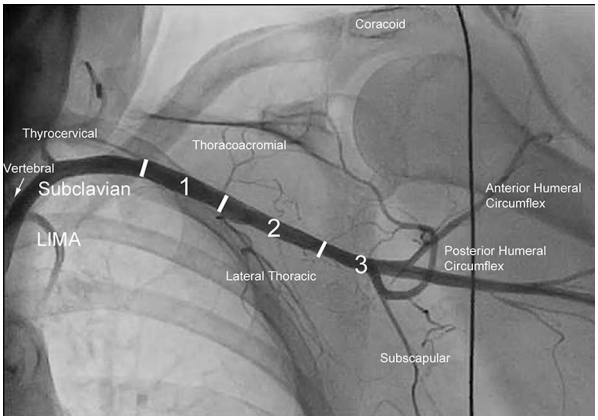

Figure 3. Angiographic anatomy of the axillary artery with branches.

suitability of the axillary artery can be assessed by computed tomographic angiography images if available, or with angiographic and ultrasound imaging at the time of the procedure. Absolute contraindications to transaxillary access include prior vascular procedures or surgical repairs which render the axillary artery unsuitable for percutaneous access such as prior covered stent placement. Relative contraindications include vessel calcification, stenosis, tortuosity, aneurysmal dilatation, or prior dissection. Patients on therapeutic anticoagulation may be at increased risk for bleeding complications after transaxillary access. Contralateral transaxillary access should be considered where an arteriovenous fistula or internal mammary bypass graft may be at risk of injury or decreased flow. The presence of a left sided pacemaker or defibrillator may physically limit access to the second segment of the axillary artery, though a shallow angle of needle entry often allows for success.

Insertion techniques

Numerous techniques have been described for obtaining percutaneous transaxillary access, with varying location, approach, and methods. All require a strong fundamental working knowledge of large-bore vascular access and the anatomy within the deltopectoral triangle as noted previously. The clavicle, second rib, and humeral head serve as useful bony fluoroscopic landmarks for the first, second, and third segments.

Selective angiography

Access may be facilitated by the concomitant use of selective angiography which may be performed from a secondary vascular access site such as the femoral, ipsilateral radial, or brachial arteries. Angiography provides essential information on vessel size, presence of stenosis, or severe tortuosity, and may be of particular benefit when pre-procedural imaging (such as CTA) cannot be performed. Digital subtraction angiography and roadmapping are useful tools to guide puncture. In addition, the lateral thoracic and subscapular arteries provide excellent landmarks for the second segment as they take perpendicular caudad courses off of the axillary artery, just outside of the rib cage and proximal to the head of the humerus, respectively (Figure 3).

Placement of a guide wire through a diagnostic catheter across the vessel may provide a fluoroscopic or ultrasound target for the needle. Such a wire may also reduce vessel tortuosity which may be misrepresented on CTA based on the positioning of the patients arms during that examination. If left in place during the procedure this wire can subsequently be used as a bailout or safety wire for balloon tamponade of the vessel.

Laterality and location

The left axillary is often the preferred side for access (Figure 2) due to avoidance of the origin of the right common carotid artery which theoretically reduces stroke risk. For TAVR, the left transaxillary approach more closely approximates femoral access.

Access is most commonly obtained with the needle being inserted directly through the pectoralis minor muscle into the second segment. Rarely, the access can be performed infra-pectorally, with the access point being in the axilla itself where the pulse is easily palpated. However, the transpectoral approach is typically favored due to device stability independent of the patient's arm position and lower risk of infection with prolonged implantation.

Needle angle

The single most important technical point in percutaneous transaxillary access relates to the angle of access. While a 45-degree needle access angle is desired for ideal femoral access, experience has shown that shallower access angles of 25 to 30 degrees parallel to the vessel improve vessel access success and decrease sheath malformation or kinking, bleeding or vessel perforation.

Needle size

As with any vascular access, micropuncture needles are likely to be helpful in minimizing trauma to adjacent tissues such as the pectoralis minor muscle. Micropuncture needles have a smaller crossing profile and require less force to puncture the artery. Fluoroscopy and care during advancement of the micropuncture wire is recommended reduce the risk of inadvertent dissection or perforation.

Wire and progressive dilation

The fascia and pectoralis minor muscle tend to resist sheath placement over a typical micropuncture wire. A small, tapered sheath can be passed more easily to confirm vessel cannulation, and a series of dilators exchanged over a stiff supportive 0.035″ wire enables the progressive enlargement of the tract to allow for large-bore access.

Ultrasound

Ultrasound imaging allows the operator to identify the pectoralis minor muscle, brachial plexus, and axillary artery and vein, which are distinguished with compression or Doppler flow (Figure 2). Ultrasound provides vessel size information and screening for atherosclerosis without radiation exposure or iodinated contrast. A vascular ultrasound probe (linear array, 5-13 MHz) can be used to image the artery in axial or longitudinal planes, and provide real-time guidance for needle cannulation. A smaller profile probe may be helpful to image between the bony structures. A single anterior wall stick is frequently possible and accuracy is often improved with experience or use of a needle guide.

Positioning

Abduction of the patient's arm to 45-90 degrees may decrease the tortuosity of the axillary artery and subclavian, improve alignment of the artery with the needle angle, aid in dissection of the pectoralis, and decrease the depth of the vessel due to the position of soft tissue and the pectoralis minor above it. While experienced operators are able to successfully place transaxillary devices with the arm in a neutral position, the consensus is that arm abduction facilitates transaxillary access.

Removal & closure techniques

The optimal technique for the removal of any transaxillary device is not known, but one must consider the size of the sheath, the insertion site's proximity to the second rib for possible compression, anticoagulation status, duration of access, and operator experience/comfort level.