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Transcaval Access for TAVR Across a Polyester Aortic Graft

Robert J. Lederman, MD[1,*], **William W. O'Neill, MD**[2], and **Adam B. Greenbaum, MD**[2]

[1]Cardiovascular and Pulmonary Branch, Division of Intramural Research, National Heart Lung and Blood Institute, National Institutes of Health, Bethesda, Maryland [2]Division of Cardiology, Henry Ford Health System, Institute for Structural Heart Disease, Detroit, Michigan

Abstract

Transcaval access to the aorta allows transcatheter aortic valve replacement in patients without other good access options. The resulting aortocaval fistula is closed with a nitinol cardiac occluder device. There is no experience traversing a synthetic aortic graft to perform transcaval access and closure. We describe a patient who underwent successful traversal of a polyester aortic graft using radiofrequency energy applied from the tip of a guidewire, to allow retrograde transcatheter aortic valve replacement from a femoral vein, along with details of our technique. The patient did well and was discharged home after 3 days. There was residual aortocaval fistulous flow immediately after implantation of a polyester-seeded nitinol muscular ventricular septal defect occluder device, but this fistula spontaneously occluded within one month.

Keywords

structural heart disease; transcatheter aortic valve implantation; caval-aortic fenestrated graft; vascular access and closure; extra-anatomic procedures

INTRODUCTION

The transcaval approach to transcatheter heart valve implantation addresses the challenge some patients face with inadequate femoral artery caliber and high risk of complications from surgical access (trans-apical, direct aortic, or subclavian) [1,2]. The technique entails entering the abdominal aorta from the femoral vein through the adjoining inferior vena cava. After transcatheter heart valve implantation, the caval-aortic tract is closed using a nitinol cardiac occluder device. The technique is planned from a contrast-enhanced CT which identifies nearby calcium-free aortic crossing points without interposed obstacles or jeopardized branches such as renal arteries or veins [3]. Transcaval access relies on caval vein decompression of peri-procedural aortic bleeding, which allows even frail and elderly

[*]Correspondence to: Robert J. Lederman, MD, National Heart Lung and Blood Institute, National Institutes of Health, Building 10, Room 2c713, Bethesda, MD 20892-1538. lederman@nih.gov.

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patients to tolerate the procedure without catastrophic hemorrhage. To date we are aware of 54 cases of transcatheter heart valve implantation using transcaval access [4].

Despite advanced atherosclerotic or degenerative aortic disease in most patients requiring the transcaval technique, so far femoral vein introducer sheaths have universally advanced across the native caval-aortic access tracts. Moreover, these sheaths have proven immediately hemostatic in all patients to date, suggesting a degree of tissue recoil that contributes to device closure of the transcaval access tract.

We describe a patient with critical aortic valve stenosis having no good conventional options for surgical or transcatheter aortic valve replacement, and who had prior graft replacement of the abdominal aorta. It is not known whether surgical aortic grafts are suitable for transcaval crossing. Because in situ endograft fenestration has been applied in the management of complex branch aortic disease [1,5–7], we considered late in situ temporary fenestration of this patient's surgical graft, at-a-distance via a transcaval approach.

CASE SUMMARY

A 78-year-old man with critical native aortic valve stenosis developed Canadian Cardiovascular Society class III angina. He also had ischemic cardiomyopathy with reduced left ventricular systolic function; coronary artery disease treated by multivessel coronary artery bypass grafting and multivessel coronary artery stenting, now dependent on a right internal mammary to anterolateral artery bypass graft. Fifteen years previously he underwent treatment of a Crawford type IV thoracoabdominal aortic aneurysm using a 24-mm polyester aortic tube graft, and thereafter he underwent multiple iliac artery stents treatment for claudication.

The multidisciplinary institutional heart team agreed he was at prohibitive risk of surgical or direct aortic valve replacement because of porcelain aorta, and unattractive for transapical access because of reduced ventricular function and graft dependence on a right internal mammary to left coronary artery bypass. Femoral artery access was unsuitable because of diffuse heavily calcific bilateral iliac artery stenosis despite stents, with minimum lumen diameters of 4 mm on the right and 3 mm on the left. Axillary artery access was unsuitable because of peripheral artery disease.

