PERSPECTIVES ON RADIAL ACCESS APPLICATIONS

Embolization Therapies

By Tiago Bilhim, MD, PhD, EBIR, FCIRSE, FSIR; Roberto Iezzi, MD, FCIRSE; and Marcelo Guimaraes, MD, MBA, FSIR

The transradial approach (TRA) has been proven to have fewer access site complications and lower mortality when compared to the transfemoral approach (TFA) and has been adopted as the first-line approach for most coronary interventions. However, TRA remains underused by interventional radiologists (IRs), mainly due to misperceptions related to its safety and feasibility. This article discusses a few open questions and future perspectives that could drive the decision to select the best vascular access for embolization therapies.

LEARNING CURVE: HOW MANY CASES AND WHERE TO START

The need for a longer learning curve for TRA is one of the main misperceptions related to this approach. A few studies have looked into this question, and the short answer is 20 procedures.[1] Of course, the learning curve depends not only on the procedure but also on the operator. Some physicians may have steeper learning curves, whereas others may take longer to achieve the same skills. The background of the interventionalist also plays a fundamental role. For a seasoned IR with many years of expertise on vascular procedures and ultrasound-guided vascular access, TRA interventions should be a "no-brainer." After three to five cases, the experienced interventionalist should feel very comfortable with TRA.

Another aspect to consider is the operator's previous general vascular access experience. If you compare an IR used to performing TFA for more than 30 years with a resident/student who never performed a single femoral access, the perspectives on radial access will be strikingly different. For the experienced IR, TRA will be a challenge compared to TFA. For the resident/student, both accesses will be "difficult" to start off with. Recently, a multinational survey demonstrated that TRA is mainly used by IRs aged < 40 years who have < 5 years of experience in the field.[2] We could speculate that some well-experienced IRs (aged > 50 years) may have the perception that there is no reason to move from TFA to TRA due to their low complication rates with TFA and familiarity with this approach, as opposed to the learning curve required for TRA.

TRA is an opportunity for the novice IR.[3] For someone who has never performed a single vascular access, there is a clear initial advantage toward TFA when you compare puncture and procedural times between TRA and TFA. However, after the initial 20 procedures, there is a reversal, with TRA resulting in lower puncture and procedure times. Why? Because the learning curve with TRA is steeper than for TFA. The greatest reduction in puncture and procedural times is seen in the first 20 procedures using TRA, whereas this number is 40 procedures for TFA for the novice interventionalist.[2,3]

For experienced IRs, radial puncture took longer than femoral puncture during the first 20 procedures.[1] After that, the time for puncture was similar for TRA or TFA. The number of punctures, radiation exposure, contrast volume used, and overall procedural time are also not significantly different between TRA and TFA after the initial 20 procedures. Initially, it is expected that two or more punctures will be required, but the numbers will be similar to TFA after those first 20 cases. The learning curve can be reduced even further when ultrasound guidance is used for radial access. The only parameters that took longer to reach comparable numbers to TFA were the time of preparation of the angiography room and fluoroscopy time, where 30 procedures were needed.[1] This highlights the need to have everyone in the angio room (including nurses and radiographers/technicians) involved to optimize room setup. Because most IRs will be using radial access for liver arterial interventions, reaching the celiac axis and hepatic arteries from TFA is faster than from TRA during the first 30 procedures, highlighting another potential challenge beyond arterial puncture. To establish a successful TRA program, the radial artery should be ideally > 2 mm in the anterior-posterior diameter and TRA should be used for elective procedures. Choose procedures that the operator has the most experience with and gradually expand to emergencies, and add smaller radial artery diameters (eg, > 1.6-mm radial arteries can safely accommodate a smaller-profile 5-F Glidesheath Slender sheath [Terumo Interventional Systems]) and more challenging procedures with growing confidence and expertise. If you have a lot of experience with uterine fibroid embolization and liver transarterial chemoembolization/radioembolization but never have performed prostatic artery embolization, it probably goes without saying that you should not start a TRA program with a prostatic artery embolization or emergency case.

