Radial Access for Peripheral Vascular Procedures

Why and how this approach is used for arterial access in peripheral endovascular procedures.

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Campeau first described the use of radial artery access for coronary angiography in 1989.[1] Subsequently, Kiemeneij and Laarman performed the first coronary intervention using this approach in 1993.[2] In many Asian and European countries, radial access is the default approach for coronary angiography and intervention. Worldwide, it is estimated that 20% of interventional procedures are performed via the radial artery. If the United States is excluded, 29% of procedures use radial access. In North America, 50% of procedures in Canada are performed radially compared to the United States where only < 2% of procedures in 2008 were transradial.[3,4]

The decrease in access site complications, more rapid ambulation, same-day discharge, and increased patient comfort has led to these changes in access site selection. The risk of bleeding complications with transfemoral access has been reported to range from 2% to 12%.[5] Yatskar et al[6] reviewed data from the National Heart, Lung, and Blood Institute Dynamic Registry for hematomas requiring blood transfusions and reported a 1.8% incidence. These data were collected during a time when glycoprotein IIb/IIIa inhibitors and large-sized catheters were common.

It is generally accepted that groin complications delaying discharge or requiring treatment now affect 2% of procedures. Risk factors identified for bleeding complications include acute coronary syndrome, female sex, peripheral vascular disease, advanced age, chronic renal insufficiency, low body mass index, congestive heart failure, and hypertension. The ability to reduce access site bleeding in this patient subset would make them perfect candidates for radial access.

Patient comfort is also an important factor in choosing the appropriate access site. In patients who have back pain or poor pulmonary function, the ability to sit up immediately postprocedure is appealing to many patients. At times, in elderly male patients with benign prostatic hyperplasia, the chance to stand soon after the procedure to use the bathroom is a major benefit and prevents the need for bladder catheterization in a patient who is on antiplatelet agents and is anticoagulated.

RADIAL ACCESS FOR PERIPHERAL ARTERIAL THERAPY

Several studies and feasibility reports have shown successful application of transradial access for observational peripheral interventions.[7-9] There are several anatomic reasons to approach peripheral interventions from the wrist. First, proximity and catheter support make subclavian, vertebral, and certain carotid interventions better suited when approached from the arm rather than from the groin. Second, renal and mesenteric vessels have a superior oriented origin, and their access from the arm is easier, and more natural. Third, lower extremity interventions, in particular, iliac and proximal superficial femoral artery, are more accessible from the arm when there is contralateral disease or if the iliac bifurcation is hostile.

Upper extremity interventions are very well performed transradially. Occasionally, ultrasound guidance is required to access the radial artery in the setting of severe subclavian/innominate disease. Once access is obtained, a 5- to 6-F, 70- to 90-cm sheath will offer excel-

Figure 1. Difficult cannulation of the right renal artery from a femoral approach.

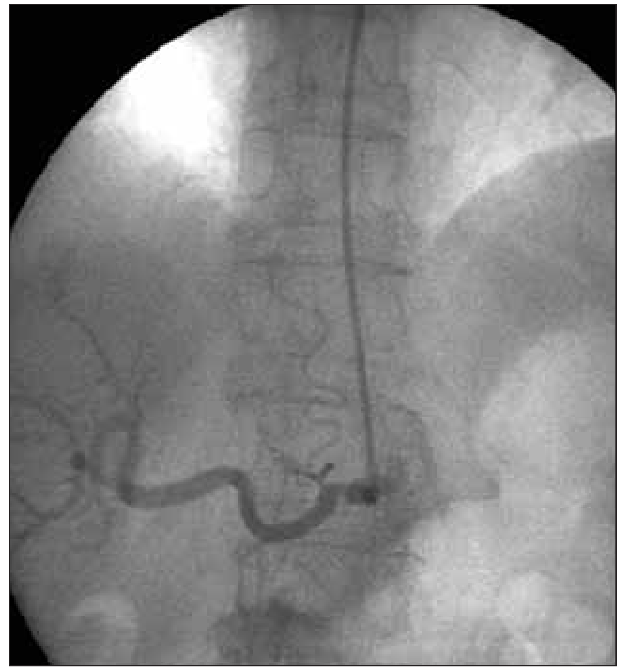

Figure 2. Cannulation of the right renal artery (view from above).

