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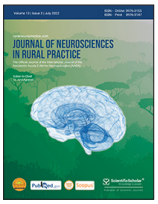

Review Article

Transradial approach in neurointervention: Part-I: Patient selection, preparation, and access site considerations

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ABSTRACT

Transradial access (TRA) is gradually getting attention in neurointervention radiology. Neurointerventionists now understand its advantages such as lesser complications, short hospital stay, and better patient satisfaction than transfemoral access. This review aims to provide a comprehensive approach for the interventionist to get familiar with the TRA. In this first part of the review, we will focus on patient selection, preparation, and access-related issues of a standard TRA.

Keywords: Angiography, Cerebral, Neurointervention, Transradial

INTRODUCTION

Transradial access (TRA) for interventions has become the standard approach for interventions in cardiology.[1]

The interventional radiology community is also gradually showing keen interest in adopting radial artery as an alternative or preferable access route for diagnostic or therapeutic interventions.[2-6]

This review aims to delineate a step-by-step approach for the interventionist to better understand the radial access route to perform neurointervention. In this first part, we will concentrate on the patient selection, preparation, and puncture to get radial access.

ADVANTAGES OF RADIAL APPROACH AS COMPARED TO FEMORAL APPROACH[7,8]

1. Shorter preprocedural preparation and much more comforting to the patient as no groin exposure is required.
2. Early immobilization/discharge
3. Lower incidence of backache
4. Reduced risk of significant hematoma, dissection, or pseudoaneurysm formation as compared to femoral approach
5. Safer in patients with deranged coagulogram or dual antiplatelet therapy.
6. No requirement for specific closure devices.

CURRENT CHALLENGES IN SHIFTING TOWARD A TRANSRADIAL APPROACH[3-5]

1. Relative inexperience
2. Operator apprehension to navigate the catheter using the radial approach
3. Lack of dedicated radial specific hardware for neurointerventions
4. Challenges with the smaller diameter of the radial artery when a larger bore sheath/catheter is required
5. Fear of complications such as dissection, perforation, and occlusion of the radial artery.

UNDERSTANDING THE RADIAL ARTERY ANATOMY

The radial artery arises from the brachial artery after its bifurcation at the level of the elbow. It is anatomically segregated into three segments – forearm, wrist, and hand. The ulnar and radial arteries share arterial perfusion of the hand with multiple connections forming an anastomosis. Both arteries' wrist and hand segmental branches constitute the superficial palmar, deep palmar, and dorsal carpal arches. The superficial palmar branch of the radial artery forms an anastomosis with the terminal part of the ulnar artery constituting the superficial palmar arch. Then, it traverses from the palmar to the dorsal aspect through the floor of the snuffbox giving branches to the dorsal carpal arch and returning to the palmar aspect giving branches to the lateral part of the index finger and the thumb.

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The terminal part of the radial artery forms an anastomosis with the deep palmar branch of the ulnar artery constituting the deep palmar arch.[9,10]

The consequences of radial artery occlusion will depend on the anastomosis between these two arterial arches complete or incomplete status.[11]

PATIENT SELECTION

Experience with TRA for neurointerventions is rapidly growing and appears safe and feasible in most patients.[3-7] Although TRA can be universal, patient selection is critical to avoid complications. Radial artery diameter, as well as patient's age, is significant determinants in patient selection. Both factors play a role in radial artery spasms, a common complication of transradial access. Radial artery spasm is common in young adolescent females with small radial artery diameters. We recommend that the lower limit of the radial artery diameter be at least 1.8 mm to accommodate a 5F sheath. A routine collateral circulation assessment through Modified Allen's or Barbeau test is not routinely recommended, and we have also stopped performing these before radial access.[1]

Contraindications are patients requiring fistula for chronic renal disease in the future, patients requiring radial artery graft for coronary artery bypass grafting, and patients with peripheral arterial disease.[12]

SETUP/PATIENT PREPARATION

The radial access from the right side is the most preferred. Various arm positions have been described in the literature.[13,14]

i. The arm is positioned at an angle of 0–15° [Figure 1] to the side of the patient, and this positioning matches that of the patient's groin use in transfemoral access (TFA) (our preferred position as drapes and catheters can be kept similar to TFA)
ii. The arm can also be placed at an angle of 75–90° to the side, which permits easier access, but catheter exchanges can become cumbersome and also can interfere with the lateral tube of the biplane machine.

