Catheter Drainage: Seldinger Technique

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[A]n object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

—Newton's First Law of Motion

Long and curvy, bad. Short and straight, good.

—George Zaleski's advice on catheter insertion

Catheter drainage is among the most fundamental procedures in interventional radiology. Whether you enjoy this procedure or not, there is no disputing the fact that it may be the single most successful and long-lived procedure we perform. When we treat an abscess, we expect to *cure* the patient. Compare that to stenting a superficial femoral artery or inserting a transjugular intrahepatic portosystemic shunt or declotting a dialysis graft. Nearly all nonvascular visceral interventions from nephrostomy to biliary drainage are variations of abscess drainage. Most fluid collections are treated percutaneously using either the trocar method or the Seldinger technique. For the purposes of this article, the discussion will be limited to the Seldinger technique of drainage catheter insertion. However, the trocar method should not be forgotten and presents a viable and arguably better option for many collections, particularly large ones located superficially.

PROCEDURE

Planning Path

The collection is evaluated using computed tomography (CT) and the safest, most direct course is chosen. Either CT or ultrasound and fluoroscopic guidance are used to monitor the procedure.

Puncture

After subcutaneous lidocaine is administered, a 2- to 3-mm skin nick is made at the intended drainage site.

The collection is punctured using a 21-gauge needle (Fig. 1A)—I often attach the needle to the syringe containing lidocaine to anesthetize the deeper tissues. I typically use the needle from the Accustick II set (Boston Scientific, Natick, MA). A fine needle of this diameter provides a large margin for error as it can be passed through most structures without adverse sequela. Needle position should be confirmed by either aspirating contents of the collection or by direct visualization using CT or contrast injection under fluoroscopy. If contrast is injected, it is important not to overdilate the collection as this can reflux bacteria into the blood and cause sepsis.

Wire Purchase

Next, a 0.018-inch guide wire is advanced into the collection and coiled (Fig. 1B). The needle is exchanged over this guide wire for coaxial 4- and 6-F dilators included in the Accustick kit (Fig. 1C). The 4-F dilator has an inner metal cannula that strengthens the dilators and allows the set to be easily advanced into most collections. The inner 4-F dilator and metal cannula are removed (Fig. 1D) and the 0.018-inch wire is exchanged for a 0.035-inch wire via the 6-F dilator (Fig. 1E). In smaller collections, I begin with a soft wire such as a Bentson (Boston Scientific, Natick, MA) and attempt to coil as much as possible into the collection. I then exchange the dilator for a 5-F end hole catheter (e.g., Kumpe; Boston Scientific, Natick, MA) and coil as much of the catheter and guide wire in the collection as possible. The Bentson guide wire is then

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Figure 1 Abscess drainage. (A) The collection is punctured using a 21-gauge needle. (B) A 0.018-inch guide wire is coiled into the collection. (C) Coaxial 4- and 6-F dilators are advanced over the wire into the collection. (D) The 4-F dilator is removed.

exchanged for a more rigid guide wire (e.g., Amplatz Superstiff; Boston Scientific, Natick, MA) via the 5-F catheter. In larger collections, I skip the step with the small guide wire and instead coil the rigid wire into the collection.

Serial Dilatation

The tract is then serially dilated to a size 1-F larger than intended drainage catheter (Fig. 1F). For example, if an 8-F catheter is being inserted, 7- and 9-F dilators are

chosen. It is critical to keep the wire pinned in position when dilating the tract, especially if the tract is not straight.

Catheter Insertion

The catheter is advanced over the wire into the abscess. When the tip of the catheter enters the collection, the catheter is unlocked from the inner stiffener and advanced over the wire into the fluid. The wire is then removed and the catheter is locked in position (Fig. 1G).

Figure 1 (continued) (E) The 0.018-inch wire is exchanged for a 0.035-inch wire. (F) Serial dilatation is performed over a rigid 0.035-inch wire. (G) The catheter is inserted over the rigid wire.

Remember to keep the wire pinned down in position and monitor this step when possible using fluoroscopy.

