CHAPTER 3

Femoral Arterial Access Considerations: Step-by-Step Troubleshooting, and Tip-and-Tricks

Karim Al-Azizi, MD,[1] Molly Szerlip, MD[1]

[1]Baylor Scott and White The Heart Hospital Plano, Plano, TX

Introduction

Obtaining safe and precise arterial access is the most critical step in starting and successfully completing a cardiac catheterization procedure. The importance of this step serves as a foundation on which the whole procedure will be built upon. As the case unfolds, a simple coronary angiogram may progress to percutaneous intervention, requiring anticoagulation or the need for using large bore access devices as with mechanical circulatory support devices (MCS) or larger diameter sheaths to treat complex coronary disease. Although there has been an increased utilization of radial artery access for coronary angiography and percutaneous coronary intervention, femoral artery access remains extremely important due to several factors. These factors include but are not limited to anatomic variability of the aortic arch, vessel size dictating access for certain procedures [Transcatheter aortic valve replacement (TAVR) or insertion of mechanical circulatory support devices (MCS)], and cannulation of bypass grafts.

Careful and detailed procedural planning that promotes safe techniques and good operator skills are vital for completing this step safely and successfully as well as managing anatomic variables and complications. Careful understanding of a patient's clinical history, especially that pertaining to femoral access, is extremely important. This may include concomitant medical therapy on oral anticoagulation, recent vascular interventions or surgeries, or even clinical claudication pointing towards undiagnosed peripheral vascular disease. Prior procedures and reports of prior difficulties with access should be reviewed and noted.

In an era where imaging has affected our practices drastically, prior computed tomography scans of the abdomen and pelvis that may be on file for any other indication may be of great use. This can be informative prior to catheterization and may help identify anatomical landmarks (femoral artery bifurcation and inferior epigastric artery), artery calcification, stenotic disease and iliac tortuosity. In addition to viewing of prior imaging studies, the use of imaging at the time of access is very useful and important in obtaining safe femoral access. Ultrasound guided femoral artery access has been shown to be safer with reduced risk of complication. [1] This step is also crucial, as it may be the most painful part of the procedure to the patient, which points to the importance of adequate local anesthesia and conscious sedation prior to the arteriotomy and sheath insertion.

Despite careful planning and experience, femoral access can still be difficult and challenging. Here are a few tips and tricks to help guide successful access and a successful procedure.

Tips and tricks to navigate femoral access

A. *Ultrasound guided access: the how*

Ultrasound (US) guided access has been gaining a lot of attention in many cardiac catheterization labs around the world given its advantages. There is a learning curve but once mastered, this requires no additional time and may even shorten the time to access.

1. Apply the probe to the groin above the palpated pulsation. The ultrasound probe should be perpendicular to the course of the femoral artery, and a complete circle should be seen clearly on the screen.

2. Identify the marker on the probe that correlates with the marker on the ultrasound machine screen. This is very important to align both as this is used to direct the needle as it traverses the skin and subcutaneous tissue. The common femoral vein is medial to the artery.
3. The vein is compressible, whereas the artery is usually pulsatile and is not collapsible.
4. Scan the artery by moving the US probe on the skin caudally following the femoral artery course to identify the bifurcation of the femoral artery and the profunda. Then scan upwards until the artery dives deep into the pelvis, which indicates the transition to the external iliac artery. It is important to identify an adequate anterior wall segment free of atherosclerotic disease or calcification, especially if a vascular closure device (VCD) is considered at the end of the procedure. This becomes particularly important when large bore access is needed for TAVR or MCS.
5. Once a desired segment is identified above the bifurcation but below the inguinal ligament and inferior epigastric artery, lidocaine can be applied to the skin and subcutaneous tissue.
6. Depending on the depth of the femoral artery, the needle skin puncture site is adjusted accordingly by puncturing away from the probe at a distance similar to the depth of the artery.
7. The goal is to visualize the needle tip at all times as it traverses the subcutaneous tissue. The ultrasound probe and essentially beam should remain stable and constant. The needle direction should be adjusted in the subcutaneous tissue by pulling out to the skin and redirecting, with the goal of puncturing the anterior arterial wall of the segment visualized on US. Never lose sight of the needle tip. Watch the tip enter the artery.
8. Extreme caution should be practiced NOT to move the probe/left hand as this will result in a different US plane and subsequently a puncture in an undesirable location, increasing the risk of retroperitoneal bleed.

