Overcoming Anatomic Challenges to Transradial Access

An overview for interventionists who are considering transradial access training.

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The benefits of transradial access have been well documented in numerous studies during the past 2 decades, and it is now accepted as an alternative approach for coronary interventional procedures. A disadvantage of the transradial technique is that it involves anatomic challenges that are different from the femoral approach, and the purpose of this article is to briefly address the common problems.

ACCESS ISSUES

A preprocedure Allen test should be performed using plethysmography/oximetry. Transradial procedures are contraindicated in patients without a patent ulnar artery and an intact palmar arch.[1] Radial artery access is achieved with a 21-gauge needle, and typically, a 0.018-inch guidewire. Commercial kits using either a sheath-covered needle, or alternatively, a bare needle are available. These smaller needle/guidewire systems have resulted in substantially higher access success rates than the larger hardware typically used for femoral puncture. The ideal site is 1 cm proximal to the styloid process of the radius because the radial artery narrows, bifurcates, and becomes tortuous more distally in the wrist. A short (≤ 10 cm) 5- or 6-F hydrophilic sheath is preferred by most operators.

SPASM

The radial artery is a muscular vessel with a rich supply of alpha-1 adrenoreceptors and has been classified a type III vessel, reflecting the high rates of vasospasm found within the vessel compared to others.[2] Circulating catecholamines and mechanical stimulation result in spasm that can preclude arterial access and interfere with catheter manipulation. Thus, pharmacologic prevention of vasospasm is mandatory for successful transradial procedures.

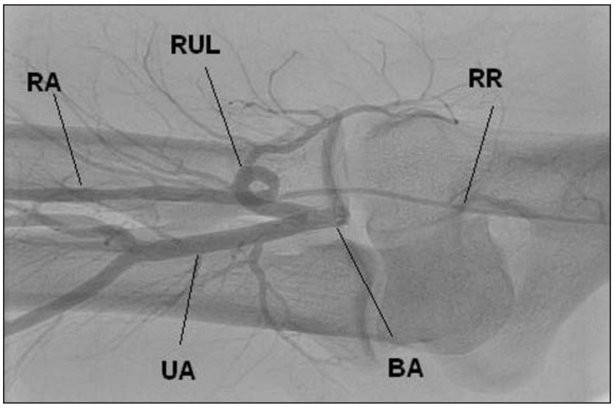

Figure 1. A radioulnar loop (RUL). After leaving the brachial artery (BA), the radial artery (RA) takes a 360° loop before returning to its normal course. Note the radial recurrent artery (RR), which runs retrograde up the arm parallel to the brachial artery. The ulnar artery (UA) course is normal.

Controlling patient anxiety and discomfort throughout the procedure is important in reducing circulating catecholamines. On arrival in the catheterization laboratory, patients generally receive 25 mg of diphenhydramine and 0.5 to 1 mg of midazolam intravenously; subsequent increments are administered as needed. Before catheter insertion, most operators administer 2.5 to 5 mg of verapamil with or without 100 to 200 µg of nitroglycerin (diluted in 10 mL saline) directly into the radial artery through the side arm sheath.[3,4] Vasodilatation occurs immediately, as seen by using radial artery intravascular ultrasound. In one study, the radial artery area increased 44% after administration of 3 mg of intra-arterial verapamil, with only a modest reduction in mean arterial pressure and no significant change in heart rate.[5]

ANATOMIC VARIATIONS

Anomalies in radial, brachial, and axillary arterial circulation are common.[6] These variations can make accessing the central circulation and achieving adequate guide and catheter seating difficult. It is important that physicians learning the radial technique become familiar with the common anatomic variations and how to navigate through them. This section will deal with the most commonly encountered circulation anomalies: radioulnar loops, tortuous radial arteries, high radial-ulna bifurcation, tortuous subclavian system, and short ascending aorta. Operators should have a low threshold for angiography if they encounter resistance to wire passage at any point while they move through the arm. It is likely that the problem will fall into one of the previously described categories, and with experience, the procedure can often be successfully performed.

Radioulnar loops occur in approximately 2% of patients and present several challenges.[6,7] The loop consists of a tight retrograde bend of the radial artery before joining the ulnar artery in the forearm. Complicating this severe bend, which is often > 180°, is the frequent finding of the recurrent radial artery branch at the top of the loop (Figure 1). This side branch then runs parallel to the brachial artery and back up the arm. The retrograde loop and the concomitant recurrent branch tend to deflect straight-tipped wires up the side branch. This not only presents wiring challenges, but puts the patient at risk for wire perforation or avulsion of the recurrent branch if the anatomy is not recognized. Once angiography has defined the loop, the operator should attempt to bring a soft-tipped hydrophilic wire (either 0.035 or 0.014 inches) through the loop and into the brachial artery. Often, wire passage alone will straighten the loop. If not, passage of a low-profile catheter to exchange to a 0.035-inch wire combined with gentle back tension on the system will often straighten the loop and permit completion of the case.[8] Despite these techniques, roughly 20% of loops cannot be crossed, and this variant is a cause for failure even in experienced hands.

Beyond the radioulnar loop, it is quite common for operators to encounter other variations in the course of the radial artery. Approximately 7% of radial arteries have their origins above the antecubital fossa (Figure 2). These high-origin radial arteries will frequently be tortuous and of small caliber. In addition, it is not unusual to find a tortuous course of the radial or brachial system anywhere along the arm, regardless of the bifurcation point. Vessel tortuosity should be suspected anytime there is difficulty with wire passage and should be confirmed and mapped with early angiography. Once it is imaged and the anatomy is understood, most angulated segments can be crossed with a soft-tipped wire and standard catheters with a high success rate (> 90%).

