Managing Radial Access Complications

Gaining familiarity with this technique can help transcend the radial access learning curve.

BY S. ELISSA ALTIN, MD, AND VARINDER P. SINGH, MD

Campeau first proved the feasibility of radial access for diagnostic coronary angiography in 1989.[1] Four years later, Kiemeneij pioneered the first transradial coronary intervention in the Netherlands.[2] Despite its validation, use of the transradial approach has been limited in the United States. A meta-analysis of studies comparing radial and femoral approaches showed that in the 23 randomized trials selected, there was a 73% reduction in major bleeding in the radial group compared to the femoral group and a trend for a composite reduction in death, myocardial infarction, and stroke.[3] A recent randomized clinical trial (RIVAL) showed comparable procedural success rates between radial and femoral access sites and a significant difference in the rate of major vascular complications occurring in 1.4% of patients treated with the radial approach compared to 3.7% among those treated using the femoral approach.[4]

Due to the anatomy, radial access has definite advantages over femoral access with regard to vascular access site complications. It is superficial and easily compressible compared to the femoral artery, without adjacent veins, decreasing the likelihood of arteriovenous (AV) fistula. Also, the median and radial nerves are not nearby, making nerve damage less likely. The most common complications of radial access include spasm and occlusion; less likely complications include arterial dissection, perforation, hematoma, hand ischemia, granuloma formation, AV fistula, and compartment syndrome.

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RADIAL ARTERY OCCLUSION

Radial artery occlusion was one of the predominant concerns of early transradial operators, but long-term consequences are generally less worrisome given the dual supply of blood flow to the hand from the radial and ulnar arteries. Kiemeneij recommended only using radial access in patients with a patent ulnar artery and palmar arch by Allen's test. Patency can also be accurately predicted with Doppler ultrasound and plethysmography. The predominant factors in decreasing rates of radial artery occlusion are heparin administration, patent hemostasis, avoiding vasospasm, minimizing sheath size, and removing the sheath as soon as possible.

In the first prospective series to determine the safety and procedural success of radial access, Spaulding et al studied 415 consecutive patients with a positive Allen's test who underwent left radial access in terms of immediate and 2-month radial artery patency rates.[5] Their procedural success rate was > 95%. With the addition of 5,000 units of heparin, the radial artery occlusion rate declined from 71% to 4.3%. Predictive factors for radial artery occlusion in their

TABLE 1. STRATEGIES TO MANAGE POTENTIAL COMPLICATIONS OF THE TRANSRADIAL APPROACH	
Complication	**Management Strategy**
Local access bleeding	Compression of RA both proximally and distally to the puncture site using manual pressure (or compression devices)
Forearm hematoma	Perform RA arteriography when any resistance to guidewire or catheter insertion occurs
	Elastic bandage to forearm
Compartment syndrome	Ensure that occlusion of both the RA and UA does not occur during the procedure
	Fasciotomy with hematoma evacuation
Access failure	The puncture site should not be too distal
	If radial loop is present, transverse with hydrophilic guidewires
	If RAs are smaller than 2 mm in diameter, use a 5-F guidewire
Pseudoaneurysm formation	Thrombin injection and or mechanical compression
Radial artery avulsion	Prevent RA spasm
Radial perforation	Cross the perforation site using a guidewire with extreme caution
	Seal the perforation with the guiding catheter
Abbreviations: RA, radial artery; UA, ulnar artery.	

series included small artery size with diameters of < 2.7 mm.

Patent hemostasis was shown to be superior to an occlusive hold in the PROPHET study, with a 75% reduction in radial artery occlusion at 30-day follow-up and a similarly significant reduction at 24 hours.[6] This technique involves applying a hemostatic device to the radial artery with a sheath in place while a pulse oximeter is placed on the ipsilateral index finger or thumb. During tightening of the band, the sheath is removed, and the ipsilateral ulnar artery is occluded while the hemostatic band is loosened until the plethysmographic signal returns or bleeding occurs. If bleeding occurs, manual compression is indicated, but if the plethysmographic signal returns without bleeding, the band is left in place for 2 hours.

A larger sheath size appears to be associated with an increased risk of radial occlusion. In the Leipzig prospective registry to investigate the impact of sheath size, occlusion occurred in 18.5% of patients with the use of a 5-F sheath compared to 29.8% with the use of a 6-F sheath.[7] What appears to be more predictive is the ratio between the diameter of the radial artery and the radial sheath. Saito and colleagues found that when the sheath diameter was larger than the radial artery, the incidence of occlusion increased from 4% to 13% despite the absolute diameter of the sheath.[8]

In a Japanese experience to test the safety and efficacy of the transradial approach versus the transfemoral approach, the investigators found lower rates of access site complications with radial access, with similar rates of major complications.[9] Importantly, they found lower radial artery occlusion rates in patients who had the sheath removed immediately versus 3 hours after the procedure (5% vs 0%), suggesting a role for sheath removal as soon as it is feasible.

