Top Tips for Successful Radial Neurointervention

Evidence-based strategies for optimizing transradial access in neurointervention, including patient selection, premedication, careful puncture and catheter navigation, and nonocclusive compression for closure.

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Transradial access (TRA) in neurointervention offers a safer alternative to traditional transfemoral access, having demonstrated reduced access site complications and hospitalization times.[1] While limitations to TRA exist, such as arch anatomy, system sizes, and sheath-to-artery ratios, those who are candidates for TRA often report better overall satisfaction. TRA has now become more widely adopted into general practice, and its scope is expanding to encompass a larger spectrum of interventions, including aneurysm embolization, carotid stenting, and thrombectomy.[2] The neurointerventional literature suggests technical success rates > 90%, with single-digit percentile crossover rates to transfemoral access.[2,3] Given its increase in clinical practice and research, this article describes five tips for successful TRA.

PATIENT AND ACCESS SITE SELECTION

Tip 1: Screen Patients Preprocedure for Radial Artery Size and to Assess Aortic Arch Anatomy

Appropriate patient and access site selection are a prerequisite to successful TRA. Like any intervention, the patient's history and physical exam, medical comorbidities, clinical stability, and procedural indications should be thoroughly evaluated. Once TRA is decided upon, there are several further anatomic considerations, including radial artery size, radial artery bifurcation, and aortic arch type. Aortic arch type and variants are particularly important, with TRA being advantageous in type III arches and bovine variants.[4] Preprocedural CTA of the neck, when available, is helpful for planning neurointerventional TRA.

TRA is preferable in specific cohorts, including those at elevated bleeding risk (eg, thrombocytopenia, anticoagulation, chronic kidney disease), body mass index that limits femoral access, or inability to lie flat.[5] TRA is contraindicated in patients with known radial artery occlusion (RAO), small radial artery size, severe vaso-occlusive disease (eg, Takayasu arteritis, Raynaud syndrome, thromboangiitis obliterans), presence of an arteriovenous fistula, need for radial artery in future bypass grafting, or old age with extensive atherosclerotic disease.[5] For radial artery size, the limiting factor is typically the outer diameter of the system used, with sources often stating that a radial artery < 1.7 mm is too small to accommodate a 5-F system.[6] Of note, although radial occlusion is a contraindication to TRA, some authors have described recanalization techniques when necessary.[7]

Once a TRA approach is selected, interventionalists traditionally have performed an Allen or Barbeau test to evaluate collateral circulation in the access hand. These tests have lost favor among interventionalists, given a lack of evidence-based support in the literature. Multiple reviews have concluded that neither test reliably predicts postprocedural hand ischemia.[6,8,9] One such study is RADAR, which found that among 30% of patients with an abnormal test, none had upper limb dysfunction at 1-year follow-up.[8] In 2018, the American Heart Association (AHA) stated these tests are not required prior to TRA, describing them as "only of historical interest."[10] As discussed in Tip 3, literature suggests that using real-time two-dimensional (2D) ultrasound is a more reliable technique to determine the anatomic suitability of a radial artery.[10,11]

When considering TRA, two options are available: proximal or distal access. Proximal access is used most often and is described as access 2 to 3 cm proximal

to the palmar crease.[10,12] Distal radial access refers to puncture of the radial artery in the anatomic snuffbox.[10,12] Distal access is associated with 65% to 70% lower rates of RAO compared to proximal access, given the preservation of radial flow into the superficial palmar branch, the takeoff of which lies proximal to the artery at the snuffbox.[13] Distal access can be performed without supination, preserves the proximal site for future use, and is associated with lower rates of bleeding and hematoma formation; however, it is more technically challenging, with higher crossover and lower first-pass success rates.[13,14]

PREPROCEDURAL PHARMACOLOGIC MANAGEMENT

Tip 2: Avoid Artery-to-Sheath Ratios Over 1 and Administer a Radial Cocktail

TRA can be complicated by radial artery vasospasm and occlusion. Preprocedural medication with a radial cocktail given through the sheath can help limit the incidence of these complications. In our practice, we use an intra-arterial radial cocktail of 2.5 mg verapamil, 200 µg nitroglycerin, and 3,000 units heparin (70 mg/kg for interventions) after placing the radial sheath.

