PERSPECTIVES ON RADIAL ACCESS APPLICATIONS

Lower Extremity Disease

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LEARNING CURVE: HOW MANY CASES AND WHERE TO START

When starting to perform lower extremity arterial interventions from the wrist, operators must have all the necessary tools (wires, catheters, sheaths, balloons, stents) available at their disposal. Proper clinical judgment, physical exam, and available imaging must be used to determine the appropriateness of using the radial artery. Familiarity with radial artery access and postprocedure care is essential to minimize risk of access site complications. Staff must be comfortable using radial artery compression devices and monitoring for hematoma or other neurovascular damage.

From a technical standpoint, operators must be able to traverse the upper extremity arterial system, including radial loops, and carefully navigate down to the descending aorta. Ideally, operators have this experience from other infradiaphragmatic interventions performed via the radial artery. The cardiology literature demonstrates that in operators new to transradial access (TRA), case fluoroscopy time and contrast volume curves initially have sharp downward slopes and then typically flatten out after approximately 30 to 50 cases.[1]

It is important to note that the left radial artery is the preferred access site compared to the right, as fewer great vessels are crossed and less catheter distance is used reaching the target vessels. This is of particular importance when considering treating the lower extremities via TRA. Nevertheless, crossing the aortic arch must be done with caution and patients with documented or high suspicion for aortic arch disease should be avoided. TRA for arterial lesions should only be attempted by experienced operators who regularly treat peripheral artery disease (PAD). Careful manipulation of the wire while attempting to cross lesions is needed to avoid vessel injury, and understanding the limitations of TRA is critical.

Patient selection is equally important to ensure optimal outcomes. Patients with unfavorable femoral artery access, such as history of prior surgery, excess overlying soft tissue, or unfavorable anatomy may make attempting intervention via the radial artery more appropriate. In addition, patients with short height and arm span as well as more proximal disease will make treatment from the radial artery much easier.

PATIENT CANDIDACY: CASES TO EMBRACE AND CASES TO AVOID

TRA is an essential component of the endovascular PAD treatment toolbox in cases where it is difficult or unsafe to access the common femoral artery. In patients who have occluded femoral arteries or who are obese, a radial approach is particularly useful. In cases where groin access is unsafe, such as a common femoral artery above the inguinal ligament, a patient with a groin infection or recent groin access or surgery, or if anticoagulation is unable to be stopped, TRA is the safest approach.[2] In addition, PAD interventions are not ideal via transfemoral access (TFA) in patients who have had previous abdominal endografts or bifurcation stenting, endarterectomy, or bypass involving or adjacent to the femoral artery. Furthermore, a TRA approach may be beneficial in patients with steep or tortuous iliac arteries.

In certain cases, treating lower extremity disease via a transradial approach should be avoided. In patients with a radial artery smaller than 2 mm, there is an increased risk of radial artery occlusion after TRA. Using a 6-F sheath for PAD cases is ideal to ensure adequate catheter and stent platform compatibility, so in patients

with very small radial arteries, treating PAD via radial artery approach is not recommended.

A Barbeau D waveform has classically been considered a contraindication to TRA. However, this has become more controversial as new data emerges suggesting that an incomplete superficial palmar arch is not associated with increased risk of upper extremity dysfunction after TRA.[3]

PAD patients tend to have diffuse atherosclerosis in vessels that need to be crossed to access the lower extremity vessels. In patients with known aortic arch atherosclerosis or calcification, there is a theoretical risk of stroke from atherosclerotic emboli during endovascular manipulation within the aorta, and a femoral approach is considered safer. In practice, these risks may be overstated.[4,5] In patients with a radial loop, it may be difficult to navigate tools to the lower extremities. Lastly, in patients with advanced chronic kidney disease or end-stage renal disease, the radial artery should be preserved for future hemodialysis access.

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

To position the patient for a radial access PAD case, the patient's left arm is supinated and abducted, laying on an arm board adjacent to the patient's torso. This allows the long tools required for TRA lower extremity PAD treatment to rest on the drape over the patient's body, in a similar fashion to femoral access cases. A towel roll is placed underneath the left wrist so that the wrist is partially extended. A pulse oximetry device is placed on the patient's thumb or forefinger to assess hand perfusion.

Patient comfort and safety are important considerations when deciding whether to approach a PAD case via radial or femoral access. TRA allows patients to ambulate shortly after the conclusion of a procedure without the need to lay flat, which is especially advantageous in patients with congestive heart failure who cannot tolerate lying flat for extended periods of time. In addition, the need for prolonged manual pressure in the case of a closure device failure in a TFA is obviated if a transradial approach is used. This is especially important in PAD cases because patients are actively anticoagulated during the procedure. In addition, major bleeding and access site complications are less frequent and more easily recognizable in TRA compared to TFA cases.

