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C3 – Core Curriculum in Cardiology

How to do radial coronary angiogram?

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Radial access has become the preferred route for performing coronary angiogram and interventions due to its safety and cost effectiveness. Fewer access site complications, shorter hospital stay and patient comfort in terms of early ambulation are factors in favor of this approach over the traditional femoral route. With the radial route, a meta-analysis found a 73% reduction in major bleeding complications as compared to the femoral route.[1] In the RIVAL study the incidence of major vascular complications was 1.4% with the radial approach as compared to 3.7% in the femoral access group.[2] Though the first radial coronary angiogram was first performed in 1989 by Campeau,[3] only in the recent decade there has been an explosive growth in the number of procedures done through the radial route. A steep learning curve and the increasing availability of hardware specific to the radial procedures have resulted in gradual uptake of the procedure by the interventional cardiology community.

To make transradial procedure easier and safer, an operator needs to understand the radial artery anatomy and the methods to enhance its palpability, the correct positioning of the patient, the ideal hardwares to be used and the optimal post procedure care to avoid complications and to maintain a patent radial artery.

1. Radial or femoral access (Table 1)

The radial artery is smaller, more superficial and thinner than the femoral artery. The smaller diameter makes it difficult to access, but easier to achieve hemostasis.

Another major difference is the route from the wrist to the heart is strewn with bends, loops and many branches. Careful manipulation of the guidewire and the catheters is important in taking the catheter to the heart, avoiding the bends, loops and spasm.

2. Patient selection

All patients undergoing coronary angiography and most patients undergoing PCI should be evaluated for a primary transradial access. The palpation of a good volume radial pulse in the right wrist is an indicator of ease of transradial angiogram. Radial artery size is the major determinant of the ease of access and the avoidance of spasm. The radial artery diameter is smaller in women, short people and Asians. The mean diameter of radial artery in the caucasian population is 2.5 mm, the external diameter of a 6F Radial Sheath.[4] This precludes the use of sheaths larger than 7F in most patients and it is evident that the sheath as well as the catheter comes into close contact with the artery predisposing it to spasm. Therefore the hardware used should be as small as possible.

3. Left or right radial access?

Most operators prefer to use right radial access as the positioning of the patient becomes almost similar to right femoral route. If the right radial pulse is weaker than the left, then the left radial artery is cannulated. The absolute indications for a

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Table 1 – Comparison of radial and femoral access.

	Radial	Femoral
Access	Difficult	Easy
Diameter (approximately)	2.5 mm	10 mm
Access site complications	Negligible	Significant
Hemostasis	Easy	Difficult
Post procedure ambulation	Immediate	Delayed

left radial access are: a. Acute coronary syndrome in a post CABG patient with a LIMA graft and b. Absence of a pulse in right wrist. In elderly (age > 75), it is preferable to use left radial artery as the unfolding of aorta creates an unfavorable angulation from the right.

4. Pulse evaluation

The presence of a good volume pulse and the adequacy of collateral circulation, assessed using Barbeau's Test[5] (checking SpO2 pulse wave on sequential release of occluded radial and ulnar artery) or Allen's test is advisable for operators who are starting their transradial program. Appearance of a good plethysmographic waveform on release of ulnar arterial compression, while maintaining the radial compression is a normal test and indicates adequate collateral supply from the ulnar artery. Recent evidence suggests that even in patients with abnormal Barbeau's test, the risk of hand ischemia is negligible and outweighs the bleeding risk of femoral access. However, for medico-legal issues, it is ideal to document a normal Barbeau's test before transradial access.

5. Preparation and positioning

Both the forearms and groins are shaved, and intravenous cannula is inserted into the contralateral forearm. Rings, bangles and wrist watch are removed. Both radial arteries are palpated and the better palpable radial is selected. The right arm is positioned by the side of the body on an arm board. For easier palpability and puncture of the radial artery, the wrist needs to be hyperextended by keeping a soft roll under the wrist. Fig. 1.