9. Once access is obtained, the probe should remain in place as it is maintaining the track as well as the position of the subcutaneous tissue, until a wire is introduced through the needle and into the vessel. Only then can the probe be removed.

B. Navigating tortuous and diseased iliac arteries

Tortuous and diseased femoral and iliac arteries represent a serious challenge when obtaining femoral access. As critical as access is, the risk of complications increases with the complexity of the femoral and iliac arteries. Preparation is key, and one should understand prior cardiac catheterization experiences and reports that document difficulty of access, tools/techniques used to navigate the difficulty, as well as whether or not a VCD was used.

Tortuous iliac arteries are common in elderly patients. Using peripheral interventional skills, similar tools can be used to navigate difficult iliac arteries to reach the aorta and safely insert the femoral sheath.

1. After obtaining access, evaluate how much of the access wire is in the femoral/iliac vessel.
2. If a micro-puncture was used, angiography can be performed using the inner dilator by hand injection.
3. If the J-wire meets resistance due to tortuosity in the iliacs or stenotic disease, place the micro-puncture sheath and then exchange the J-wire for a soft angled glide wire. It is not recommended to put a glide wire directly through the introducer needle as the hydrophilic coat can be stripped off the wire into the vessel.
4. Once the wire is in the aorta, the micro-sheath can be switched out to a long (25 cm-45cm) femoral sheath inserted over the wire under fluoroscopic visualization. The long sheath is used in this case to bypass all possible resistance points that may interfere with the catheter manipulation.

5. If there is any resistance encountered, stop and reevaluate the possibility of being subintimal or in a dissection plane, especially if there is significant plaque.
6. If the aorta is tortuous a 45-90cm sheath may be needed. This is best placed over a stiff 0.035” guidewire.
7. Once committed to a long femoral sheath, if a VCD is to be used, a long wire will be needed for closure.

C. Access through femoral grafts

Patients may have prior aorto-femoral grafts that may need to be punctured/traversed to obtain access. Ultrasound guidance is of great significance as one may be able to identify the anastomosis site as well as the best possible puncture site. Grafts are variable, and may require different techniques to puncture, traverse and obtain hemostasis at the end of the procedure.

1. Puncturing of a graft is performed using fluoroscopic and ultrasound guidance to avoid high arterial punctures. This will help avoid retroperitoneal bleed and puncturing the native artery.[2] Ultrasound guided access is preferred to obtain access in the graft and to confirm an anterior wall puncture.
2. In an aorto-bifemoral bypass graft, careful attention should be directed towards correctly directing the wire into the graft and aorta. If there is difficulty encountered, use an angled glide wire to traverse the graft.
3. Manipulation within the graft should be kept at a minimum, given the atherosclerotic disease and debris within the graft.
4. Insertion of the sheath into the graft may require multiple serial dilators to traverse the rubbery nature of the graft.
5. A long femoral sheath can be inserted to avoid frequent catheter exchanges through the graft.

6. VCDs are usually not recommended when grafts are accessed. Though this has been described and attempted, manual pressure to obtain hemostasis is usually ideal.

D. Access in obese patients

Obese patients pose a serious challenge in obtaining safe femoral artery access. Using the crease is not reliable as it is usually much lower as compared to the inguinal ligament. Sometimes, there is a protruding part of the abdomen and a significant pannus present. If this is the case, these should be retracted by tape that goes under the abdomen or tape on the upper torso to retract the abdomen. Similarly, a “seatbelt” can be applied which also can be used to retract the protruding abdomen towards the head and tied to the table.

