

Research Article

# Cut-down Access to Avoid Vascular Complications During Transcatheter Aortic Valve Implantation

Attilio Cotroneo<sup>1</sup> , David Barillà<sup>2</sup> , Carmen Diana Botezatu<sup>1</sup> , Roberto Pedretti<sup>1</sup> , Gian Luca Martinelli<sup>1\*</sup> 

<sup>1</sup>Cardiac Surgery Unit, IRCCS MultiMedica, Milano, Italy

<sup>2</sup>Vascular Surgery Department, Humanitas, Milano, Italy

\*Correspondence author: Gian Luca Martinelli, MD, Direttore UOC Cardiocirurgia, Cardiac Surgery Unit, IRCCS MultiMedica, Milano, Italy;  
Email: [martinelligluca@gmail.com](mailto:martinelligluca@gmail.com)

Citation: Cotroneo A, et al. Cut-down Access to Avoid Vascular Complications During Transcatheter Aortic Valve Implantation. Jour Clin Med Res. 2024;5(1):1-9.

<http://dx.doi.org/10.46889/JCMR.2024.5111>

Received Date: 27-03-2024

Accepted Date: 07-04-2024

Published Date: 15-04-2024



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CCBY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Abstract

**Objective:** Vascular Complications (VCs) are independent predictors of mortality after Transcatheter Aortic Valve Implantation with Transfemoral Access (TF-TAVI) and remain an unsolved problem regardless of the Percutaneous (PC) or Surgical Cut-down (SC) access for patients with severe Aortic Valve Stenosis (AVS). The debate about the short- and long-term results, safety, risks of procedural complications and the complementary roles of SC and PC approaches is still open. We aim to show VCs in our series of patients submitted to TF-TAVI using a surgical-cutdown.

**Methods:** Retrospective analysis of consecutive patients with symptomatic severe AVS receiving TF-TAVI. The accesses were studied by computed tomography and Echo Color Doppler. The STS score was <4 in 172 (66.4%), 4-8 in 72 (27.8%) and >8 in 15 (5.8%) patients. The outcomes were the incidence of VCs. SC procedures were applied by Edwards SAPIENTM 3 (Edwards Lifesciences, Irvine, CA, USA) BE device.

**Results:** We enrolled 259 patients, 244 (94.2%) underwent TF-TAVI with the SC approach. The mean patients' age was  $82 \pm 2$  (range: 58-99). Female patients were 160/259 (62%) and male 99/259 (38%). The mean fluoroscopic time was 22 minutes. The 30-day mortality rate was 0.77% (two deaths). Intraoperative VCs were 6 (2.3%) and 1 (0.4%) at 1-year follow-up. The ICU stay was one day, the median post-operative hospitalization was two days.

**Conclusion:** This study contributes to the debate about the advantages of the SC approach compared to PC according to the patients' profile with AVS and proposes multicenter prospective trials, especially for a future TAVI use in young and low-risk patients.

**Keywords:** Vascular Complications; Transcatheter Aortic Valve Implantation; Percutaneous Transfemoral Aortic Valve Replacement; Surgical Cut-Down Transfemoral Aortic Valve Replacement; Aortic Valve Stenosis

## Introduction

Transcatheter Aortic Valve Implantation (TAVI) for patients with Aortic Valve Stenosis (AVS) is preferably performed by Trans-Femoral Access (TF-TAVI) and the approaches of TF-TAVI are Percutaneous (PC) or Surgical Cut-down (SC) [1,2]. The TF-TAVI procedure is widespread, but may bear specific complications. In particular, the Vascular Complications (VCs) of TF-TAVI, such as annular rupture, vessel dissection or major bleeding, classified by the Valve Academic Research Consortium-2 (VARC-2) are deemed independent predictors of mortality after TAVI [3-5]. Early complications of TF-TAVI at the peripheral vasculature can arise in the presence of small vessels, calcification at the puncture site, tortuosity of high vessels, inadequate ratio total tortuosity/arterial diameter and concomitant peripheral vascular disease [6-8]. Despite the advancing technology and the heart teams' experience in recent years, the reduction of VCs after TF-TAVI has not decreased regardless of the access methods [9]. Therefore, the TF-TAVI-related VCs remain an unsolved problem, even though downsized over time [10,11].