During left radial access, the puncture is done while the arm is kept hyperextended, and after establishing access, the hand is positioned over the left groin with a pillow kept under the left elbow.

6. Premedication

Premedication is important during transradial procedure. Anxious patients are very prone to spasm of the radial artery. Administering small doses of Fentanyl and Midazolam to such patients has a soothing effect and helps in successful cannulation of the radial artery.

7. Puncture technique

a. **Site of puncture**: The ideal site of puncture is 2–3 cm, above the wrist crease, where the artery is best palpable. The subsequent punctures in a patient who had a prior successful of unsuccessful access attempt should be at 1 cm proximal to the initial site.
b. **Local anesthesia cocktail**: Local anesthesia plays a very important role in ease of access and avoiding spasm. Most operators use very miniscule amount of Lignocaine infiltration at the puncture site, concerned about the loss of pulse. This is to be avoided, as pain during puncture decreases the chance of a successful access and causes patient to become very anxious, predisposing to spasm. A local anesthesia cocktail should be prepared (4 ml 2% Lignocaine + 1 ml Nitroglycerine 500 μg) and liberal infiltration of 1–2 ml around the puncture site will enhance the palpability of the radial artery[6] (Fig. 2). Other methods to enhance the palpability of the radial artery in difficult, tiny radials include transient occlusion of the brachial artery, followed by release using a blood pressure cuff and transient occlusion of the ulnar artery.
c. **Access hardware and technique:** One of the most important steps is the selection of the correct hardware from access to the completion. The ideal puncture hardware is the Radifocus sheath kit manufactured by Terumo (Terumo, Tokyo, Japan) (Fig. 3). The puncture is performed using a 20 G cannula and needle assembly, by the Seldinger technique with through and through puncture of the radial

Fig. 1 – Hyperextension of the wrist.

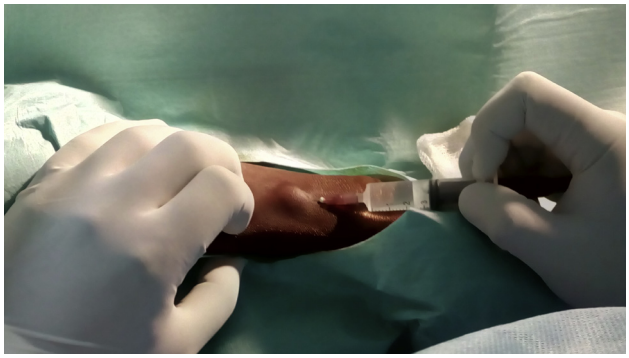

Fig. 2 – Infiltration of local anesthesia cocktail.

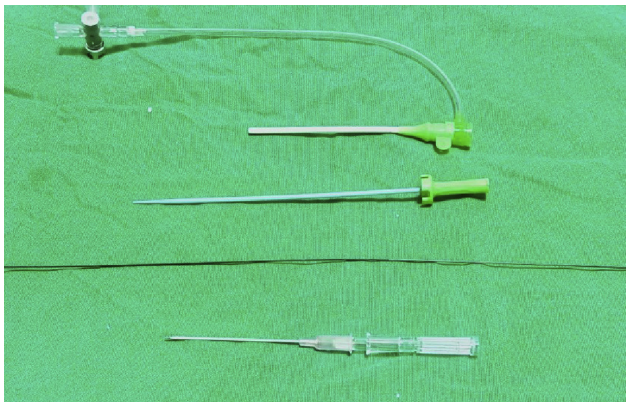

Fig. 3 – Terumo Radifocus Kit (7 inch sheath, dilator, 0.025 inch straight tipped glidewire and 2 inch puncture needle with cannula).

