2	164.8 ± 8.3	0.95
Weight [kg]	72.5 ± 17.6	71.3 ± 16.4	0.60
Current smoker	19/205 (9)	10/76 (1)	0.34
Cardiac characteristics			
Ejection fraction [%]	52.9 ± 11.7	51.3 ± 13.8	0.36
Aortic valve peak gradient [mmHg]	69.3 ± 22.9	77.6 ± 23.4	0.02
Aortic valve mean gradient [mmHg]	44.3 ± 15.5	44.4 ± 14.9	0.95
NYHA class			0.58
Class I	6/222 (3)	1/77 (1)	
Class II	47/222 (21)	18/77 (23)	
Class III	145/222 (65)	46/77 (60)	
Class IV	24/222 (11)	12/77 (16)	
Cardiac comorbidities			
CAD	138/224 (62)	46/77 (60)	0.77
Previous CABG	15/223 (7)	4/77 (5)	0.63
Previous MI	33(222 (15)	13/77 (17)	0.67
Other comorbidities			
Hypertension	165/222 (74)	66/77 (86)	0.04
Diabetes Mellitus	58/222 (26)	21/77 (27)	0.84
PVD or hostile PV anatomy	105/224 (47)	23/77 (30)	0.01
COPD	48/222 (22)	16/76 (21)	0.84
Creatinine ≥ 2.0 mg/dl	14/224 (6)	8/77 (10)	0.23
STS score [%]	9.4 ± 8.3	7.9 ± 4.8	0.14

V_{max}: maximum velocity; NYHA: New York Heart Association; CAD: coronary artery disease; CABG: coronary artery bypass graft; MI: myocardial infarction; PVD: peripheral vascular disease; COPD: chronic obstructive pulmonary disease; STS: Society of Thoracic Surgeons; TAo: transaortic.
[a]For comparison of all four NYHA classes.

Table 2: Access route

	TAo-first choice $N = 224$ *n* [%]	TAo-last resort $N = 77$ *n* [%]	*P*-value (last vs. first)
Access			<0.01
Ministernotomy	218/224 (98)	70/77 (91)	
Right anterior thoracotomy	5/224 (2)	7/77 (9)	
Comorbidities potentially interfering with access route decision			<0.001
PVD	45/224 (20)	21/77 (27)	
Vessel status	20/224 (9)	37/77 (48)	
Significant respiratory disease	8/224 (4)	6/77 (8)	
Poor LV function	3/224 (1)	5/77 (7)	
Multiple re-do surgeries	4/224 (2)	0/77 (0)	
High stroke risk	2/224 (1)	3/77 (4)	
Chest wall deformity	1/224 (1)	1/77 (1)	

PVD: peripheral vascular disease; LV: left ventricular; TAo: transaortic.

group were comparable (5%, 0% and 3%, respectively), with no differences between groups and no effects related to the type of access decision (first vs. last) detected at multivariate analysis (adjusted for baseline characteristics). The same was true in terms of an increase in creatinine, rate of MI, and valve-related dysfunction requiring a repeat procedure. Indeed, the only notable difference in 30-day outcomes was a higher rate of temporary dialysis in TAo-last patients compared to TAo-first (11% vs. 3%; $P = 0.014$). After adjusting for baseline parameters, multivariate analysis also suggested that temporary dialysis was less likely in the TAo-first condition (adjusted OR: 0.2; 95% CI: 0.0–0.8).

Early safety (defined as an absence of mortality, stroke, life-threatening bleeding, acute kidney injury stage 2 and 3, coronary obstruction, major vascular complication and valve-related dysfunction requiring operation or reintervention) was 81% in both groups ($P = 0.98$). Clinical efficacy (defined as absence of

Table 3: Procedural characteristics

	TAo-first choice $N = 224$ (mean [SD] or *n* [%])	TAo-last resort $N = 77$ (mean [SD] or *n* [%])	*P*-value (last vs. first)
Valve size			
23 mm	66/223 (30)	17/77 (22)	0.27
26 mm	108/223 (48)	37/77 (48)	
29 mm	49/223 (22)	23/77 (30)	
Valve type			0.55
SAPIEN XT	128/224 (57)	47/77 (61)	
SAPIEN 3	96/224 (43)	30/77 (39)	
Pre-TAVI balloon dilatation completed	178/223 (80)	44/77 (57)	<0.001
Post-TAVI balloon dilatation	53/223 (24)	17/77 (22)	0.76
Duration of procedure [min]	98.5 ± 32.7	131.4 ± 40.4	<0.001
Fluoroscopy time [min]	11.5 ± 8.2	14.9±8.8	0.003
Volume of contrast agent [ml]	99.1 ± 44.5	111.7 ± 63.0	0.10

TAVI: transcatheter aortic valve implantation; TAo: transaortic.
[a]For comparison of all valve sizes.