The current evidence about the comparisons between SC and PC approaches for TAVI is based on meta-analyses of different study types (randomized or non-randomized trials, retrospective reports). Observational studies and unmatched cohorts often

miss clinical information and different follow-up times [2]. Moreover, the SC and PC approaches also differ from access routes or transcatheter valve systems.

The objective of this retrospective study is to contribute to the current debate about the short- and long-term effectiveness, safety, risks of procedural complications and complementary roles of SC and PC approaches of TF-TAVI according to the characteristics and predictive factors of the patients with AVS.

## Material and Methods

We report the retrospective analysis of 259 consecutive patients with AVS who received TAVI for aortic valve replacement between 2016 and 2019. Data was collected in accordance with the Declaration of Helsinki. Ethic Committee is not mandatory due to the retrospective nature of this study, according to Italian law. An informed consent was not obtained due to the retrospective nature of the study.

A TF access for TAVI was performed in 244/259 (94.2%) of patients. TF access site was not suitable for 15/259 (5.8%) patients due to artery diameter, tortuosity and calcifications.

We included patients with symptomatic severe AVS, classified according to New York Heart Association (NYHA) and life expectancy greater than two years. All the cases not suitable for the transfemoral approach were excluded from this study.

The preoperative characteristics of the patients enrolled in the present study are displayed in Table 1. Our patients were at a different level of risk according to the STS (Society of Thoracic Surgeons) score; most of them, 172/259 (66.5%) were at low-risk (STS score <4), while 72/259 (27.8%) at intermediate-risk (STS score 4-8) and 15/259 (5.8%) at high-risk (STS score >8).

TF is the first access choice for TAVI. When the diameter of common femoral and iliac artery is more than 5 mm, we selected valve sizing 23 and 26. If the diameter is 5.5 mm, the TF access was suitable for valve sizing 29, unless there were circumferential calcifications and/or excessive tortuosity. The 1-year follow-up was performed by transthoracic echocardiography.

The outcomes of the study were defined as the incidence of VCs. The bleeding during the surgical procedures was defined according to VARC-2 and Bleeding Academic Research Consortium (BARC) criteria [3].

The SC procedures were applied for all the patients by Edwards SAPIENTM 3 (Edwards Lifesciences, Irvine, CA, USA) BE device. This device is a balloon-expandable, radiopaque, cobalt-chromium frame, trileaflet bovine pericardial tissue valve, with a skirt made of polyethylene terephthalate.

Surgical procedures were conducted under trans-esophageal echographic guidance. We systematically studied the accesses by imaging with both Computed Tomography Angiography (CTA) and Echo Color Doppler. The hemostasis technique was always performed by a polypropylene purse-string and additional suture if needed. The vessels were not less than 5 mm. Methods and criteria of assessment were obtained by CT scan planning.

In the follow-up, we collected data of VCs and other post-procedural complications at 30 days and one year after TF-TAVI intervention for all 259 patients. We conducted the follow-up by Echo Color Doppler and clinical examination. Continuous and categorical variables were reported as numbers and percentages, means, medians and ranges.

## Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore was exempt.

## Results

In this study, we enrolled and followed up 259 patients. All the patients underwent TAVI with the SC approach and a TF access was performed for most patients (244/259, 94.2%). The baseline demographic and clinical preoperative characteristics of the 259

participants are described in Table 1. The mean age of the patients was  $83 \pm 3.2$  (range: 58-99), the median age was 86 years and 160/259 patients (62%) were female.

The Edward SAPIENT<sup>TM</sup> 3 valve measures that we used were 20 mm for 4 (1.5%), 23 mm for 106 (41%), 26 mm for 88 (34%) and 29 mm for 61 (23.5%) patients. Two-hundred and forty-six (95%) patients underwent general anesthesia, while the remaining 13 (5%) local anesthesia.

The mean fluoroscopic time was 22 minutes. During the present study, the procedures concomitant to TAVI were Percutaneous Coronary Intervention (PCI) for one patient and Superior Mesenteric Artery (SMA) stenting for another patient.

Table 2 and Table 3 summarizes the pre-operative and post-operative echocardiographic parameters. Intra-hospital, 30-days and 1-year follow-up data about the procedural outcomes are reported in Table 4.

Table 5 shows the data about major bleedings, while Table 6 displays the data regarding ilio-femoral artery and access site complications.

