

Percutaneous Transaxillary Access

Tips and tricks for a successful and safe alternate large-bore access.

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Arterial access for insertion of larger sheaths, also referred to as “large bore,” mandates a thorough understanding of vascular anatomy, scrupulous screening for suitability, and a meticulous technique with high fidelity for best clinical outcomes in patients.^{1,2} With the widespread use of percutaneous mechanical circulatory support devices (MCSDs) in the management of cardiogenic shock and complex high-risk percutaneous coronary interventions (HRPCIs), bridge to cardiac transplant, large-bore sheath insertion for transcatheter aortic valve replacement (TAVR), and endovascular interventions, the knowledge to safely perform large-bore access is pivotal. With the increasing prevalence of concomitant peripheral artery disease (PAD) in the iliofemoral arterial system in patients meeting the indication for large-bore access, the option of alternate access, such as percutaneous axillary artery access and transcaval access, can be crucial.³

In this article, we discuss the indications, anatomic considerations, a step-by-step approach to safe access, potential complications and bailout techniques, and achievement of patent hemostasis with percutaneous axillary arterial access for large-bore sheath insertion.

The feasibility of axillary access was described in the nascent phases of interventional cardiology and, with the evolution of percutaneous technology, it has been shown that this can be performed safely without a surgical cutdown.

INDICATIONS FOR PERCUTANEOUS AXILLARY ACCESS

Severe PAD in the iliofemoral arteries and a vessel diameter of < 5.5 mm of the common femoral artery pose significant risk of acute limb ischemia due to the occlusive nature of indwelling sheaths in these vessels

and are considered to be prohibitive. Prior endovascular therapy to the abdominal aorta and iliofemoral arteries, hemodynamic instability needing prolonged mechanical support, obesity, the risk of infection with femoral indwelling systems, and early ambulation and initiation of physical therapy with axillary access make this an appealing and viable alternative to femoral access.^{4,5}

The safety and ease of large-bore percutaneous axillary access has been demonstrated in HRPCI patients needing MCSD in cardiogenic shock and TAVR.⁶ The novel technique of performing PCI via single access through the 14-F introducer sheath of the Impella CP (Abiomed, Inc.), which can additionally accommodate up to a 7-F system and reduces the need for a secondary access, has been a game changer.

PREPROCEDURAL PLANNING

The axillary artery is relatively spared of atherosclerotic processes, as noted on pre-TAVR CT angiograms, and is a viable choice for alternate access in patients with severe iliofemoral PAD. If feasible, evaluation of bilateral axillary arteries with any imaging modality, such as angiography, CT, Doppler ultrasound, or a basic bilateral upper extremity pulse check can serve as an essential screening tool prior to choosing the axillary artery as the alternate site for access. CT is a powerful tool in determining the size of the vessel, extent of atherosclerosis or calcification, angulation at the origin of the branch vessel to the aorta, and presence of a patent left internal mammary artery. The axillary artery is typically smaller relative to the femoral artery (4.8-8 mm in diameter; median diameter, 6 mm); however, an artery measuring ≥ 6 mm can easily accommodate up to an 18-F sheath, which is adequate to deliver an MCSD or percutaneous implantable valves or an endovascular procedure without causing acute limb ischemia due to a vaso-occlusive sheath.

Contralateral axillary access should be considered when the angulation between the origin of the innominate or the subclavian arteries is $< 90^\circ$, is in the presence of an intracardiac device, or if it's the dominant arm of the patient. The angulation of the origin of the left subclavian or the innominate artery on the right to the aorta when $< 90^\circ$ or with severe tortuosity may impair deliverability of the MCSD or implantable valve. The presence of stenosis, calcium, or significant atherosclerosis at the site of arteriotomy in the axillary artery may pose additional risks, including atheroembolization into the branches of the axillary artery or downstream into the upper extremity, arterial complications such as dissection or failure of vascular closure device, and bleeding complications. This can be prevented with the use of ultrasound to aid the arteriotomy, in addition to angiography or CTA.⁷

ANATOMIC CONSIDERATION AND TECHNIQUE FOR SAFE ACCESS

The axillary artery is a continuum of the subclavian artery, is extrathoracic lateral to the lateral margin of the first rib, and is easily accessible percutaneously. The artery can be divided into three parts. The artery supplies branches to the chest wall, its muscles, and then distally provides collaterals to the brachial artery in the event of occlusion of the axillary artery (Figure 1). Knowledge of the branches and the relationship of the brachial plexus in relationship to the axillary artery is essential in preventing neurovascular complications. The first part is lateral to the first rib, between the superior thoracic artery and the thoracoacromial artery, the second part is between the thoracoacromial artery and the lateral thoracic artery, and the third part is lateral to the lateral thoracic artery that

supplies the subscapular artery. It is preferred to perform arteriotomy in the second part of the axillary artery and avoid the third part of the vessel. Arteriotomy in the first segment may also be performed without significant risk of brachial plexus injury; however, it may increase the risk of pneumothorax or intrathoracic access. In the second part of the vessel, the brachial plexus lies laterally and can be appreciated on ultrasound, which omits the risk of inadvertent injury during access. The second part and prior to the origin of the subscapular branch is considered the sweet spot; the subscapular artery provides collaterals to the brachial artery and prevents ischemia of the upper extremity in the event of stenosis or occlusion of the axillary artery proximal to this branch.

