

Outcome of transcatheter versus transthoracic access for transcatheter aortic valve replacement

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Abstract

Backgrounds:

Short-term outcome of transcatheter aortic valve replacement (TAVR) through transcarotid access (TC) and transthoracic access (TT) such as transapical or transaortic has been reported as alternative access options in patients who were not feasible with transfemoral access. However, mid to long-term outcomes have been poorly documented. The purpose of this study was to evaluate postoperative outcomes comparing TC with TT groups.

Methods

Between January 2016 and January 2024, 93 patients underwent TAVR through TC access while 62 through TT access. To adjust baseline differences, 1:1 propensity score matching was performed using the nearest neighbor method between the TC and TT groups.

Results

38 pairs were matched in propensity score matching. A significant higher incidence of postoperative new atrial fibrillation was detected in the TT compared with TC groups (10.5% vs 0%, $p = 0.04$). 30-day mortality rate, postoperative stroke, permanent pacemaker placement, and surgical reintervention for access site did not differ between the two groups. Length of hospital stay was shorter in the TC group (4.9 ± 5.5 days vs 7.7 ± 4.8 days, $p = 0.02$). Mean follow-up term was 2.3 ± 2.1 years. Cumulative survival rate in 5 years was 70.1% in the TC group and 54.3% in the TT group. There was no significant difference in mid-term outcome between the 2 groups ($p = 0.47$).

Conclusions

Transcatheter aortic valve replacement through transcarotid access was associated with lower rate of new postoperative atrial fibrillation and shorter hospital stay compared with transthoracic access. However, short and mid-term survival rates were comparable in this patient cohort.

Introduction

Transcatheter aortic valve replacement (TAVR) has become the standard treatment for severe symptomatic aortic stenosis across all surgical risk categories due to its favorable clinical outcomes and reduced procedural invasiveness compared with surgical valve replacement (1). Although transfemoral access remains the preferred route for TAVR, approximately 5–10% of patients are not candidates because of unfavorable iliofemoral anatomy, including severe peripheral arterial disease, vessel tortuosity, extensive calcification, or small vessel caliber (5, 14). Historically, transthoracic (TT)

approaches, including transapical and transaortic access, represented the predominant alternatives when transfemoral access was not feasible. However, these approaches require thoracotomy and are associated with greater procedural invasiveness, longer recovery, and higher perioperative morbidity. As device technology and operator experience have evolved, extrathoracic access strategies such as transcarotid (TC) access have emerged as attractive alternatives. Recent registry analyses and multicenter studies have demonstrated favorable short-term outcomes with TC access, including lower rates of mortality, atrial fibrillation, and prolonged hospitalization compared with TT approaches (2–4, 7). Consequently, TC access has become one of the most frequently utilized nonfemoral access strategies and is increasingly favored by contemporary expert consensus recommendations. Despite growing adoption, most comparative studies have focused on early outcomes, with follow-up limited to 30 days or 1 year. Data regarding the durability of these results and the impact of access strategy on mid-and long-term outcomes remain limited (4). The purpose of this study was to compare perioperative and mid-term outcomes following TC and TT TAVR in a contemporary single-center cohort using propensity score matching. We hypothesized that TC access would be associated with improved perioperative outcomes while providing comparable mid-term survival relative to TT access.

Patients and Methods

This study included consecutive 93 patients who underwent TAVR through TC access and 62 patients through TT access at Albany Medical Center between January 2016 and January 2024. Of 62 with TT access, 54 experienced transapical (TA) approach while 6 had transaortic (TAo) approach. All patients in the TC and TT groups received SAPIEN 3 (Edwards) balloon expandable valve. All patients were evaluated by structural heart team, and the decision of TC or TT accesses in patients who were not feasible for transfemoral access were decided according to preoperative computer tomography angiography. Postoperative outcomes in the TC group were compared with those in the TT group. Primary endpoint was early mortality and survival rates in 5 years. The early mortality was defined as mortality within 30 days from TAVR procedure. Secondary endpoint was postoperative complications, length of hospital stay, and readmission for cardiac events included myocardial infarction, exacerbated heart failure, and arrhythmia. Cardiac events included Clinical data were obtained through retrospective review of the electronic health record system at Albany Medical Center.