He therefore was offered transcaval access for TAVR, despite uncertainty about the feasibility of crossing a 15-year-old polyester aortic graft. He understood and accepted these risks and consented in writing. The transcaval crossing target and procedure were identified on a contrast enhanced CT examination shown in the Table I and Fig. 1. The aortic graft is seen wrapped by native aorta and postoperative fibrosis, which increases the normal distance between the inferior vena cava (IVC) and aortic lumen.

On a benchtop, a woven polyester graft was perforated with an 18-G needle and directly crossed with a 22-Fr dilator (Edwards) using slight torque during traversal, and thereafter inspected (Fig. 2). This suggested that a 0.035″ hole might adequately expand using a vascular dilator without tearing.

Under general anesthesia, the femoral veins and arteries were accessed percutaneously and heparin administered. Simultaneous aortography and venography identified crossing targets previously identified on CT (Fig. 3A). Transcaval access to the aorta was obtained using a coaxial combination of rigid 0.014″ guidewire (Confienza Pro 12, Abbot) with its distal 10 mm amputated, inside a 0.014–0.035″ wire converter catheter (Piggyback, Vascular Solutions), inside a braided microcatheter (Navicross, Terumo), inside a short 7-Fr renal guiding catheter (RDC-1, Cordis) positioned in the cava. The crossing kit was aimed at a loop snare 5 mm larger than the aortic diameter (Amplatz Gooseneck, Covidien) positioned in the aorta so as to appear as a “bullseye” on an orthogonal radiographic projection (Fig. 3B). The proximal end of the guidewire was connected to an electrosurgery pencil, and set to cutting mode at 70 W while it was advanced into the aorta over approximately 1 sec. The snare captured the guidewire, confirming aortic intraluminal position (Fig. 3C). However, unlike our experience with native transcaval crossing, the 0.014–0.035″ wire convertor could not cross the rigid aorta graft (Fig. 3D). Therefore, the coaxial system was removed and a noncompliant coronary angioplasty balloon (2.0 mm × 20 mm NC Raptor) predilated the tract, to permit the wire convertor and the braided microcatheter to then traverse the caval aortic tract into the aorta over the snared guidewire (Fig. 3E). The microcatheter exchanged a rigid 0.035″ guidewire (Lunderquist, Cook) into the aorta. We chose next to predilate the transcaval tract further before introducing a sheath. We used a 20-Fr tapered silicon-coated dilator (Edwards), and mindful of potential aortocaval bleeding, rapidly exchanged for the 18-Fr heart valve sheath (Cook, RCFW-18.OP-38-40-RB) known to have a 22 Fr outer diameter. Using a twisting motion, the sheath advanced into the aorta without evidently displacing it (Fig. 3F). Next a transcatheter heart valve (Medtronic Corevalve 31 mm) was implanted uneventfully (Fig. 4A).

The transcaval tract was closed using a nitinol occluder device (Amplatzer Muscular VSD occluder, 8 mm diameter neck) through a deflectable catheter (Agilis NxT 8.5 Fr 61 cm small curve) itself inserted through the 18 Fr sheath, alongside a 0.014″ “buddy” guidewire (Fig. 4B–D). The device achieved stable position in the transcaval tract, and after heparin reversal, there was residual aortocaval flow but no contrast extravasation (Fig. 4F). The venous disc only partially reached the cava (Fig. 4E). Systolic blood pressure fell further from 120 to 100 mm Hg during device closure, coincident with protamine reversal of heparin. The systolic pressure spontaneously returned to 120 mm Hg after approximately 1 min. The patient was extubated immediately after the procedure, hemoglobin fell from 13.6 to 11.6 mg/dL, yet he did not require vasopressors or blood products. He was discharged home on post-procedure day 3.

His convalescence was uneventful and his angina resolved completely. A routine surveillance contrast-enhanced CT obtained after 30 days showed the caval-aortic tract occluded, and the ninitol occluder in place with no evidence of other vascular or perivascular injury (Fig. 5).