Characteristic	N=259
Demographic	
Age (years)	
mean	$83 \pm 3.2$ (range 58-99)
median	86
Gender (n, %)	
female	160 (62)
male	99 (38)
Clinical	
NYHA (n, %)	
Class I	3 (1)
Class II	98 (38)
Class III	124 (48)
Class IV	34 (13)
STS score (n, %)	$3.67 \pm 6.1$ (1.1-17)
<4	172 (66.4)
4-8	72 (27.8)
>8	14 (5.)
EuroSCORE II	$3.93 \pm 7.28$ (range: 0.84-28.6)
Hypertension	207 (80)
Diabetes (n, %)	63 (24.3)
COPD (n, %)	23 (8.9)
Severe pulmonary hypertension	17 (6.5)
CAD (n, %)	80 (30.8)
Previous PCI (n, %)	48 (18.5)
Previous CABG (n, %)	21 (8.1)
Neurological dysfunction (n, %)	14 (5.4)
Preoperative creatinine > 2 mg/dl (n, %)	17 (6.5)

Hemoglobin <10 mg/dl (n, %)	15 (5,7)
Preoperative PM (n, %)	33 (12.7)
Sinus rhythm (n, %)	181 (69.9)
Previous Atrial fibrillation (n, %)	54 (20.8)
Left bundle branch block (n, %)	23 (8.9)
Right bundle branch block (n, %)	28 (10.8)
Systolic annular perimeter on CT-mm	81
Systolic annular area on CT – mm <sup>2</sup>	461
CABG: Coronary Artery Bypass Graft; CAD: Coronary Heart Disease; COPD: Chronic Obstructive Pulmonary Disease; Euroscore, risk stratification score including age, gender, COPD, extracardiac arteriopathy, neurological dysfunction, creatinine, previous cardiac surgery, critical state, active pericarditis, left ventricular dysfunction, unstable angina, recent myocardial infarction, pulmonary hypertension; NYHA: New York Heart Association; PCI: Percutaneous Coronary Intervention; PM: Pacemaker; STS risk score: Society of Thoracic Surgeons risk score. Severe pulmonary hypertension systolic pulmonary artery pressure > 60 mmHg	

**Table 1:** Demographic and clinical baseline characteristics of the patients who received TF-TAVI.

Parameter	N=259
Max gradient (mmHg)	80
Mean gradient (mmHg)	46
Aortic valve area – cm <sup>2</sup>	0.7
EF (%)	59
Moderate-severe aortic regurgitation (n, %)	88 (34)
MR (n, %)	
• none	37 (14.3)
• mild	136 (52.5)
• moderate	74 (28.6)
• severe	12 (4.6)
PAPs > 60 mmHg	17 (6.5)
EF: Ejection Fraction; MR: Mitral Regurgitation; PAP: Pulmonary Artery Pressure; PVL: Paravalvular Leak; TOE: Transesophageal Echography	

**Table 2:** Pre-operative echographic parameters.

Parameter	N=259
Max gradient (mmHg)	22
Mean gradient (mmHg)	11
EF (%)	60
MR (n, %)	
• none	37 (14.3)
• mild	136 (52.9)

<ul style="list-style-type: none"> <li>• moderate</li> <li>• severe</li> </ul>	74 (21.0) 12 (4.6)
PAPs >60 mmHg	8 (3.1)
Median aortic valve area (cm)	
PVL by TOE <ul style="list-style-type: none"> <li>• none</li> <li>• mild</li> <li>• moderate</li> <li>• severe</li> </ul>	259 (100) 170 (65.5) 67 (26) 21 (8) 1 (0.5)
EF: Ejection Fraction; MR: Mitral Regurgitation; PAP: Pulmonary Artery Pressure; PVL: Paravalvular Leak; TOE: Transesophageal Echography	

**Table 3:** Post-operative echographic parameters.

	Intra-hospital	30 days	1-year
Atrial fibrillation (n, %)	18 (7)		0
AMI (n, %)	2 (1)		
major stroke (n, %)	1 (0.5)		
PM (n, %)	14 (5.4)		
mean post-operative creatinine (n, %)	1.28 (range: 0.53-5.37)		
dialysis (n, %)	0		
orotracheal intubation time (hours)	4		
ICU stay (days)	1		
median post-operative hospitalization time (days)	2		
mortality (n, %)	2 (0.77)	2 (0.77)	
AMI: Acute Myocardial Infarction; PM: Pacemaker			