Ensuring patient comfort is of paramount importance, and a long removable arm board and comfortable padding are used. [Figure 1] After placing the arm on padding, the wrist is supinated and hyperextended by keeping a soft roll under the distal forearm.

All monitors, drugs, and equipment must be available in the lab before the start of the procedure. A pulse oximeter is attached to the ipsilateral thumb or index finger and should be available throughout the procedure with a constant vigil over the recordings by the operator (Supplementary figure).

Radial puncture

It is essential to explain the procedure to the patient to counter any anxiety that may precipitate spasm. Some interventionists recommend applying 2–3 mL of a topical analgesic cream of lidocaine and prilocaine to the expected radial access site to reduce the risk of vasospasm.[15]

The puncture should preferably be done under ultrasound guidance or can be done with experience through palpation. Meticulous use of ultrasound to puncture has been shown to be superior, with higher success rates, shorter duration, reduced attempts, and reduced incidence of complications in many prior studies.[16,17]

A radial puncture set typically consists of a 21-gauge needle with a 0.018 inches micro-guidewire and a 5 or 6F sheath with a dilator (Supplementary figure). Our preference is to use hydrophilic sheaths shown to reduce the risk of vasospasm in prior studies. The Seldinger technique is used. A single-wall entry is preferable, but practically, a double-wall puncture is often the result.[18]

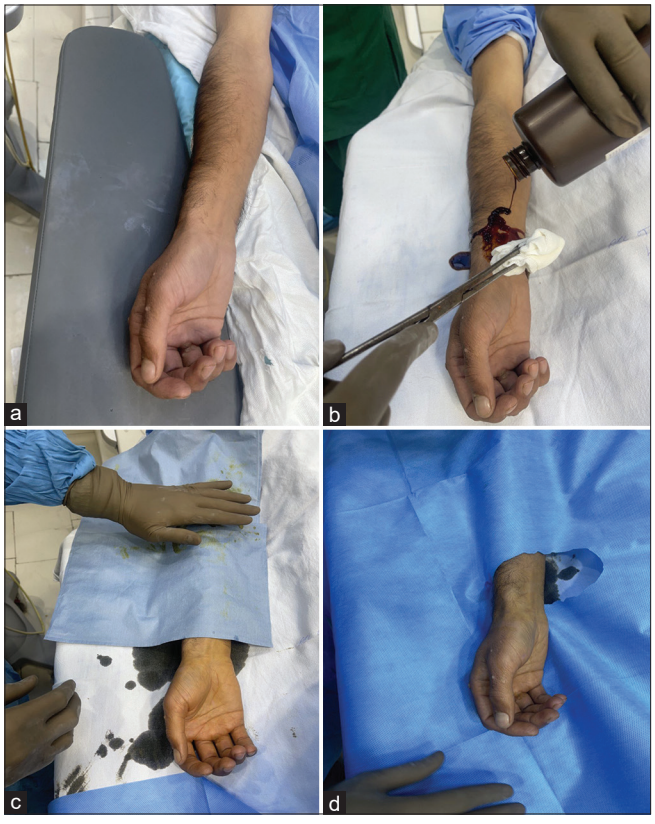

Figure 1: (a) Placing the right arm of the patient at 0–15°to the patient side on a removable radial board with a foam pad for patient comfort, (b) entire forearm and hand should be cleaned with betadine, (c) a radiation protection shield can be applied to reduce scatter to the operator, and (d) complete draping is performed, and the final position will be similar to as in the transfemoral for the operator.

The preferred puncture site is about 2–3 cm proximal to the level of the radial styloid process, as the artery is more prominent and less tortuous in this region. Subcutaneous injection of 0.5–1 ml of xylocaine 1–2% is given at the expected puncture site [Figure 2].

After sheath placement, it is essential to give antispasmodic prophylaxis before the catheter is advanced into the artery through the sheath [Figure 3]. The radial cocktail usually includes a combination of heparin, nitrates, and calcium channel blockers.[1,3-7] Different cocktail regimens are described in the literature, and there is no universal ideal cocktail. We typically use a combination of 200 micrograms of nitroglycerine, 2.5 mg diltiazem, and 2500/5000 IU of heparin which work well in all cases.