DISCUSSION

“In situ” fenestration of endografts is performed to protect against side-branch occlusion [5–7] during endograft therapy for aortic disease. In our patient, we had been concerned about

either failure to cross because of fabric rigidity or fibrous tissue ingrowth, about linear fabric tear during traversal, and about transcatheter closure which appears to rely to some degree on recoil of the aortic wall. Our concerns were partially assuaged by our benchtop traversal of similar woven graft material without linear tears using the proposed dilator, and by the absence of significant graft calcification on CT. Eadie et al. [8] showed reassuringly minor changes in graft tear strength after bench-top radiofrequency perforation and dilatation of popular polyester and expanded polytetrafluoroethylene materials used in endografts. Riga et al. [9] also performed benchtop fenestration and found graft tears were unlikely when grafts were entered at an orthogonal angle and dilatated using standard balloons, compared with oblique entry or cutting-balloon dilatation.

CONCLUSION

In this case, transcaval access and closure was successful through a polyester abdominal aortic graft placed 15 years previously. Our experience with this case suggests transcaval access may be feasible in others with surgical aortic grafts.

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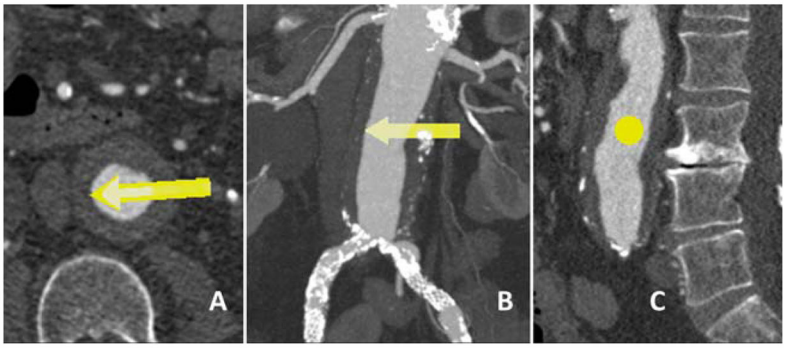

Fig. 1.

Planning transcaval access on contrast-enhanced CT. Pre-procedure contrast-enhanced CT. (A) axial, (B) coronal, and (C) sagittal reconstructions show the graft and surrounding wrapped native aorta and organized thrombus or fibrosis. The proposed crossing target is indicated with a yellow arrow. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

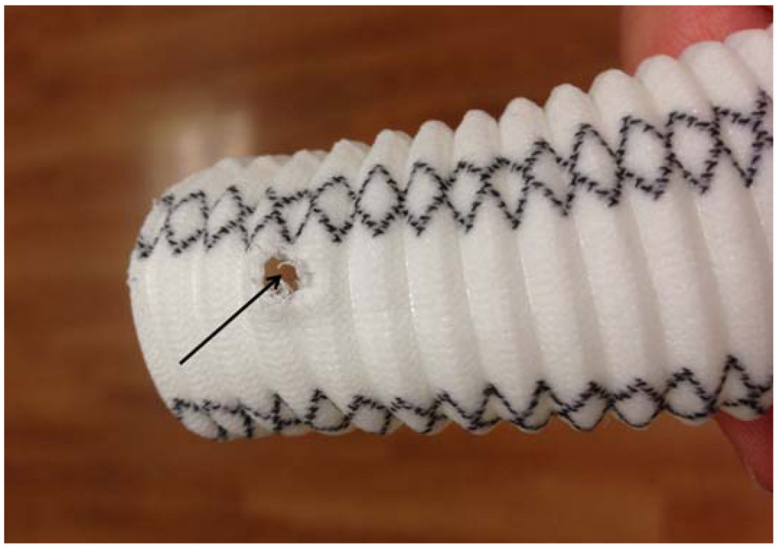

Fig. 2.

Bench-top perforation of a similar polyester graft using a vascular dilator. A woven polyester graft after bench-top fenestration (arrow) with a 22-Fr vascular dilator shows fraying but neither recoil nor tear. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary. com.]

