Unconventional Central Access: Catheter Insertion in Collateral or in Recanalized Veins

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ABSTRACT

Catheter hemodialysis is an unfortunate but necessary option for patients with end-stage kidneys. Patients on chronic catheter hemodialysis often slowly exhaust veins in the neck and chest, necessitating use of unconventional veins such as the femoral veins, translumbar inferior vena cava, hepatic veins, or recanalized or collateral veins. Recanalized or collateral veins are an attractive option because using these veins preserves the limited remaining access sites. Patients favor this approach because catheter care is simplified; catheters inserted in these veins appear identical to catheters inserted in the internal or external jugular veins.

KEYWORDS: Catheter hemodialysis, collateral veins, recanalized veins, central venous access

Objectives: Upon completion of this article, the reader should be able to (1) summarize the access options for patients with thrombosed internal and external jugular veins, (2) describe the technique of retrograde recanalization for insertion of catheters into neck and chest veins.

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Catheter hemodialysis is the least desirable and often the last option for patients with end-stage renal disease. The internal and external jugular veins are generally considered the best choice for access.¹ Unfortunately, prolonged catheterization commonly leads to venous thrombosis and occlusion. If this occurs, there is no consensus about which is the next best access site. Choices include the subclavian veins, femoral veins, translumbar inferior vena cava, hepatic veins, and recanalized or collateral neck and chest veins (Table 1). This article briefly outlines unconventional catheter access

sites and provides a more detailed discussion of the retrograde technique for recanalization of occluded veins or catheterization of collateral veins suitable for dialysis catheter access.

SUBCLAVIAN VEINS

Subclavian veins are commonly used for central venous access and are often the veins of choice for physicians who insert catheters using anatomic landmarks rather

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Table 1 Thrombosis and Infection Rates in Various Access Sites

Access Site	Thrombosis Rate per 100 Catheter-Days	Infection Rate per 100 Catheter-Days
Right internal jugular vein ⁷	0.22	0.08
Recanalized or collateral vein ⁶	0.67	0.06
Femoral vein ²	1.39	0.24
Inferior vena cava ³	0.33	0.28
Hepatic vein ⁵	2.40	0.22

than ultrasound and fluoroscopy. In the dialysis population, the subclavian veins should be used only in patients who are not candidates for ipsilateral upper extremity graft or fistula creation because venipuncture and an indwelling catheter predisposes to central stenosis and occlusion.¹ Iatrogenic central venous lesions can render the extremity unfit for shunt creation. Notably, such lesions might be asymptomatic until a shunt is created. Increased flow into the arm veins then leads to swelling or shunt thrombosis.

FEMORAL VEINS

Femoral veins are a reasonable choice for long-term catheterization because they are easily accessed and provide adequate flow for dialysis. Zaleski et al² reported a 3-year experience with 41 tunneled femoral vein catheters in 21 patients. Catheters ranged in length from 40 to 60 cm and were tunneled to the lateral thigh. Tips were positioned immediately above the iliac bifurcation, at the mid inferior vena cava, or at the junction of the cava and right atrium. The 30-, 60-, and 180-day primary patency rates in this series were 78, 71, and 55%, respectively. The 30-, 60-, and 180-day secondary patency rates were 95, 83, and 61%, respectively. Average time of function per intervention was 61 days. Infections requiring catheter removal occurred at a rate of 2.4 per 1000 catheter-days. One episode of partial inferior vena cava (IVC) thrombosis occurred after a catheter infection developed 78 days after initial catheter placement. No episodes of symptomatic pulmonary embolism occurred. The authors concluded that femoral vein catheters require more frequent interventions than do thoracic catheters and are more susceptible to infection. However, in patients with difficult central venous access, the common femoral vein might be successfully used for permanent tunneled hemodialysis access.