Table 4: Procedural outcomes

	TAo-first choice $N = 224$ (mean [SD] or *n* [%])	TAo-last resort $N = 77$ (mean [SD] or *n* [%])	Univariable unadjusted OR (95%CI)	Multivariable adjusted[c] OR (95%CI)
Valve delivered and catheter retrieved	220/220 (100)[b]	77/77 (100)	n.a.	n.a.
Device success	221/223 (99)	75/77 (97)	3.0 (0.4–21.3)	3.3 (0.3–31.7)
Conversion to open surgery	3/223 (1)	2/77 (3)	0.5 (0.1–3.1)	0.5 (0.0–6.2)
Second valve required	3/223 (1)	2/77 (3)	0.5 (0.1–3.1)	0.4 (0.0–3.5)
Atrioventricular block	13/223 (6)	2/77 (3)	2.3 (0.5–10.5)	2.0 (0.4–11.1)
Permanent pacemaker implantation	10/223 (5)	1/77 (1)	3.6 (0.5–28.3)	6.2 (0.7–54.4)
Access complications	5/223 (2)	1/77 (1)	1.7 (0.2–15.2)	1.3 (0.1–15.1)
Dissection	2/223 (1)	0/77 (0)	n.a.	n.a.
Rupture	1/223 (0)	1/77 (1)	0.3 (0.0–5.5)	0.3 (0.0–51.6)
Severe bleeding	3/223 (1)	0/77 (0)	n.a.	n.a.
Paravalvular regurgitation			0.6 (0.3–1.4)[a]	n.a.
None/trace	171/223 (77)	62/77 (81)		
Mild	44/223 (20)	13/77 (17)		
Moderate	7/223 (3)	1/77 (1)		
Severe	1/223 (0)	1/77 (1)		
Central regurgitation			0.7 (0.1–3.5)	n.a.
None/trace	212/223 (95)	74/77 (96)		
Mild	11/223 (5)	3/77 (4)		
Moderate	0 (0)	0 (0)		
Severe	0 (0)	0 (0)		

TAo: transaortic.
[a]For comparison of all four grades of regurgitation.
[b]For three patients no information was available.
[c]Adjusted for age adjusted for age, gender, hypertension at baseline, PVD or hostile PV anatomy at baseline, aortic valve peak gradient [mmHg] and comorbidities interfering with decision.

mortality, stroke, rehospitalization, NYHA class III or IV, valve-related dysfunction with mean residual gradient > 20 mmHg, or moderate or severe paravalvular leak) was also similar between the TAo-first and TAo-last groups (80% vs. 82%, respectively; $P = 0.73$). At multivariate analysis, after adjusting for baseline characteristics, no effect of the type of access decision (first vs. last) was detected for either early safety (adjusted OR: 1.1; 95% CI: 0.5–2.5) or clinical efficacy (adjusted OR: 1.0; 95% CI: 0.4–2.2).

DISCUSSION

The present analysis was performed to assess the feasibility and safety of a first-line TAo-TAVI approach (TAo-first) under routine clinical conditions. TAo-first patients were further compared to those for whom TAo-TAVI was chosen only because of contraindications to both the TA and TF access routes, which is current practice at most sites. It was found that first-line TAo-TAVI was highly successful, with low rates of

paravalvular regurgitation and permanent pacemaker implantation. Thirty-day mortality was 6% and only 2% of the patients suffered from stroke, with just 4% experiencing life-threatening bleeding.

Baseline characteristics and comorbidities potentially interfering with access route decision

In order to address all of the study aims, the registry gathered data on preoperative patient characteristics as well as the clinical decision pathway leading to the TAo-TAVI intervention. At baseline, surgical risk and most comorbidities/disease parameters were generally well balanced between groups. One (perhaps surprising) difference was the proportion of patients found to have PVD or hostile PV anatomy in each group, applying to only 30% of patients in the TAo-last group compared to 47% of the TAo-first group. However stratification into the two patient subsets was based on overall feasibility (or lack thereof) and although PVD sometimes precludes the use of TF access, it is neither the sole reason nor always a contraindication. Indeed, there are many PDV patients in clinical practice who are suitable for TF-TAVI, such as those with obliterative disease of the thigh, inguinal area or lower limb and those for whom minimal lumen diameter is above 5.5 mm. Thus, it does not necessarily follow that half of TAo-first patients automatically had contraindications to the TF route, nor that clinical decision-making was inappropriate.

