Standardized Measurement of Femoral Artery Depth by Computed Tomography to Predict Vascular Complications After Transcatheter Aortic Valve Implantation

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Vascular complications (VCs) are difficult to predict and remain an important issue after transfemoral (TF) transcatheter aortic valve implantation (TAVI) although their incidence has decreased with size reduction of introducers. We aimed to evaluate a standardized measurement of femoral artery depth (FAD) using computed tomography (CT) to predict VCs after TAVI. We performed a retrospective study of 679 TF TAVI patients. We evaluated a standardized CT method to measure FAD immediately above the bifurcation. Sheath-to-femoral-artery ratio (SFAR), calcification, and tortuosity were also evaluated. VCs were defined by the Valve Academic Research Consortium (VARC)-2. Receiver operating characteristic (ROC) curves were used to predict major VCs and the need for a stent-graft. The median values of FAD and SFAR were 49.0 (36.2 to 66.7) mm and 0.95 (0.81 to 1.18), respectively. Major VCs occurred in 37 (5.4%) patients and a stent-graft was required in 49 (7.1%) patients. FAD predicted the need for a stent-graft [0.61 (0.51 to 0.70), p = 0.04] but not major VCs [0.52 (0.40 to 0.63), p = 0.76]. In contrast, SFAR did not predict the need for a stent-graft [0.53 (0.43 to 0.62), p = 0.61] but predicted major VCs [0.70 (0.58 to 0.81), p = 0.001]. Calcification and tortuosity predicted neither major VCs nor the need for a stent-graft. In conclusion, the results of our study suggest that CT measurements of FAD and SFAR provide additional information to predict major VCs and the need for a femoral stent-graft after TF TAVI. **(Am J Cardiol 2021;145:119−127)**

Transcatheter aortic valve implantation (TAVI) is currently recommended in patients who are not suitable for surgical aortic valve replacement (SAVR) and in patients who are at increased surgical risk, particularly if patients are suitable for a transfemoral (TF) approach.[1−4] Major vascular complications (VCs) are feared after TF TAVI given their prognostic impact although they have considerably decreased in recent years with improved patient selection and size reduction of introducers.[3−6] Multidetector computed tomography (MDCT) of the ilio-femoral access is currently the gold standard technique to determine the feasibility of a TF approach.[7] MDCT traditionally evaluates the degree of arterial tortuosity, the extent and localization of calcification (particularly at the puncture site), and the minimal diameter to compute the sheath-to-femoral-artery ratio (SFAR).[8] Among these parameters, SFAR is considered as the strongest predictive factor of major VCs.[9−11] On the other hand, it has been frequently observed that puncture of the femoral artery in obese patients, especially when the artery is deep, is more difficult and increases the risk of VCs.[12] However, to our knowledge, the impact of femoral artery depth (FAD) to predict VCs after TF TAVI has been poorly evaluated. The aim of our study was therefore to assess the impact of FAD on VCs after TF TAVI using a new standardized protocol to measure FAD using MDCT.

Methods

Between January 2013 and December 2018, 1,411 consecutive patients were prospectively included in our TAVI database. All patients selected by our multidisciplinary team had severe symptomatic aortic stenosis and gave written informed consent. Patients who had TAVI via a nonfemoral route and who did not have CT in our center or when CT was not archived were excluded. The study was approved by our local ethics committee with a waiver for retrospective analysis.

Pre-procedural MDCT examinations were performed either with a 64-slice Discovery 350 HD® or with a 256-slice Revolution CT scanner (both from General Electric Healthcare, Milwaukee, Wisconsin). Acquisition protocol was homogeneous and conformed to the recommendations of the Society of Cardiovascular Computed Tomography and the European Society of Cardiovascular Radiology.[8]

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Tube voltage was set at 100 kVp when patient's body mass index (BMI) was less than 25 kg/m^2 and 120 kVp when BMI exceeded 25 kg/m^2. Sixty milliliters of 350 mgI/mL contrast agent (iohexol or iobitridol) were injected at a flow rate of 4 mL/s pulsed by 20 mL of saline at the same flow rate. Bolus tracking was used. CT scanning of the thorax and abdomen was performed on breath-hold in a cranio-caudal direction. Chest scanning was prospectively ECG-gated. ECG was automatically switched off during acquisition for scanning the abdomen and pelvis down to the common femoral artery bifurcation. Cardiac images were not considered in the present study. Sub-millimetric abdominal-pelvic images were reconstructed and transferred to a workstation (ADW Server, General Electric Healthcare, Milwaukee, Wisconsin)

Measurements were performed with the Reformat tool of the workstation and standardized as follows. To measure FAD, the axial view passing through the center of the femoral heads was first selected (Figure 1). A horizontal line was drawn between the ischial spines. An orthogonal vertical line was drawn from this bi ischiatic line and directed anteriorly. Another orthogonal horizontal line connected the vertical line to the geometric center of the common femoral artery that was used as vascular access for TAVI. Finally, a second vertical line was traced from the center point of the common femoral artery to the skin surface. An experienced examiner processed all measurements retrospectively on the side of the arterial puncture used for TAVI. The same operator reproduced blindly the same measures a second time in 30 random patients to evaluate intra-observer variability. A second experienced examiner performed independently the measures in the same 30 patients to evaluate inter-observer variability. MDCT reports were also reviewed for calcification and tortuosity, and scored, as previously described.[8] Briefly, calcification at the puncture site were quantified as follows: 0) absent; (1) < 30% of the circumference of the vessel; (2) 30% to 50% of the circumference of the vessel; (3) > 50% of the circumference of the vessel; and (4) 100% of the circumference of the vessel or the totality of the anterior wall. The tortuosity of the ilio-femoral axis was also analyzed using a semi quantitative score as follows: 0) no tortuosity; (1) mild tortuosity (30° to 60°); (2) moderate tortuosity (60° to 90°); and (3) severe tortuosity (> 90°). Finally, Iliac and femoral artery diameters were measured. SFAR was obtained by dividing the sheath size (outer diameter) by the minimum ilio-femoral diameter on the access side.

