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Scientific letter

Transfemoral TAVI in hostile access: experience with the paving and cracking technique

TAVI transfemoral en acceso hostil: experiencia con la técnica paving and cracking

Rocío Vázquez Pérez,[a,*] Raquel del Valle Fernández,[b] Alberto Alperi García,[b] Ahmad Amer Zanabili Al-Sibbai,[a] Francisco Álvarez Marcos,[a,c] and Manuel Alonso Pérez[a,c]

[a] *Servicio de Angiología y Cirugía Vascular, Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain*
[b] *Servicio de Cardiología, Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain*
[c] *Instituto de Investigación Sanitaria del Principado de Asturias (ISPA), Oviedo, Asturias, Spain*

To the Editor,

Femoral access is the preferred route for transcatheter aortic valve implantation (TAVI), according to the most recent clinical practice guidelines of the European Society of Cardiology and the European Association for Cardio-Thoracic Surgery (ESC/EACTS).[1] However, iliac vessel stenosis, tortuosity, and calcification may render transfemoral access unfeasible or lead to complications in up to 5%-10% of cases.[2]

To overcome these anatomical limitations, the paving and cracking (P&C) technique was described,[3] originally used in endovascular aneurysm repair. This strategy allows preparation of the iliac vessels using covered stents followed by postdilatation.[4] Other adjunctive techniques, such as intravascular lithotripsy,[5] modify iliac vessel calcification and facilitate the advancement of large-bore introducer sheaths.

We present our experience using the P&C technique to perform transfemoral TAVI in patients with hostile iliofemoral anatomy. We conducted a retrospective analysis of all patients who required adjunctive iliac endovascular treatment with covered stents (P&C technique) as part of transfemoral TAVI from 2021 through 2024 at our center. All cases were recorded in a prospectively maintained database including demographic variables, valve type and implantation characteristics, anesthetic technique, and procedural information. We analyzed preoperative computed tomography scans to assess maximum and minimum intraluminal iliac diameters, tortuosity, degree of calcification, and presence of thrombus. Because of the retrospective design of the study, the institutional Research Ethics Committee waived the requirement for specific informed consent.

Severe arterial tortuosity was defined as an angle > 90°, and grade 4 calcification as calcium involving > 75% of the vessel circumference. Vascular complications were defined according to the criteria outlined by the Valve Academic Research Consortium-3 (VARC-3).[6] Technical success was defined as successful completion of transfemoral TAVI. Quantitative variables were expressed as mean and standard deviation, and the qualitative ones as frequencies. We did not perform inferential analysis due to the limited sample size.

During the study period (2021-2024), a total of 739 transfemoral TAVI were performed, 6 of which (0.8%) required simultaneous iliofemoral endovascular treatment prior to valve implantation using the P&C technique (table 1). Evolut valves (Medtronic, United States) were used in all cases.

Table 1. Demographic, clinical, and anatomic characteristics of the 6 patients undergoing transfemoral TAVI using the paving and cracking technique

Variable	N = 6
Male sex	6 (100)
Age, years	77.5 ± 6 [68-84]
Smoking history	6 (100)
Peripheral arterial disease	4 (66.7)
Valve-in-valve procedure	3 (50.0)
Minimum luminal diameter, mm	3.5 (0.4-6.0)
Calcification (grade 3 or 4)	5 (83.3)
Severe tortuosity	2 (33.3)
Presence of thrombus	5 (83.3)
TAVI sheath profile	
14-Fr (Evolut Pro 23 or 26)	3 (50.0)
16-Fr (Evolut-R 34)	1 (16.7)
18-Fr (Evolut Pro+ 34)	1 (16.7)
22 Fr (Evolut FX 34)	1 (16.7)

TAVI, transcatheter aortic valve implantation.
Data are expressed as no. (%), mean ± SD, or median [interquartile range].

