

The Use of Ultrasound Guidance for Targeted Femoral Access

This technique has gained popularity due to its ability to mitigate the risk of complications.

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Safe and successful retrograde cannulation of the common femoral artery remains the most fundamental step in most interventional cardiology procedures. However, practicing cardiologists and trainees have noted a growing trend in the use of radial artery catheterization.¹ Despite the adoption of radial artery catheterization, familiarity and comfort with safe and accurate femoral artery cannulation cannot be undervalued. Factors such as high-risk interventional procedures requiring mechanical hemodynamic support, the need for large-bore arterial sheaths, and operator preference will continue to require the use of retrograde femoral artery cannulation for coronary, structural, and peripheral interventions.

In the past, the main appeal for supplanting femoral artery catheterization with the radial approach was reduced vascular access site complications noted in several randomized data sets.²⁻⁵ Even trainees are noted to successfully adopt radial artery catheterization over the course of an academic year at the expense of some increased procedural time and radiation exposure but with the benefit of reduced vascular complications.⁶ The incidence of major and minor vascular complications after accessing the radial artery versus the femoral artery ranges from 0.05% to 3.1% versus 2.1% to 10.3%, respectively.^{2-4,7}

Many of the noted risks/complications of femoral artery cannulation occur with the traditional method of utilizing anatomical landmarks, fluoroscopy, and palpation to achieve femoral access. There have been many investigations reporting the reduced rates of vascular access complications and improved first-pass success rates with the skillful use of ultrasound-guided femoral access.⁸⁻¹¹ In this article, we focus on the technical aspects of successfully gaining ultrasound-guided access to the common femoral artery. The traditional and ultrasound-

guided access methods do not have to be mutually exclusive, and a hybrid approach often works best.

BASIC ANATOMIC REVIEW

The common femoral artery is defined by the inferior epigastric artery proximally and the common femoral artery bifurcation (into the superficial femoral artery and the profunda femoris) more distally. In a reported 80% of patients referred for cardiac catheterization, the common femoral artery bifurcation occurs below the femoral head.¹¹ The superior edge of the common femoral artery can be defined by the inguinal ligament, which is identified by drawing an imaginary line from the iliac crest to the symphysis pubis. An arteriotomy above this imaginary line increases the patient's risk for catastrophic retroperitoneal bleeds, whereas access well below the femoral head increases the risk of arteriovenous fistulas, as the artery and vein often override each other.¹² An important fact is that despite our understanding of the femoral anatomy and its relationship to surrounding structures, a considerable amount of variability occurs in the takeoff of the inferior epigastric artery, location of the common femoral artery bifurcation, and relationship to the femoral vein. Collectively, this variability may account for a substantial proportion of nontargeted common femoral artery punctures and their associated complications.

STEP-BY-STEP TARGETED FEMORAL ARTERY CANNULATION USING ULTRASOUND-GUIDED ACCESS

Review Previous Angiographic Films

Previous femoral access angiograms can be invaluable when planning femoral artery cannulation for an upcoming procedure. Knowledge of a high common femoral artery bifurcation or a low inferior epigastric artery takeoff can help the interventionist to plan the arteri-

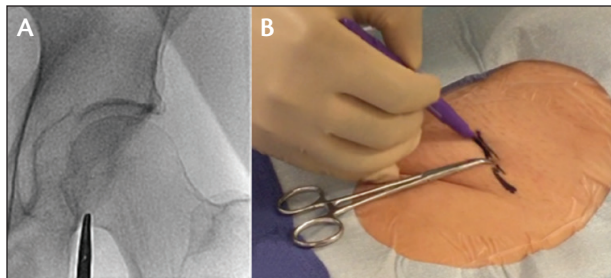


Figure 1. With the use of fluoroscopic guidance, the mid-lower femoral head is identified using a radiopaque object, such as curved Kelly hemostatic forceps (A). Once the site is identified, we then use a surgical marker to create a skin mark that is transverse to the direction of the femoral artery (B).

otomy site. Alternatively, knowledge of significant vessel calcification or high atherosclerotic burden may guide the operator to use the contralateral femoral artery or proceed with radial catheterization instead.