PATIENT CANDIDACY: CASES TO EMBRACE AND CASES TO AVOID

We believe that a successful and safe radial artery access practice requires specific inclusion and exclusion criteria. It is not a matter of "Can I do this by radial?" but rather "Is TRA better than TFA for this specific patient?" This question opens the door to key concepts in radial access: patient comfort and safety. However, IR comfort is also paramount—we would not advise anything that could be better for the patient and increase patient comfort if, on the other hand, it turned a simple procedure into a complete nightmare. Parameters to consider when deciding between TFA and TRA include patient age, patient height, left versus right radial (for infradiaphragmatic interventions, left TRA is recommended), radial artery diameter, palmar arch patency, type/size of catheters required, and the target area of treatment (embolization or angioplasty). Also, the pros/cons of radial access should be adjusted to the patient, considering obesity or hostile groins, tortuous iliac arteries, and/or uncorrectable coagulation parameters.

Regarding age, we would agree that TFA is probably safer than TRA in patients aged ≥ 70 years because the risk of stroke increases with age and navigating elongated aortic arches may challenge the access to the abdomen. Thus, we would consider age > 70 years a relative contraindication to TRA. There is one reported case of stroke after radial access for liver radioembolization in an 89-year-old patient.[4] After percutaneous coronary interventions, the reported risk of stroke is 0.2% to 0.4% from either TFA or TRA, which is probably due to aortic arch manipulation and not the vascular access site. The mean age of patients with stroke after coronary interventions by TRA is > 70 years of age, whereas it is < 70 years of age for patients without a stroke.[5,6] One can argue that the risk of stroke with TFA is absolute 0% for IRs if you do not cross the aortic arch. However, the reported increased risk of stroke due to TRA versus TFA is virtually 0% based on the cardiology literature.[5,6] Older age, chronic kidney disease, peripheral artery disease, and acute coronary syndrome are proven risk factors for stroke during cardiac catheterizations.[5,6] Thus, femoral access may be wiser for elderly patients. However, if an elderly patient without other proven risk factors for stroke has an existing chest CT demonstrating no significant atherosclerotic disease and a type 1 or 2 aortic arch, TRA is acceptable despite the patient's age.

Also, ensure your catheters are long enough! If the patient is extremely tall, you may fall short. Always use left radial access for infradiaphragmatic interventions. If the left radial artery has a small diameter for the selected sheath, consider the left ulnar artery, and if that is not usable, then go for femoral access. Think twice before using the right radial artery. There is a proven twofold higher risk of stroke when you use right radial compared to the left radial as shown in the cardiology literature.[5,6] There is no need to increase the risk of stroke by crossing the supra-aortic vessels. Consider radial artery size: if you puncture radial arteries that are < 1.6 mm, there is an increased risk of spasm, radial rupture, or radial occlusion after the procedure. The Barbeau test screens the palmar arch patency. In the presence of Barbeau type D, the palmar arch is not complete/patent and radial access should be avoided to mitigate the risk of hand ischemia. If the catheters are larger than 6 F and/or many "over-the-wire" catheter exchanges are expected, then TRA might not be the best option. With current catheters and microcatheters on the market, radial access is feasible for thoracic, abdominal, and pelvic arterial interventions. Recently, angioplasty balloon and stent shafts of 200 cm became available for iliac and superficial femoral artery interventions.

In summary, we recommend as formal contraindications: radial artery inner diameter not compatible with the outer diameter of the introducer sheath, Barbeau test with type D waveform (negative Barbeau test), and catheter/device shaft profile > 7 F. We recommend as relative contraindications for radial access: age > 70 years, very tall patients (> 6 ft 3 inches with the current catheters), and zone of target embolization/angioplasty below the groin. These exclusion criteria have to be adjusted to each patient, and common sense should prevail. It may be preferable to use TRA in patients with relative contraindications to avoid obese patients with hostile groins, tortuous iliac arteries, and/or patients with uncorrectable coagulation parameters or whenever anticoagulation or antiaggregation therapy cannot be stopped.

