

# Pearls and Pitfalls: Radial First for Neurointervention

Tips for navigating the learning curve to gain proficiency in transradial neurointervention.

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The first description of transradial access (TRA) was published in 1989 by Campeau from the Montreal Heart Institute.<sup>1</sup> Since then, the American Heart Association (AHA) has recommended a radial-first strategy for coronary interventions due to level 1 evidence demonstrating a > 60% reduction in access site complications and significant decreases in all-cause mortality with TRA.<sup>2-4</sup> Progressive adoption of TRA for coronary, peripheral, and neurointerventional procedures has been further driven by additional TRA advantages, including immediate ambulation, reduced postprocedural hospital stay and cost, and overwhelming patient preference.<sup>5,6</sup> However, underuse of TRA in the neurointerventional community remains due to challenges with the initial learning curve and dedicated radial neurointervention tools, as well as a lack of training. This article provides a guide for successful transradial neurointervention from setup to closure, including strategies to avoid pitfalls and overcome challenges.

## RADIAL ARTERY ANATOMY

The radial and ulnar arteries are terminal branches of the brachial artery. The radial artery typically arises in the cubital fossa and travels along the radial aspect of the anterior compartment of the forearm under the brachioradialis. The radial artery gives off the superficial palmar branch and proceeds along the floor of the anatomic snuffbox, forming the deep palmar arch of the hand with anastomoses from the ulnar artery. Due to its superficial location, the radial artery is readily compressible, decreasing the risk of postprocedural complications. In contrast to the femoral artery, inadvertent injury or occlusion of the radial artery has little clinical consequence due to collateral flow from the ulnar artery to the hand.

## TIPS FOR SUCCESSFUL TRANSRADIAL NEUROINTERVENTION

### Patient Selection

We have adopted a default transradial approach for all neurointerventional procedures,<sup>7-13</sup> but the benefits of TRA are particularly maximized in patients with large body habitus, bovine or type II/III aortic arches, previous iliac stenting/bypass, or femoral occlusion, as well as those who require antiplatelet agents or anticoagulation. We consider alternative access routes—such as the ulnar or femoral artery—in patients with known radial or subclavian anatomic variants, radial artery occlusion (RAO), radial artery stenosis, or arteriovenous fistulas in the ipsilateral arm. We do not perform Allen/Barbeau tests because the AHA recommended abandoning preprocedural collateral testing after recent studies found that abnormal preprocedural testing did not predict a higher incidence of hand ischemia.<sup>4,14,15</sup>

### Room Setup and Access Technique

Patients are positioned supine, and an arm extension board is inserted under the patient. The right arm is placed tightly against the hip, with the distal forearm and hand in a slightly supinated position (approximately 45°) and the wrist extended with a towel roll. We place several towels under the forearm and caudal to the hand to elevate it to hip level so the catheters rest at thigh level rather than falling down the side. As with transfemoral access (TFA), access is achieved with only the anteroposterior plane in position at head side. Depending on the patient's habitus, the table may need to be rotated 5° to 10° to visualize the right brachial bifurcation.

Topical 2.5% lidocaine/prilocaine cream is applied to the wrist and covered with an adhesive dressing in the

preoperative area for 30 minutes prior to the procedure. A pulse oximeter is attached to the ipsilateral hand, and the radial artery area is sterilized and covered with a radial catheter drape. The periarterial tissue is infiltrated with 1 mL of lidocaine ( $\pm$  nitroglycerin). Under ultrasound guidance, the radial artery is punctured with a through-and-through technique using a 20-gauge needle. The desired introducer sheath (5- to 7-F Glidesheath Slender, Terumo Interventional Systems) is then placed over a 0.025-inch hydrophilic guidewire. Antispasmodic agents (2.5 mg of verapamil and 200  $\mu$ g of nitroglycerin) are diluted with blood and administered through the sheath prior to introducing the guide catheter, and 70 U/kg of heparin are administered intravenously or intra-arterially through the sheath. In our practice, a radial artery angiogram/road map is routinely obtained through the sheath to elucidate any radial artery anomalies.