Identifying the Mid-Lower Femoral Head

With the use of anatomic landmarks (ie, the iliac crest and pubic symphysis), the trajectory of the inguinal ligament can be identified. It is possible to generally palpate the femoral artery several finger breadths below the mid-point of the inguinal ligament at the presumed mid-femoral head. In many nonobese patients, this location may be at the site of the inguinal crease. However, in many patients, the inguinal crease is often several centimeters from the actual location of the mid-femoral head.¹³ As such, the inguinal crease is not a reliable landmark, and our practice is to always use fluoroscopy to help aid in locating the lower femoral head, regardless of body habitus. Once the femoral artery is palpated at the presumed site of the mid-lower femoral head, we then place a radiopaque object (eg, curved Kelly hemostatic forceps) at that location, followed by fluoroscopic confirmation in the anteroposterior projection (Figure 1A). If needed, the Kelly forceps are then moved to the mid-lower femoral head.

Use of Ultrasound to Define Common Femoral Artery Anatomy

At the location of the Kelly forceps tip, we use a sterile skin marker (often provided in all cath lab kits) to mark the skin in a transverse axis in relation to the longitudinal orientation of the common femoral artery (Figure 1B). This mark now corresponds to the level at which the arteriotomy should occur if the common femoral artery bifurcation is well below the lower femoral head. However, to confirm this, we then place the linear ultrasound probe (which has been covered with a disposable

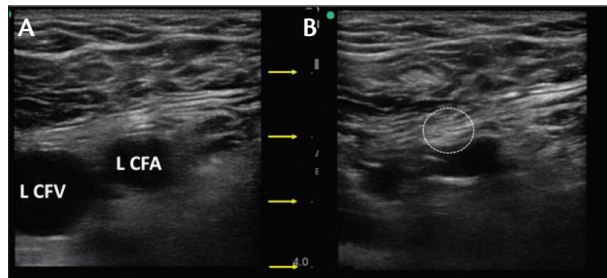


Figure 2. Once the ultrasound probe is placed at the marked site, the vessels are viewed in the appropriate anatomic orientation (A). Also noted are the depth markers (yellow arrows) indicating the skin-to-artery depth; in this case, approximately 2 cm. The needle then enters the skin 2 cm distal to the ultrasound probe at a 45° orientation. In this case, 2 to 3 mL (dashed circle) of lidocaine is delivered just above the arteriotomy site (B). L CFA = left common femoral artery; L CFV = left common femoral vein.

sterile sleeve) with the lateral marker of the probe corresponding to the left of the ultrasound screen. This step allows the operator to view the artery and its surrounding structures in the appropriate anatomic position, regardless of whether the left or right common femoral arteries are accessed.

The probe is first placed at the site of the skin marked earlier, with the femoral artery in transverse orientation. The common femoral artery is centered on the screen, and the probe is swept caudal and cephalad to identify important structures, such as the inferior epigastric artery and the common femoral artery bifurcation, and to identify a potential site of arteriotomy devoid of significant anterior wall atherosclerotic disease. If the common femoral artery bifurcation occurs well below the lower femoral head, we then move back to the skin site that was originally marked and prepare for femoral access. If a high bifurcation is encountered, the probe is swept more caudally until the common femoral artery is visualized. In the latter case, the arteriotomy will be higher and may be even close to the upper femoral head where precision of the arteriotomy becomes ever more important.

The advantage of ultrasound to identify diseased segments of the common femoral artery cannot be understated. The presence of atherosclerotic calcific plaque or adherent thrombus will lead to suboptimal access. Calcified plaque can lead to difficulty in advancing larger sheaths. Additionally, noncalcified plaque may be unstable and dislodge during multiple exchanges, leading to an embolic complication. Hence, being able to scan the common femoral artery for relatively disease-free segments for arteriotomy is a major advantage of ultrasound-guided common femoral artery access.