RADIAL ARTERY ANGIOGRAM

Our usual practice is taking a radial artery angiogram (Supplementary figure) after sheath insertion to visualize any anatomical variations, loops, or spasms before catheter insertion.

ACCESS SITE COMPLICATIONS

TRA involves a learning curve, and it is recommended that a new operator must perform up to 50 TRA cases before the complication rate and other metrics plateau.[19]

Commonly encountered access site complications are mild-to-severe spasm [Figure 4], arterial occlusion, puncture site hematoma, perforation [Figure 4], dissection, pseudoaneurysm [Figure 5], and fistula formation.[19-25]

A brief review of access site complications is shown in [Table 1].[19-25]

Radial artery occlusion is one of the most common complications of TRA and is seen in up to 10% of the cases. However, most of these get recanalized on follow-up. The risk of significant ischemia is very low, and routine use of

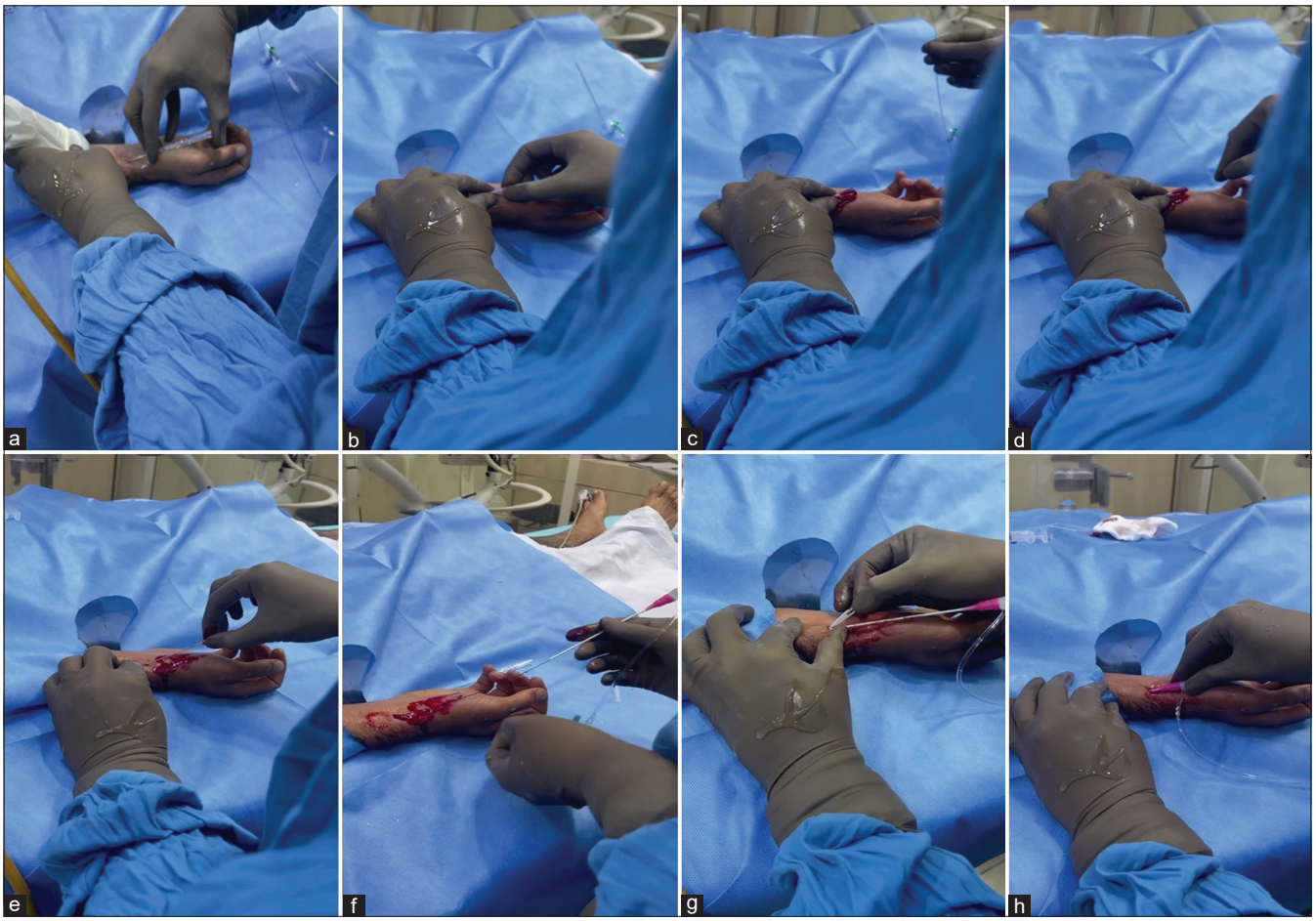