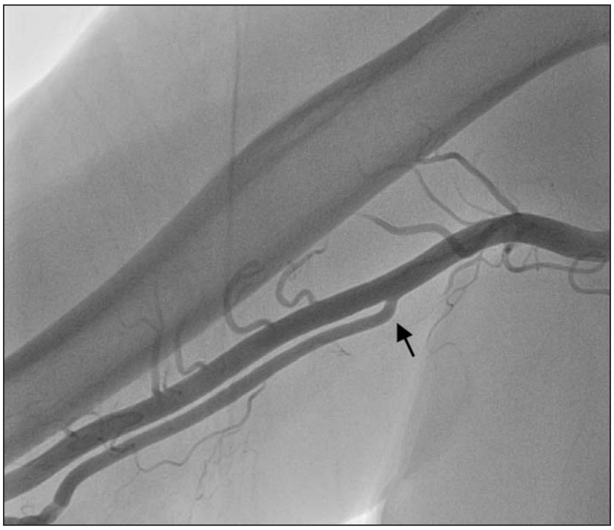

Figure 2. A high-origin radial artery. Tortuous segments (arrows) are commonly present with this anomaly.

Subclavian tortuosity (ST) occurs in up to 10% of patients. Risk factors for ST include short stature, hypertension, female gender, and advanced age.[9] When ST is combined with a short ascending aorta, the operator can face overwhelming turns that inhibit catheter seating. Having patients take deep breaths when working through the subclavian and into the ascending aorta will generally elongate the bends and allow successful cannulation of the coronaries.[10] However, if the arteries become calcific and nonpliable, such maneuvers may not be successful. Recent data have confirmed that patient height and age are risks for procedure failure, with the highest failure rates occurring in patients < 165 cm tall and older than 75 years.[11] It is likely that calcific ST plays a major part in these failures. It is the authors' practice to consider the left approach in shorter elderly patients because ST is often less severe and catheter entrance into the aorta is often easier. ST should be distinguished from a true lusoria subclavian artery, an anatomic variant in which the right subclavian artery courses behind the esophagus and enters the aorta distal to the left subclavian. Fortunately, this finding occurs in less than 1% of patients because it generally cannot be successfully navigated.

In summary, anatomic variations in arm anatomy are routine, and passage through them is a basic part of the transradial procedure. Fortunately, most anomalies can be passed through once the physician understands the anatomy. Therefore, it is important that physicians contemplating transradial training become familiar with these common anatomic findings, employ limb angiography to map them out, and use safe, established techniques to work through them.

CATHETERS

Size is an important but often overlooked consideration in catheter selection for transradial procedures. The incidence of postprocedure radial occlusion is significantly increased when the external diameter of the catheter is larger than the internal diameter of the radial artery.[12] Virtually all interventional procedures can now be performed through 6-F catheters, and the radial artery diameter of most men, and the majority of women, are sufficiently large to accommodate this size. However, many straightforward procedures can be performed through 5-F guide catheters, and it is currently our policy to use as small a catheter as possible for the given interventional procedure. Sheathless guides will be available in the future and may allow further downsizing.[13] The routine use of 5-F catheters for diagnostic procedures is recommended in order to minimize the risk of radial occlusion, thus preserving this access for interventional procedures.

A variety of specialty transradial catheters have been introduced during the past decade that are designed to cannulate both the left and right coronary arteries with a single catheter in the case of an intervention. These catheters have the common characteristic of a primary and secondary curve. The latter curve is positioned off the contralateral aortic wall from the target coronary ostium, thus providing extra support for the guidewire and balloon advancement. However, in a recent international survey of more than 1,000 transradialists in 75 countries, the overwhelming majority of operators used standard femoral curves for their procedures (O. Bertrand, personal communication, November 2009). For diagnostic procedures involving the left coronary artery and for interventions involving the left anterior descending artery, a Judkins 3.5 catheter is most commonly used. The EBU and XB curves provide excellent support and are particularly useful in left circumflex interventions. The Judkins R 4 or AR 2 are the most commonly used for right coronary diagnostic and interventional procedures.

Cannulation of saphenous vein grafts, particularly high takeoff left coronary vein grafts, is difficult from the right radial approach, and diagnostic procedures are easiest using femoral access. Interventions involving these grafts are best performed from the left radial approach; an AL 1 or Kimny catheter is useful in this situation. The left radial approach is the preferred technique for interventions involving left internal mammary grafts.

With increased experience, a new operator may develop skill with transradial catheters of his own preference. For example, in patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention or in patients undergoing ad hoc percutaneous coronary intervention, it may be expeditious to use a Kimny guide for both the diagnostic angiography and the intervention. In addition, the Optitorque Tiger transradial catheter (Terumo Interventional Systems, Somerset, NJ) has been increasingly used for diagnostic procedures.

Finally, cannulation of coronary arteries may involve more catheter manipulation than operators are accustomed to with the femoral approach. A useful trick is to keep the J wire in the catheter during these manipulations for better control and torqueability. Furthermore, if a Tuohy-Borst (Cook Medical, Bloomington, IN) or other Y adapter is in place on the proximal end of the catheter, contrast injection can be performed even with a guidewire in place.

CONCLUSION

It is important to select straightforward cases early in the learning curve; patients with peripheral vascular disease or those who have other reasons that make femoral access undesirable may also be challenging transradially. With patience and a commitment to the technique, the learning curve can be mastered readily. ■

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