*** Corresponding author.**
E-mail address: rociovazquezperez@hotmail.com (R. Vázquez Pérez).

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Table 2. Procedural details, adjunctive endovascular and surgical techniques, and short- and mid-term clinical outcomes in the study cohort

Variable	N = 6
Fully transcatheter approach	4 (66.7)
Anesthesia	
Local	2 (33.3)
General	4 (66.7)
Use of intravascular lithotripsy	2 (33.3)
Endovascular procedure	
1 self-expanding stent[a]	2 (33.3)
2 self-expanding stents[b]	1 (16.7)
2 balloon-expandable stents[c]	1 (16.7)
1 self-expanding + 1 balloon-expandable stent[d]	2 (33.3)
Adjunctive surgical procedures	
Femoral endarterectomy	1 (16.7)
Iliofemoral bypass	1 (16.7)
Profundoplasty	1 (16.7)
Technical success	6 (100)
Minor complications (VARC-3)	1 (16.7)
Follow-up (months), median	25
Patency at end of follow-up	6 (100)

VARC-3, Valve Academic Research Consortium-3.
Data are expressed as No. (%) or median.
[a] Single 8 mm × 100 mm and 11 mm × 50 mm self-expanding stent (VIABAHN, W. L. Gore & Associates, United States).
[b] Combination of 2 self-expanding stents (11 mm × 100 mm VIABAHN + 11 mm × 50 mm VIABAHN).
[c] Two 10 mm × 59 mm + 10 mm × 39 mm balloon-expandable stents (VBX, W. L. Gore & Associates, United States).
[d] Combination of 1 self-expanding + 1 balloon-expandable stent (10 mm × 39 mm VBX + 10 mm × 100 mm VIABAHN; 11 mm × 79 mm VBX + 11 mm × 100 mm VIABAHN).

The anatomical characteristics of the treated iliac axes are shown in table 1. Iliac axis preconditioning was performed in 4 patients (67%) entirely percutaneously via ipsilateral femoral access. In 1 patient, intraoperative hemorrhage required conversion to open surgery with femoral endarterectomy, profundoplasty, and prosthetic patching. In 2 cases (33%), the endovascular procedure was complemented with open surgery on the common femoral artery: 1 endarterectomy and 1 bypass from the distal external iliac artery to the common femoral artery.

Additional details regarding the implanted stents are shown in table 2. In 2 patients, intravascular lithotripsy was performed prior to stent implantation using a 6-mm and 8-mm Shockwave M5+ catheter (Shockwave Medical, United States). We systematically performed postdilatation of all implanted self-expanding stents, using a balloon of the same diameter in 5 cases and a balloon 1 mm larger in 1 case.

Technical success was achieved in all patients. One patient developed a contralateral femoral pseudoaneurysm a few hours after the procedure, which was treated with ultrasound-guided thrombin injection. Follow-up ultrasound 20 days later showed partial persistence of the pseudoaneurysm and resulted in a 7 mm × 29-mm covered stent implantation (GORE VIABAHN VBX Balloon Expandable Endoprosthesis; W. L. Gore & Associates, United States) via contralateral femoral access. Two patients experienced major complications unrelated to vascular access: 1 case of aspiration pneumonia and 1 case of incomplete left bundle branch block.

All iliofemoral procedures remained patent during follow-up, with a mean follow-up of 25 months. Of note, 4 of the 6 patients (66.7%) died 5, 6, 24, and 28 months after the intervention.

In our series, P&C was used adjunctively to transfemoral TAVI in 6 patients, 3 of whom required adjuvant surgery (femoral endarterectomy with or without profundoplasty, or short iliofemoral bypass). Despite anatomical complexity, we achieved technical success in all cases, which confirmed the safety and efficacy profile of this strategy to enable femoral access in patients with severe atherosclerotic disease.