In our center, TAVI procedures have been performed since 2002.[13] The operating team for TF TAVI consists of 5 experienced operators. Prior to the procedure, the decision to perform TAVI was made by a multidisciplinary team. Only if small ilio-femoral vessel diameters and/or vascular abnormalities preclude a transfemoral approach did patients have TAVI via nonfemoral access. Oral anticoagulants were stopped 3 to 4 days before the procedure and we did not use a loading dose of clopidogrel. Balloon and self-

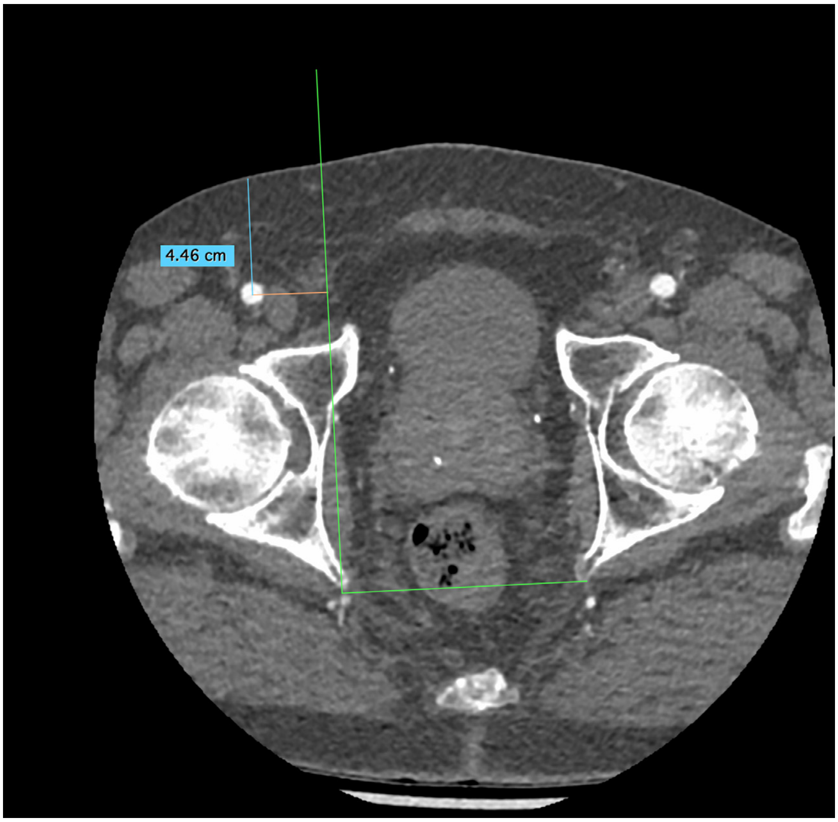


Figure 1. Axial CT slice passing through the geometric center of the femoral heads. First, a horizontal line was drawn between the ischial spines (green line). An orthogonal vertical line (green line) was drawn from this bi-ischiatic line and directed anteriorly. Another orthogonal horizontal line (pink) connected the vertical line to the geometric center of the common femoral artery that was used as a vascular access (the right one in the present case). Finally, a second vertical line (blue) was traced from the center point of the common femoral artery to the skin surface.

expandable prostheses were used during this study: SAPIEN XT prosthesis from January 2013 to September 2014 and SAPIEN 3 prosthesis thereafter. For the SAPIEN XT prosthesis, we used a 16-F sheath for the 23-mm valve, a 18-F sheath for the 26-mm valve, and a 20-F sheath for the 29-mm valve. For the SAPIEN 3 prosthesis, we used a 14-F sheath for the 23- and 26-mm valves and a 16-F sheath for the 29-mm valve. During the studied period, first generation Corevalve was used in 2013 with an 18-F sheath. From 2014 to 2017, we used the Corevalve Evolut R with a 14-F sheath, and since 2018, the Corevalve Evolut Pro is preferred with a 16-F sheath.

All the procedures were performed using exclusively local anesthesia ± conscious sedation with access site closure using a single Prostar device (Abbott Vascular, Santa Clara, California).[14] Angiographic guidance was used for puncture of the common femoral artery. Heparin (70 UI/kg) was administered after sheath insertion. Anticoagulation was measured by activated clotting time with, if necessary, repetitive administration of heparin to achieve a clotting time of 250 to 300 seconds. Protamine was systematically administered at the end of the procedure before vascular closure. Final angiography was obtained to verify the absence of VCs. Dual antiplatelet therapy was prescribed for one month in patients without indication for anticoagulant. In patients at high risk of bleeding, a single antiplatelet therapy was preferred. In patients with an indication for anticoagulant, vitamin K antagonist or direct oral anticoagulant were used without antiplatelet therapy.[15,16]

VCs were defined according to the updated standardized end point definitions for TAVI according to the Valve Academic Research Consortium (VARC-2 criteria) and classified as minor or major.[17] Thirty-day mortality was also recorded.