Ethics Statement

Albany Medical Center Institutional Review Board approved the protocol (No. 6945, March 7, 2025), and the requirement for individual informed consent was waived.

Statistical Analyses

Categorical variables were described as numbers and percentages, while continuous variables were presented as mean±standard deviation. Student's t-test was performed for continuous variables that

have a normal distribution and Mann-Whitney U test was used for them that do not have a normal distribution. Categorical variables were assessed by Chi-squared test or Fisher's exact test. Propensity score matching was conducted to control for potential confounding variables between the TC and TT groups. Age, sex, hypertension, diabetes mellitus, chronic lung disease, atrial fibrillation (Afib), chronic heart failure, peripheral vascular disease, bicuspid aortic valve, left ventricular ejection fraction (LVEF), and valve in valve procedure were selected as confounding variables based on previous reports. Propensity scores were calculated using a logistic regression model. The model fit was confirmed by the area under the curve (0.83) in the receiver operative characteristic curve. A 1:1 matching was performed using the nearest-neighbor method between the 2 groups. Kaplan-Meier method was carried out to evaluate the cumulative survival, and readmission for cardiac events. Statistical differences were analyzed using the log-rank test. Cox proportional hazard analysis was conducted to evaluate the predictors for mid-term mortality. Four predictors (age, Afib, LVEF, and TT access) for the mid-term mortality were chosen. The proportional hazard assumption was verified by stratified log minus log plots and independent of time in covariables. There was no missing data. Data analyses were performed using SPSS version 29.0.0.0 (IBM) and GraphPad Prism version 10.4.1.

Results

Preoperative patient characteristics and intraoperative findings

Patient characteristics and intraoperative findings were summarized in Table 1. In the matched TC and TT groups, age, sex, history of hypertension, diabetes mellitus, chronic lung disease, Afib, chronic heart failure, peripheral vascular disease, bicuspid aortic valve, and LVEF were similar between the 2 groups. The Society of Thoracic Surgeons (STS) score was 5.1 ± 3.0 in the matched TC group, and 8.3 ± 5.8 in the matched TT group. The STS score in the matched TT group was significantly higher than that of the matched TC group ($p < 0.01$). In the matched intraoperative findings, the rate of valve in valve procedure and each size of TAVR valve were comparable among the 2 groups.

Table 1
Preoperative characteristics and intraoperative findings

Pre-matching Propensity matched						
Preoperative characteristics	TC n = 93	TT n = 62	p	TC n = 38	TT n = 38	p
Age, years old	76.9 ± 8.7	82.3 ± 7.7	< 0.01	80.8 ± 7.5	80.4 ± 8.1	0.83
Sex male	48 (51.6)	33 (53.2)	0.84	24 (63.2)	24 (63.2)	1.00
Hypertension	85 (91.4)	51 (82.3)	0.09	35 (92.1)	33 (86.8)	0.71
Diabetes mellitus	40 (43.0)	22 (35.5)	0.35	14 (36.8)	11 (28.9)	0.46
Chronic lung disease	43 (46.2)	23 (37.1)	0.26	16 (42.1)	14 (36.8)	0.64
Afib	36 (38.7)	32 (51.6)	0.11	17 (44.7)	20 (52.6)	0.49
Chronic heart failure	80 (86.0)	34 (54.8)	< 0.01	27 (71.1)	26 (68.4)	0.80
Myocardial infarction	19 (20.4)	12 (19.4)	0.87	4 (10.5)	7 (18.4)	0.52
Peripheral vascular disease	62 (66.7)	21 (33.9)	< 0.01	21 (55.2)	17 (44.7)	0.25
Bicuspid aortic valve	6 (6.5)	2 (3.2)	0.48	0 (0)	2 (5.3)	0.49
LVEF, %	54.0 ± 12.3	56.4 ± 9.0	0.17	53.9 ± 9.9	52.8 ± 8.8	0.62
STS score	4.4 ± 3.1	7.6 ± 5.1	< 0.01	5.1 ± 3.0	8.3 ± 5.8	< 0.01
Operative procedures						
Valve in valve procedure, n (%)	4 (4.3)	6 (9.7)	0.19	3 (7.9)	2 (5.3)	0.50
Balloon expandable valve, n (%)	93 (100)	62 (100)	1.00	38 (100)	38 (100)	1.00
20mm	9 (9.7)	2 (3.2)	0.20	2 (5.3)	2 (5.3)	1.00
23mm	38 (40.9)	25 (40.3)	0.95	13 (34.2)	10 (26.3)	0.45
26mm	39 (41.9)	23 (37.1)	0.55	20 (52.6)	17 (44.7)	0.49
29mm	7 (7.5)	12 (19.4)	0.04	3 (7.9)	9 (23.7)	0.11
Values are mean ± standard deviation or n (%)						
Afib = atrial fibrillation, LVEF = left ventricular ejection fraction, STS = The Society of Thoracic Surgeons, TC = transcarotid, TT = transthoracic						

