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Alternative Aortic Access: Translumbar, Transapical, Subclavian, Conduit, and Transvenous Access to the Aorta

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Large-caliber access to the arterial system is more frequently required in the age of thoracic endovascular aneurysm repair, endovascular aneurysm repair, and transaortic valve implantation. Frequently either anatomical or vessel size constraints preclude use of common access points such as the common femoral, radial, and brachial arteries. Alternative approaches include percutaneous access at alternate sites (subclavian, axillary, and carotid), open surgical access to the heart (left ventricular apex), open surgical access to large-caliber vessels (ascending aorta, subclavian, and axillary arteries, retroperitoneal access to the iliac artery or distal aorta), and novel percutaneous approaches (transvenous). Such approaches require additional skill sets, equipment, and, frequently, multidisciplinary teams to ensure safety and success. The techniques and approaches outlined in this article may allow expansion of endovascular treatments to greater patient populations and disease states than previously thought feasible.
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Background

Procedures such as endovascular aneurysm repair (EVAR), transaortic valve implantation (TAVI), and thoracic EVAR (TEVAR) frequently require large-bore access and typically a transfemoral route is usually the first choice. When the iliac artery is small, heavily calcified, or extremely tortuous it may not accommodate large sheaths. Alternate access sites may be necessary to perform complex endovascular interventions, including axillary or subclavian arterial access, carotid access, transapical access, and retroperitoneal conduit, as well as endoconduit (EC) and transcaval approaches. These approaches allow endovascular treatments to be offered to a larger population of patients. Such approaches require additional expertise, equipment, and surgical staff. In addition, these approaches may entail longer recovery time, more incisional pain, and a host of unique alternative access site complications.

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Transfemoral access is currently considered to be the least-invasive approach for large-bore access and is therefore the most widely used for procedures such as TAVI or TEVAR or EVAR.[1] With the currently used 18-24-Fr sheaths, most of the patients can undergo procedures through this approach. However, some patients, especially elderly women, may have small calcified iliac arteries, which may preclude safe delivery of endografts or implants.

Preprocedural Workup

Although great improvements in device profile have occurred in recent years for patients undergoing aortic interventions, the delivery sheaths typically necessitate iliac or femoral arteries to be between 6 and 8 mm in diameter, without circumferential calcification or severe tortuosity. In 15%-33% of patients, femoral arterial system disease or other comorbidities preclude aortic endovascular intervention via transfemoral approach.[2,3] Preprocedural imaging and planning with computed tomography (CT) angiography or alternatively with magnetic resonance angiography is critical. Anatomical issues that would preclude transfemoral access include severe circumferential

calcification (>60% of arterial circumference), excessive tortuosity especially when combined with calcified vessels, and small diameter of the iliac vasculature and common femoral artery.

Transarterial Approaches

Translumbar

Translumbar arteriography has long been described in the radiology literature.[4,5] This approach is performed under fluoroscopic or CT guidance, using bony landmarks.[6] Both high and low punctures have been described.[7] High puncture uses the inferior endplate of T12 as the osseous landmark, whereas low puncture uses the inferior endplate of L3. The high approach is more commonly used owing to the frequency of distal aortic disease and infrarenal aortic aneurysm. For high access, the skin is anesthetized midway between the left 12th rib and the left iliac crest. Deep anesthesia can be administered with a 20 G spinal needle. A small skin nick is made and access is obtained utilizing an 18 G access needle. The needle is advanced medially and superiorly toward the inferior endplate of T12. As the needle approaches the aorta, deflection of aortic calcification or transmitted pulsation may be observed with the needle. The needle is then advanced 1-cm further, without crossing the midline. The stylet is removed and an 038 stiff access wire is advanced. The needle is exchanged for a 5-Fr sheath and the remainder of the intervention can be performed.

The chief complication for direct aortic puncture is retroperitoneal hematoma. Access is historically limited to 5-Fr maximal sheath diameter, as larger bore access causes a higher risk of significant retroperitoneal hematoma. Most of the patients receiving direct aortic puncture experience a small contained retroperitonal hematoma in the psoas musculature. Only a small subset (<1%) have clinically symptomatic hematoma.[7] Depending on the level of puncture, potential complications may also include extension of hematoma into the pleural space (hemothorax). There has been a recent increase in the use of this technique for the direct treatment of type II endoleaks.