### Catheter Selection and Formation

For diagnostic cerebral angiography, a 5-F, 100-cm Simmons 1, 2, or 3 catheter can be used to catheterize the great vessels. The Simmons 1 is the easiest to form and has the best trackability; however, it is sometimes too short to catheterize the left vertebral artery, thus requiring a Simmons 2 or 3. Nevertheless, adequate left vertebral artery angiography can almost always be performed with a Simmons 1 by timing the inflation of the sphygmomanometer cuff on the left arm with contrast injection in the proximal left subclavian artery.

The simplest way to form the Simmons curve is to place the guidewire into the descending or ascending aorta. Then, track the catheter over the wire until the secondary curve is positioned over the apex of the arch. Finally, retract the wire and twist while slightly advancing the catheter; the curve will then herniate down the opposite limb of the aorta. Alternatively, the Simmons shape can be formed by bouncing the wire off the aortic valve and tracking the catheter over the wire. However, in patients with insufficient valves, herniation past the valve will cause temporary arrhythmias. Finally, the Simmons curve can be formed from the common carotid arteries. Position the secondary curve over the origin of the common carotid artery and then twist the catheter 180°. This is typically sufficient to herniate the Simmons 1 catheter into the innominate artery or arch, but additional forward advancement is sometimes necessary.

For our TRA interventions, a 6-F guide catheter is placed through a 6-F Glidesheath Slender, or a 0.088-inch AXS Infinity guide catheter (Stryker) is placed “sheathlessly” into the radial artery. In the latter case, a 7-F

Glidesheath Slender is placed first and exchanged over a guidewire; this method is reserved for patients with a radial artery diameter > 2.5 mm. Next, the guide catheter is coaxially navigated into the target vessel over a 125-cm Simmons 2-shaped Select diagnostic catheter (Penumbra, Inc.) and a 180-cm, soft-tipped, 0.035-inch Glidewire hydrophilic guidewire (Terumo Interventional Systems). As with TFA interventions, heparin is administered to maintain an activated clotting time of 250 to 300 seconds.

### Radial Artery Hemostasis

Patent hemostasis involves holding the minimum amount of pressure needed to maintain hemostasis to lower the rate of RAO. A radial armband is secured 1 to 2 cm proximal to the arteriotomy and then inflated. The sheath is removed with the band inflated, and the band is then slowly deflated until oozing is seen from the puncture site. Next, 1 mL of air is reintroduced into the band to reestablish hemostasis. The ulnar artery can then be manually compressed to monitor the oximetry pulse wave for radial artery patency (the reverse Barbeau test). If radial artery patency is not confirmed, ulnar artery compression can be continued while maintaining patent hemostasis with the band and pulse oximeter in place.<sup>16</sup> This sequence is often effective at reestablishing patency. After the procedure, patency and hemostasis of the radial artery are assessed every 15 minutes. In our practice, 30 minutes after the band is initially placed, it is slowly deflated. If there is no bleeding, the band is removed and a noncompressive dressing is applied. If bleeding is encountered after deflation, the band is reinflated for an additional 15 minutes before resuming deflation.

## ACCESS SITE AND OTHER VASCULAR CHALLENGES

### Access Failure and Radial Artery Spasm

Failure to access the radial artery is typically due to puncture error and/or radial artery spasm (RAS). Prevention is paramount with adequate sedation and analgesia, routine use of ultrasound, and intra-arterial prophylactic vasodilators after placement of the vascular sheath. Ultrasound and the “through-and-through” posterior wall puncture technique significantly reduce the number of attempts and failures and improve efficiency.<sup>17</sup> Additionally, a longer vascular sheath (25 vs 10 cm) may be useful in preventing repetitive friction along the radial artery. Finally, preoperative planning with appropriate catheter system selection can minimize catheter exchanges and manipulation, thus reducing the risk of RAS.