Quantitative variables were expressed as mean ± SD or median (25th to 75th interquartile range) and compared with the Student *t* test or Wilcoxon rank-sum test, depending on variable distribution. Correlations were assessed using Spearman's rank correlation coefficient. Qualitative variables were presented as number with percentage and compared with chi-square test or Fisher's exact test. A logistic regression multivariable analysis was used to assess independent correlates of major VCs and the need for a stent-graft. Receiver operator characteristic curves were also used to predict major VCs and the need for a stent-graft. To analyze the SFAR and FAD thresholds that best predicted major VCs and the need for a stent-graft, the intersection of sensitivity and specificity curves was determined with their accompanying positive and negative predictive values. Inter- and intra-observer variabilities were evaluated using Bland-Altman plot and linear logistic regression analysis.

Differences were considered statistically significant at a p value of ≤0.05. All data were analyzed using SPSS software (version 23.0, IBM, Chicago, Illinois).

Results

The flowchart of the studied population is presented in Figure 2. From January 2013 to December 2018, 1,411 patients had TAVI in our center. Among them, 182 (12.9%) patients were excluded because they were implanted via a nonfemoral route. An additional 540 (38.3%) TF TAVI patients were excluded because MDCT was performed in another center or was not archived in the picture archiving computerized system (PACS) currently used in our center (Carestream, Rochester, New York). Thus, 689 (55.7%) TF TAVI patients were included and represented the studied population.

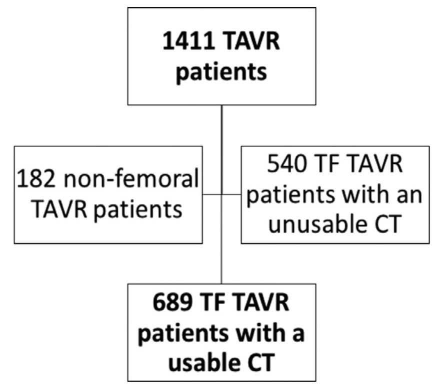


Figure 2. Study flow chart.

Baseline characteristics of the studied population are shown in Table 1. The mean age was 83.9 ± 6.0 years and 45.8% of patients were male. The mean logistic EuroSCORE was 15.4 ± 8.9% and all patients had severe symptomatic AS.

MDCT analysis of the ilio-femoral axis is represented in Table 2. The median of FAD was 49.0 (36.2-66.7) mm.

Table 1
Baseline characteristics

Characteristics	Overall Population (n = 689)
Age (years)	83.9 ± 6.0
Men	311 (45.8%)
Weight (Kg)	71 (62-82)
Height (cm)	165 (158-170)
Body mass index (Kg/m^2)	26.5 (23.8-29.7)
Body area (m^2)	1.79 (1.65-1.94)
Hypertension	536 (78.9%)
Diabetes mellitus	199 (29.3%)
Dyslipidemia	406 (59.8%)
Prior myocardial infarction	60 (8.8%)
Prior coronary angioplasty	154 (22.7%)
Prior coronary bypass	35 (5.2%)
Atrial fibrillation	236 (34.7%)
Peripheral vascular disease	60 (8.8%)
History of stroke	57 (8.4%)
History of neoplasia	123 (18.1%)
Logistic EuroSCORE (%)	15.4 ± 8.9
Creatinine clearance (mL/ mn)	49.7 ± 20.8
NYHA class	
I	45 (6.6%)
II	253 (36.9%)
III	342 (49.9%)
IV	39 (5.7%)
Aortic valve area (cm^2)	0.73 ± 0.21
Median aortic gradient (mmHg)	45.0 ± 14.9
Left ventricular ejection fraction (%)	60.4 ± 13.1
Systolic pulmonary artery pressure (mm Hg)	38.5 ± 13.5

Table 2
Computed Tomography analysis of the ilio-femoral axis.

Characteristics	Overall Population(n = 689)
Tortuosity	
- Absent or mild	381 (55.3%)
- Moderate	247 (35.8%)
- Severe	61 (8.8%)
Calcium	
- Absent	184 (26.7%)
- < 30%	372 (54.0%)
- 30-50%	110 (16.0%)
- > 50%	23 (3.3%)
Minimal femoral diameter (mm)	6.8 (5.9-7.6)
Femoral artery depth (mm)	49.0 (36.2-66.7)
SFAR	0.95 (0.81-1.18)

Abbreviations. SFAR = sheath-to-femoral-artery ratio.

Intra- and inter-observer variability of the measurement of the FAD site was evaluated using Bland-Altman analysis (Supplemental Figure 1). Using linear regression, we observed a good agreement for both analyses. There was a significant correlation between FAD and weight ($p < 0.0001$), BMI ($p < 0.0001$), and body area ($p < 0.0001$) but not with height ($p = 0.4$) (Figure 3). In the studied population, 154 (22.3%) patients had a BMI ≥ 30 Kg/m^2. FAD was significantly higher in obese patients than in non-obese patients [73.4 (55.9 to 93.8) versus 43.8 (33.7 to 57.2) mm, $p < 0.0001$].

Moderate or severe tortuosity of the ilio-femoral axis selected for the implantation was observed in 44.6%. No or less than 30% of anterior calcification was observed at the puncture site in the majority of cases (80.7%). The median of the minimal femoral diameter at the puncture site and SFAR were 6.8 (5.9 to 7.6) mm and 0.95 (0.81 to 1.18), respectively. The severity of tortuosity and calcification were not significantly different in obese and non-obese patients. In contrast, SFAR was significantly lower in obese than in non-obese patients [0.91 (0.79 to 1.08) vs 0.95 (0.82 to 1.20) mm, $p = 0.02$].

A balloon-expandable valve was used in 88.8%. A 14-F, 16-F, and 20-F sheath was used in 446 (65.1%), 204 (29.8%), and 35 (5.1%) patients, respectively.

During in-hospital follow-up, 105 (15.2%) patients had a VC classified as minor in 68 (9.9%) patients and major in 37 (5.4%) patients. Of note, the incidence of major VC in patients excluded of our study was closely similar (5.5% vs 5.4%, $p = 0.92$).