artery (Fig. 4). The anterior puncture technique and 18 G needle used in femoral puncture should not be used. After the initial blob of blood is seen in the proximal hub of the needle-cannula assembly (Fig. 5), the whole assembly is advanced to pierce the posterior radial wall and the needle removed. Gradual withdrawal of the cannula with the left hand, while holding the straight tipped hydrophilic Terumo 0.025 inch straight glidewire in the right hand will cause the arterial blood to spurt out (Fig. 6). At this point the wire should be introduced smoothly into the radial artery and the cannula removed (Figs. 7 and 8). Over the wire, the Radifocus Terumo 7 cm sheath with hydrophilic coating is advanced and the dilator removed (Fig. 9).

d. **Anti spasmodic cocktail:** Immediately after the insertion of the sheath, it is important to monitor the sheath arterial pressure and heart rate. If the patients systolic BP is above 100 mmHg, a cocktail containing 500 μg Nitroglycerine and 5000 U of unfractionated Heparin is given through the sheath, diluted gradually in patients own blood. Many operators give Verapamil 3–5 mg in addition to the NTG and Heparin, but it can be avoided when there is bradycardia. Recent publications did not find any benefit of verapamil in preventing radial spasm.[7]

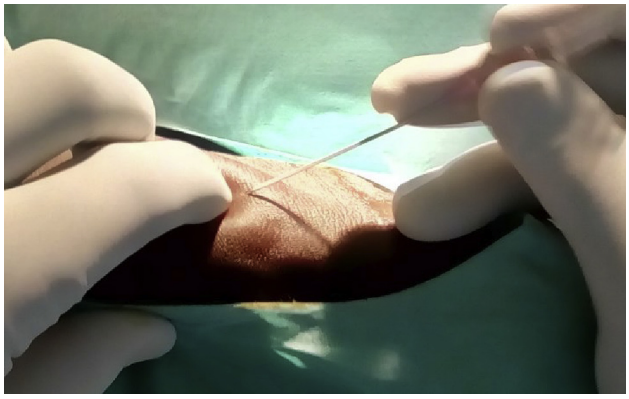

Fig. 4 – Fixing the radial artery with the left index finger of the operator and puncturing the artery at an angle of 30 to 45°.

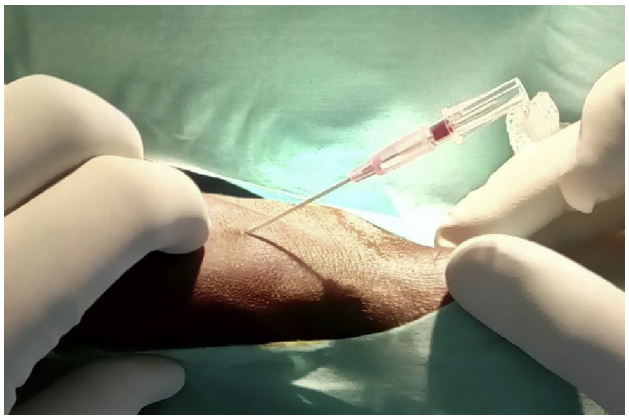

Fig. 5 – Backflow of blood into the Hub of the needle indicating entry into lumen, the needle is advanced to counter-puncture the posterior wall of radial artery, and the inner needle is removed, the cannula is left behind.

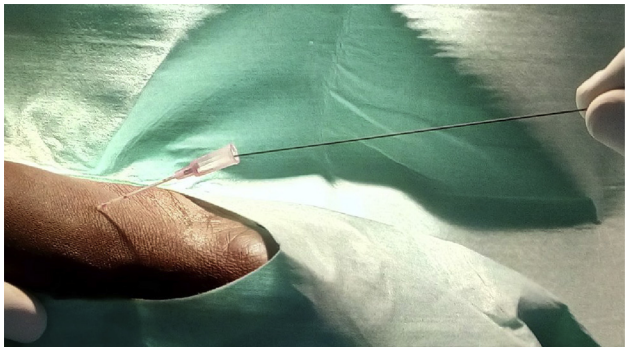

Fig. 6 – The 0.025 inch glidewire is kept inside the hub, without obstructing the lumen.