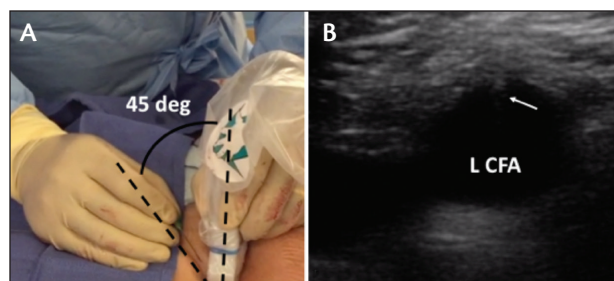


Figure 3. Orientation of the probe to the artery is critical in ultrasound-guided femoral access. If the needle enters the skin at the same distance from the probe as the probe is to the artery (skin to artery), a 45° trajectory of needle advancement (A) will allow you to directly visualize the needle tenting/entering the artery (arrow) (B). L CFA = left common femoral artery.

Local Anesthetic and the Importance of Needle Trajectory

With the ultrasound probe on the skin, the targeted area of the femoral artery is centered on the screen (Figure 2A). We then inject 2 to 3 mL of subcutaneous lidocaine with a 25-gauge needle, creating an intradermal wheal. We then advance a 22-gauge needle at a 45° trajectory to just above the arteriotomy site, an additional 2 to 3 mL of lidocaine is delivered in this area, and the needle is withdrawn (Figure 2B). The trajectory of this needle (and ultimately, the access needle) is critical. The location of skin entry is determined by the depth of the artery (ie, skin-artery depth) from the ultrasound probe. Depth markers are readily visible on all ultrasound screens (Figure 2A). Once the depth is noted, the skin entry site should be the same distance from the probe on the skin. At a 45° trajectory, the needle should then advance directly to the anterior surface of the artery. After delivery of lidocaine to the arteriotomy site, we are now ready for femoral artery cannulation.

Ultrasound-Guided Cannulation

We next advance the access needle (standard access needle or micropuncture needle) in the same trajectory as our lidocaine needle (Figure 3A). Traditionally, this needle is a bevel-tipped 18- or 19-gauge hollow needle that is compatible with a 0.035-inch guidewire. The needle is advanced until tenting of the anterior arterial wall can be seen on the ultrasound screen (Figure 3B). Tenting identifies the exact site of needle entry. It is extremely important to recognize the needle tip as it traverses the front wall of the femoral artery. Operator diligence during this part of the procedure will prevent blind punctures based on tissue motion, which leads to a nontargeted puncture.

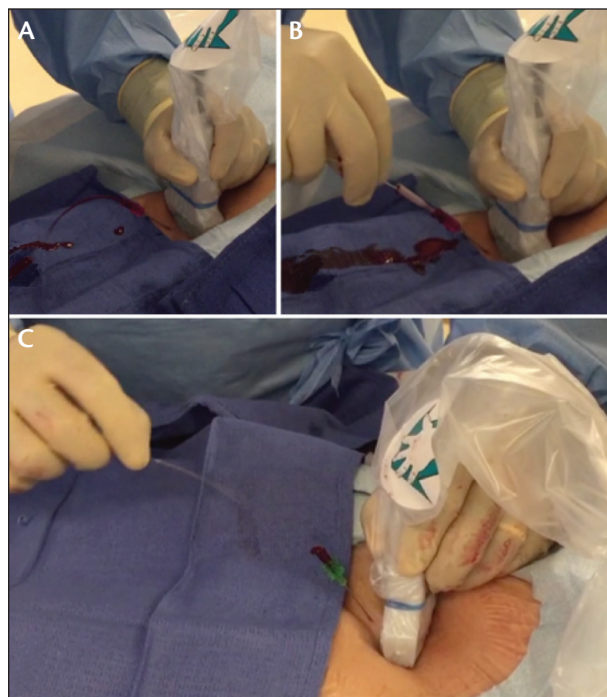


Figure 4. Once the standard (18- or 19-gauge) hollow, bevel-tipped needle enters the artery, pulsatile blood will be seen. It is important to maintain the same amount of downward pressure on the probe (A) while the wire is advanced (B). If a 21-gauge micropuncture needle is utilized (C), a slow “dribble” is noted.

