Intravascular ultrasound-guided transcaval approach for thoracic endovascular aneurysm repair

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ABSTRACT
Thoracic endovascular aortic repair will typically require adequate caliber iliofemoral arteries for device deployment. We describe the case of a patient with extensive iliofemoral disease, which necessitated transcaval delivery of an aortic graft to repair a distal aortic arch aneurysm. Our case report highlights the novel use of intravascular ultrasound to localize an optimal site for creation of an aortocaval connection and the subsequent use of a ventricular septal defect occluder to close the connection after successful stent deployment. (J Vasc Surg Cases Innov Tech 2022;8:660-3.)

Keywords: Intravascular ultrasound; IVUS; TEVAR; Thoracic endovascular aortic repair; Transcaval

Thoracic endovascular aortic repair (TEVAR) has achieved acceptance as a primary treatment option for thoracic aortic pathology. However, for TEVAR, the iliofemoral arteries must be of adequate caliber to support large diameter devices. We present the case of a patient with extensive aortoiliac disease, which precluded the use of these arteries as an access site. The disease burden necessitated a transcaval approach, which was facilitated through the novel use of intravascular ultrasound (IVUS) to determine the site for aortocaval access. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT
The patient was a 78-year-old man with a history of coronary artery disease (after coronary artery bypass graft surgery and percutaneous coronary intervention), chronic kidney disease, hyperlipidemia, and hypertension. He had presented with an enlarging saccular aneurysm of the descending thoracic aorta, measuring 5.5 cm. The patient was scheduled for TEVAR and left carotid artery to subclavian artery bypass. Although the bypass was completed, the femoral access did not allow for device insertion owing to the calcified iliofemoral occlusive disease. During the remainder of his hospitalization, he had experienced chest pain, which required drug eluting stent placement. Subsequently, the patient reported new left lower extremity rest pain. Follow-up imaging studies demonstrated left iliac and common femoral artery occlusions, in addition to diffuse a circumferential calcific burden involving the infrarenal aorta and bilateral iliac arteries. Thus, the patient provided written informed consent for a right-sided approach for the TEVAR reattempt and for femoral artery to femoral artery bypass. The right iliac artery was treated with intravascular lithotripsy, balloon angioplasty, and stenting. However, the TEVAR could not be advanced. The patient experienced ST-segment changes intraoperatively, likely secondary to demand ischemia, which normalized. The patient was admitted to the intensive care unit for close monitoring. The remainder of the patient’s admission was uneventful.

Because of the failed TEVAR attempts owing to the atherosclerotic burden of the bilateral iliofemoral systems, a transcaval approach was used for the third attempt. This approach has been cited in the literature as an option for repair of type II endoleaks. The challenges of this approach included selecting the safest area in the calcified aorta to create the connection and the risk of embolism or bleeding from an iatrogenic injury. Alternative options included open repair or a transapical (redo sternotomy) approach.

PROCEDURE PERFORMED
The patient received anticoagulation, and the right superficial femoral artery and common femoral vein were accessed to place 6F sheaths. A single preclosure device was placed into the right common femoral vein, with subsequent insertion of an 8F sheath. This process was repeated on the right superficial femoral artery with placement of two preclosure devices. The initial guidewire was subsequently removed from the right superficial femoral artery access site and a stiffer guidewire placed. This allowed for introduction of a 10F sheath through the right superficial femoral artery into the aorta. An optimal site for creation of the aortocaval connection was found using IVUS (Fig 1). The criteria defining the optimal site included a minimal separation between the inferior vena cava (IVC) and aorta.
degree of calcification, and sufficient length of the sheath required to reach the location to ensure adequate guidewire purchase. The IVUS findings confirmed the preoperative computed tomography (CT) findings, showing diffuse circumferential calcification. In addition, IVUS provided an increase in resolution compared with CT alone.

Next, we focused on creating the connection between the IVC and aorta. An 8.5F deflectable sheath (TourGuide sheath; Medtronic, Santa Rosa, CA) was introduced into the vena cava via the right common femoral vein. The back end of a guidewire and an access catheter were inserted into the sheath. The guidewire was attached via electrocautery (60 W in cutting mode for 3 seconds requiring two bursts), allowing for cauterization of an aortocaval tract (Fig 2). We chose cautery because of our experience with this modality compared with other options such as lasers. This allowed for placement of a stiff guidewire into the aorta.

Returning to the arterial access site, a 12F introducer sheath was advanced into the abdominal aorta, allowing for placement of a compliant aortic balloon (Molding and Occlusion Balloon; W.L. Gore & Associates, Flagstaff, AZ). An 8F sheath was then introduced through the aortocaval connection with subsequent arteriography. Next, a 16F dilator, followed by a 22F sheath, was placed into the abdominal aorta through the IVC.
We chose a 34 mm × 10 cm TEVAR device (conformable TAG thoracic endoprosthesis; W.L. Gore & Associates). The proximal landing zone was the left common carotid artery, with intentional coverage of the left subclavian artery, because the patient had had a preexisting left carotid–subclavian bypass.

We then shifted to closing the aortocaval connection. An 8-mm ventricular septal defect (VSD) occlusion device was prepared by an interventional cardiology colleague, and an 8F guide catheter (TorqVue delivery system; St. Jude Medical, St. Paul, MN) was advanced into the aorta. The catheter was sized according to the outer diameter of the sheath used to create the aortocaval connection. Next, the guidewire and TorqVue dilator were removed. The VSD occluder device was advanced until the aortic side had deployed and was pulled back against the aortic wall. The compliant balloon in the abdominal aorta (originating from the arterial access) was inflated against the aortic side of the VSD occluder to ensure it remained in place and opposed to the aortic wall during placement of the venous side of the device. The VSD device was then deployed on the IVC side of the aortocaval connection. After confirmatory imaging, the VSD delivery system (TorqVue delivery system; St. Jude Medical) was used to finish deploying the VSD occluder device. A minimal amount of contrast extravasation from the aorta into the IVC remained after deployment; however, this fistula was small enough to close on its own (Fig 3). If our VSD occluder had failed to seal the connection, we would have used individual covered stents in the aorta and IVC. In addition, we were prepared to advance a compliant balloon to manage bleeding during this period. Next, the TorqVue device (St Jude Medical) and the remaining sheaths in the vascular access sites were removed. The preclosure devices were deployed to achieve hemostasis.

The patient tolerated the procedure well, and the remainder of his hospitalization was uneventful, with no myocardial infraction or other cardiac complications. The CT scan at 1 month of follow-up showed that the saccular aneurysm had decreased flow, and a small type Ia endoleak was present. The IVC and aorta demonstrated no evidence of intravascular compromise or injury (Fig 4). At 6 months of follow-up, the CT scan showed an additional decrease in aneurysm size.

**DISCUSSION**

Patients requiring TEVAR can possess a concomitant degree of diffuse atherosclerotic disease, making iliofemoral access challenging. Alternate options for treatment involving transapical TEVAR or open repair will often be undesirable because of patient comorbidities. A transcaval approach is a viable option in such situations but can also be complicated by atherosclerosis. In our present case, we used IVUS to safely overcome this challenge and optimize the location of the transcaval crossing.

**CONCLUSIONS**

Using IVUS to identify an appropriate site for creation of the aortocaval connection in a calcified aorta requiring TEVAR is a novel approach and was crucial to our completion of the procedure.

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