Unfractionated heparin has long been shown to have a benefit in angiography. Periprocedural unfractionated heparin reduces the incidence of RAO when undergoing TRA.[15,16] This holds true even when already on oral anticoagulation.[16] The benefit of heparin has been known since 1996, when a report found an arterial occlusion rate of 71% in unanticoagulated patients, dropping to 4% when patients were given 5,000 units of heparin periprocedurally.[15] Guidelines from the Society for Cardiovascular Angiography & Interventions (SCAI) and AHA currently recommend a dose of 50 U/kg or a 5,000-unit bolus.[10,17] Trials are currently exploring the optimal dose of procedural anticoagulation, with recent evidence suggesting doses up to 100 U/kg may confer additional benefit. For example, The SPIRIT OF ARTEMIS trial randomized patients to 100 or 50 U/kg of heparin and observed rates of radial occlusion of 3% and 8.1%, respectively, without an increase in bleeding events.[18] Heparin remains the most important modifiable variable in preventing RAO. Intravenous and intra-arterial dosing are considered equivalent, and enoxaparin and bivalirudin may be used alternatively.

Another component of the radial cocktail is spasmolytics. Radial artery vasospasm is a predictor of occlusion and occurs in approximately 14% of cases.[19] Prophylactic spasmolytics are given to help reduce this risk. The most studied radial artery cocktail is verapamil (2.5-5 mg) with or without nitroglycerin (100-200 µg).[10] A pooled analysis of 22 clinical studies reported a 12% radial artery spasm rate with placebo, declining to 4% with 5 mg of intra-arterial verapamil and 2% with 200 µg of nitroglycerin.[20] However, reducing spasm does not necessarily reduce occlusion rates. Several trials have demonstrated no change in access site conversion with use of spasmolytics, rate of occlusion despite reduction in spasm, or rate of occlusion when performed by an experienced interventionalist using best practices.[21-23] Currently, administration of intra-arterial verapamil with or without nitroglycerin and heparin is routinely employed for TRA unless contraindicated by medical comorbidities.[10]

PUNCTURE TECHNIQUE AND PROCEDURAL EFFICIENCY

Tip 3: Use Real-Time 2D Ultrasound for Puncture

Technical proficiency, puncture technique, and overall procedural efficiency can directly impact success in TRA. Importantly, increasing puncture attempts is an independent predictor of RAO.[24]

Real-time 2D ultrasonography is an evidence-based technique that improves TRA success.[11] Direct visualization of the radial artery with ultrasound allows for evaluation of artery size, confirmation of patency, identification of variants, and visualization of the needle during insertion.[10,17] Ultrasound-guided access improves first-pass success rates and reduces time to access, overall attempts, and crossover.[10,17] This is independent of overall operator experience.[25] The multicenter RAUST trial randomized 698 patients to palpation-guided puncture versus real-time, ultrasound-guided puncture, reporting a first-pass success rate nearly 21% higher in the ultrasound cohort, with fewer total attempts and reduced time to access.[26] Furthermore, measuring artery size with ultrasound can exclude those at risk for sheath-to-artery mismatch.[17,27] Sheath-to-artery ratios > 1 are an independent predictor of RAO, and occlusion increases dramatically with sheath size, with rates of 5% at 5 F up to 19.5% at 7 F.[27] Some sources report that vessel sizes < 1.7 mm are too small to support 5-F sheaths. Direct measurement of the artery in real time therefore allows for use of the smallest system necessary to perform the procedure.