DISCUSSION

To further illustrate the procedure, it is helpful to analyze what can go wrong. In my experience, the most significant common error in catheter placement involves catheter malposition adjacent to the target. This usually occurs in deeper or smaller collections and is caused by guide wire kinking or bending. The error in placement usually occurs during the final steps of catheter insertion as the tube is advanced with an inner

stiffener over a guide wire into the collection. A “proximal curve” or “kink” in the guide wire can be disastrous at this stage (Fig. 2A). When the leading end of the catheter reaches the kink, the tube may change direction away from intended target. Instead of following the course of the wire into the collection, it may be diverted alongside the abscess (Fig. 2B). The guide wire is simultaneously pulled out of the collection. Recall that the distal end of the guide wire is not fixed (Fig. 2C). If the procedure is monitored fluoroscopically, the error is typically recognized prior to final catheter deployment. However, for procedures without real-time guidance (e.g., CT guidance in abscess drain placement), the

Figure 2 Abscess catheter malposition. (A) The path to the abscess is curved and there is a kink in the wire. (B) The dilator is advanced in a straight line and rather than negotiating the curve, it travels alongside the collection. (C) The dilator continues on its course and begins to pull the guide wire out of the collection. (D) The catheter is inserted adjacent to the collection rather than in the collection.

radiologist may not recognize that the wire is being pulled out of the desired target, leading to catheter malposition (Fig. 2D). The more acute the proximal curve, the more likely this is to occur—in cases with two loops in a “Z” configuration, it can be impossible to maintain access when attempting to insert the catheter.

What are the techniques that can be used to minimize this complication? First, choose the safest, shortest, and most direct path to the desired target. Needles should not change directions significantly after insertion. Second, after gaining access, use a rigid guide wire (e.g., Superstiff Amplatz) to facilitate passage of

larger catheters and dilators. The stiff wire serves two purposes: it “straightens” out the course of the access and blunts any sharp turns, allowing larger catheters to pass over it without kinking. The wire must be held steady while the catheter is advanced, especially around a curve. Otherwise both may advance in an unwanted direction. Third, advance as much wire as possible into the collection to gain the best “purchase.” This helps to prevent the wire from being pulled out of the collection. Fourth, sequentially dilate the tract. This step is intended to make the desired path, the one of least resistance. Dilators have a long tapered end to facilitate

the transition between tissue planes and are relatively short and rigid, allowing them to track through tissue better than blunt-nosed catheters. Finally, in some cases, it is helpful to use a peel-away sheath to limit the friction of the catheter as it passes through the soft tissues on the way to the intended target. Also remember that an incision site on the skin needs to be large enough so the catheter is not compressed longitudinally like an accordion.

I have a few other preferences for fluid drainage:

- Collection size. For collections 3 cm or smaller, I will aspirate the fluid but not place a catheter. For all larger collections, I will insert a catheter. I use an 8-F catheter for most simple collections and 10-F or larger for complex collections or pancreatic abscesses.
- Shape. Occasionally, for superficial, elongated collections, I will insert a biliary drainage catheter to take advantage of the additional side holes along the length of the tube.
- Urgent drainage. I will drain any infected fluid collection on a weekend day when appropriate but rarely at night unless the patient is actively septic.
- Guidance modality. I prefer real-time sonographic guidance rather than CT guidance for any collection that can be easily visualized. I use CT if access is tricky or the collection is surrounded by vital structures.
- Pelvic abscesses. I prefer endorectal or endovaginal drainage over transgluteal drainage except in children because I believe it is more comfortable for the patient and associated with fewer bleeding complications.
- Catheter care. Our interventional radiology service rounds on catheters daily and will remove tubes with no further imaging if signs and symptoms abate after several days to 1 week and when drain output is less than 10 mL per day. If there is any question regarding complete drainage, a follow-up CT scan is obtained.
- Complex collections/thrombolytic infusion. For complex, poorly draining collections, I will inject a dilute solution of tissue plasminogen activator (tPA) into the collection and allow it to dwell for several hours in an attempt to improve drainage. Our protocol is to mix 4 to 6 mg of tPA into 20 to 40 mL normal saline solution, which is then infused through the drainage catheter. The catheter is capped and the patient is encouraged to roll in bed or move around if possible. After 4 hours, the catheter is uncapped and is put to bulb suction.
- Portable drainage. I do not routinely perform bedside drainage.
- Seldinger versus trocar methods. I believe the choice of Seldinger versus trocar drainage is mostly a matter of personal preference. I typically use the Seldinger technique except for very large, superficial collections and endocavitary drainage.