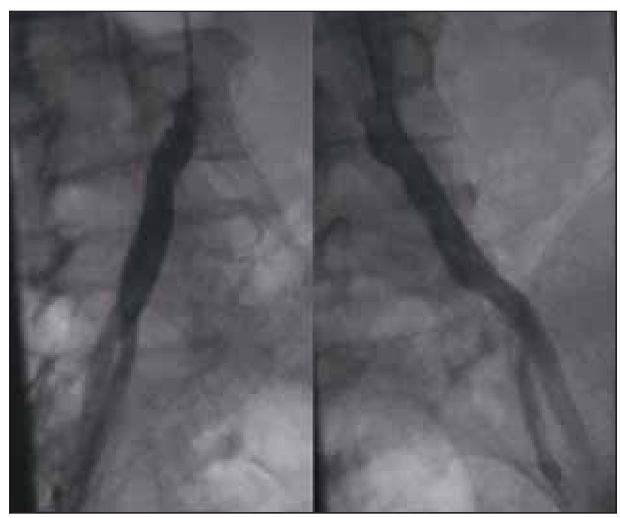

Figure 3. Selective cannulation of the iliac arteries using a radial approach.

lent support for subclavian, vertebral, or carotid interventions. In our practice, the only carotid interventions performed from the arm are for the left carotid arising from the innominate artery or for the right carotid artery in the face of a severely diseased type 3 aortic arch.

In general, the renal and mesenteric arteries have a superior oriented origin from the abdominal aorta. Selective cannulation from the arm allows for the use of a JR 4 guide or a multipurpose catheter (Figures 1 and 2). Support for delivery of stents is excellent from this approach. In almost all patients, a 6-F guide can be used. Occasionally, the use of a 5-F, 90-cm Flexor Ansel 1 or 2 introducer sheath (Cook Medical, Bloomington, IN) may be used instead of a 6-F guide.

For the treatment of iliac disease (Figure 3), there are potential advantages for a radial puncture compared with the more traditional femoral approach. Femoral access can have associated difficulty when crossing an iliac lesion from the contralateral side, and precise placement of a stent can be a problem if contralateral iliac ostial disease needs to be treated. If the ipsilateral femoral artery is accessed, subsequent compression of the site just distal to a fresh stent or placement of a closure device in a diseased vessel may be needed. We have found that in patients with iliac disease, radial access allows for same-day discharge and prevents the need to access the contralateral groin and for crossover.

In the event that kissing iliac stents are required, placement of two wires into each iliac artery can be performed, followed by staged stent deployment; alternatively, a second femoral puncture can be used to allow simultaneous stenting, with one stent being placed via the radial puncture. However, in cases in which two wires are needed, or if larger stents or stent grafts need to be implanted, larger sheaths (7–8 F) may be required at the radial access site. Alternatively, the interventionist can use the radial artery and femoral artery when kissing balloons or stents of the iliac system are required. Large (up to 14 mm) self-expanding stents can be placed using a 6-F introducer, but, if balloon-expandable stents are required, there is a limitation to 8-mm balloon-expandable stents via a 6-F introducer and 10-mm balloon-expandable stents via a 7-F introducer.

WHICH PATIENTS ARE NOT SUITABLE CANDIDATES FOR RADIAL ACCESS?

Equipment length limits the ability to perform most endovascular procedures below the mid-superficial femoral artery, depending on patient size and arterial tortuosity. We have found that in patients with long arms or upper body, standard coronary catheters will often not even reach to the level of the renal arteries. Catheterization labs that embark in performing transradial peripheral interventions should be equipped with long introducer sheaths (up to 110 cm) and long-shaft balloons and stents. Currently, the shaft length for balloons is limited to 150 cm and for the stents to 135 cm.

Although most peripheral interventions could be performed safely from the arm, the access for left carotid artery (when arising normally from the aortic arch) is not ideal from either radial artery; therefore, in our practice, the left carotid interventions are performed via femoral access.

Relative contraindications to radial access include absent pulse, an abnormal Allen's test result (in many high-volume labs in Asia and Europe, Allen's tests are not performed), Raynaud disease, the need for a dialysis shunt, or functioning shunts.