Radiation precautions for transradial PAD cases are similar to those taken during transfemoral PAD cases. To minimize radiation exposure, a radiation shield can be placed between the patient and operator. In the majority of PAD cases treated via TRA, the operator is typically farther from the radiation source compared to TFA, leading to reduced radiation exposure for the operator.

FROM ACCESS TO TARGET: TIPS AND TRICKS FOR SUCCESSFUL NAVIGATION

A list of the tools currently available for use in TRA PAD cases[6] and a description of the procedural steps for treating a variety of infrainguinal PAD lesions via TRA[7] have been previously reported in the literature.

To initiate a TRA PAD case, radial access is obtained and a 6-F short sheath is introduced. A solution consisting of 200 µg of nitroglycerin, 2.5 mg of verapamil, and 5,000 units of heparin is diluted and administered slowly through the radial artery sheath to limit spasm. Unfractionated heparin is given at a dose of 80 to 100 mg/kg. Throughout the procedure, active clotting time (ACT) is checked every 30 to 60 minutes and heparin can be re-dosed to reduce risk of thromboembolic events. We start by navigating to the infrarenal abdominal aorta using a 150-cm guidewire (eg, Bentson guidewire) and a guiding catheter such as a 5-F, 110-cm Optitorque Sarah Radial (Terumo Interventional Systems).

The Bentson guidewire is then exchanged for a stiff support wire (eg, 0.035-inch X 260-cm angled Glidewire, Terumo Interventional Systems), and the Sarah Radial catheter is exchanged for an angled guiding catheter within the aorta. Examples of guiding catheters used are a 6-F, 90-/110-cm Mach or Runway Guide MP1 guiding catheter (Boston Scientific Corporation) or a 4-F X 120-/150-cm angle Glidecath (Terumo Interventional Systems). Aortography and lower extremity angiography are then performed.

Common and External Iliac Artery Lesions

For common and external iliac artery lesions (up to 125-135 cm from left wrist), the lesion is crossed with a support catheter (eg, 3.2-F X 150-cm Quick-Cross Select catheter, Philips) over the support wire. If stenting is indicated, the stiff support wire is then exchanged for a super stiff 0.035-inch, 260-cm Amplatz wire in preparation for stent deployment. The Quick-Cross support catheter is removed and an appropriately sized bare-metal stent is deployed. The largest-diameter stent that can be deployed via TRA is a 12-mm-diameter X 60-mm-long self-expanding stent, which is available on a 6-F X 120-cm platform (Epic stent, Boston Scientific Corporation), allowing stenting of the majority of external iliac arteries and common iliac arteries in select patients. If there is residual stenosis, balloon angioplasty can be performed. There are currently no drug-coated balloons indicated for treatment of the iliac arteries, and numerous plain percutaneous transluminal angioplasty (PTA) balloons are available on 6-F platforms reaching up to 10 mm in diameter. PTA balloons with working lengths capable of treating iliac artery lesions are compatible with both 0.035-inch and 0.018-inch wire systems.

Common Femoral and Superficial Femoral Artery Lesions

For common femoral and superficial femoral artery (SFA) lesions (up to 155-170 cm from left wrist), we exchange the short introducer sheath and diagnostic catheter for a stiff long introducer sheath and support guiding catheter. Options include the 6-F, 45-cm Pinnacle Destination guiding sheath (Terumo Interventional Systems) with 5-F, 100-cm Glidecath; 5-F, 119-/149-cm R2P Destination Slender sheath (Terumo Interventional Systems); 7-F (6-F inner diameter [ID], 120-/150-cm R2P Slenguide catheter; Terumo Interventional Systems); 6.5- to 7.5-F (4–5-F ID), 100-cm Sheathless Eaucath (Asahi Intecc, USA); and 5-F, 110-cm Shuttle sheath (Cook Medical). For the 150-cm sheaths, note that at least 150 cm of the support wire must be outside of the patient to safely advance the long sheath. A crossing support catheter (eg, 3.2-F X 150-cm Quick-Cross Select catheter) is advanced to the proximal SFA. The support catheter is advanced forward as the Glidewire is advanced.

All currently available over-the-wire PTA balloons with long working lengths compatible with radial access require no more than a 0.018-inch guidewire. The Glidewire is exchanged for a 0.018-inch stiff guidewire (eg, 0.018-inch X 300-cm V-18 Control steerable guidewire, Boston Scientific Corporation), and the wire is advanced to the distal SFA/popliteal artery. The Quick-Cross crossing catheter is then removed, an angioplasty balloon is advanced over the guidewire to the site of the lesion, and the balloon is dilated under fluoroscopic guidance. Available PTA balloons with working lengths compatible with TRA include the Advance 14LP (4 F, 170 cm; Cook Medical) and Pacific Plus (4 F, 180 cm, 7-mm maximum outer diameter [OD]; Medtronic], as well as rapid exchange PTA balloons Ultraverse Rx (0.014 inch, 5-mm maximum OD; 4-5 F; 200 cm; BD Interventional) and Metacross (5 F, 200 cm, 8-mm maximum OD; Terumo Interventional Systems). If a stent is required to treat a lower extremity PAD lesion, stents with shafts long enough to be used via TRA include the 150-cm Everflex Entrust (5 F, 7-mm maximum OD; Medtronic) and the newly available 200-cm R2P Misago RX line of self-expanding stents (6 F, 6–8-mm maximum OD; Terumo Interventional Systems).