The distribution types of VCs of the studied population are shown in Figure 4. Most of the VCs were access-related.

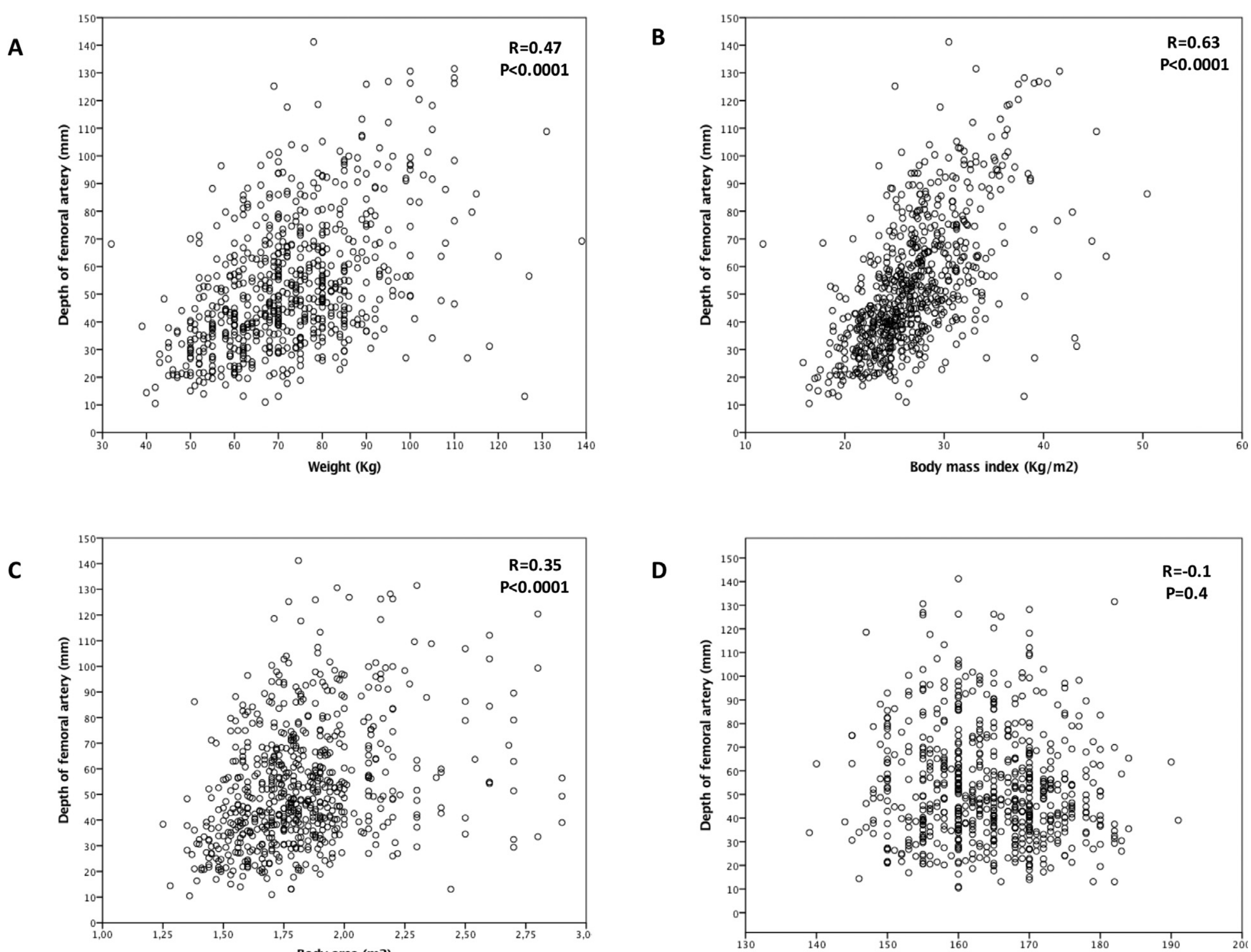


Figure 3. Correlation between femoral artery depth and weight (A), body mass index (B), body area (C) and the height (D).