8. Hardware for performing radial coronary angiogram

Catheter: After the access, it is important to use the smallest diameter catheter, avoid entry of the guidewire into side branches and catheter exchange. The most commonly used catheter to perform radial coronary angiogram is the 5F TIG

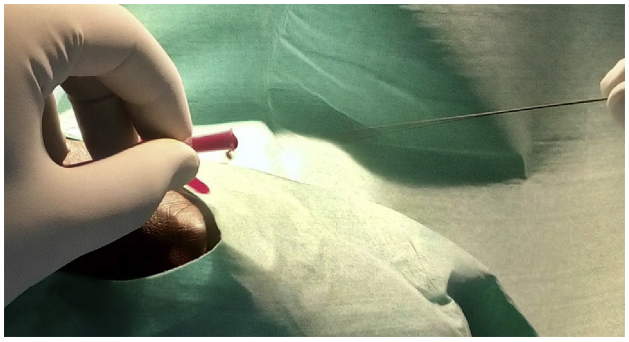

Fig. 7 – The Cannula is withdrawn by millimeters till a spurt of blood is seen, when the guidewire is advanced into the artery.

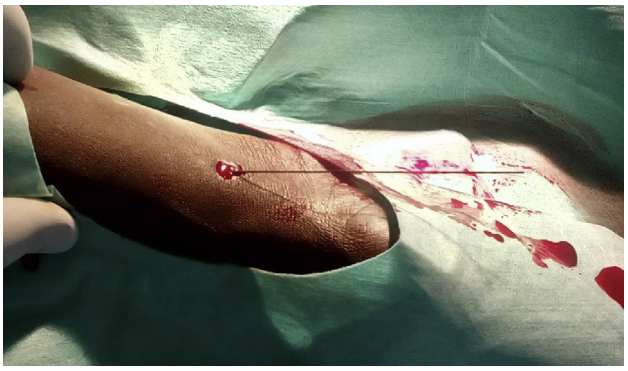

Fig. 8 – The cannula is removed, leaving the wire *in situ*.

catheter by Terumo. This catheter has a special hydrophilic coating which prevent spasm and the same catheter can be used to cannulate both left and right coronary arteries.

Guidewire: The ideal first wire that has to be used to advance the catheter should be J tipped, 0.035 inch Teflon coated braided steel core wire. This wire prevents the entry into side-branches. The operator has to advance the wire through the arterial tree, ahead of the catheter, feeling for any resistance. There is no need to do fluoroscopy while the wire is traversing smoothly till the subclavian artery. If there is any resistance felt, fluoroscopy guided manipulation has to be done. If the Teflon wire fails to navigate the course smoothly, a polymer coated hydrophilic Terumo 0.035 J wire is used.

9. Overcoming loops and bends en route to the heart

The two most common sites of loops are just above the elbow, and at the subclavian artery.

The initial loop around the elbow is usually overcome by using a smaller diameter hydrophilic polymer coated Terumo J guidewire 0.021 or 0.025 inch, followed by withdrawal of the wire, while the catheter is advanced. If this fails, two 0.014 used PTCA wires can be introduced sequentially and the catheter is advanced over the two PTCA wires. The third technique is called the Balloon Assisted Tracking,[8] where a partially inflated PTCA balloon is kept at the tip of the catheter and the balloon and the catheter is advanced simultaneously at the loop.

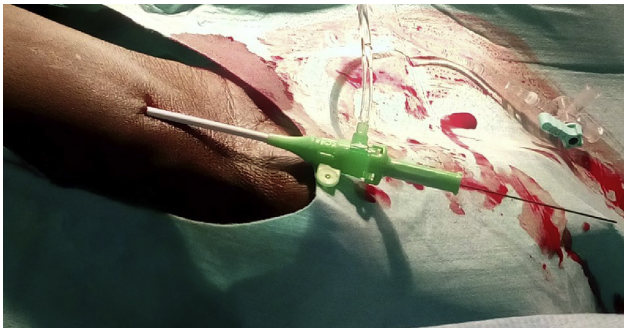

Fig. 9 – The Sheath Dilator Assembly is advanced over the wire in a screwing forward motion and the dilator and wire is removed.