Postoperative in-hospital outcomes

Postoperative outcomes were summarized in Table 2. Two patients in the matched TC group died within 30 days from TAVR procedure whereas five patients were expired in the matched TT group. The early mortality was higher in the matched TT group, but the mortality rate did not reach out to significant difference statistically (5.3% vs 13.2%, $p = 0.27$). Four patients in the matched TT group experienced postoperative new onset Afib whereas no one had postoperative Afib in the matched TC group. A significant difference was detected between the 2 groups in the incidence of postoperative Afib (0% vs 10.5%, $p = 0.04$). The length hospital stay was 4.9 ± 5.5 days in the matched TC group, and 7.7 ± 4.8 days in the matched TT group, respectively. The matched TT group required significantly longer hospital stay than that of the matched TC group ($p = 0.02$). The incidence of postoperative stroke, permanent pacemaker requirement, dialysis requirement, and surgical intervention for the access site did not differ among the 2 groups.

Table 2
Operative procedures and postoperative outcomes

Pre-matching Propensity matched						
Postoperative outcomes	TC	TT	p	TC	TT	p
Stroke	2 (2.2)	0 (0)	0.52	2 (5.3)	0 (0)	0.49
New onset Afib	0 (0)	5 (8.1)	< 0.01	0 (0)	4 (10.5)	0.04
New permanent pacemaker requirement	8 (8.6)	8 (12.9)	0.39	5 (13.2)	4 (10.5)	0.50
New dialysis requirement	1 (1.1)	0 (0)	0.60	1 (2.6)	0 (0)	0.50
Surgical reintervention for access site	1 (1.1)	2 (3.2)	0.56	0 (0)	1 (2.6)	0.50
Length of hospital stay, days	5.0 ± 5.4	8.3 ± 7.0	< 0.01	4.9 ± 5.5	7.7 ± 4.8	0.02
30day mortality	5 (5.4)	5 (8.1)	0.50	2 (5.3)	5 (13.2)	0.27
Cardiac related	3 (3.2)	3 (4.8)	0.68	0 (0)	3 (7.9)	0.24
Non-cardiac related	2 (2.2)	2 (3.2)	0.53	2 (5.3)	2 (5.3)	1.00
Mean follow-up term, years	2.1 ± 1.7	2.6 ± 2.4	0.15	2.1 ± 1.8	2.4 ± 2.4	0.66
Cumulative survival rate in 5 years, %	60.6	64.6	0.70	70.1	54.3	0.47
Readmission for cardiac events at 5 years, %	32.6	12.6	< 0.01	22.8	2.9	0.02
Values are mean $\pm$ standard deviation or n (%)						
Afib = atrial fibrillation, TC = transcarotid, TT = transthoracic						