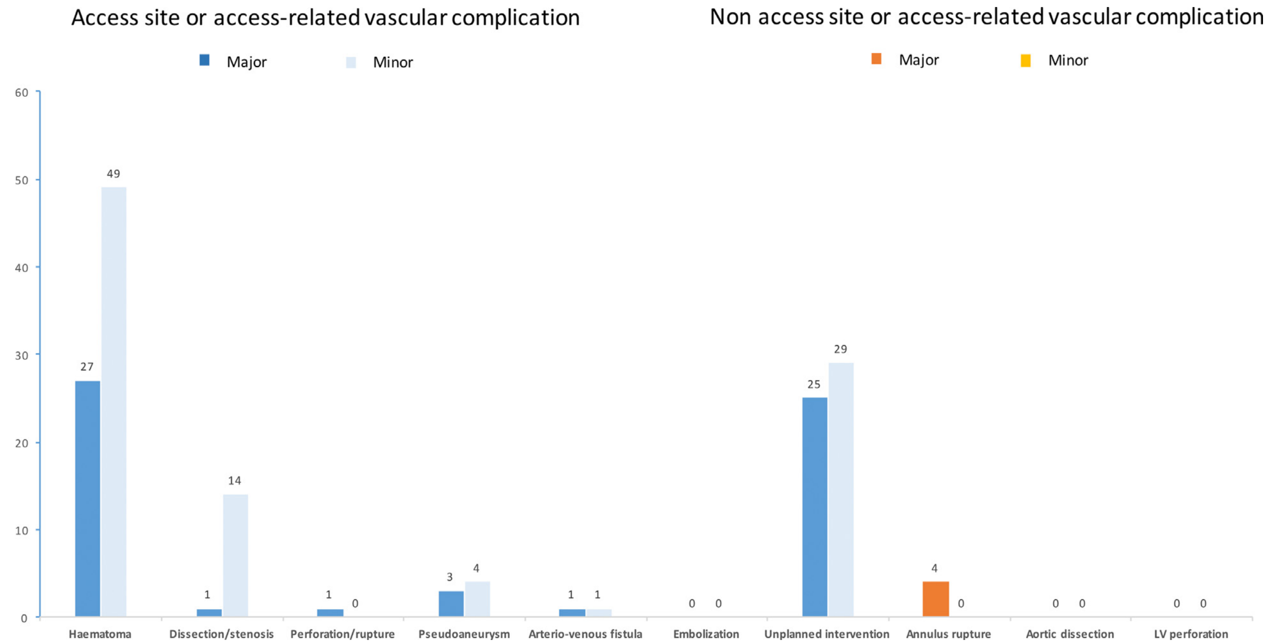


Figure 4. Distribution types of vascular complications. The rates of all vascular complications divided in access (blue) and non-access (orange) related vascular complications and major and minor vascular complications according to the VARC-2 definitions.

The most frequent complication was hematoma and 4 patients had a non-access related major VC all related to annulus rupture. A stent-graft was used in 49 (7.1%). In 48 cases, the stent-graft was used for failure of vascular closure device (VCD) and in one case due to iliac rupture. Among patients who need a stent-graft, 25 had a minor VC and 24 had a major VC. Five (0.7%) patients required vascular surgery and all had major VC. Vascular surgery was indicated in 2 cases for persistent bleeding after stent-graft implantation, in 2 cases for evacuation of large hematoma, and in 1 case for acute lower limb ischemia. Obese patients (BMI $\geq$ 30 kg/m^2) required more frequently a stent-graft as compared with those with a BMI < 30 kg/m^2 (13.6% vs. 5.4%, $p < 0.0001$) and the incidence of major VCs was increased, but not significantly different, in obese patients as compared with nonobese patients (7.8% vs 4.8%, $p = 0.15$).

FAD was significantly greater in patients requiring a stent-graft for a VC ($p = 0.007$, Figure 5). In contrast, minimal femoral diameter and SFAR were not significantly different in patients requiring or not a stent-graft (Figure 5 and 5). The degree of the tortuosity and the extent of calcification at the puncture site were not significantly different in patients requiring or not a stent-graft ($p = 0.82$ and $p = 0.51$, respectively). The incidence of stent-graft increased according to the size of the sheath ($p = 0.04$).

FAD was not significantly different in patients with or without major VCs (Figure 6). The minimal femoral diameter was not significantly different in patients with or without major VCs (Figure 6). In contrast, SFAR was significantly higher in patients with than without major VCs ($p < 0.0001$, Figure 6). The degree of the tortuosity was not significantly different in patients with or without major VCs ($p = 0.81$) but the extent of calcification at the puncture site was significantly greater in patients with than in those without major VCs ($p = 0.02$). The incidence of major VCs increased according to the size of the sheath ($p < 0.0001$).

Predictors of major VCs and the need for a stent-graft were evaluated using multivariate and ROC curve analysis.

After multivariate analysis, FAD was the only predictor of the need for a stent-graft (Table 3) whereas SFAR was the only predictor of major VCs (Table 4)

ROC curve analysis for predictors of the need for a stent-graft is shown in Figure 7. The area under the ROC curve for FAD was 0.61 (0.51 to 0.70, $p=0.04$) indicating poor accuracy to predict the need for a stent-graft. Other parameters were not significant.

ROC curve analysis for predictors of major VCs is shown in Figure 8. The area under the ROC curve for SFAR was 0.70 (0.58-0.81, $p = 0.001$) and for sheath diameter was 0.66 (0-54 to 0.78, $p = 0.006$) indicating fair and poor accuracy to predict major VCs, respectively. Other parameters were not significant.

To analyze the FAD that best predicted the need for a stent-graft, sensitivity and specificity curves were composed. The identified intersection points of the 2 curves provided a threshold of 54 mm. The accompanying sensitivity for the threshold was 63.3% with a specificity of 40.9%, a positive predictive value of 4.9%, and negative predictive value of 89.4%.

To analyze the SFAR that best predicted major VCs, sensitivity and specificity curves were also composed. The identified intersection points of the 2 curves provided a threshold of 1.03. The accompanying sensitivity for the threshold was 67.6% with a specificity of 65.2%, a positive predictive value of 9.5%, and negative predictive value of 97.4%.

Interestingly, major VCs were significantly higher in patients who combined a SFAR >1.03 and a FAD >54 mm than in those with a SFAR < 1.03 and a FAD <54 mm (12% vs 2.1%, $p < 0.0001$). Two examples of low-risk and high-risk patients of VCs according to MDCT analysis of the ilio-femoral access are shown in supplemental figure 2.