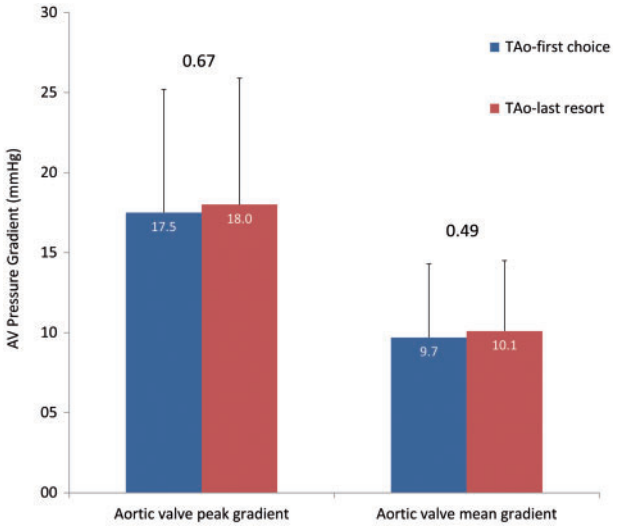

Figure 2: Aortic gradients. AV: aortic valve; TAo: transaortic.

Procedural outcomes

Procedural outcomes were excellent in TAo-first patients, with all patients having the valve delivered and the catheter retrieved. Furthermore, the significant drop in peak pressure gradients across the aortic valve suggest excellent efficacy of the prosthesis. The finding that this reduction was nominally greater in TAo-last patients is likely due to their higher baseline values for this variable, rather than the conditions of the access route decision. Complications included conversion to open surgery in three patients (1%), the requirement for a second valve (1%), AV block in 13 patients (6%) and pacemaker implantation in 10 patients (5%). Moderate and severe paravalvular regurgitation was seen in 3% and 0% of the patients, respectively. There numbers are all within expectation.

The 26 mm valve was the most commonly used valve type in TAo-first patients, which is in agreement with other studies regarding TF-, TA- and TAo-TAVI [5]. The mean duration of procedure and fluoroscopy were found to be significantly shorter for

Table 5: 30-day follow-up

	TAo-first choice $N = 219$ *n* [%]	TAo-last resort $N = 74$ *n* [%]	Univariable unadjusted OR (95%CI)	Multivariable adjusted[e] OR (95%CI)
All-cause mortality	14/219 (6)	4/74 (5)	1.2 (0.4–3.8)	1.0 (0.3–3.8)
Stroke	4/219 (2)	0/74 (0)	n.a.	n.a.
Life-threatening bleeding	8/219 (4)	2/74 (3)	1.4 (0.3–6.6)	0.9 (0.2–5.0)
Acute kidney injury[a]				
Temporary dialysis	7/216 (3)	8/71 (11)	0.3 (0.0–0.7)	0.2 (0.0–0.8)
Increase in creatinine [b]	4/213 (2)	1/70 (3)	1.3 (0.1–12.0)	0.7 (0.0–12.1)
Myocardial infarction	1/219 (1)	2/74 (3)	0.2 (0.0–1.8)	0.2 (0.0–4.4)
Major vascular complication	8/219 (4)	2/74 (3)	1.4 (0.3–6.6)	1.1 (0.2–6.7)
Valve-related dysfunction requiring repeat procedure	1/219 (1)	0/73 (0)	n.a.	n.a.
Permanent pacemaker implantation	23/220 (11)	3/74 (4)	2.8 (0.8–9.5)	2.6 (0.7–9.9)
Early safety [c]	179/220 (81)	60/74 (81)	1.0 (0.5–2.0)	1.1 (0.5–2.5)
Clinical efficacy [d]	176/219 (80)	60/73 (82)	1.1 (0.6–2.2)	1.0 (0.4–2.2)

[a]Patients with dialysis pre-intervention excluded.
[b]Creatinine increase of ≥ 4.0 mg/dl or ≥ 200% according to AKIN.
[c]Early safety defined as absence of mortality, stroke, life-threatening bleeding, acute kidney injury stage 2 and 3, coronary obstruction, major vascular complication and valve-related dysfunction requiring operation or reintervention.
[d]Clinical efficacy defined as absence of mortality, stroke, rehospitalization, NYHA class III or IV, valve-related dysfunction with mean residual gradient > 20 mmHg, or moderate or severe paravalvular leak.
[e]Adjusted for age adjusted for age, gender, hypertension at baseline, PVD or hostile PV anatomy at baseline, aortic valve peak gradient [mmHg] and comorbidities interfering with decision.

the TAo-first group, whereas the reduced volume of contrast agent did not reach statistical significance. This is likely due to the greater experience of the surgeons that carried out the implantation for the TAo-first group. The centres where these patients were enrolled used TAo access as their standard approach and so would be more familiar with the technique in comparison to the surgeons at the sites that only used TAo as a last resort. While all surgeons that took part in the study underwent extensive training, in addition to the requirement of having carried out at least five TAo-TAVI procedures, a gap in the level of experience between centres was inevitable.