Once the tent location is confirmed, gentle forward pressure is applied, and the needle should enter the vessel with pulsatile blood seen from the external lumen of the needle (Figure 4A). At this point, it is important to maintain the same amount of pressure on the ultrasound probe with the left hand while the right hand is holding the needle steady (more advanced users can leave the needle in place and use their right hand to advance the 0.035-inch guidewire; Figure 4B). When first starting to perform ultrasound-guided access, we recommend the use of a second operator or assistant to feed the 0.035-inch guidewire through the needle and into the femoral artery while the primary operator is still holding the ultrasound probe and the needle with their left and right hands, respectively. Once the wire is safely within the iliac system, the ultrasound probe can be placed aside.

If appropriate tenting or tissue motion is not noted despite advancing the needle close to the same distance as the skin-artery depth, the trajectory of the needle is off-axis, and adjustments are needed. In this case, it is better to withdraw the needle altogether and start over. If tissue motion is noted, the ultrasound

probe can be tilted either caudal or cephalad to identify tenting. This maneuver allows visualization of the arteriotomy site, but the operator must remember that the target site has now moved. This can be a potential hazard of ultrasound-guided access, as it is easy to “creep” higher or lower along the artery and end up puncturing at a site distant from the intended target. Integrating ultrasound access with surface landmarks is a skill that requires practice.

Sheath Insertion and Angiography

At this point, the location of the arteriotomy and the presence of the distal wire within the iliac system are confirmed by fluoroscopy (Figure 5A). After appropriate positioning is confirmed, a dermatotomy (ie, skin nick) is created over the needle with a surgical blade. The size of the dermatotomy is based on the ultimate access sheath to be placed. The needle is then removed, and a side arm sheath is inserted into place and flushed appropriately. Iliofemoral angiography is then routinely performed at our institution to confirm not only the location of arteriotomy, but also to evaluate for access-related complications (Figure 5B).

ADVANCED SCENARIOS

Use of a Micropuncture Needle

In most patients, the use of a standard cannulation needle (previously discussed) and a J-tipped, 0.035-inch wire is sufficient for achieving common femoral artery access. However, an alternative could be the use of a micropuncture system (21-gauge hollow access needle, 0.018-inch guidewire, and 4- or 5-F microcatheter for femoral artery access). For this scenario, the same steps are used as previously described in this article. However, once it comes time for femoral artery cannulation, a micropuncture needle is utilized.

Once cannulation is achieved, the blood return is not pulsatile, but rather a slow “dribble” (Figure 4C). Immediately after advancement of the wire, we then perform fluoroscopy to evaluate the arteriotomy location and also to assess the course of the guidewire. The micropuncture guidewire does not have a J-tip and has the tendency to navigate into smaller branches off of the common femoral artery, such as the lateral femoral circumflex artery. If the course is not confirmed and corrected before converting to a 0.035-inch wire (and ultimately, insertion of the sheath), substantial vessel injury and/or perforation can occur.

Once the appropriate position of the micropuncture wire is confirmed, the needle is removed, and the 4- or 5-F microcatheter is inserted. The microwire is removed, and a standard 0.035-inch, J-tipped wire is

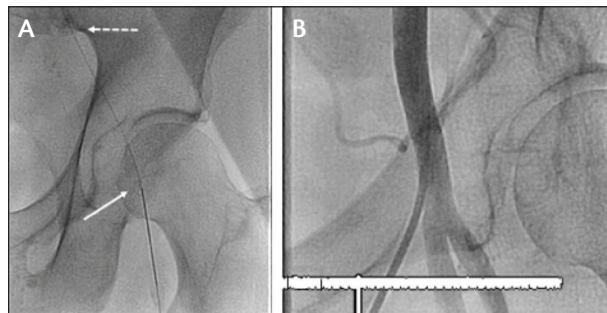


Figure 5. After the wire has successfully advanced, a fluoroscopic image is obtained to confirm the location of the arteriotomy site (A, solid arrow) and also that the wire has navigated into the iliac artery (A, dashed arrow). Femoral angiography (B) confirms the arteriotomy at the mid-femoral head without any vessel injury or contrast extravasation.

then advanced into the iliac system. The microcatheter is removed, and the side arm sheath is inserted, followed by iliofemoral angiography for the previously indicated reasons.