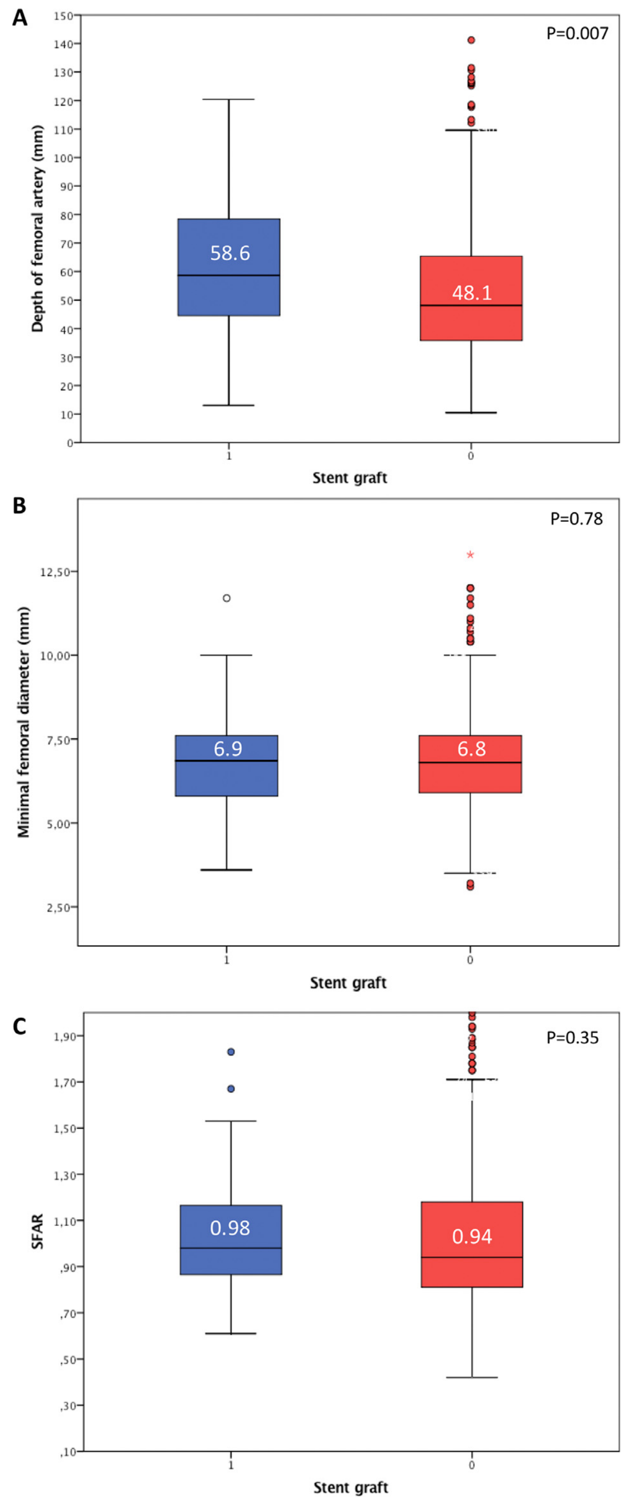


Figure 5. Scatter box plot of femoral artery depth (A), minimal femoral diameter (B), and SFAR (C) in patients whether they required or not a stent-graft for vascular complication.

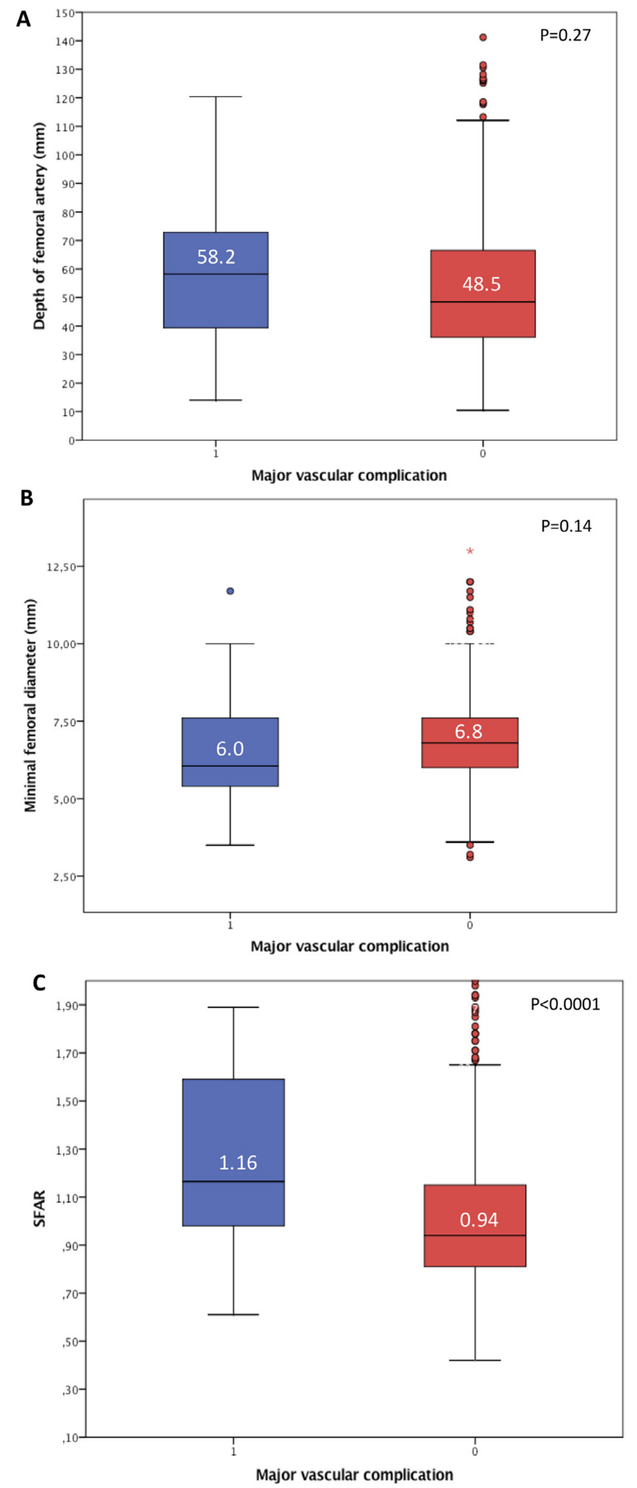


Figure 6. Scatter box plot of femoral artery depth (A), minimal femoral diameter (B), and SFAR (C in patients with or without major vascular complication

The 30-day mortality rate was 8.6% for patients with major VCs and 2.3% for patients without major VCs (p = 0.06). The 30-day mortality rate for patients requiring a stent-graft was 4.3% and 2.5% for patients not requiring a stent-graft (p = 0.45).