1. After retracting the protruding abdomen, using both fluoroscopic guidance to mark the femoral head, as well US guidance to look for the femoral artery bifurcation, the desired location of the common femoral artery can be identified.
2. It is important to account for the depth of the artery, by allowing a similar distance of the needle from the US probe as explained in the US guided access section.
3. It is important to maintain the same angle and not to change the angle of the needle multiple times within the thick subcutaneous track, as this may cause a “zigzag” track, which may make sheath and VCD devices tracking over a wire difficult.
4. Utilize a long 0.035” wire to help the sheath track over the wire. A stiff long wire is often used to help the sheath track through the excess tissue.
5. If the sheath fails to track, then a 4 French dilator can be used to switch out wires to a stiffer 0.035” wire. In obese patients, it is not uncommon to have the wire “kink” in the subcutaneous

tissue. Stiff long wires and blunt dissection down to the artery with hemostats prior to sheath insertion can help prevent this.

6. If the wire kinks in the subcutaneous tissue, attempts at straightening the wire and pulling the kinked part out of the track may help advance a 4 French dilator into the vessel for wire exchange.

E. Exchanging an intra-ortic balloon pump or closing the site with a VCD

Intra-aortic balloon pumps (IABP) are inserted in patients for different reasons when deemed clinically necessary. Typically, a 7 or 8 French sheath is used. Traditionally, device removal is done followed by manual pressure for at least 30 minutes to achieve hemostasis. Sometimes, an IABP may not be enough, and an upgrade to a different MCS device such as a percutaneous left ventricular assist device (LVAD) may be required. The steps to re-access the femoral artery after explanting the IABP using the same arteriotomy are as follows:

1. Careful cleaning and sterilization to the area where the IABP is inserted is carried out. Operators should be double gloved, so that one pair can be removed after IABP explant. Patients should be administered prophylactic antibiotics (e.g. 2 grams of Cefazolin or 1 gram of Vancomycin).
2. Using scissors, and before draping, the IABP is turned off; the optic wire and gas tubings are cut.
3. After draping, the end of the IABP is exposed. A 180 cm 0.018” guidewire is introduced through the arterial line and visualized under fluoroscopy to confirm cannulation of the IABP (wire exit from the IABP into the aorta).
4. The IABP is slowly pulled to the sheath. Pressure is applied to the groin above the arteriotomy to occlude the vessel. Once resistance is met, the IABP is slowly pulled within the sheath over the wire. The wire is maintained in the aorta under fluoroscopy.

5. While another operator is holding pressure, a sterile drape is placed on top of the explanted balloon pump.
6. An 8 or 9 French sheath is placed over the 0.018” wire and the sheath is flushed.
7. If closure is the goal, a 6 French suture-based closure device or an 8 French collagen-based closure device can be used to close the arteriotomy over a traditional 0.035” wire inserted through the sheath.
8. If the goal is to upgrade to a different MCS like a percutaneous LVAD, angiography through the side arm of the sheath is performed to confirm that the sheath is above the bifurcation.
9. A 0.035” wire is inserted, and serial dilations are performed for MCS sheath and device insertion.

F. Closing arteriotomy when a percutaneous LVAD (e.g. Impella CP) is placed

If a percutaneous LVAD is already inserted, and the goal is to explant and close the site with a VCD rather than achieving hemostasis with prolonged manual pressure, careful consideration should be made with regard to patient body habitus and bail out techniques. The current Impella CP implanted sheath comes with a 0.035” compatible side port. This technique of removal can be carried out at bedside without fluoroscopy.