RADIAL ARTERY SPASM

The published incidence of radial artery spasm ranges from 3% with intra-arterial vasodilatory treatment administration to 22% in patients treated with placebo, likely with variation deriving from different "cocktails" used to prevent spasm.[10-12] In general, rates of spasm are much lower with the addition of nitroglycerin and verapamil. Other agents, such as phentolamine and nitroprusside, have been shown

Figure 1. Radial artery perforation is a rare complication of radial access that can lead to forearm hematoma.

to be less effective at preventing spasm.[11,13]

Diffuse spasm can occur along the upper extremity vasculature from the radial artery to the subclavian artery, leading to entrapment of the catheter. Hydrophilic-coated sheaths can help prevent this complication, as well as adequate sedation and time to allow the spasm to resolve. Rathore et al found less radial artery spasm when using hydrophilic sheaths (19% vs 39.9% with conventional sheaths) without a difference based on the length of the sheath used.[14] It is likely that the reduction of friction and endothelial damage induced by the catheter plays a role in the superiority of the hydrophilic sheath.[15] Additionally, circulating catecholamine levels play a role in vasospasm, and adequate sedation and subcutaneous local anesthesia with 1% lidocaine are important preventative measures. Fear, anxiety, and pain are important causes of radial artery spasm and may be effectively managed with moderate sedation.

PERFORATION

Perforation is a rare complication of radial access (Figure 1) that can lead to forearm hematoma. Out of 34,000 transradial cases reported by Patel et al, only 15 perforations (0.04%) were noted, and the procedures were completed successfully in all cases.[16] The most important management strategy in these cases is early recognition, as delayed intervention can lead to compartment syndrome. In this series, angiography was routinely performed before and after the procedure, as well as whenever a complication was suspected. In the event of perforation, intravascular tamponade with a sheath that was sufficiently long enough to cover the injured vessel wall and external compression of the arm can reduce hematoma formation. Other groups have published case reports outlining similar management strategies of internal and external tamponade for this relatively rare complication, also noting that, in rare instances, prolonged multiple balloon inflations or even vascular surgical intervention may ultimately be necessary.[17,18] Postprocedure management includes close monitoring for ischemia, hemorrhage, and compartment syndrome.

COMPARTMENT SYNDROME

Compartment syndrome is the most dangerous complication of transradial access. This risk can be minimized by ensuring that occlusion of both the radial and ulnar arteries does not occur during the procedure. Signs and symptoms include pain, paresthesia, pallor of the arm with preserved radial and ulnar pulses, lack of capillary refill, and decreased sensation. Immediate surgical consultation is necessary, and fasciotomy may be necessary to evacuate hematoma.

STERILE ABSCESS

The first reported case series of sterile abscess showed an incidence of 2.8% in cases with confirmed use of hydrophilic sheaths (30 of 1,063 patients).[19] The time course for lesion development was 2 to 3 weeks, which is longer than expected for bacterial infection. Later in their series, several patients had biopsies proving granulomatous reactions, with a few showing an amorphous extravascular substance consistent with the catheter coating. Subsequently, there have been numerous reports of sterile abscesses associated with hydrophilic sheaths (Figure 2). Rathore et al noted an approximate 5% rate of sterile abscess after radial

Figure 2. A sterile abscess. The granuloma formation is associated with hydrophilic sheaths. Reprinted with permission from Ian Gilchrist, MD.

Figure 3. Radial pseudoaneurysm, pictured here, is less common than femoral pseudoaneurysm. Reprinted with permission from Afshar A, Nasiri B. Radial artery pseudoaneurysm at the previous site of monitoring. The Univ Heart Center. 2009;4:193–196.

access using a hydrophilic sheath.[14] Duplex imaging may be required to rule out an infected pseudoaneurysm and can be used as a treatment modality. Most commonly, observation and local drainage without antibiotics is curative.

RARE COMPLICATIONS

Rare complications of radial access include pseudoaneurysm (Figure 3) and AV fistula, occur in 0.5% to 1% of cases,[7] and less commonly, mediastinal hematomas. Radial pseudoaneurysm is much less common than femoral, with the mechanism likely related to inadequate compression after the procedure or delayed bleeding. Management of pseudoaneurysm includes compression to thrombose the false aneurysm, thrombin injection, and surgical closure. AV fistula is another rare complication that usually follows a self-limited course but, in rare cases, may require surgical ligation.[20,21] Mediastinal hematoma results from the perforation of small vessels near the aortic arch but is exceedingly rare.[22]

CONCLUSION

Transradial access for PCI is safe and feasible, with results comparable to the transfemoral approach. The transradial approach has fewer vascular access site complications, as well as decreased bleeding, earlier ambulation, and shorter hospital stays. Disadvantages of the radial approach include the operator learning curve, with increased access failure and longer procedure and fluoroscopy times for less-experienced operators. These disadvantages can be overcome by increasing familiarity with the radial access technique and with methods to decrease complications. ■

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