Puncture techniques can also vary among interventionalists, with the two common techniques being anterior wall and through-and-through puncture. Although guidelines currently favor the anterior wall technique, especially paired with 2D ultrasonography for precision, the literature does support faster access with fewer attempts and higher first-pass success with through-and-through techniques.[10,25]

CATHETER NAVIGATION DISCIPLINE

Tip 4: Master Efficiency of Shaping and Navigating a Simmons 2 Catheter

The Simmons 2 catheter is frequently used in TRA given its ability to navigate complex arches. Learning how to form the catheter proficiently can reduce overall procedure time and therefore reduce contrast volume and radiation dosing. Several methods have been described to form the catheter. Hadley et al presented seven techniques for forming the Simmons 2 for TRA: within the ascending aorta, descending aorta, aortic arch, right common carotid, or left common artery; by deflecting off the aortic valve with the guidewire anchored in the common carotid artery; or by deflecting off the aortic valve with the guidewire in the anchored in the descending aorta.[28] Of these, formation within the ascending aorta is most common. The guidewire is advanced into the descending aorta followed by the catheter. The wire is then retracted into the straight portion of the catheter, and the catheter is gently advanced into the ascending aorta with rotation as needed.[28] Proficiency with TRA, for which the Simmons 2 is a workhorse, is generally thought to occur after 30 to 50 cases, at which point crossover rates and fluoroscopy times decrease.[29] The inability to cannulate target vessels, in addition to repeated guide herniation and kinking, are reasons to convert to transfemoral access.

CLOSURE TECHNIQUE

Tip 5: Use Nonocclusive Compression for Closure

A good closure technique can determine if the radial artery will remain patent and suitable for future use. The hallmark of good closure is nonocclusive hemostasis, regardless of the system used. This means maintaining anterograde flow throughout compression. Nonocclusive hemostasis is the most important evidence-based technique to avoid RAO during closure.[10,17]

Occlusive compression can trigger thrombus formation and occlusion of the artery.[30] The PROPHET trial compared nonocclusive and occlusive compression, noting a 59% decrease in RAO rates at 24 hours and a 75% decrease at 30 days with the nonocclusive compression.[31] Nonocclusive compression mitigates this RAO risk by maintaining blood flow across the arteriotomy site and interrupting the cascade of clot formation.[17] It is endorsed by the Society of Interventional Radiology and SCAI as the default closure technique for TRA.[5,17] At our institution, we use a TR Band (Terumo Interventional Systems) with the localizing marker located over the estimated arteriotomy site (not skin puncture site) and deflate until a flash is seen. At this point, we add 2 mm Hg pressure, confirm no active bleeding is seen, and confirm that there is a palpable pulse distal to the device. Air is then gradually removed over a period of 2 hours to avoid hematoma formation.[32]

Concomitant nonocclusive ulnar compression may also have a benefit in TRA closure by increasing radial artery flow and peak velocity.[10,17] PROPHET-II demonstrated a decrease in RAO from 3% to 0.9% at 30 days with ulnar compression, without ischemic complications in the hand.[33] Similarly, the SAFE and FAST trial found decreased rates of RAO, rebleeding, and hematoma formation with increased rates of patent hemostasis and shorter compression when using dual-balloon closure devices.[34]

CONCLUSION

TRA is now commonly performed in neurointervention and growing in scope. Successful TRA depends on several factors, including appropriate patient selection, premedication to avoid vasospasm and artery occlusion, careful puncture and catheter navigation, and nonocclusive compression for closure. Fortunately, there are guidelines and recommendations to guide our transradial practice and increase success.

Key tips for success are:

1. Screen patients before the procedure for radial artery size and to assess their aortic arch anatomy.
2. Avoid artery-to-sheath ratios > 1 and administer a radial cocktail that includes heparin and verapamil with or without nitroglycerin.
3. Use real-time 2D ultrasound for puncture.
4. Master efficiency of shaping and navigating a Simmons 2 catheter
5. Use nonocclusive compression for closure.

As literature and technology continue to grow, these recommendations may also change. Thus, as neurointerventionalists, we must continue to educate ourselves and keep up to date with societal guidelines and high-quality publications to maintain TRA expertise. ■

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