As previously mentioned, calcification and atherosclerotic areas can be visualized on ultrasound in addition to the brachial plexus, and therefore real-time angiography, road-mapping, or digital subtraction angiography, in addition to point-of-care ultrasound, should be utilized at all times when feasible. The use of a micropuncture needle with a shallow angle, preferably 30° or less (unlike in femoral access where the access is at 45°), is preferred. A 4-F microcatheter sheath should then be inserted and an angiogram should be obtained to confirm arteriotomy in the safe zone.

STEPS TO SUCCESSFUL PERCUTANEOUS AXILLARY ACCESS AND CLOSURE: HOW I DO IT⁸

See the *Equipment Checklist* sidebar for a list of the materials needed.

Step 1. The patient is draped in standard sterile fashion in the supine position with the ipsilateral arm in the abducted position at 90° .

Step 2. A 5- or 6-F sheath is placed in the ipsilateral radial or femoral artery in the standard fashion. The left subclavian artery or innominate artery is selectively engaged with a Judkins right (JR4) catheter. Regular angiography or digital subtraction imaging is performed to assess the axillary artery and its branches and the suitability for large-bore sheath insertion. This step is crucial to determine the zone of safe access, medial to the subscapular artery and lateral to thoracoacromial artery (Figure 1). An arterial roadmap could be utilized for safe access and to minimize contrast administration.

Step 3. After determining the safe zone, local anesthesia is administered in the area of interest. A micropuncture needle is then inserted into the anesthetized area and advanced at an angle of 30° to 45° to the skin (note that the angle is much shallower than for femoral arterial access) under fluoroscopic/angiographic/roadmap and ultrasound guidance.

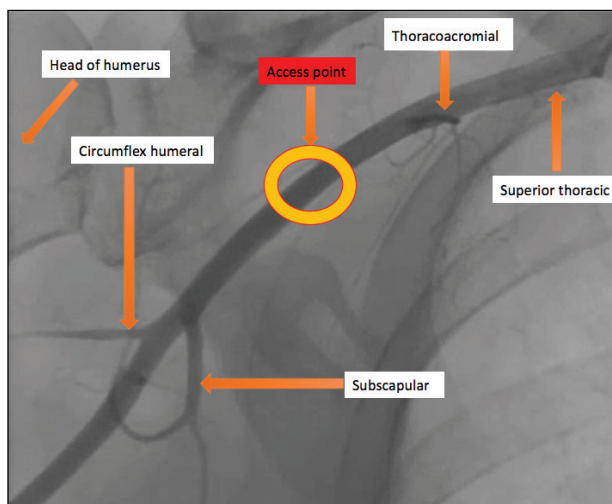


Figure 1. Anatomy of axillary artery and safe access point.⁸

EQUIPMENT CHECKLIST

- ✓ Micropuncture needle kit, 4-F micropuncture sheath, 6-F sheath
- ✓ 0.035-inch exchange length J wire
- ✓ 0.035-inch stiff wire (Supra Core, Amplatz Super Stiff, or Lunderquist)
- ✓ Two Perclose ProGlide closure devices
- ✓ 5- or 6-F JR4 diagnostic catheter
- ✓ Large-bore sheath kit with serial dilators
- ✓ Over-the-wire peripheral balloon sized to the vessel (8-10 mm X 40 mm)
- ✓ In-deflator
- ✓ Covered stent (Viabahn [Gore & Associates] or iCast stent [Getinge] sized to the axillary artery for bailout in the event of perforation or continued extravasation after dry closure
- ✓ Point-of-care ultrasound device for vascular access

Step 4. A micropuncture sheath (4 F) is inserted into the arteriotomy site, and the suitability of the access site is confirmed with an angiogram. After this, the sheath is exchanged for a 6-F sheath.

Step 5. A stiff 0.035-inch wire (eg, Supra Core [Abbott], Amplatz Super Stiff [Boston Scientific Corporation], or Lunderquist [Cook Medical]) is inserted into the subclavian artery via the sheath.

Step 6. Two Perclose ProGlide closure devices (Abbott) are then deployed in 10-o'clock and 2-o'clock positions and secured without tightening or cinching them down (preclose technique).

Step 7. The site is then serially dilated with dilators in the sheath kit prior to inserting the large-bore sheath.

Step 8. If the sheath needs to stay in for a prolonged period, it should be secured in an appropriate fashion. When there is no further indication for the sheath and it needs to be explanted, a dry closure in the setting of the cardiac catheterization laboratory is performed.