ACHIEVING ACCESS

Technical Considerations

It is often easier to use the left radial artery for peripheral procedures because this prevents the need to cross the aortic arch and provides an additional 5 to 10 cm of useful catheter length. In our lab, and the majority of United States cath labs, an Allen's test or Barbeau test (also called a *modified Allen's test*) is performed. This is done using a plethysmographic pulse oximeter to detect the presence of a pulse waveform after compression of the radial artery.[10]

The patient's wrist is placed in hyperextension, and local anesthesia is given 1 cm proximal to the radial styloid. Because the radial artery has a large alpha innervation, patient anxiety should be controlled from the beginning of the case with adequate medication and

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verbal support from the cath lab staff. A single anterior wall puncture is performed using a 21-gauge short micropuncture needle directed 45° toward the radial artery, and when brisk flow is noted, a 0.018- to 0.025-inch wire is introduced via the needle into the radial artery followed by the placement of an introducer sheath. A double-wall puncture can also be performed using a 20-gauge intravenous cannula (Angiocath, BD, Franklin Lakes, NJ).

Over the years, we have found it easier to train fellows and senior operators in radial access using the double-wall technique. The Angiocath is directed at a 30° to 45° angle to the skin and, when bleeding is noted from the needle tip, the Angiocath is advanced though the posterior wall of the radial artery. The needle is removed, and the plastic portion of the intravenous cannula is slowly withdrawn until pulsatile flow is seen. The 0.018- to 0.025-inch guidewire is advanced into the radial artery followed by placement of a short arterial sheath. The visual and haptic feedback inherent to this technique facilitates easy adoption by interventionists who are unfamiliar with radial puncture. To enhance the radial pulse before puncture, infiltration of anesthetic admixed with 500 µg of nitroglycerine has been described.[11]

It is believed that hydrophilic sheaths are less likely to induce spasm. It has been reported that with the Cook hydrophilic sheath, a higher incidence of sterile granuloma formation at the insertion site can be seen as a later complication; nevertheless, the only 110-cm sheath in the United States market (mandatory for lower extremity interventions) is provided by Cook Medical.[12] Once the sheath is in the radial artery, an antispasmodic solution is administered. In almost all labs, the solution will contain 2.5 to 5 mg of verapamil and, in some labs, 100 to 200 µg of nitroglycerin. It has been found that heparin or bivalirudin will decrease the incidence of radial artery occlusion.[13]

If an intervention is planned, once access is achieved, bivalirudin or systemic heparin can help to achieve an activated clotting time of 250 to 300 seconds. For diagnostic procedures, 50 to 70 U/kg of heparin can be administered intravenously or via the arterial sheath. If the heparin is to be given via the arterial route, it is important to administer it slowly and dilute the heparin

Figure 4. A 55-cm sheath is placed in the left subclavian artery.

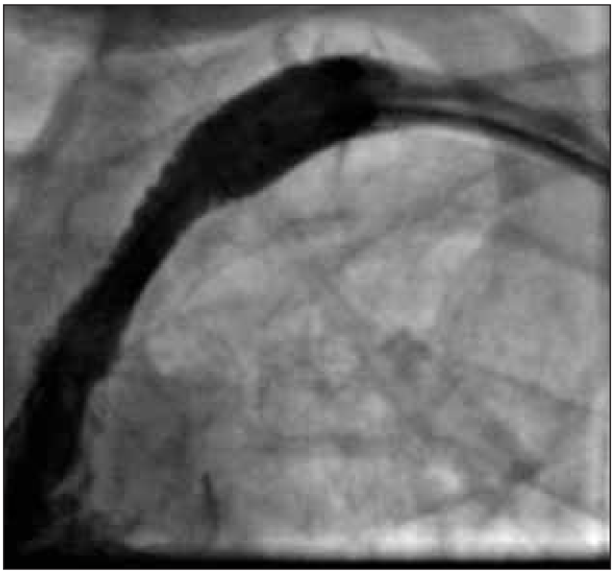

Figure 5. Image obtained after completion of subclavian artery stenting.

with blood to help avoid burning and discomfort to the patient at the access site.