Paravalvular and central regurgitation rates were similar between the two groups, with more than 95% of patients being classed as none/trace or mild. No patient was classified as having moderate or severe central regurgitation, whereas moderate or severe paravalvular regurgitation was reported in 2% vs. 3% of patients in the TAo-last and TAo-first groups. These values are comparable to the 4.6% and 2.9% previously reported for TAo-TAVI [2, 8], the 2.3% and 2.2% reported for TA-TAVI [2], and the 1.5% and 6.6% reported for TF-TAVI [13]. Other studies also noted similar rates of regurgitation; however, it is difficult to directly compare values as different valve types were used and classification of this event is only qualitative and highly variable between publications [5].

30-day outcomes

All-cause 30-day mortality was 6% for the TAo-first patients, with rates for TAo-last patients being nominally lower (5%). The mortality rates for TAo-TAVI reported in the literature range from 6.8–14% [3, 5, 7, 8]. For TA-TAVI on the other hand, 30-day mortality has been documented to be slightly higher, with a range of 7.7–18.2% [3, 10], while the values for TF-TAVI are slightly lower at 4.2–11.1% [9, 14]. Thus, the observed mortality rates for TAo-first are at the lower end of what has been reported by other data sources.

A permanent pacemaker was implanted in 11% of the TAo-first patients, which was higher than the 4% documented for the TAo-last cohort, without reaching statistical significance. These rates vary between 2%–11.4% in the literature [5, 7, 8]. While values for TA-TAVI range from approximately 6.2%–11.6%, those for TF-TAVI are generally below 7% [14]. Increased pacemaker rates have been reported for the SAPIEN 3 vs the SAPIEN XT valves, although the use of these valve types was not different between groups. Implantation height, which was not recorded in the present dataset, may be another explanatory variable, as has been reported in a recent analysis of more than 577 patients receiving either the SAPIEN XT or the SAPIEN 3 [15]. In this analysis, the mean implantation height was significantly lower in patients requiring pacemaker implantation (aortic/ventricular stent extension 67%/33% vs 72%/28%, respectively; $P = 0.032$). At multivariate regression analysis, implantation height was the only independent predictor of pacemaker implantation (OR 0.94; 95% CI: 0.90–0.99; $P < 0.01$).

Acute kidney injury with need for temporary dialysis was diagnosed more often in the TAo-last group, and was the only variable associated with the type of access route decision (first vs last) at multivariate analysis. One reason for this effect may be the differences in procedure time and volume of contrast agent used. The rates of other complications during the 30-day follow-up period were all low and roughly equivalent between the two groups. Furthermore, they corresponded to those previously reported for TAo-TAVI [7, 8].

Limitations

There were some limitations to the present analysis. Firstly, the procedures carried out on TAo-last patients were performed at institutions where TAo-TAVI was not the standard approach. As such, the surgeons at these centres would inevitably have less experience in performing the implantation. The effect of this was minimised by ensuring that all surgeons had completed at least five TAo-TAVI procedures prior to taking part in the study. Furthermore, every surgeon underwent extensive training according to the Edwards Standard Operating Procedure. A second limitation is the observational nature of the registry, meaning that the decision to perform TAo-TAVI was made by an institutional interdisciplinary Heart Team based on assessment of anatomical and clinical conditions, likely resulting in two distinct patient populations. Due to the nature of the clinical decision required, it was not possible to provide randomized or risk-adjusted data, and this may have been a source of bias during comparisons. However, the observational aspect may also be seen as an advantage, as it offers valuable insight into the real-world rationale behind access route selection. Finally, there was a low rate of adverse events during the 30-day follow-up period, which makes it difficult to compare outcomes between the two groups of patients. However, this demonstrates the excellent safety of the TAo-TAVI approach.

CONCLUSIONS

Although comparative data to TA and TF procedures were not available in the present analysis, the ROUTE registry provides valuable data on the efficacy and safety of TAo as a first-line access choice in patients with severe symptomatic aortic stenosis undergoing TAVI. Findings suggest that TAo may be considered not only as a last resort strategy when classical access routes are deemed unfeasible, but also as a potential first-line option, with only low rates of paravalvular regurgitation and permanent pacemaker implantation. Future observational studies comparing each of the alternative access routes as first-line procedures would be useful.

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