Step 9. Using the 5-F or 6-F sheath in the ipsilateral radial or femoral artery (mentioned in *Step 2*), the subclavian or the innominate artery is engaged with a JR4 catheter. A 0.035-inch Glidewire Advantage wire (Terumo Interventional Systems) is advanced through the subclavian artery and delivered distal to the sheath.

Step 10. The side arm of the sheath is attached to the transducer to monitor arterial waveform and real-time pressure.

Step 11. An over-the-wire balloon sized to the vessel (8-10 mm X 40 mm) is advanced over the 0.035-inch wire and delivered in the distal subclavian artery. The sheath is removed and the balloon is inflated with simultaneous monitoring of the arterial pressure waveform. The balloon is inflated to a degree that the arterial waveform is corrected.

Step 12. The preclose sutures are simultaneously cinched down and tightened. The balloon is then deflated.

Step 13. Digital subtraction angiography is performed to evaluate for extravasation due to failure of closure or vessel perforation. After this is confirmed, the Glidewire Advantage wire is removed.

Step 14. In the event of closure device failure or perforation, the arteriotomy site can be sealed with prolonged balloon inflations or manual compression. Rarely, deployment of a covered stent may be needed to prevent hemorrhagic complications when prolonged inflations or manual compression fail.

CLOSURE OF THE ACCESS SITE

Dry Closure

Dry closure of the access site in the cardiac catheterization laboratory should be a standard practice because it is perhaps the safest for the patient due to availability of a bailout strategy in case of failure of the primary hemostasis strategy. A secondary access site, either femoral or ipsilateral radial access, can be utilized for dry closure. A 0.035-inch wire is advanced via the secondary access site and advanced past the large-bore sheath. The large-bore sheath is retracted and an appropriately sized over-the-wire peripheral balloon is advanced into the arteriotomy site and inflated to seal off the puncture.

Preclose

The preclose technique is a popular practice with femoral large-bore access, with deployment of two Perclose ProGlide devices in the 10-o'clock and 2-o'clock positions during initial sheath insertion, without cinching down on the sutures but securing them loosely over the sheath. These sutures are then tightened immediately after sheath removal to achieve patent hemostasis. The advantage of this technique is that it could be performed at the bedside without use of the balloon tamponade technique, as described previously. Failing to achieve hemostasis at the arteriotomy site, especially in anticoagulated patients, can result in significant bleeding from the arteriotomy site, which could be catastrophic. A bailout strategy should be readily available in such a scenario. We therefore prefer the dry closure technique.

Manual Compression

Manual compression can be performed, although it is not preferred.

COMPLICATIONS AND THEIR MANAGEMENT

Large-bore access in the axillary artery poses additional complication risks due to the size of the arteriotomy and the anatomic location.

Bleeding

Mild bleeding from the arterial access site is common; however, severe bleeding and hematoma formation needing further intervention is rather rare, up to 6% based on registry data.⁹ Bleeding at the arteriotomy site can be controlled with cinching of one of the sutures of the Perclose ProGlide device placed prior to sheath insertion to tighten the arteriotomy site and prevent further bleeding. Bleeding after removal of the peel-away sheath and introduction of the indwelling sheath for prolonged use can be controlled by securing the sheath with forward tension and aligning it in approximately the same angle as that of the initial sheath insertion. Reversal of anticoagulation where possible, especially after TAVR implantation, can minimize bleeding. Dry field closure is an effective primary hemostasis technique to prevent postsheath removal bleeding or in the event of closure device failure. Covered stents should be considered as a bailout when all other strategies for hemostasis fail.

Acute Limb Upper Ischemia

Ipsilateral limb ischemia due to occlusive sheath, especially in axillary arteries of smaller diameter with concomitant vasospasm or distal embolization of laminar clot formed around the large-bore sheath or indwelling device for a prolonged period, is a potential complication.¹⁰ This is rare due to robust collateral branches from the subscapular artery to the brachial artery. However, vaso-occlusive complications can be managed by minimizing the duration of indwelling device or sheath and early explantation. Revascularization can be achieved with an external axillary artery-to-radial artery conduit, connecting the side ports of a large-bore sheath and a 5-F radial arterial sheath through an external tubing via a male-to-male connector. Limb ischemia due to thrombus can be managed with heparin infusion or rarely with thrombectomy.

BRACHIAL PLEXUS INJURY

Although the risk for brachial plexus injury has previously been well described, these events were typically associated with access in the third part of the axillary artery due to the proximity of the plexus with the artery in this area, as well as due to the presence of the brachial fascial

sheath that encompasses the artery, vein, and nerve and increases the risk of a compression palsy. Although the risk of injury is reduced when the arteriotomy is performed in the second part of axillary artery where the plexus lies lateral to the artery, there are reported cases of nerve injury. It is, however, more likely to have brachial plexus injury due to nerve compression from large hematoma formation, with some events resolving with time.³ ■

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