Discussion

We aimed to evaluate a new MDCT parameter (i.e., measurement of FAD), in addition to usual parameters, to predict major VCs and the need for a stent-graft after TF TAVI. The main results can be summarized as follows: (1)

Table 3
Predictors of the need for a stent graft

Variables	HR	CI 95%	p
SFAR	0.77	0.14−4.34	0.77
Tortuosity	1.01	0.60−1.71	0.97
Calcification	0.81	0.50− .32	0.40
Sheath diameter	1.23	0.93− .64	0.15
Minimal femoral diameter	0.96	0.65−1.41	0.83
Femoral artery depth	1.02	1.00−1.04	0.048

Abbreviations. SFAR = sheath femoral artery ratio.

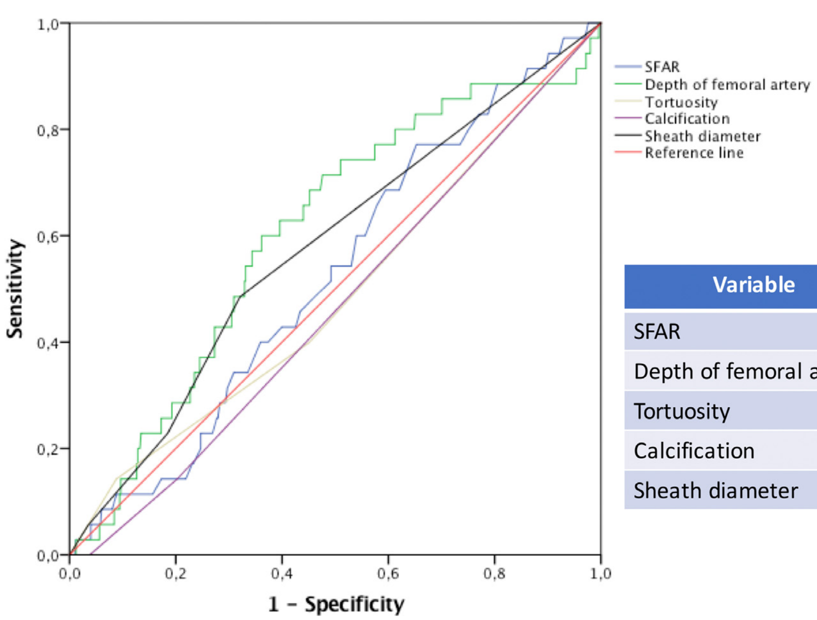
Table 4
Predictors of major vascular complications

Variables	HR	CI95%	p
SFAR	8.86	1.42−55.24	0.02
Tortuosity	0.64	0.32−1.28	0.21
Calcification	1.00	0.58−1.73	0.99
Sheath diameter	1.09	0.80−1.49	0.58
Minimal femoral diameter	1.32	0.81−2.14	0.26
Femoral artery depth	1.00	0.98−1.02	0.86

Abbreviations.SFAR = sheath femoral artery ratio.

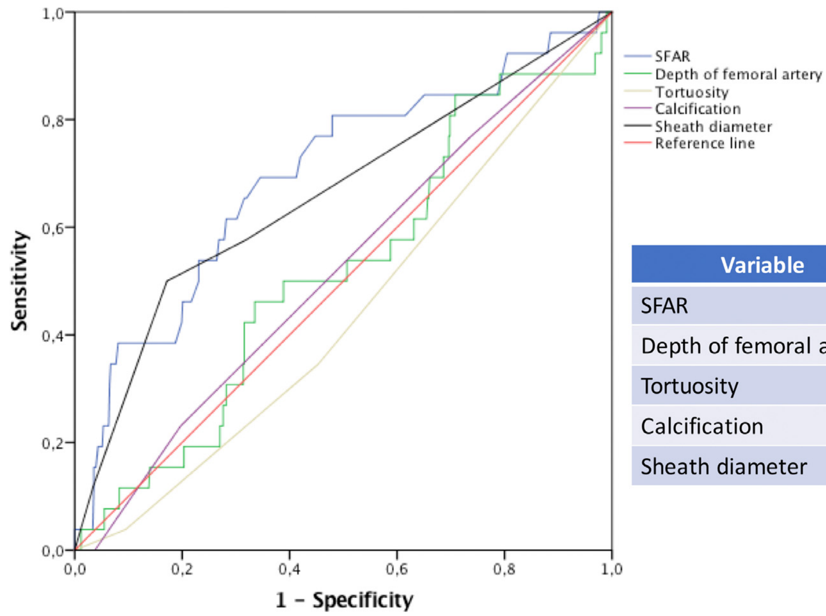
FAD measurement using standardized MDCT is easy and reproducible and was significantly increased in patients requiring a stent-graft; (2) FAD was the only predictor of the need for a stent-graft although ROC curve analysis indicated poor accuracy with a threshold value of 54-mm; (3) Among the other usual parameters, SFAR was the only factor with a fair accuracy to predict major VCs.