Figure 2: Demonstrating the radial puncture steps. (a) Puncture is done at 2–3 cm proximal to the radial styloid process by keeping the puncture needle at 25-40°to the forearm under ultrasound guidance, (b) Puncture needle is advanced until the blood is seen in the hub of the puncture needle, (c) at this point, the inner stylet is removed and gentle withdrawal is made until arterial backflow is observed, (d) the 0.018" wire is gently advanced avoiding any resistance, (e) Outer Cannula is removed keeping the wire in place, (f) 5F sheath with dilator are gently passed over the wire into the radial artery, (g) a small nick may be required at the skin site, and (h) complete sheath is inserted into the radial artery and the dilator is removed.

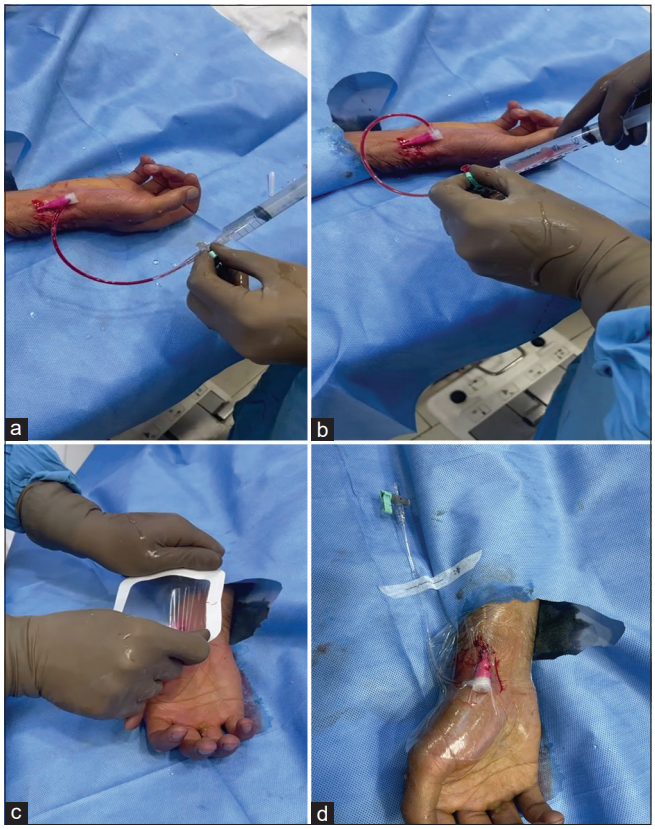

Figure 3: (a) Backflow through the sheath is checked, and any air bubbles are removed. (b) Slow injection of the radial cocktail is given at the rate of 0.5-1 ml/sec after diluting with the blood. (c) A Tegaderm is applied to secure the sheath to avoid repeated movements at the puncture site, which may cause spasm. (d) Final sheath position in the radial artery.