**Table 4:** Intra-hospital, 30-day and 1-year results.

Complication	Intra-hospital	30-day	1-year
Procedural (n, %)	4 (1.5)		
<ul style="list-style-type: none"> <li>• aortic dissection</li> <li>• ventricular perforation</li> <li>• annular rupture</li> </ul>	1 (0.4) 2 (0.77) 1 (0.4)		
Vascular (n, %)	6 (2.3)	0 (0.00)	
<ul style="list-style-type: none"> <li>• major (with life-threatening bleeding)</li> <li>• minor (no bleeding)</li> <li>• femoral artery stenosis (patch correction)</li> </ul>	4 (1.5) 2 (0.77)		1 (0.4)
Access site (n, %)		7 (2.7)	0 (0.00)
<ul style="list-style-type: none"> <li>• wound dehiscence</li> <li>• hematoma</li> <li>• wound infection in obese patient (VAC therapy)</li> <li>• linforrea</li> </ul>		3 1 1 2	

with hospitalization without hospitalization		2 5	
Vascular and access site (n, %)	2 (0.7)		
• iliac stenting and Dacron bypass	1 (0.4)		
• autologous venous patch	1 (0.4)		
• transfusion	0 (0.0)		
AMI: Acute Myocardial Infarction; PM: Pacemaker			

**Table 5:** Major bleeding complications.

Complication	Intra-hospital	30-day	1-year
Bleeding	0	0	0
• major (with life-threatening bleeding)	0	0	0
• minor	0	0	0
Vascular	2 (0.77)		
• iliac stenting and Dacron bypass	1(0.4)	0	
• autologous venous patch	1 (0.4)	0	
• late femoral artery stenosis	0 (0.00)	0	1
Access site (n, %)		7 (2.7)	0
• wound dehiscence		3	0
• hematoma		1	0
• wound infection in obese patient (VAC therapy)		1	0
• linforrea		2	0

**Table 6:** Ileo-femoral artery and access site complications.

## Discussion

Most of the patients of our study with severe AVS who underwent TF-TAVI with SC approach were deemed at high-risk based on baseline characteristics, such as a mean age (83 years), STS score <4 in 66.4%, EuroSCORE II value (3.93), III and IV NYHA in 61%. The results showed a mortality rate and an incidence of intra-hospital and VCs values remarkably lower than those found in the studies on patients with comparable baseline characteristics. The 30-day mortality rate was 0.77% (two deaths) and there were a total of 6 intraoperative VCs (2.3%) and one 1-year follow-up VC (0.4%). The two intra-hospital deaths were due to aortic dissection (1 patient) and annular rupture (1 patient). The reduced number of major and minor VCs and vascular and access site complications in 2 (0.77%) patients were observed only in the operative time and access site complications were found in 7 (2.7%) patients at 30-day. Most intrahospital complications were atrial fibrillation in 18 (7%) patients. Regarding the patients' access site complications, the three patients with hematoma required hospitalization.

The absence of dialysis requirement and the mean value of post-operative creatinine suggested the renal safety of our SC approach. Moreover, our patients remained in ICU stay for one day and the median post-operative hospitalization time was two days. The follow-up (1-year) data achieved for all the patients strengthened the safety findings of this study.

The limitations of the present study are mainly due to the retrospective nature of the data capture. However, most of the data related to SC and PC approaches of TF-TAVI currently reported in the literature is retrospective and this reduces the possibility of direct comparisons.

It is known that the VCs and risk of serious bleeding events after TAVI are associated with morbidity and mortality rates [12,13]. A retrospective chart review of 388 consecutive patients who most underwent TF-TAVI of Raju, et al., reported a high incidence

of VCs defined by VARC-2 guidelines [8]. Of the 68 (28.7%) VCs, only 7 (3.38%) were major, 42 (17.9%) were post-operative and the remaining 26 (11.4%) occurred in the perioperative phase. Perioperative VCs significantly correlated with short-term (30-day) mortality rate that involved 6 (2.5%) patients. The majority of the VCs were dissections and hematomas. Of the 26 (10.9%) intra-operative VCs, 4 (1.6%) were classified as major and 22 (9.3%) as minor; of the post-operative 42 (17.2%) VCs, 3 (1.3%) were minor. In 10 (4.2%) cases, VCs required correction procedures, most (90%) received surgical correction and the remaining were corrected by endovascular techniques. However, this study did not report the precise numbers of patients per each approach, thus hindering a comparison. The authors underscored the importance of the involvement of cardio surgeons in the multidisciplinary team to optimize the patients' selection and reduce the incidence of major VCs [8].