Table 3
Univariable analysis for predictors of early mortality

Risk factors	Adjusted OR	95% CI	p
Age	1.15	1.01–1.32	0.04
Afib	2.89	0.53–15.9	0.22
LVEF	0.82	0.93–1.10	0.82
TT access	2.73	0.50–15.0	0.25
OR = odds ratio, CI = confidence interval, Afib = atrial fibrillation, LVEF = left ventricular ejection fraction, TT = transthoracic			

Mid-term outcomes

The median follow-up period was 2.1 ± 1.8 years in the matched TC group, and 2.4 ± 2.4 years in the matched TT group. During these periods, nine patients in the matched TC group died, along with 12 in the matched TT group. Kaplan-Meier survival curve in the pre-matching was shown in Fig. 1A while that of the matched groups was shown in Fig. 1B. In the matched groups, the survival rate in 5 years was 70.1% in the TC group and 54.3% in the TT group, respectively (Table 2). There was no significant difference in the mid-term outcomes between the 2 groups ($p = 0.47$) (Fig. 1B). Cox hazard proportional analysis revealed that TT access was not a risk factor of mid-term survival ($p = 0.47$) (Table 4). Readmission for cardiac events at 5 years was 22.8% in the TC group and 2.9% in the TT group after propensity score matching. There was a significant difference in the rate of readmission between the 2 groups ($p = 0.02$) (Fig. 2).

Table 4
Multivariable analysis for predictors of mid-term mortality

Risk factors	Adjusted HR	95% CI	p
Age	1.04	0.98–1.11	0.17
LVEF	0.97	0.93–1.01	0.13
TT access	1.38	0.58–3.29	0.47
HR = hazard ratio, CI = confidence interval, LVEF = left ventricular ejection fraction, TT = transthoracic			

Discussion

In this study, we compared perioperative and mid-term outcomes following transcatheter aortic valve replacement (TAVR) performed through transcarotid (TC) and transthoracic (TT) access in a propensity-match cohort of patients who were not candidates for transfemoral access. Three principal findings emerged: 1) TT access was associated with a numerically higher 30-day mortality rate than TC access, although this difference was not statistically significant; 2) cumulative mid-term survival was

comparable between the two groups although TC access was associated with a significantly higher rate of cardiac-related readmission compared with TT access; and 3) TC access was associated with a lower incidence of postoperative new-onset atrial fibrillation (NOAF) and shorter hospital stay compared with TT access.

As TAVR has expanded across all surgical risk categories, the need for alternative access strategies has declined but remains clinically important for patients with unfavorable iliofemoral anatomy. Historically, transthoracic approaches, including transapical and transaortic access, represented the primary alternatives to transfemoral TAVR. However, advances in device technology and increasing operator experience have facilitated the adoption of less invasive extrathoracic approaches. Current evidence increasingly supports a hierarchical approach favoring extrathoracic over intrathoracic alternatives when transfemoral access is not feasible (4, 5, 7, 14, 15). The 2025 Society for Cardiovascular Angiography and Interventions (SCAI) Expert Consensus Statement recommends transcarotid or transcaval access as preferred alternatives when anatomically feasible and generally positions extrathoracic access strategies above transthoracic approaches (5). Our findings are consistent with this evolving paradigm and provide additional data regarding outcomes beyond the early postoperative period.

One of the most notable findings of the present study was the significantly lower incidence of NOAF in the TC cohort. Patients undergoing TT access experienced a more than ten-fold higher rate of postoperative atrial fibrillation than those undergoing TC access. This finding is plausible and likely reflects the greater procedural invasiveness associated with transthoracic approaches. Thoracotomy, direct myocardial and pericardial manipulation, postoperative pain, inflammatory activation, and transient impairment of pulmonary mechanics have all been implicated in the pathogenesis of postoperative atrial arrhythmias (6, 8, 9). In contrast, TC access avoids thoracotomy and extensive pericardial manipulation, potentially reducing physiologic stress and promoting more rapid recovery.