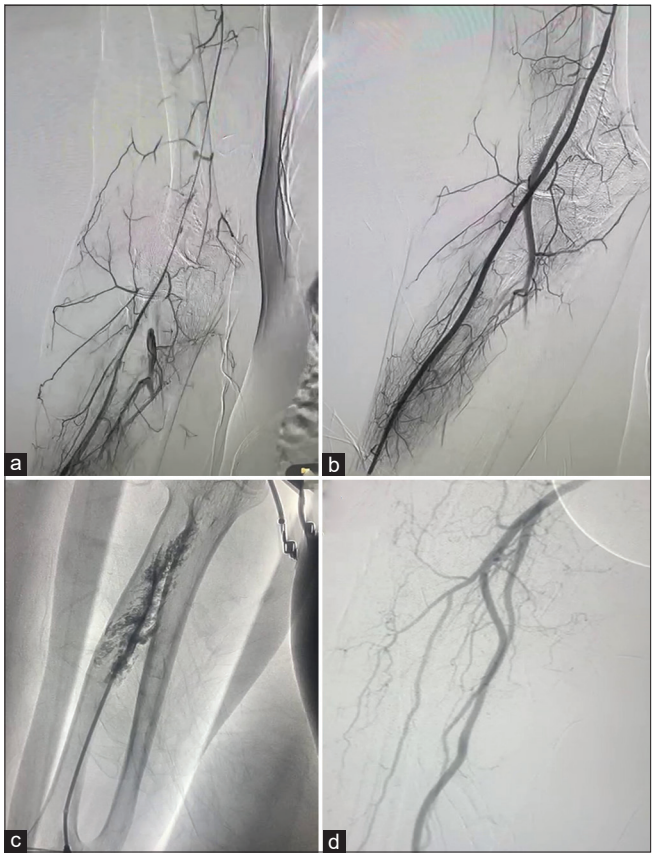

Figure 4: A 45-year-old male patient with severe pain after the diagnostic catheter was passed through a 5 F radial sheath placed in the radial artery. (a) Angiographic run through the sheath after slow removal of the catheter shows severe spasm of the radial artery (b) Patient was given IV midazolam, NTG through the radial sheath and was reassured. Angiographic run after 15 min showed almost complete disappearance of spasm (Note the brachioradialis variant in this case). Another case of a 32-year-old female for diagnostic cerebral angiography. There was mild resistance to the wire during 5F sheath insertion. (c) An angiographic run taken through the sheath shows contrast extravasation suggestive of perforation. Manual compression was done with the application of a radial band at the perforation site. The procedure was converted to transfemoral in this case due to pain and patient apprehension. (d) An angiographic run taken after 30 min from the right axillary artery showed mild spasm of the radial artery however no evidence of any extravasation. The patient recovery was uneventful.

Modified Allen's or Barbeau test is no longer advocated.[1] In very few cases, acute occlusion of the radial artery can happen due to endothelial injury and the thromboembolic phenomenon. Intra-arterial catheter-assisted thrombolysis, mechanical thrombectomy using a stentriever or aspiration device, or balloon angioplasty can be done in these cases. Even after aggressive therapy, rarely amputation may be necessary due to gangrene formation.[26]

Closure

To reduce the chances of occlusion of the radial artery, a patent hemostasis technique is recommended. It typically involves using a radial wrist band device while maintaining an antegrade flow which is evaluated by plethysmography.[13,27] Radial wrist bands through multiple vendors are available in the market.

The marker on the radial band is kept at the arterial puncture site with monitoring of the pulse oximeter readings and then inflation of the radial band with a syringe containing room air (Supplementary figure). After the device inflation, the air is released slowly until the waveform returns, which denotes the patency of the radial artery. We inflate the radial band with the accompanying syringe and then remove the air in 1 mL increments until we see an ooze. At this point, we add another 1 ml of air while observing the oximeter waveform. Slow deflation is then performed every half-hourly. Usually, we keep the wrist band for about 1–2 h after a diagnostic angiogram and 3–4 h after a therapeutic procedure. It usually depends on the amount of heparin administered and the antiplatelet status of the patient.