A standard 3-cm, 0.035-inch J wire is the first wire we use because it provides satisfactory tactile feedback. If resistance is felt, angiography via the introducer sheath is performed. The most common reason for resistance is the presence of a radial loop, which is seen in close to 2% of patients. A second reason may be spasm.[14] If dealing with spasm, the addition of verapamil will often correct the spasm and allow for passage of the wire and catheter. With radial loops, a small recurrent radial artery may come off of the loop, and if the interventionist is not aware of the presence of this small branch, the wire may enter this vessel and lead to perforation. Once the loop is visualized, a 0.035-inch hydrophilic wire or a 0.014-inch coronary guidewire can be used to transverse the loop. Once the wire is in the subclavian artery, a 30º left anterior oblique view can assist with entry into the descending aorta.

If difficulty is encountered using a left internal mammary catheter, a soft-tip 0.035-inch hydrophilic wire can often be safely directed into the descending aorta. If lower extremity intervention is planned, a 0.035-inch exchange-length guidewire can be placed in the descending aorta, and the short sheath can be removed from the wrist and exchanged for a long introducer sheath. In most patients, a 110-cm sheath will reach the common iliac artery. For subclavian interventions, the short sheath is removed from the wrist, and a 55- to 70-cm-long sheath is placed. Figures 4 and 5 show a 55-cm sheath used in a subclavian intervention. Finally, renal interventions can be performed using a 6-F coronary guidewire in the majority of patients.

COMPLICATIONS

Transradial access failure in coronary angiography was examined in a single-center study of more than 2,000 patients; all patients underwent radial angiography. An anatomic variation was found in 23% of patients, but successful completion of the procedure was accomplished in 98.9% of cases. Failure was most commonly due to the lusoria subclavian artery (an aberrant right subclavian artery arising from the descending thoracic aorta) in 0.2%, radial loop in 0.1%, and tortuous arteries in 0.05% of patients. Because the left radial artery is used for most patients, a lusoria subclavian artery anatomic variation will not be an issue.[14]

Spasm becomes less of a problem with increasing experience of the operator due to fewer punctures and better recognition of the appropriate tactile feedback for easy wire passage. If spasm is encountered, additional sedation and calcium channel blockers will often relieve the spasm and discomfort.

Radial artery occlusion with intact collateral circulation is asymptomatic and is reported to occur in 4% of patients. Recently, with the use of patent hemostasis, the incidence is believed to be closer to 1%. The sheath is removed at the completion of the procedure, and a compressive device is placed at the puncture site. With the pulse oximeter in place, the ulnar artery is compressed, and pressure is slowly removed from the compression device until a waveform is seen.[15] Generally, when using bivalirudin, we attempt to remove the compression device after 2 hours. With heparin, we begin to remove pressure after 2 hours and continue

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to slowly release pressure, monitoring the site for bleeding.

Perforation is a rare complication that can arise from wire or catheter perforation of the radial artery or a side branch. The incidence is reported to be 0.01%.[16] If the perforated segment of the radial artery can be crossed with a wire, the best solution is to continue the case, with the introducer or guide catheter in place to cover the perforation site. If the segment cannot be crossed, applying a pressure dressing along the course of the radial artery will often seal the leak. Compartment syndrome is rare and has been reported to occur in 0.004% of patients in one large case series.[17]

Pseudoaneurysms are uncommon but can present as a pulsatile mass in days to a week after a procedure. Treatment can be ultrasound-guided compression, thrombin injection, surgery, or reapplication of a TR Band radial compression device (Terumo Interventional Systems, Somerset, NJ), as noted in a recently published case report, leading to closure of the pseudoaneurysm.[18] Kanei et al recently published an excellent, extensive review of radial access site complications.[19] Generally, radial artery occlusion is seen at the time of discharge; if the radial artery is patent at discharge, it was patent at 24 hours and 30 days after the procedure. Of the occluded radial arteries at discharge, almost 50% were open at 30 days.[20]

CONCLUSION

Utilization of the radial artery for peripheral procedures has allowed for same-day discharge, early ambulation, increased patient satisfaction, and fewer access site bleeding complications. In some anatomic situations, the approach from the upper extremity makes the procedure easier. Because the patients who will benefit the most from this approach are often the most difficult patients to start a radial program with, it is often best to build a learning curve, starting with younger male patients who have radial pulses that are easy to palpate and build up your technique to allow the 84-year-old frail female patient with peripheral vascular disease to benefit from your skills. ■

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