Popliteal and Below-the-Knee Lesions

For popliteal artery and below-the-knee lesions (up to > 170 cm from left wrist), a longer crossing catheter is required. Through the long sheath, we exchange the system for a 5-F, 200-cm ViperCath XC support catheter (Cardiovascular Systems, Inc.) and a specialized crossing wire (0.014-inch X 475-cm ViperWire Advance, Cardiovascular Systems, Inc.). Note that > 200 cm of the wire must be outside of the patient to safely advance the catheter. There are various support catheters ranging from 4 to 6 F, and other wire options include the Nitrex (0.035 inch, 400 cm; Medtronic) Glidewire (0.035 inch, 350-450 cm), and NovaGold (0.018 inch, 480 cm; Boston Scientific Corporation) (off label). The crossing wire and catheter are advanced to just proximal to the occlusion. The occlusion is then crossed using the ViperWire, advancing the support catheter forward for support as the wire is advanced.

Atherectomy

To perform atherectomy on a popliteal artery or below-the-knee lesion, once the identified lesion is crossed, the ViperWire is advanced distally. Leaving the wire in position, the support catheter is removed and the atherectomy device is advanced over the wire (CSI Diamondback atherectomy, Cardiovascular Systems, Inc.; 200-cm shaft length, 1.5-mm crown). After ensuring adequate distal positioning of the ViperWire, atherectomy is performed under direct fluoroscopic guidance. It is important to note that long over-the-wire devices with up to 200-cm shaft length require at least 360-cm wires, which are technically cumbersome and difficult. Following adequate atherectomy of the target lesions, angioplasty may be performed. Note that the stiff 0.014-inch ViperWire can be used as the support wire for angioplasty. An angioplasty balloon is advanced over the guidewire to the site of the lesion and dilated under fluoroscopic guidance.

CURRENT RADIAL TECH CAPABILITIES AND NEXT-GENERATION WISH LIST

With the available tools, we are currently able to treat lower extremity PAD below the inguinal ligament with plain PTA, atherectomy, and bare-metal stenting via radial artery access. New longer devices that are small enough to fit through a 6-F sheath have expanded the scope of PAD interventions that can be performed via TRA. For example, the 200-cm shaft length R2P Misago stents that are now available in the United States allow us to treat arterial lesions and dissections below the knee.

Although drug-coated balloons (DCBs) are frequently used in conjunction with atherectomy to treat femoropopliteal lesions, and DCBs have been shown to be superior to PTA in preventing femoropopliteal restenosis,[8] the currently available DCBs are only available with a shaft length up to 130 cm and are unable to be used with a transradial approach. Similarly, while drug-eluting stents (DESs) demonstrate improved 1-year patency compared to bare-metal stents in infrapopliteal arteries and similar 1-year patency rates to balloon angioplasty,[9] DESs with shafts long enough to treat these lesions transradially are not available.

The full range of endovascular PAD tools is not yet available in lengths compatible with a transradial approach. If a subintimal path is created while crossing a lesion, a reentry device could not be used to enter back into the true lumen from the wrist. In addition, covered stents are currently only available in catheter lengths up to 135 cm and on a 6-F platform, so bailout options from the wrist are limited in the case of infrainguinal vessel perforation. In this case, prolonged balloon tamponade and preparation of the groin for additional femoral artery access would be required.

ADJUSTMENTS DURING COVID-19

Performing procedures via TRA has become even more valuable during the COVID-19 pandemic, especially to help reduce patient time in shared recovery areas, and consequently helping to theoretically limit the nosocomial spread of the virus. Particularly in PAD cases in which we routinely heparinize the patient during the procedure, using TRA can limit recovery time to 60 to 90 minutes, compared to 4 to 6 hours when TFA is used.

During the era of COVID-19, treating PAD efficiently and successfully has been essential. For many patients, the shutting down of outpatient facilities led to a gap in care, leading to an increase in severity of lower extremity PAD at presentation.[10] Using TRA to successfully open up lower extremity PAD lesions while minimizing complications has been crucial in this population. There has been a documented increase in lower extremity arterial thrombus burden in patients diagnosed with COVID-19.[11] At this time, technologic limitations of TRA still preclude route use of tools such as suction thrombectomy to treat acute limb ischemia due to sheath size requirements. Industry collaboration and future research are warranted to expand the role of TRA in these scenarios. ■

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