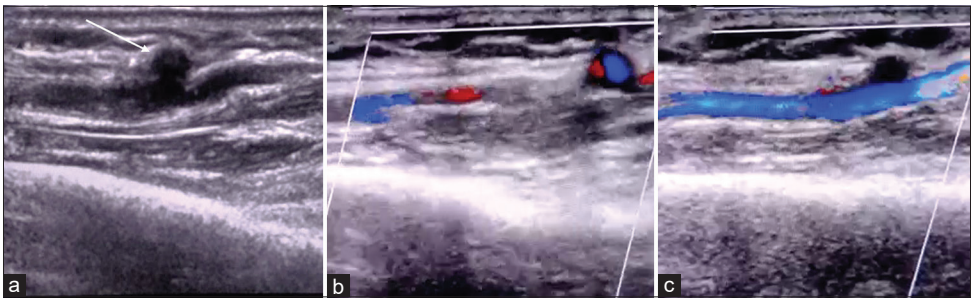

Figure 5: A 56-year female patient who had undergone successful coiling for an Acom aneurysm came for routine follow-up after 1 month with pain at the radial puncture site. (a) Gray scale ultrasound shows the presence of a small outpouching of size 5 × 6 cm at the radial artery (b). Color Doppler images show the presence of flow within the outpouching suggestive of pseudoaneurysm. A TR band was applied at the level of pseudoaneurysm for 3 h to achieve suitable compression. (c) Color Doppler images post-compression show a lack of flow within the pseudoaneurysm. This patient is currently on follow up.

Table 1: Brief review of access site complications in transradial access.

Complication	Incidence	Clinical signs	Risk factors	Prevention	Management
Radial spasm	Up to 10%	Forearm pain, resistance while inserting sheath/ catheters.	Female, diabetes, thin patients, small radial diameter, multiple catheter exchanges, Larger diameter sheath/ catheter	Ultrasound-guided puncture, appropriate patient selection, avoiding multiple catheter exchanges and larger diameter sheaths	Reassurance as most cases will subside in a few minutes, do not attempt to push or withdraw the sheath/ catheter forcefully, repeat nitroglycerin intra-arterial/ subcutaneous, IV midazolam, gentle diagnostic run to define the area and severity of the spasm
Radial artery occlusion	5–10%	Mostly asymptomatic Rarely ischemia	Female, Diabetes, Thin patients, Radial artery inner diameter/sheath outer diameter>1	Adequate anticoagulation Patent hemostasis technique Frequent assessment of TR band to relieve compression Prophylactic ipsilateral ulnar artery compression	Usually, recanalizes on follow up. No treatment is usually required. Compression of the ulnar artery by TR band to increase flow in radial artery suggested
Hematoma	1–5%	Visible swelling	Improper positioning of TR band	Proper positioning of TR band at the arteriotomy site	Manual compression Additional TR band proximal to arteriotomy site
Perforation	<1%	Extravasation of contrast, Visible swelling. Rarely compartment syndrome	Variant anatomy Learning phases of TRA for the operator Forcible push of wire	Radial artery run to see for variant anatomy, gentle wire manipulation. Giving a slight curve to the artery with gentle corkscrew movements	Gently pass the wire across the perforation followed by catheter to have a tamponade effect. Larger diameter catheter for tamponade. Manual compression BP cuff inflation
Dissection	1%	Resistance to pass the wire. Lack of backflow through the sheath	Variant anatomy loops Early learning phase	Ultrasound guidance for puncture. Use of soft tip wire with a gentle curve. Gentle wire manipulation	Usually, self-limiting. Cross the segment with soft tip 014 wire. Advancing the catheter will usually seal the dissection
Pseudoaneurysm	0.1%	Pain with Pulsatile swelling at the puncture site	Inadequate compression, obese patient	Ensure adequate compression by TR band Ultrasound of RA prior to discharge of patient	Usually, asymptomatic. TR band compression, ultrasound-guided compression, rarely thrombin injection or surgical intervention

DISTAL RADIAL ACCESS (SNUFFBOX)

Distal radial access involves a puncture at the anatomical snuffbox with the puncture site (Supplementary figure) lying between the extensor pollicis longus and extensor pollicis brevis/abductor pollicis longus tendons at the level of the scaphoid bone. Potential benefits include fewer chances of ischemia as the puncture site lies distally and the palmar arch formation is not compromised. It is also more comforting to the awake patient due to the neutral hand position.[28,29]

There is no difference in the sheath size and other hardware between the distal TRA and proximal TRA.