HOW WE DO IT: ROOM SETUP, PATIENT COMFORT, AND RADIATION SAFETY

When starting a TRA program, room setup is fundamental. The whole team should be involved in the process, including nursing and technologists. Depending on the versatility and space of the room, adopting a left radial approach may justify positioning the patient with the head facing in the position usually for the toes (ie, the other way around). Of note, working with the patient positioned the other way around requires relocation of the screens and table protection shields. Regarding the positioning of the left arm, there are two options: arm tucked against the torso of the patient over the procedure table or 45° to 90° abduction with arm support. This second option has the advantage of lowering radiation exposure to operators, as you will work further away from the patient and x-ray source. With a left radial approach, operators will work from the left side of the patient. Make sure you have room for an ultrasound machine to assist with the radial artery puncture. Regarding patient comfort, do not overabduct the left arm, as many patients will not tolerate this position for a prolonged time. The left hand should be supine, and the operator should ensure that the patient is comfortable with the position. Some advocate dedicated hand supports to increase patient comfort. The table height is usually a little bit higher with a radial approach for operator comfort. Comfort during radial access flows both ways—for patients and operators.

Make sure you can visualize the left arm with fluoroscopy. The guidewire and diagnostic catheter should be advanced through the aortic arch under active fluoroscopic guidance. Moveable, ceiling-mounted, and table skirt protection shields are very useful and can be positioned between the patient and the operator. Using these recommendations, radiation exposure is similar or even inferior when comparing TRA to TFA. Yamada et al demonstrated a threefold reduction of operator radiation exposure when a shield (door on wheels) was placed between the procedure table and the operator while the left arm was in 45° to 90° abduction.[7]

Patient comfort is key and the most important reason to adopt TRA for IR procedures. It is unlikely that superiority of TRA over TFA will be demonstrated in terms of safety in IR, as has been shown in the cardiology literature, because it would require a study with thousands of patients. Other potentially interesting advantages of TRA include no need to correct international normalized ratio or platelet count for arterial interventions (which is useful for patients with chronic liver interventions and/or on anticoagulation) and implementation of outpatient protocols with faster recovery and ambulation, which reduces the need for hospitalization and overall costs. The biggest advantages include lower access-related complications and faster discharge, as well as ability to ambulate and ample mobility immediately after the procedure. The IR literature has demonstrated that 80% to 85% of patients who had both TRA and TFA preferred TRA.[7,8]

FROM ACCESS TO TARGET: TIPS AND TRICKS FOR SUCCESSFUL NAVIGATION

Dedicated materials are needed for TRA, including dedicated radial sheaths with micropuncture sets, 4- to 6-F, 110- to 135-cm-long catheters (as opposed to standard 90-100 cm used for TFA), and 150-cm-long microcatheters (as opposed to the standard 130 cm used for TFA). Nitroglycerin and heparin (and optional verapamil) need to be prepared as well.