The evidence based on Randomized Clinical Trials (RCT) comparing PC and SC strategies is limited to the small trial of Holper, et al., performed at a TAVI-experienced center on 30 consecutive patients, who most were at high risk [14]. This trial has highlighted no significant differences in safety and efficacy between PC and SC approaches. Major and minor VCs as the primary endpoint was 25% in the PC group versus 29% in the SC group. Female gender and pre-operative femoral arterial velocity were identified as significant predictors of complications [14]. In the Optimized CathETER vAlvur iNtervention (OCEAN)-TAVI registry study, PC and SC methods were compared in a non-randomized trial on 332 propensity-matched patients and evaluated under the VARC-2 criteria [15]. In this study, the PC approach provided fewer VCs, bleeding and acute kidney injuries than the SC approach. Real-world evidence about the differences between PC and SC approaches encompasses national registries, retrospective reports and single or multi-center observational prospective studies. Several meta-analyses have been contributing to the literature synthesis over time. The Spanish TAVI registry reported different VCs patterns in 3,046 patients who received PC- or SC-TAVI; higher rates of minor VCs but lower rates of major VCs in the PC group of patients compared to the SC group at 30-day and 323-day [16].

The vascular access site complications observed in 162/1680 patients of the Polish registry were significantly higher in the PC than the SC group performed in the groin with exposure of the artery and manual suture after the procedure [17]. Data of the Brazilian national registry showed similar 1-year safety and effectiveness data of PC and SC approaches in two comparable groups of patients who underwent TF-TAVI with different procedural profiles [18]. A multicenter registry was used by Kochman, et al., to retrospectively compare PC and SC in 683 high-risk patients with major and minor VCs incidence as primary endpoints [19]. The Heart Team (general cardiologist, interventional cardiologist, cardiac surgeon) qualified the patients for TAVI based on clinical symptoms, echocardiography findings and multi-slice CT imaging and chose the approaches. The baseline characteristics revealed a significantly higher risk of the patient who underwent the SC approach. There was no significant difference between the two groups regarding the VARC-2 major VCs and type of bleedings, but minor VCs were significantly higher in the PC group. The procedure duration, the volume of contrast media and the length of hospital stay were superior in the PC than in the SC group [18].

The performance of the SC approach resulted significantly superior to the PC method in 667 consecutive patients regarding mean procedure time ( $P < 0.001$ ), with lower access, bleeding complications and hospital mortality rates [20]. A retrospective analysis compared the outcomes of SC or PC access complications in TF-TAVI 334 patients >75-year-old at high surgical risk or with contraindications for conventional surgery [21]. The SC group showed a significantly shorter mean time of procedure ( $69 \pm 19$  min) than PC group ( $91 \pm 22$  min;  $P < 0.01$ ); significantly less VARC-2 access complications ( $n=11/135$ ; 8.1%) ( $n=41/190$ ; 20.6%;  $P = 0.04$ ); and less frequent VARC-2 bleeding complications (18.1% vs 4.4%;  $P=0.029$ ). Moreover, the hospital mortality with the SC approach was less than PC (1.5 vs 3.5%,  $P = \text{n.s.}$ ). The authors underscored the SC hallmarks as more advantageous, in particular, for patients with calcified vessels, such as controlled and safe access to the puncture site. This SC feature has an adjunctive benefit of the direct vision that can ease the repair in the presence of vessel injury. There was no significant difference in major complications in the hospital stay duration. The authors evaluated the PC and SC as complementary approaches instead of superior or inferior one another. Furthermore, they suggested tailoring the two strategies as per the patients' characteristics through multidisciplinary TAVI teamwork to achieve the best outcomes [21].