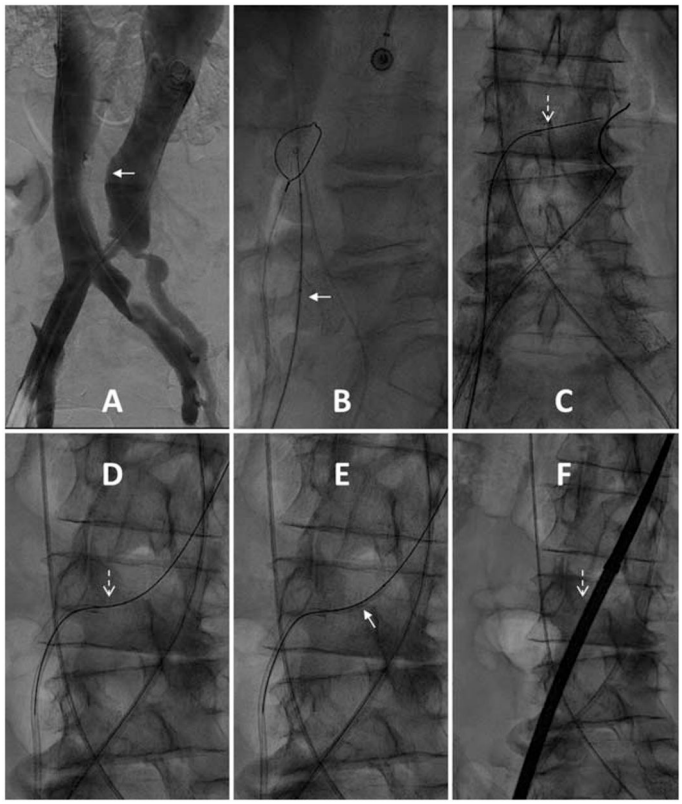

Fig. 3.

Transcaval access to an aortic graft. (A) Simultaneous caval and aortic angiogram. Arrow indicates planned traversal site based on CT. (B) Orthogonal lateral image of crossing catheter (arrow) pointed at snare positioned in aorta. (C) Electrified guidewire enters native aortic tissue (dotted arrow) and enters aortic lumen toward snare. (D) With 0.014″ guidewire snared in aorta, the 0.014–0.035″ convertor catheter is unable to cross native aortic tissue (dotted arrow) wrapped around graft. (E) The caval-aortic tract is dilatated with a 2.0 mm non-compliant balloon catheter. (F) Next the convertor catheter delivers a microcatheter that delivers a rigid 0.035″ guide-wire. The 18-Fr sheath crosses the outer aortic wall (dotted arrow) and enters the aortic lumen to enable conventional retrograde TAVR.