The procedure starts with draping and preparation of the left wrist. You can use 200 µg of nitroglycerin (2 mL) diluted with 3 mL of lidocaine for skin anesthesia (5 mL of total volume). Try to inject this mixture around the radial artery, as it will help increase radial artery diameter and provide efficient local anesthesia. Then, ultrasound-guided puncture of the radial artery is made using a 21-gauge needle and 0.018-inch wire. Ultrasound can be used to ensure the wire has progressed correctly through the lumen of the radial artery before placing the sheath. Do not make skin incisions, as these radial sheaths are very hydrophilic and have a sharp tip and may retract during catheter manipulation. After access is achieved, the radial cocktail of 200 µg of nitroglycerin and 3,000 to 5,000 units of heparin is slowly injected through the sheath. Make sure that this radial cocktail is injected slowly and gently because it may cause the blood pressure to drop, with resulting patient discomfort. Keep some nitroglycerin on the table. Although rare, radial artery spasm may occur while hampering the catheter and/or sheath removal. In these situations, nitroglycerin can be injected through the sheath and/or with ultrasound guidance in the tissues surrounding the artery. Nitroglycerin and heparin injected through the radial sheath have proven benefits for reducing the rate of radial artery occlusion (RAO) after TRA, which can occur in 5% to 8% of patients after TRA.[9] Smaller radial arteries, younger age, female sex, and larger sheaths have also been shown to increase the risk of RAO. RAO will not cause hand ischemia if the Barbeau test is used and type D patients excluded from TRA. However, RAO has been shown to increase the risk of diminished hand sensibility.[10]

After placing the sheath, fluoroscopy can be used to visualize guidewire progression through the forearm into the shoulder region. A 0.035-inch Glidewire Baby J guidewire (Terumo Interventional Systems) with a smaller J configuration of the tip (1.5 mm instead of 3 mm) is very useful to progress over the radial/brachial artery, avoiding collateral branches. Although rare, radial loops and spasm may challenge this part of the procedure. Once in the shoulder and thorax, use left anterior oblique projections at 25° to help visualize the aortic arch and progress into the descending aorta. With younger patients, a Berenstein-shaped catheter with a hydrophilic 0.035-inch wire will do the job in most cases. However, with older patients and elongated aortic arches, dedicated catheters commonly used for cardiac catheterizations are often useful such as TIG, Jacky, Sarah, BLK, and Ultimate. These catheters are also very useful for bronchial, celiac, and mesenteric catheterizations, whereas Berenstein catheters can be used for most other arteries. Another great alternative to achieve access to the descending aorta and for visceral embolizations is combination of a 5-F Jacky or Sarah catheter with the 0.035-inch Glidewire Baby J hydrophilic wire. Try to minimize the time and catheter manipulation when catheterizing the descending aortic arch, as this is theoretically the part of the procedure with the highest risk of inducing a stroke event. In addition, minimize the number of contrast injections at this time and watch out for air embolism.

We do not advise using continuous saline flushing through the sheath because this may cause hand hypoperfusion. At the end of the procedure, we recommend using dedicated radial wrist bands with specific syringes to inflate and deflate air for hemostasis. A protocol of patent hemostasis is advisable to mitigate the risk of RAO after the procedure. This means just enough air is inflated in the wrist band to avoid bleeding and hematoma, while allowing maintained patency of the radial artery.

CURRENT RADIAL TECH CAPABILITIES AND NEXT-GENERATION WISH LIST

Dedicated long radial sheaths (3-6 F) would be very useful. Most frequently, radial sheaths are 11- or 23-cm long and will end in the forearm. Longer introducer sheaths of 119 and 139 cm are now available, such as the 6- and 7-F Destination Slender sheath (Terumo Interventional Systems). If you need many over-the-wire catheter exchanges or if you manipulate the catheter too much, this may lead to radial spasm because there will be a lot of "uncovered" manipulations inside of the radial artery without the protection of the sheath. Radial artery spasms are usually seen during brisk manipulation and retraction of catheters—so be gentle. We usually retract the catheters at the end of the procedure with a wire in to minimize any potential trauma of the catheter tip on the radial artery as you pull the catheter out. Currently, radial catheters and sheaths only go down to 4 F, so 3-F sheaths and catheters would be very useful. New longer catheters with different shapes dedicated to radial interventions will be available soon.