A retrospective cohort analysis compared the PC and SC approaches for TF-TAVI according to the VCs at 30 days and late vascular adverse events at 12 months of 146 patients with severe AVS at high risk for surgery [22]. Compared with SC, the PC approach showed a shorter hospital length of stay but required a significantly more endovascular balloon assist ( $P < 0.001$ ) and covered stents ( $P < 0.05$ ) [22]. The meta-analysis of Ando, et al., of eight observational studies and one RCT (2513 patients with

PC and 1767 with SC), did not show any relevant difference of major and minor VCs, bleeding complications, need for surgical intervention for VCs and peri-operative all-cause mortality [23].

In a recent meta-analysis of 13 trials with a total of 5,859 patients (PC in 3447 patients; SC in 2412 patients), the two approaches have led to similar major VCs and bleeding risk, perioperative mortality, urgent surgical repair, stroke, myocardial infarction and renal failure. Compared with SC, PC was linked to a shorter hospital stay ( $9.1 \pm 8.5$  versus  $9.6 \pm 9.5$  days; mean difference of 1.07-day, 95% CI=-2.0 to -0.15,  $P=0.02$ ) and less blood transfusion (18.5% versus 25.7%; OR=0.61, 95% CI=0.43-0.86,  $P=0.005$ ), but showed a higher risk of minor VCs (11.9% versus 6.9%; OR=1.67, 95% CI= 1.04-2.67,  $P=0.03$ ) [2].

## Conclusion

In the literature, VCs are not always univocally defined and the technological evolution occurred over time may account for the varied outcomes and limit the possible comparisons. Therefore, comparative studies, systematic reviews and meta-analyses about PC and SC strategies have not yet reached definitive conclusions on their safety and effectiveness, highlighting the importance of accurate patient selection and center TAVI's experience. The strengths of our observational study are the careful preoperative planning, echo-guided mini-access, purse-string in a non-calcific point, preparation of a small clamping zone, access vascular skills and immediate management of any bleeding. The results of the present study can be generalized based on the criteria of patients' selection and assessment and the experience of the Heart team. This real-world study meant contributing to the debate about the advantages of the SC approach compared to PC of TF-TAVI for patients with severe AVS. A multicenter randomized trial, especially for a future use of TAVI in young and low-risk patients, may provide data to optimize the results concerning vascular access complications according to the patients' profile. In addition, future prospective studies can provide further evidence to optimize the patients' selection and matching with the SC and PC approaches.

## Conflict of Interests

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

## Acknowledgement

The authors acknowledge Rossella Ferrari for editing the manuscript and providing editorial assistance.

## Financial Disclosure

No funding was not involved in the manuscript writing, editing, approval or decision to publish.

## Authors Contribution

All authors contributed equally for the preparation of this paper.

## Data Availability

All authors had access to the data and a role in writing the manuscript. All data generated or analyzed in this study are included in this article. Access to data is possible with permission from the responsible author.

## Consent for Publication

Informed consent was obtained from the patient for publication of this case report and is stated in the manuscript.

## References

1. Chandrasekhar J, Hibbert B, Reul M. Transfemoral vs non-transfemoral access for transcatheter aortic valve implantation: a systematic review and meta-analysis. *Can J Cardiol*. 2015;31:1427-38.
2. Abdelaziz HK, Megaly M, Debski M. Meta-analysis comparing percutaneous to surgical access in trans-femoral transcatheter aortic valve implantation. *Am J Cardiol*. 2020;125:1239-48.
3. Kappetein AP, Head SJ, Génèreux P. Updated standardized endpoint definitions for transcatheter aortic valve implantation: the Valve Academic Research Consortium-2 consensus document. *J Thorac Cardiovasc Surg*. 2013;145:6-23.
4. Sardar MR, Goldsweig AM, Abbott JD. Vascular complications associated with transcatheter aortic valve replacement. *Vasc Med*. 2017;22:234-44.