Our findings are consistent with prior studies comparing TC and TT access. Allen et al., using a propensity-matched analysis of the STS/ACC TVT Registry, reported significantly lower rates of NOAF among patients undergoing TC access compared with TT access (2). Similarly, Chamandi et al. demonstrated reduced rates of atrial fibrillation and improved early recovery with TC access in a multicenter cohort (10). A systematic review and meta-analysis by Ryan et al. further identified transapical access as an independent predictor of NOAF following TAVR (11). Given that NOAF has been associated with increased risk of stroke, prolonged hospitalization, and long-term mortality, minimizing its occurrence may provide clinically meaningful benefits beyond the immediate postoperative period (8, 9).

The shorter hospital length of stay observed in the TC cohort likely reflects the same advantages associated with reduced procedural invasiveness. Patients undergoing TC access avoided thoracotomy-related pain and pulmonary dysfunction and generally experienced a more rapid postoperative recovery. Similar findings have been reported in prior registry analyses and meta-analyses, which consistently demonstrate shorter hospitalization and faster discharge following TC compared with TT access (2–4,

7). As healthcare systems increasingly emphasize value-based care and resource utilization, reductions in hospital length of stay may represent an important advantage of TC access.

Although mortality differences did not reach statistical significance, the observed trend warrants consideration. Early mortality was 2.5-fold higher in the TT cohort, a finding that is directionally consistent with prior studies demonstrating increased perioperative mortality among patients undergoing intrathoracic alternative-access TAVR (2–4, 7). The lack of statistical significance in the present study likely reflects limited sample size and event rates rather than definitive equivalence between approaches. Importantly, patients undergoing TT access remained at higher operative risk despite propensity matching, as evidenced by significantly higher STS predicted risk scores. Therefore, residual confounding may have contributed to the observed mortality differences. Although multivariable analysis did not identify TT access as an independent predictor of mid-term mortality, the possibility that baseline patient risk influenced outcomes cannot be excluded.

Interestingly, the perioperative advantages associated with TC access did not translate into significantly improved mid-term survival. Five-year survival was numerically higher in the TC cohort (70.1% TC vs 54.3% TT, $p = 0.47$); while this 15.8% absolute survival advantage did not reach statistical significance, this is likely due to the modest sample size of our matched cohorts, which limits the statistical power to detect mid-term survival differences. Additionally, TC access was associated with a significantly higher rate of cardiac-related readmission compared with TT, both before propensity matching (32.6% vs 12.6%, $p < 0.01$) and after propensity matching (22.8% vs 2.9%, $p = 0.02$). In contrast, the largest available propensity-matched comparison of TC and TT TAVR reported fewer 30-day readmissions with TC access (9.8% vs 16.1%) (2); however, that study evaluated early readmission, whereas the present analysis assessed cumulative readmission over longer-term follow-up. The higher cumulative readmission observed in the TC group should therefore be interpreted cautiously. The matched cohort was small (38 patients per group), and the TT group had numerically higher early mortality (13.2% vs 5.3%) and lower 5-year survival (54.3% vs 70.1%), as well as a higher STS score (8.3 vs 5.1). Differential mortality may have contributed to survivor bias, as patients who die during follow-up were no longer at risk for subsequent readmission. Thus, the observed difference in readmission may partly reflect the greater opportunity for surviving TC patients to experience readmission during follow-up rather than a true difference attributable to access strategy. The TT approach has primarily been linked to certain cardiac complication in the early perioperative period, including direct myocardial (apical) injury, higher perioperative NOAF, bleeding and longer hospital stay (3, 4, 12). Considering that our data was consistent with TT access being associated with higher NOAF and longer length of stay in the perioperative period, and there is currently no established biological mechanism by which a healed TC approach would generate more late heart failure or MI than a healed thoracotomy, this finding suggests that long-term outcomes following TAVR may be driven predominantly by patient comorbidity burden and underlying cardiovascular disease rather than access strategy alone (14). Once patients survive the perioperative period, factors such as age, frailty, heart failure severity, renal dysfunction, and competing noncardiac causes of mortality may exert a greater influence on long-term survival than procedural access route. Furthermore, the predominance of transapical procedures within our TT cohort may have

attenuated differences between groups, as prior studies have suggested more favorable outcomes with transapical compared with transaortic access (13).