Subclavian or Axillary

When transfemoral access for TAVI is precluded by vessel caliber or anatomy, the preferred alternative route depends on the device being implanted. Although the transapical route has been the most commonly used for placement of the Edwards Sapien valves (Edwards Lifesciences, Irvine, CA), the Medtronic Corevalve (Medtronic, Minneapolis, MN) system cannot be deployed in this fashion due to the greater device length and the delivery catheter. As such, Medtronic has CE mark approval for subclavian or axillary artery access as an alternative route.

For subclavian or axillary access, the subclavian or axillary artery is isolated and prepared for sheath insertion by a cardiothoracic or vascular surgeon. The artery is surgically isolated and exposed through an infraclavicular incision of 3-5 cm just below the clavicle. The artery is subsequently punctured by the Seldinger technique through the center of a purse string suture, and a 6 Fr or 7 Fr sheath is inserted into the subclavian artery, through which a diagnostic catheter and 035 guidewire is advanced into the left ventricle. Subsequently, the same 18 Fr sheath used for the femoral approach is advanced over a stiff guidewire through the subclavian artery into the aortic arch and ascending aorta. The remainder of the TAVI procedure is performed by the standard transfemoral technique.

When using the subclavian or axillary approach, most operators prefer a left sided access, because of the favorable angulation with respect to the aortic valve.[8,9] However, this approach necessitates crossing of arch vessels, and may result in dissection or injury of the left internal mammary artery, which can be problematic in patients previously treated with a left internal mammary artery graft for coronary artery disease.[10] For these reasons, preprocedural assessment should consider the size (>7 mm), tortuosity, and atherosclerotic burden of the subclavian artery. A patent left internal mammary artery graft may be a reason to consider a different approach. There are reports of percutaneous closure devices being used to achieve hemostasis during subclavian or axillary approaches,[11] although typically closure is surgically performed (Fig. 1).

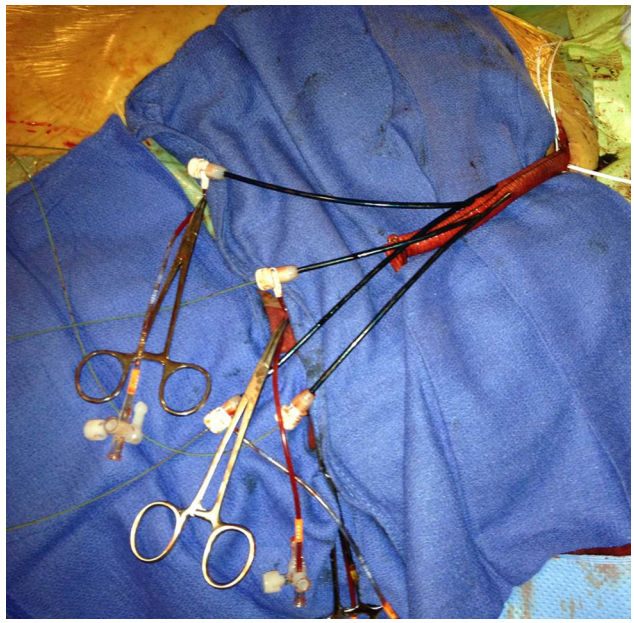

Figure 1 Case 1: Axillary access. Patient with unfavorable iliofemoral anatomy underwent axillary or subclavian access for aortic intervention. Image A demonstrates a 10-mm conduit surgically implanted into the axillary artery, accessed with multiple 5- and 7-Fr procedural sheaths. When using axillary or subclavian access, care must be taken to avoid trauma or dissection of the internal mammary artery, especially in patients with prior LIMA bypass graft. LIMA, left internal mammary artery. (Image courtesy of Dr William J. Quinones-Baldrich, MD, UCLA.) (Color version of figure is available online.)

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