The second loop at the level of subclavian artery can be a simple loop, commonly seen in the elderly or due to severe atherosclerosis, which can be overcome by asking the patient to take a deep breath. The more complex loops like arteria lusoria is overcome by using Terumo 038 J tipped guideire and careful catheter manipulation.

10. Prevention and management of spasm

Radial artery spasm is one of the most frequent complications associated with the femoral route and it occurs in approximately 5–10% of procedures. It can occur either during initial cannulation attempts or during the procedure. Radial artery spasm at the beginning of the procedure can lead to transient loss of radial pulse and change over to femoral access. It is mainly due to multiple puncture attempts with repeated entry with the wire. Anxiety, fear and pain during the procedure are contributory factors. Radial artery spasm during the procedure is more common in women, multiple catheter exchanges, a small radial artery and with use of a larger sheath size compared to the radial artery. Steps to avoid radial artery spasm include adequate sedation of the patient, use of nitroglycerine in the local anesthesia for local infiltration around the artery, radial artery cannulation with minimal attempts and use of nitroglycerin and calcium channel blocker in the anti spasmodic cocktail after cannulation. Selection of a smaller size radial sheath with hydrophilic coating will also prevent radial artery spasm. During procedure, spasm can be avoided using minimal manipulation of the catheter and guidewire and avoiding multiple catheter exchanges. Use of refurbished catheter can also lead to more frequent radial artery spasm. Spasm of the radial artery will result in pain to the patient during catheter manipulation and forceful catheter withdrawal during spasm can lead to avulsion of the radial artery. When spasm is detected during catheter exchanges, an additional bolus of 500–1000 μg of nitroglycerine can be given if the hemodynamics allows and a smaller diameter catheter should be selected to continue the procedure. If there is catheter entrapment due to intense vasospasm, it is advisable to leave the catheter *in situ* and give additional dose of sedation to the patient. Attempts to remove the catheter can be made after 30–60 min and are always successful. Rarely general anesthesia may be required to relieve the spasm and retrieve the entrapped catheter.

11. Post procedure care

Post procedure hemostasis is achieved by using rolled gauze over the puncture site and application of tight compression bandage (Figs. 10 and 11). Alternatively, a transparent band designed for transradial procedures, TR band (Terumo, Tokyo, Japan) can be used for patent hemostasis. Patent hemostasis is achieved by inflating the TR band over a partially withdrawn sheath, then sheath is removed with TR band in place. After removing the sheath, the air in the TR band is expelled, till the bleeding starts and then re-inflated again, just enough to prevent the bleeding. Using a Barbeau test, the patency of radial artery is ensured during the compression by the TR

Fig. 10 – X shaped Elastoplast bandage applied over a gauze roll.

Fig. 11 – Ensure that the Elastoplast bandage does not encircle the wrist and check SpO2 from the fingers to ensure that the ulnar flow is not obstructed.

band. This technique decreases the risk of radial artery occlusion by half.[9]

12. Prevention of loss of pulse

It is important to ensure that the radial artery is available for future cannulation and access. Factors that are more commonly associated with radial artery occlusion include use of large sheath size compared to the radial artery size, inadequate anticoagulation after cannulation, radial artery spasm, multiple cannulation attempts, prolonged duration of compression during hemostasis, compression technique used and delayed sheath removal. A recent study reports that the use of Nitroglycerine injection into the radial artery before sheath removal decreases the radial occlusion.[10]

13. Conclusion

Transradial access has the advantage of patient comfort in terms of early ambulation and shorter hospital stay. Lower risk of local bleeding complications as compared to the transfemoral access has resulted in more and more operators adopting this technique. Attention to the techniques, hardware, pre and post procedure precautions and adjunctive pharmacotherapy can make it safer and universally adaptable technique.

Conflicts of interest

All authors have none to declare.

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