This study has several limitations. First, it is a retrospective single-center analysis and is therefore subject to inherent selection bias and residual confounding. Second, the sample size was relatively modest, limiting statistical power for mortality and other infrequent clinical events. Third, despite propensity score matching, a significant difference in STS predicted risk scores remained between groups (5.1 ± 3.0 TC vs 8.3 ± 5.8 TT, $p < 0.01$), suggesting incomplete balancing of baseline operative risk and the potential for residual confounding. Finally, follow-up duration varied among patients and may have influenced survival estimates. Survivor bias in particular likely also inflated the readmission rate within the TC access group.

In conclusion, TC access was associated with lower rates of postoperative NOAF and shorter hospital stay while providing comparable mid-term survival relative to TT access. Greater readmission rates in the late follow up period associated with TC access are likely attributable to survivor bias, limited cohort size, and underlying cardiovascular issues within the patient cohort rather than a true difference in access routes. Ultimately, these findings support the growing preference for transcarotid access as a first-line alternative strategy when transfemoral TAVR is not feasible and contribute additional mid-term outcome data to an evolving body of literature favoring less invasive extrathoracic access approaches (5, 15, 16).

Conclusions

Transcatheter aortic valve replacement through transcarotid access was associated with lower rate of new onset postoperative atrial fibrillation and shorter hospital stay compared with transthoracic access. Short and mid-term survival rates were comparable between the transcarotid and transthoracic accesses although readmission for cardiac events was higher in patients undergoing transcarotid access. Future work should aim to study mid-term survival and cardiac complications within a larger sample size in order to minimize the effect of survivor bias in assessing mid-term outcomes. Future work should also aim to explore potential mechanistic relationships between different intrathoracic access routes and mid-term cardiac outcomes.

Declarations

Author Contribution

CN, JL, and AG wrote the main manuscript. ST, SK, KS, KD, and AD prepared Figures 1-2. All authors reviewed the manuscript.