If RAS is encountered later during the case, strategies include administering more antispasmodic through the guide/sheath or subcutaneously, increased sedation, general anesthesia induction, ipsilateral sphygmomanometer inflation, ulnar artery compression, and warm compresses—all of which can be used individually or in combination.<sup>9</sup> Forcefully and rapidly retracting the catheter should be avoided because it can worsen spasm and even avulse the artery.

### **Radial Artery Anomalies/Tortuosity**

Radial artery anatomic anomalies such as high-bifurcation radial origins, full radial loops, and radial tortuosity are associated with higher rates of procedural failure. An initial radial artery angiogram after vascular sheath insertion will elucidate these changes. For high radial artery bifurcations, there is a longer length of narrow artery that can contribute to RAS; thus, a longer vascular sheath can be helpful. For radial artery tortuosity and loops, advancing a soft-tipped 0.035-inch hydrophilic guidewire or 0.014-inch microwire in the radial artery will often straighten it out. Other techniques include balloon-assisted tracking or telescoping a 0.027-inch microcatheter through the diagnostic catheter over a 0.018-inch microwire around the loop.<sup>9</sup> Operators should be aware that attempts to straighten 360° radial loops are often associated with temporary patient discomfort, as well as greater radiation exposure and contrast volume.

### **Radial Artery Occlusion**

The most frequent complication of radial procedures is RAO, with a reported incidence of 1% to 6%.<sup>17</sup> RAO is almost always asymptomatic due to the ulnar-palmar collateral vascular blood supply of the hand, but persistent RAO precludes the use of TRA in any future interventions. Minimizing procedural duration, sheath size, compression time, and pressure, as well as routine use of patent hemostasis and prophylactic procedural heparin, can all decrease rates of RAO.<sup>4,16,18</sup>

### **Subclavian Anomalies and Tortuosity**

Severe subclavian-innominate artery tortuosity is present in approximately 6% to 10% of patients.<sup>19,20</sup> Severe tortuosity of the right subclavian artery is associated with difficulty in catheterizing the great vessels due to a loss of translational force around the turns of the loops. In many cases, a standard 0.035-inch guidewire may straighten out the loop, although it should be noted by the operator that significantly more support will be required to navigate a system into the cerebrovasculature and catheter length will be shorter

than anticipated. Additional techniques to navigate the loop and advance a large system include introducing a parallel wire (0.014 inch) or balloon-assisted tracking. In cases of subclavian tortuosity during diagnostic cerebral angiography, a 5-F Simmons 1 catheter (Glidecath, Terumo Interventional Systems) is more easily formed and tracked and is less prone to knotting or kinking.

*Arteria lusoria* refers to a congenital aberrancy of the right subclavian artery wherein the right subclavian artery originates separately from the aortic arch as the fourth branch distal to the left subclavian artery. In our experience, only the left and right vertebral arteries can be catheterized in this case, and angiography of the carotid arteries will likely require transition to TFA.

In the presence of proximal left common carotid tortuosity or steep angulation of the left common carotid artery origin, navigation of the Simmons catheter in the left internal carotid artery can be difficult because the system is prone to herniate in the aortic arch. This can be overcome by techniques such as using a stiffer Glidewire or slowly and repeatedly balancing wire and catheter advancement.

## OVERCOMING THE LEARNING CURVE

Series in cardiac and neurointervention literature have described a 30- to 50-case learning curve for TRA.<sup>7,21,22</sup> However, several steps can be taken to gain proficiency. First, consider observing and collaborating with interventional cardiology colleagues who are already familiar with TRA. Second, take advantage of the many workshops (including TRAIN, the Transradial Course for Interventional Neurology), podcasts, and videos demonstrating best radial practices. Third, diligently employ the aforementioned radial access techniques and consider first selecting younger patients, who tend to be less tortuous, and male patients, as they tend to have larger radial arteries than female patients.

Nonetheless, proficiency in transradial neurointervention lies in a commitment to summing the learning curve. An ability to recognize and address these pitfalls early on will decrease complications and allow a more smooth adoption of the TRA technique, which will only become more necessary for patient care as technology and equipment improve. ■

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