1. An 0.035” J-wire is inserted into the side port.
2. The Impella device is pulled out of the left ventricle through the sheath. The device then is turned off.
3. The device is pulled until resistance is felt, which indicates that the device is retracted to the sheath.
4. Another operator can apply pressure above the site of the arteriotomy. One should make sure prior to removal that there is enough wire in the aorta.

5. The sheath and Impella device are carefully removed over the 0.035" wire.
6. A perclose device is inserted while maintaining pressure above the arteriotomy site.
7. Once in the vessel, the perclose is deployed in the 11'o clock position. Careful tactile feel should be carried out to confirm the deployment is in the anterior wall of the vessel.
8. Rewire the vessel through the first perclose device with the same 0.035" wire, while keeping the device sutures on one side with hemostats.
9. Another perclose device is then inserted and deployed at the 1 o'clock position on the vessel.
10. Rewire the vessel.
11. Slowly push down both knots of both perclose devices and assess the degree of bleeding.
12. Bailout considerations for continued bleeding include an additional perclose or one 8 French angioseal on top of two percloses, knowing that access to the vessel will be lost.
13. Do not attempt to deploy more than 3 perclose devices.
14. Do not attempt to deploy an 8 French angioseal if there was no slowing down of bleeding achieved by the first or second perclose, as it will not hold in place given its smaller size.
15. If all fails, manual pressure is applied until hemostasis is achieved.

G. Closing large bore arteriotomy with a "dry closure technique"

This technique is designed to ensure a bloodless field while closing large arteriotomies. This technique requires fluoroscopy.

1. Access is obtained on the contralateral femoral side.
2. An iliac cross over catheter is used to engage the distal aortic bifurcation.
3. A glidewire is used to wire the contralateral iliac into the femoral artery.
4. Introduce the catheter further beyond the arteriotomy, into the SFA if possible.
5. Switch the glidewire for an 0.035" guidewire.

6. Deliver an 0.035-compatible peripheral balloon, sized 1:1 to the external iliac artery.
7. Inflate the balloon to occlude the vessel prior to large bore sheath/device removal.
8. Follow the steps discussed above in closing the arteriotomy with a VCD.
9. This technique eliminates the need for the unpredictable manual pressure holding while removing the large bore access sheath and inserting VCDs, which can be at times confusing and not well controlled.
10. Once removed, the balloon is brought down slowly to assess for bleeding at the site.
11. If bleeding continues despite applying VCDs, then the balloon may be introduced at the site of the arteriotomy and inflated to allow for hemostasis.

H. Use of venous "figure of 8" stitch for large-bore venous access closure

Venous access is commonly obtained for various procedures such as a right heart catheterization or trans-septal structural heart interventions. A VCD such as the perclose device has been used to pre-close the venotomies. However, due to the very fragile and thin vessel wall, as well as the low pressure nature of the venous system, manual pressure may be enough to achieve hemostasis. Here, we describe a technique that is commonly used to apply pressure at the site of the venous puncture to achieve hemostasis without applying manual pressure.

1. Using an 0 silk suture or an 0 ethylbond suture with a curved needle, a deep subcutaneous stitch is placed from the medial to lateral aspect of the body on a plane just inferior to the sheath. Once the needle exits the skin, this same suture is placed on a plane superior to the sheath moving from medial to the lateral aspect of the body. This creates a "figure of 8" stitch.
2. Skin bites should be deep enough to involve subcutaneous tissue but not very deep to cause vascular injury

3. Cut the needle off the end of the suture.
4. The first part of the knot is thrown.
5. Remove the sheath and throw the second half of the knot to “lock” it.
6. Additional knots are performed to reinforce the closure. Leave the strings long as a reminder to cut the suture after hemostasis is achieved.
7. The suture may be released in 2 hours.

Conclusion

In conclusion, vascular access is the Achilles heel of any cardiovascular procedure. If enough time is taken to carefully obtain vascular access, vascular complications can be avoided. The same applies to closure. These are a few tips and tricks to help have successful closures no matter the type of access.

References:

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