Obese Patients

Obese patients are the most difficult to achieve targeted femoral artery cannulation because the distance from the skin to the femoral artery can be quite substantial. Such patients are at substantial risk for access site–related complications. If targeted femoral access is needed for specialized cases, there are many modifications that can be utilized to achieve targeted femoral access. Hence, ultrasound-guided access is routinely used for obese patients, with the following additional adjunctive steps.

Step 1. First, we always mark the lowest edge of the femoral head on the skin, as assessed by the Kelly forceps tip and fluoroscopy (previously described).

Step 2. With the ultrasound probe in the operator’s left hand, a significant amount of downward pressure is applied to the skin to visualize the femoral artery and to minimize the skin-to-femoral artery distance. Once the femoral artery is visualized, it is important not to move the left hand nor to deviate from the pressure being applied on the skin.

Step 3. We generally do not use the micropuncture system for obese patients because the microwire generally lacks the strength required to advance the microcatheters through the significant subcutaneous tissue and into the vessel. Additionally, the microcatheter may not be long enough to reach the arteriotomy site, despite the pressure applied to reduce the skin-to-artery distance.

Step 4. We use the standard needle (and sometimes even a 9-cm-long, 18-gauge needle) and a regular 0.035-inch, 180-cm wire rather than the 0.035-inch, 20-cm wire provided in the side arm sheath kits.

Step 5. It is important to maintain the same amount of pressure with the probe in the left hand while the wire is advanced. If the pressure being applied by the left hand and the ultrasound probe is released before the wire enters the vessel, the skin and artery will move up, resulting in posterior wall puncture or subintimal puncture. Therefore, for femoral access in obese patients, the presence of two operators (or an operator and assistant) is obligatory during access. One person can feed the long 0.035-inch wire while the other maintains pressure with the ultrasound probe in the left hand and holds the access needle steady with the right hand.

Step 6. Once the femoral artery has been accessed and the wire is advanced, it is important to put the ultrasound probe down and keep pressure on the groin over the arteriotomy site with the left hand. Prolonged release of pressure before the sheath is inserted may allow a small hematoma to form, making advancement of the sheath more challenging. We keep steady downward pressure with the left hand while the side arm sheath is advanced. The steady downward pressure keeps the skin-to-artery distance relatively short and the wire in a straight rail.

Step 7. If the sheath cannot be advanced despite these measures, but a standard 0.035-inch wire is in place within the iliac system, it is possible that a wire with more stiffness is needed to maintain the rail. In this case, a longer and much smaller French dilator (eg, 4-F dilator) is often required to track over the wire and into the artery. With significant downward force over the groin, the preexisting wire is removed, and a stiff wire (eg, Amplatz Super Stiff, Boston Scientific Corporation) is advanced into the body. The smaller dilator is then removed, and the desired sheath can then be advanced. The key remains not to release the downward pressure applied with the left hand.

Step 8. We also generally do not use standard-length side arm sheaths for obese individuals. We tend to use 25- to 35-cm-long sheaths in such cases, so that the sheath remains secure throughout the entire case and the operators are not preoccupied with the sheath being inadvertently pulled during catheter exchanges.

CONCLUSION

In an era of expanding radial catheterizations, retrograde common femoral artery catheterization remains an important tool for interventional cardiologists. Over the decades, the risk of complications noted since the first description of femoral cannulation has decreased, but has not disappeared. The use of ultrasound-guided femoral access is gaining popularity to mitigate the remaining risk of these complications. Hence, understanding and developing the proper technique for ultrasound-guided femoral access is paramount for practicing interventionists and trainees. ■

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