For a long time now, it has been known that femoral arterial puncture in obese patients, particularly when the artery is deep, is more difficult and the risk of VCs and bleeding is increased.[12,18] Surprisingly, it has been reported that major VCs are not significantly increased in obese patients after TF TAVI.[5,9,11,19] We hypothesized that the measurement of FAD, rather than BMI, would be more appropriate to evaluate the risk of major VCs and in particular the risk of failure of VCD, requiring a stent-graft. In our study, we first showed that FAD can be easily and reproducibly measured using CT. Interestingly, FAD was not significantly different in patients with or without major VCs and FAD was not predictive of major VCs. These results are in accordance with those showing that obesity does not increase the risk of major VCs after TF TAVI.[5,9,11,19] However, we observed that FAD was increased in patients requiring a stent-graft and was the only predictive factor of the need for a stent-graft. Of note, most of the stent-grafts were related to the failure of VCD in our study. We therefore hypothesized that the deeper the femoral artery, the greater the risk of failure of VCD. Predictive factors of failure of VCD for coronary angiography and/or PCI using a femoral approach have been reported. Interestingly, obesity was an independent predictors of failure of VCD.[20] Predictive factors of failure of VCD have been evaluated in patients with large arteriotomy for aneurysm repair or TAVI.[21] In accordance with our studies, the distance between skin and common femoral artery (i.e., FAD) was a strong predictor of failure of VCD.[22] In order to reduce the risk of failure of VCD requiring a stent-graft in patients with a deep femoral artery, several options are possible. First, the shallowest femoral artery should be selected because FAD is commonly asymmetrical. Second, the lower belly should be pushed upwards and the puncture should be performed in a straight direction, otherwise the insertion of the sheath or preclosure device may become difficult. Third, a preventive crossover balloon occlusion technique may be also used to reduce bleeding in case of failure of VCD in patients presenting with very deep



Variable	AUC	CI 95%	P
SFAR	0.53	0.43 – 0.62	0.61
Depth of femoral artery	0.61	0.51 – 0.70	0.04
Tortuosity	0.49	0.38 – 0.59	0.82
Calcification	0.46	0.37 – 0.56	0.48
Sheath diameter	0.57	0.48 – 0.67	0.14

Figure 7. ROC curve analysis of SFAR (blue), femoral artery depth (green), tortuosity (yellow), calcification (purple), sheath diameter (black) to predict the need for a stent-graft. The reference line is indicated in red.



Variable	AUC	CI 95%	P
SFAR	0.70	0.58 – 0.81	0.001
Depth of femoral artery	0.52	0.40 – 0.63	0.76
Tortuosity	0.44	0.33 – 0.55	0.29
Calcification	0.52	0.41 – 0.63	0.72
Sheath diameter	0.66	0.54 – 0.78	0.006

Figure 8. ROC curve analysis of SFAR (blue), femoral artery depth (green), tortuosity (yellow), calcification (purple), sheath diameter (black) to predict major vascular complications. The reference line is indicated in red.

femoral artery.[23] On the other hand, a surgical cut down can be also discussed in obese patients but it has been reported that the incidence of major VCs is similar between percutaneous and surgical femoral approaches.[24] Finally, alternative accesses (e.g. trans-carotid, trans-subclavian, trans-apical) should be privileged in patients with multiple elements unfavorable for femoral approach.

We also assessed the impact of other MDCT parameters to predict VCs after TAVI. In our study, the degree of ilio-femoral tortuosity and the extent of calcification at the puncture site were neither predictive of major VCs nor the need for a stent-graft. In all the studies, the degree of ilio-femoral tortuosity was not an independent predictor of major VCs after TAVI.[9, 11] On the other hand, conflicting results were obtained for the extent of calcification at the puncture site.[9,11] We believe that calcification was not predictive in our study since patients with circumferential or anterior calcification at the puncture site had systematic TAVI via a non-femoral approach.

Our study confirmed that SFAR remains the strongest predictor of major VCs after TF TAVI although the area under the ROC curve is variable among the studies and its positive value is low to predict VCs.[9–11] However, to our knowledge, we are the first to evaluate the impact of SFAR on the need for a stent-graft. SFAR was not significantly different in patients with or without a stent-graft and FAD was the only predictive factor. We therefore believe that SFAR and FAD provide additional information and that FAD could be systematically and easily assessed during MDCT in order to evaluate the feasibility of a TF approach before TAVI.

This analysis was retrospectively conducted in a prospectively acquired single-center, nonrandomized cohort with inherent limitations related to its design. Therefore, we were only able to identify correlations and not prove any causality. Additionally, although it represents a real-world situation with inclusion of approximately 700 patients, the number of major VCs was relatively low (5.4%) and the results should be confirmed in a larger population. Furthermore, we excluded about 40% of the patients for whom MDCT was not archived in the PACS currently used in our center. It is therefore possible that this could have resulted in a selection bias. Finally, our results were obtained using preclosing with Prostar device and could not be extrapolated with other VCD.

In conclusion, the results of our study show that FAD measurement is easy and reproducible and can be performed during MDCT assessment of ilio-femoral vessels, before TAVI. Based on our findings, we suggest that FAD is an independent predictor of the need for a stent-graft for VC after TF TAVI. Further studies are needed to confirm our results prospectively and in a larger population.

Credit Author Statement

Eric Durand, Jean Nicolas Dacher and Helene Eltchaninoff have contributed to conception and design, acquisition of data, analysis and interpretation of data, drafting and revisiting the manuscript; **Eric Durand** has performed statistical analysis; **Marylin penso, Stephanie Wong Thibault Hemery, Thomas Levesque, Gustavo Moles, Christophe Tron, Najime Bouhzam, Nicolas Bettinger** have contributed to acquisition and interpretation of data.

Declaration of Competing Interest

Eric Durand has received lecture fees from Edwards Lifesciences.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2020.12.089.

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