5. Wang J, Yu W, Jin Q. Risk factors for post-TAVI bleeding according to the VARC-2 bleeding definition and effect of the bleeding on short-term mortality: a meta-analysis. *Can J Cardiol*. 2017;33:525-34.
6. Vavuranakis M, Kariori M, Voudris V. Predictive factors of vascular complications after transcatheter aortic valve implantation in patients treated with default percutaneous strategy. *Cardiovascular Therapeutics*. 2013;31:e46-54.
7. Czerwinska-Jelonkiewicz K, Michalowska I, Witkowski A. Vascular complications after transcatheter aortic valve implantation (TAVI): risk and long-term results. *J Thromb Thrombolysis*. 2014;37:490-8.
8. Raju S, Eisenberg N, Montbriand J, Cusimano RJ. Vascular complications and procedures following transcatheter aortic valve implantation. *Eur J Vasc Endovascular Surg*. 2019;58:437-44.
9. Ullery BW, Jin R, Kirker EB. Trends in vascular complications and associated treatment strategies following transfemoral transcatheter aortic valve replacement. *J Vasc Surg*. 2020;72:1313-24.
10. De Biase C, Mastrokostopoulos A, Philippart R. What are the remaining limitations of TAVI? *J Cardiovasc Surg (Torino)*. 2018;59:373-80.
11. Scarsini R, De Maria G, Joseph J. Impact of complications during transfemoral transcatheter aortic valve replacement: how can they be avoided and managed? *J Am Heart Assoc*. 2019;8:e013801.
12. Kochman J, Rymuza B, Huczek Z. Incidence, predictors and impact of severe periprocedural bleeding according to VARC-2 criteria on 1-year clinical outcomes in patients after transcatheter aortic valve implantation. *Int Heart J*. 2016;57:35-40.
13. Sticchi A, Bressi E, Nusca A. Vascular approaches and its potential implications in transcatheter aortic valve implantation. *Vessel Plus*. 2018;2-23.
14. Hopler EM, Kim RJ, Mack M. Randomized trial of surgical cutdown versus percutaneous. Access in transfemoral TAVR. *Catheter Cardiovasc Interv*. 2014;83:457-64.
15. Kawashima H, Watanabe Y, Kozuma K. Propensity-matched comparison of percutaneous and surgical cut-down approaches in transfemoral transcatheter aortic valve implantation using a balloon-expandable valve. *Eurointervention*. 2017;12:1954-61.
16. Hernandez-Enriquez M, Andrea R, Brugnaletta S. Puncture versus surgical cutdown complications of transfemoral aortic valve implantation (from Spanish TAVI Registry). *Am J Cardiol*. 2016;118:578-84.
17. Walas RL, Kukulski L, Jazwiec T. Vascular access site complications after transfemoral transcatheter aortic valve implantation in the POL-TAVI Registry. Surgical versus percutaneous approach. *Cardiovasc Surg (Torino)*. 2020;61:117-22.
18. Bernardi FLM, Gomes WF, de Brito Fs. Surgical cutdown versus percutaneous access in transfemoral transcatheter aortic valve implantation: insight from Brazilian TAVI registry. *Catheter Cardiovasc Interv*. 2015;86:501-5.
19. Kochman J, Koltowski L, Huczek Z. Complete percutaneous approach versus surgical access in transfemoral transcatheter aortic valve implantation: results from a multicentre registry. *Kardiol Pol*. 2018;1:202-8.
20. Mach M, Wilbring M, Winkler B. Cut-down outperforms complete percutaneous transcatheter valve implantation. *Asian Cardiovasc Thorac Ann*. 2018;26:107-13.
21. Spitzer SG, Wilbring M, Alexiou K. Surgical cut-down or percutaneous access- which is best for less vascular access complications in transfemoral TAVI? *Catheterization and Cardiovasc Interventions*. 2016;88:E52-8.
22. Drafts BC, Choi CH, Sangal K. Comparison of outcomes with surgical cut-down versus percutaneous transfemoral transcatheter aortic valve replacement: TAVR transfemoral access comparisons between surgical cut-down and percutaneous approach. *Catheter Cardiovasc Interv*. 2018;91:1354-62.
23. Ando T, Briassoulis A, Holmes AA. Percutaneous versus surgical cut-down access in transfemoral transcatheter aortic valve replacement: a meta-analysis. *J Card Surg*. 2016;31:710-17.

**Journal of Clinical Medical Research**



## **Publish your work in this journal**

Journal of Clinical Medical Research is an international, peer-reviewed, open access journal publishing original research, reports, editorials, reviews and commentaries. All aspects of medical health maintenance, preventative measures and disease treatment interventions are addressed within the journal. Medical experts and other related researchers are invited to submit their work in the journal. The manuscript submission system is online and journal follows a fair peer-review practices.

**Submit your manuscript here:** <https://athanaeumpub.com/submit-manuscript/>