A recent trial has shown that the distal TRA approach has significantly fewer chances of radial artery occlusion, while attempts at puncture, time to cannulate, and pain at access sites were more serious than the proximal radial approach. They have advocated the distal TRA approach as the first-line approach for intervention procedures.[30]

In our experience, we have also found that the distal TRA requires greater learning with initial difficulty in puncture and prolonged access time. We believe that obese patients with deeper radial artery location, patients with a problem in supination of the forearm, and those with significant risk for hematoma formation or hand ischemia should preferably be taken by distal TRA. Otherwise, there is no significant advantage between one approach and two other. Future meta-analysis may shed more light on this topic.

After the distal TRA approach, closure requires a specific distal radial band.

CONCLUSION

The use of TRA has significant advantages compared to TFA in terms of shorter duration, better patient experience, and lesser risk of significant hematoma and pseudoaneurysm formation. Intervention radiologists should get familiar with the anatomy, variations, and access-related metrics of the radial artery for successful procedural outcomes.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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SUPPLEMENTARY FIGURES

Figure 1: Typical plethysmography readings after attaching the pulse oximeter showing good radial artery waveform (Dashed white arrow) and good saturation (white arrow)

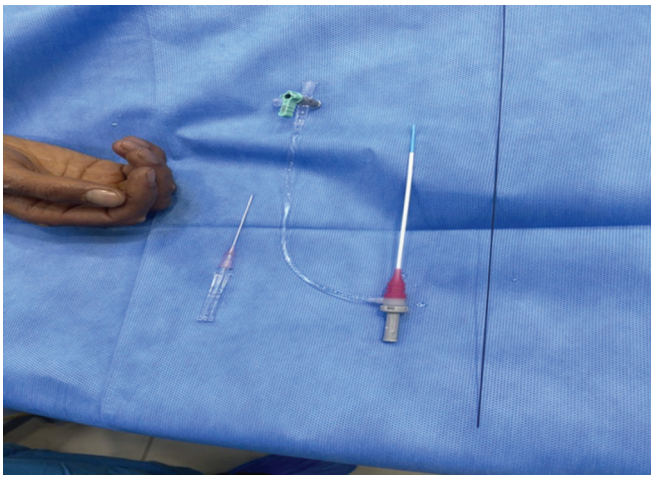

Figure 2: A typica radial sheath consisting of 21-gauge needle, 5F sheath with a dilator and 0.018" micro-guidewire (left to right).

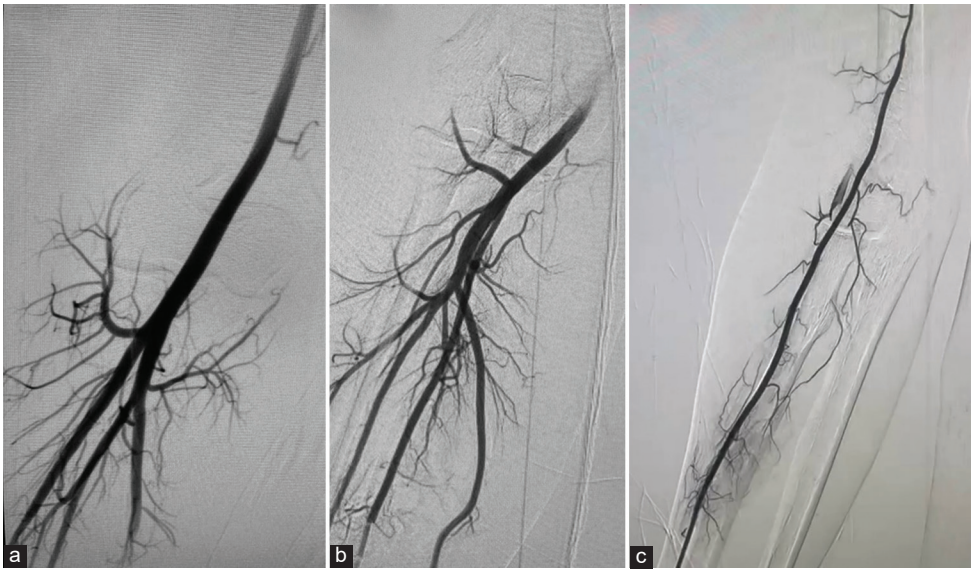

Figure 3: Angiographic runs taken after placing the radial sheath (a) Normal anatomy (b) Variant anatomy (c) Brachioradialis variant