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Figures

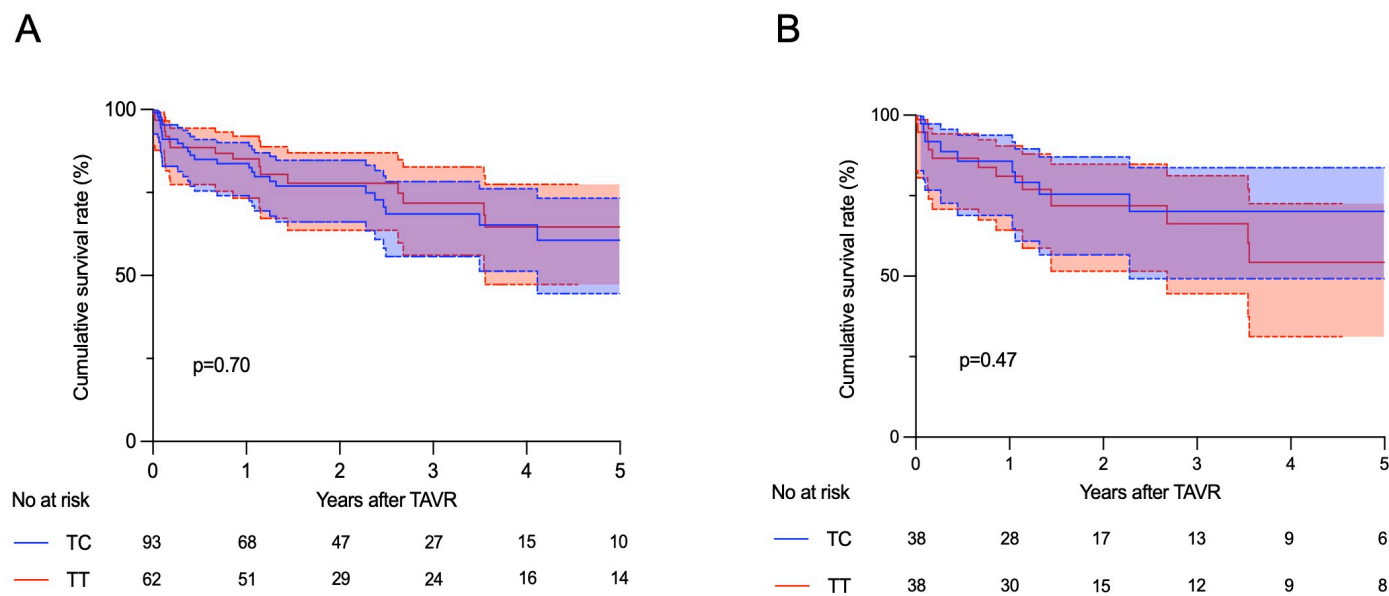


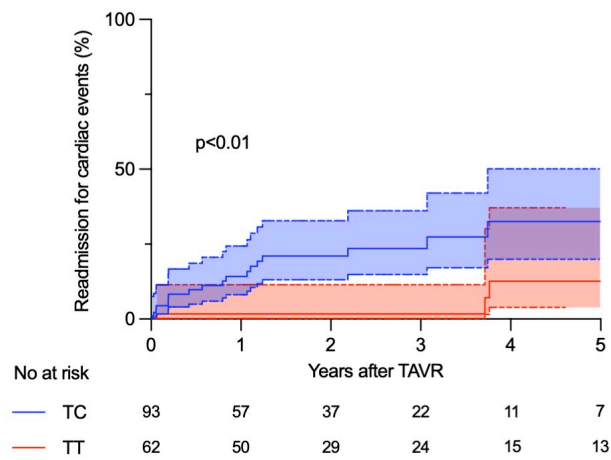
Figure 1

A: Kaplan-Meier survival curves in the pre-matching TC and TT groups. There was no significant difference in cumulative survival between the 2 groups ($p=0.70$).

B: Kaplan-Meier survival curves in the propensity matched TC and TT groups. There was no significant difference in cumulative survival between the 2 groups ($p=0.47$).

TC = transcarotid, TT=transthoracic

A



B

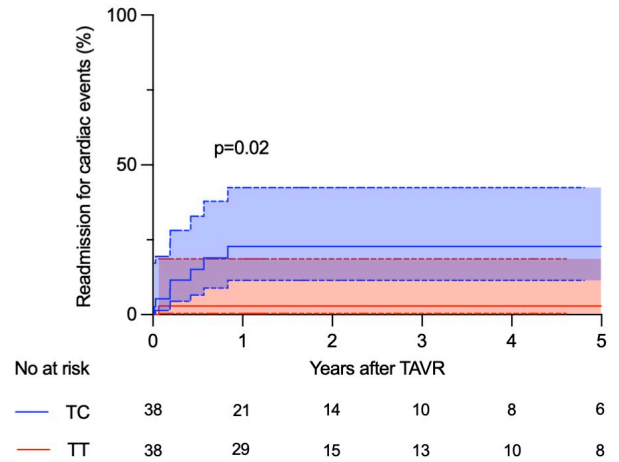


Figure 2

A: Kaplan-Meier curves of readmission for cardiac events in the pre-matching TC and TT groups. There was a significant difference in the rate of readmission between the 2 groups ($p < 0.01$).

B: Kaplan-Meier curves of readmission for cardiac events in the pre-matching TC and TT groups. There was a significant difference in the rate of readmission between the 2 groups ($p = 0.02$).