Endovascular treatment is the first-line option for complex aortoiliac occlusive lesions. In the TAVI setting, this approach expands the population eligible for transfemoral access. To optimize the procedure, ultrasound-guided puncture at the least calcified segment is recommended. Similarly, puncturing the common femoral artery 1-2 cm proximal to the bifurcation facilitates partial stent deployment within the femoral artery and simplifies potential surgical repair in case of injury.[4]

In cases requiring large-bore introducer sheaths (≥ 22Fr), large-diameter stents (10-11 mm) are typically used, and a bypass to the distal common femoral or profunda femoris artery may occasionally be required.[3] This location improves flow control by allowing more comfortable clamping of the stent. Moreover, the use of a radiopaque-tipped introducer sheath helps ensure stent deployment outside the introducer sheath. Balloon-expandable covered stents are recommended in the common iliac artery due to their high radial strength and precision, whereas self-expanding covered stents are preferred in the external iliac artery because of their flexibility and range of available lengths.[4]

If direct postoperative arterial closure is not feasible, a prosthetic bypass should be performed. Since previously available hybrid grafts are no longer on the market, reconstruction must be performed using a vascular prosthesis anastomosed end-to-end to the stent, with a recommended diameter of 10 mm to avoid size mismatch. When stent clamping is difficult, intraluminal balloon clamping (Fogarty or angioplasty balloon) may be used.

In patients treated with lower-profile devices, intravascular lithotripsy is a useful alternative that reduces the need for stent implantation; it uses a semi-compliant balloon with low inflation pressures and predictable recoil. Currently, devices up to 8 mm are available, expandable to 12 mm with the L6 balloon catheter.[5] However, in extensive, heavily calcified lesions requiring advancement of high-profile devices (>18-20-Fr), stent implantation is preferable, as it creates a smooth luminal surface that reduces friction and lowers the risk of arterial rupture. When multiple stents are required, proximal stents should be deployed first to avoid interference during device advancement.

Furthermore, treatment planning should assess hypogastric artery patency, given the risks associated with its occlusion. The P&C technique is typically used in patients with advanced iliofemoral disease, in whom the hypogastric artery is usually occluded or severely stenosed, allowing safe covered stent implantation from the external to the common iliac artery without risk of retrograde hemorrhage. If the hypogastric artery is patent, ischemic risk must be evaluated, including assessment of the contralateral hypogastric

artery and the inferior mesenteric artery. Moreover, in the event of arterial rupture, retrograde flow from a patent hypogastric artery may hinder endovascular hemorrhage control; thus, in the presence patency, prior embolization using oversized occluders (≈ 30%), coils, or other systems is recommended.[4]

The P&C technique is an effective tool to enable femoral access in patients with severe aortoiliac disease undergoing TAVI. Its success requires systematic planning based on imaging modalities and a multidisciplinary approach to optimize outcomes. This strategy expands transfemoral access options while keeping an acceptable safety profile, even in complex anatomies.

DATA AVAILABILITY

Although data supporting the findings of this study are not publicly available due to sensitivity concerns, they may be provided upon reasonable request to the corresponding author.

FUNDING

None declared.

ETHICAL CONSIDERATIONS

The study fully complied with the recommendations for medical research outlined in the Declaration of Helsinki. Given its retrospective design, the study was exempted from the need for an informed consent by our institutional Research Ethics Committee. Sex and gender were reported in accordance with the SAGER guidelines.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

No artificial intelligence tools were used in the preparation of this article.

AUTHORS' CONTRIBUTIONS

R. Vázquez Pérez, A. A. Zanabili Al-Sibbai, and F. Álvarez Marcos contributed equally to this work. R. del Valle Fernández and A. Alperi García validated the study. M. Alonso Pérez supervised its execution. R. Vázquez Pérez, A. A. Zanabili Al-Sibbai, and F. Álvarez Marcos prepared the original draft. All authors contributed to the research, reviewed, edited, and approved the final manuscript, and are accountable for all aspects of the work.

CONFLICTS OF INTEREST

R. del Valle Fernández has received honoraria for lectures and teaching activities from Medtronic and Merce V., as well as consultancy fees from Medtronic. A. A. Zanabili Al-Sibbai has received consultancy and educational honoraria from W. L. Gore & Associates, Shockwave Medical, and Medtronic. F. Álvarez Marcos has received consultancy and proctoring fees from Medtronic and Terumo Aortic. The remaining authors declare no conflicts of interest whatsoever.

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