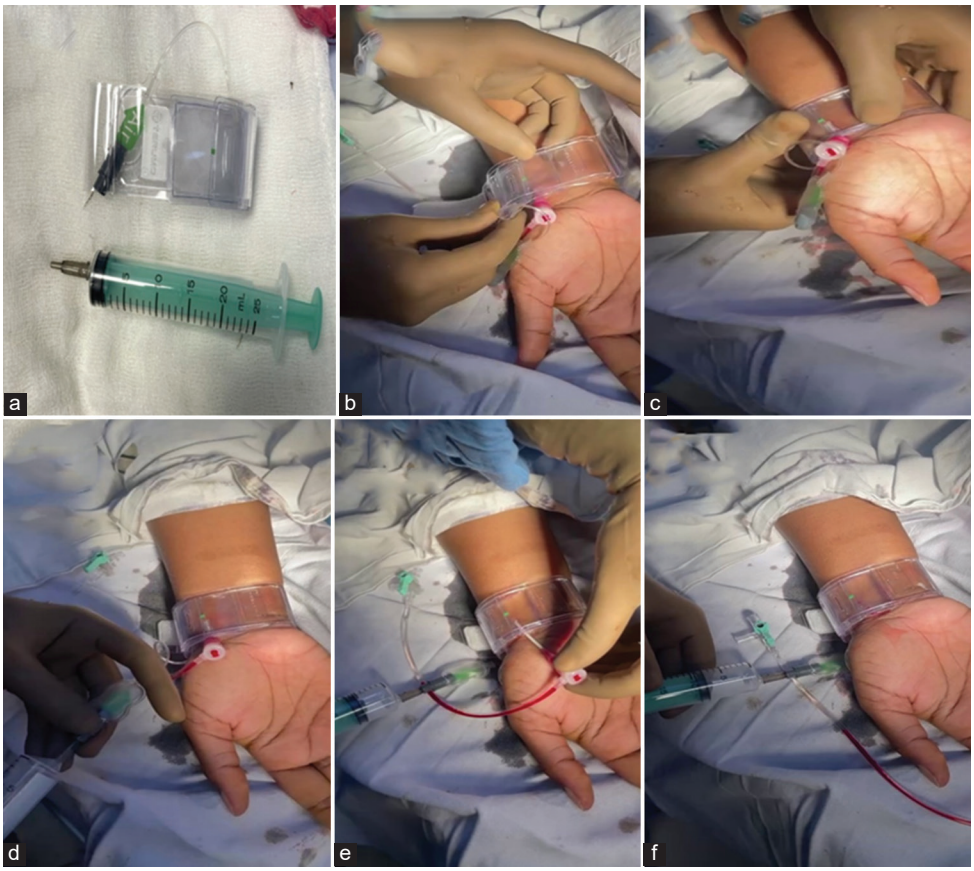

Figure 4: Steps to show application of TR band. (a) A classical TR band with accompanying syringe (b, c) The band is opened and the marker is aligned to be kept just proximal to the skin insertion site (d) The side valve is attached with the syringe and 10-14 cc of air is inserted (e) The sheath is then removed (f) Slow deflation is done from the side valve till an ooze is seen and at this point 1 ml of air is inserted.

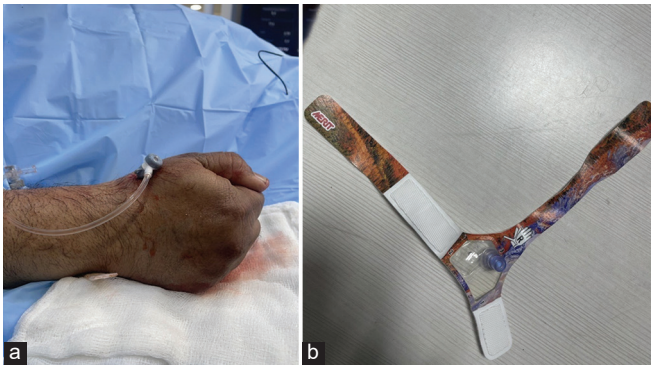

Figure 5: (a) Distal trans radial access approach with sheath inserted at the anatomical snuff box (Note the neutral hand position which is comfortable to the patient) (b) A fan shaped Distal TRA band for closure.