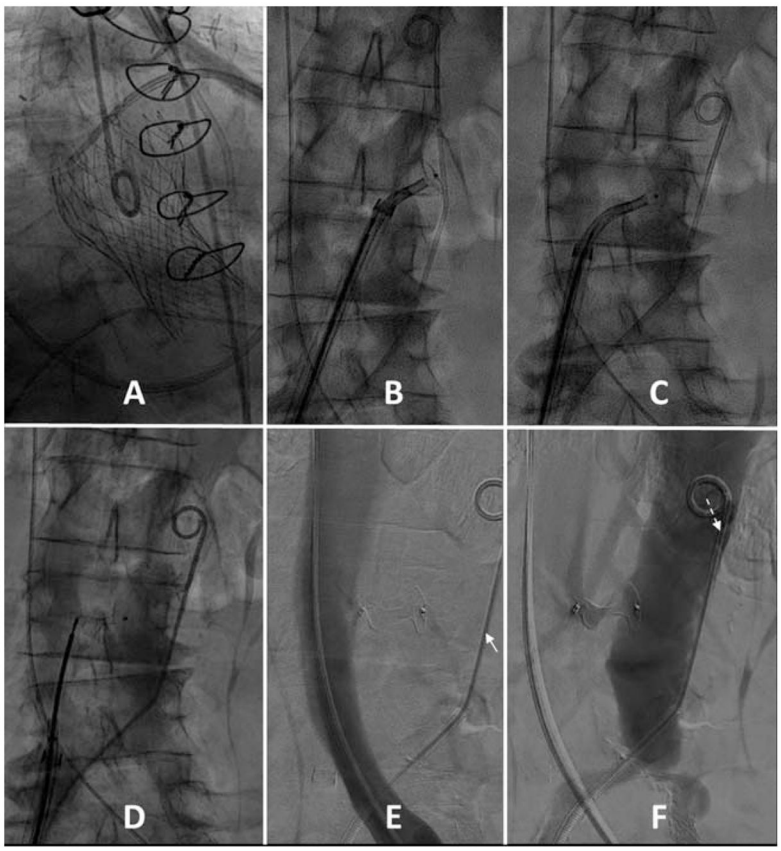

Fig. 4.

Closure of transcaval access to an aortic graft after transcatheter aortic valve replacement. (A) Medtronic Core-Valve 31 mm after implantation. (B) Deployment begins of an Amplatzer muscular VSD occluder using a deflectable catheter to rotate the aortic (distal) disc horizontally. (C) The aortic disc is retracted against the right wall of the aortic graft. (D) The device spans the caval-aortic tract, and the caval disc only incompletely reaches the cava because of excessive tract distance. Aorto-caval flow is evident on a low-volume test angiogram. (E) Cavagram shows the position of the closure device (arrow). (F) Aortogram shows residual aorto-caval flow but no contrast extravasation. Overlying superior mesenteric artery branches (dotted arrow) are evident.

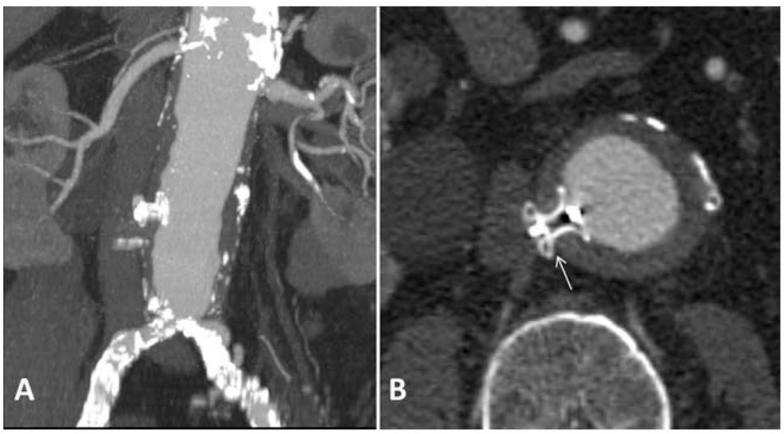

Fig. 5.

Abdominal CT scan 30 days after the transcaval TAVR procedure. Follow-up CT after 32 days. (A) Coronal oblique in the same projection as Fig. 1B, and (B) axial oblique shows the aortocaval fistula to have occluded, the aortic disc of the nitinol occluder is apposed to the endoluminal graft surface, and the caval disc continues to straddle the wall of the IVC (arrow).

TABLE I

A Standardized Treatment Plan for Transcaval TAVR in this Patient

Recommendation	Uncertain because of aortic graft
Aortic Ca^{2+}/thickening/ectasia	Aortic calcium grade 1
Target entry site lumbar vertebra	Mid-body L3 (L3.0)
Orthogonal projection	RAO 5°
Caval-aortic distance *X–Y*	8 mm (including 7 mm organized thrombus)
Interposed or nearby structures	none
Caval lumen diameter	20 mm
Aortic lumen (AAA) diameter around target (+3/0/−3 cm)	25 mm/24 mm/22 mm
Target distance above aorto-iliac bifurcation	45 mm
Target distance below R renal artery	55 mm
Endograft bailout limb access	R iliac artery 4.0 mm minimum lumen
Femoral vein to target sheath distance	26 cm