ADJUSTMENTS DURING COVID-19

The worldwide coronavirus disease outbreak has led to a dramatic challenge for all health care systems. IR services were prepared to adequately perform elective or emergency procedures under these extreme circumstances. The main issue is related to the protection of patients and health care workers from being contaminated with COVID-19. In this scenario, outpatient procedures/ambulatory care would be preferred. TRA is preferred in this setting rather than TFA whenever possible due to several advantages that include but are not limited to less postprocedural discomfort at the access site, reduced limitations for the patient in performing basic activities, faster postprocedure hemostasis, and earlier time to ambulation and discharge. ■

1. Iezzi R, Posa A, Merlino B, et al. Operator learning curve for transradial liver cancer embolization: implications for the initiation of a transradial access program. Diagn Interv Radiol. 2019;25:368-374. doi: 10.5152/dir.2019.18437
2. Liu Y, Wen X, Bai J, et al. A single-center, randomized, controlled comparison of the transradial vs transfemoral approach for cerebral angiography: a learning curve analysis. J Endovasc Ther. 2019;26:717-724. doi: 10.1177/1526602819859285
3. Peterson EC. Commentary: the learning curve in transradial access: one time when a novice interventionist may shine. J Endovasc Ther. 2019;26:725-726. doi: 10.1177/1526602819872003
4. Al-Hakim R, Gandhi RT, Benenati JF. Incident of stroke after transradial arterial access for subdiaphragmatic intervention. J Vasc Interv Radiol. 2017;28:1287-1288. doi: 10.1016/j.jvir.2017.05.012
5. Shoji S, Kohsaka S, Kumamaru H, et al. Stroke after percutaneous coronary intervention in the era of transradial intervention. Circ Cardiovasc Interv. 2018;11:e006761. doi: 10.1161/CIRCINTERVENTIONS.118.006761
6. Alkhouli M, Alqahtani F, Tarabishy A, et al. Incidence, predictors, and outcomes of acute ischemic stroke following percutaneous coronary intervention. JACC Cardiovasc Interv. 2019;12:1497-1506. doi: 10.1016/j.jcin.2019.04.015
7. Yamada R, Bracewell S, Bassaco B, et al. Transradial versus transfemoral access in liver cancer embolization: randomized trial to assess patient satisfaction. J Vasc Interv Radiol. 2018;29:38-43. doi: 10.1016/j.jvir.2017.08.024
8. Iezzi R, Pompili M, Posa A, et al. Transradial versus transfemoral access for hepatic chemoembolization: intrapatient prospective single-center study. J Vasc Interv Radiol. 2017;28:1234-1239. doi: 10.1016/j.jvir.2017.06.022
9. Rashid M, Kwok CS, Pancholy S, et al. Radial artery occlusion after transradial interventions: a systematic review and meta-analysis. J Am Heart Assoc. 2016;5:e002686. doi: 10.1161/JAHA.115.002686
10. van der Heijden DJ, van Leeuwen MAH, Ritt MJPF, et al. Hand sensibility after transradial arterial access: an observational study in patients with and without radial artery occlusion. J Vasc Interv Radiol. 2019;30:1832-1839. doi: 10.1016/j.jvir.2019.04.010

Tiago Bilhim, MD, PhD, EBIR, FCIRSE, FSIR
Nova Medical School, Interventional Radiology Unit
Saint Louis Hospital
CUF and Centro Hospitalar Universitário de Lisboa Central (CHULC)
Lisbon, Portugal
tiagobilhim@hotmail.com
Disclosures: Consultant/speaker fees for Philips, Merit, Cook Medical, and Terumo; stockholder in Embolx.

Roberto Iezzi, MD, FCIRSE
Interventional Radiology Unit
Fondazione Policlinico Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore
Rome, Italy
Disclosures: Consultant/speaker fees for Bracco, Guerbet, Pharmacept, and Terumo.

Marcelo Guimaraes, MD, MBA, FSIR
Head, Vascular Interventional Radiology
Medical University of South Carolina
Charleston, South Carolina
Disclosures: Consultant fees for Terumo, Siemens; advisory board, Medtronic.