TRANSLUMBAR INFERIOR VENA CAVA

The translumbar inferior vena cava is frequently used as the site of choice once thoracic veins have been exhausted. Lund et al³ reported 17 double-lumen hemodialysis catheters in 12 patients. Seven episodes of

thrombosis-related access failure occurred (0.33 episodes/100 days at risk). Six episodes of infection occurred (0.28 episodes/100 days at risk), with four requiring catheter removal. Two catheters were removed after defects developed in the catheter. Cumulative patency was 52% at 6 months and 17% at 12 months. Biswal et al⁴ reported insertion of 23 catheters in 10 patients. Catheters were in place for a total of 2252 catheter-days. The average duration of catheter placement was 250 days (range, 30 to 580 days) and all catheters were functioning up to the time the study was completed or the patient died. The most common complication was partial dislodgment of the catheter in 3 of 23 catheters (13%), all occurring in obese patients. One episode of retroperitoneal hemorrhage occurred but there were no episodes of infection or IVC thrombosis.

HEPATIC VEINS

The hepatic veins are generally used as a last resort and very little data are available regarding long-term patency and complication rates. Stavropoulos et al⁵ recently reported a study of 36 transhepatic dialysis catheters in 12 patients. The mean time of the catheters in situ was 24.3 days. The catheter thrombosis rate was 2.4 per 100 catheter-days and the line sepsis rate was 0.22 per 100 catheter-days. Poor patency rates were seen because of a high rate of late thrombosis. The authors concluded that transhepatic dialysis catheters should only be used as a last resort unless limitations of catheter thrombosis can be overcome.

RECANALIZED OR COLLATERAL VEINS

Catheter insertion via small collateral veins or recanalized neck and chest veins is an attractive option. Catheters placed into these veins capitalize on the fact that the path to the lower superior vena cava or upper right atrium is relatively unimportant in terms of catheter function as long as it is relatively straight (Fig. 1). Catheters inserted into these unconventional sites function and appear identical to catheters placed in larger, conventional veins. Care and maintenance is identical; anyone unfamiliar with the patient will rarely recognize that the indwelling catheter is not in the internal or external jugular veins because the catheter exits the subcutaneous tunnel in a conventional location on the chest. The most compelling reason for using these veins is that by doing so, other access sites are preserved for future use.

ANTEGRADE RECANALIZATION

The first choice in venous recanalization concerns the planned approach: retrograde (usually from a femoral vein access) or antegrade. Short segment occlusions in larger veins such as the internal jugular and external

Figure 1 Dialysis catheter deployment into collateral neck vein. (A) Initial superior vena cavagram from a femoral vein puncture shows occlusion of the upper superior vena cava. (B) Venogram shows catheterization of small thyrocervical neck vein. (C) Fluoroscopic image shows 21-gauge needle advanced through opened loop snare. (D) Fluoroscopic image shows guide wire in femoral vein sheath after being captured by loop snare.

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Figure 1 (continued) (E) Final fluoroscopic image shows deployed catheter.

jugular vein are best approached from a direct antegrade approach. The shorter distance to the occlusion and straighter path affords mechanical advantage, facilitating lesion traversal. Typically, a guiding catheter or sheath is not required. These lesions can be approached with a short 5-French catheter (e.g., Kumpe catheter) and a stiff hydrophilic guide wire. In the author's opinion, there is little science involved in crossing venous occlusions. Generally, the author probes the lesion with both the catheter and wire, often spinning the wire between my fingers. Persistence is the key but setting an upper time limit is also practical (15 to 20 minutes is a reasonable upper limit unless slow and steady progress is being made). It is important to perform frequent injections of contrast using fluoroscopy because vein perforation is not uncommon.

If the lesion is successfully negotiated, balloon dilatation to at least 6 mm is helpful for subsequent catheter passage. Inserting the dialysis catheter over a stiff hydrophilic wire is also recommended, particularly for longer occlusions because the underlying lesion might continue to partially obstruct the tract and compress the peel-away sheath. The author rarely attempts catheterization of smaller veins from an antegrade approach because it is impossible to predict their course. A tortuous vein is a poor choice for dialysis access. A straight path to the superior vena cava or right atrium is the most important consideration for catheter flow rates. If the antegrade approach fails or is deemed inappropriate, a retrograde approach can be attempted.

RETROGRADE RECANALIZATION

Good sedation is crucial for this procedure because it typically requires at least 45 minutes to complete. The

easiest way to find a relatively straight path to the central veins is to use a retrograde approach (Fig. 2). A retrograde approach allows selection of a suitable access site prior to neck or chest venipuncture (Table 2). A catheter advanced from the femoral vein into the superior vena cava in a patient with central vein occlusions will preferentially enter larger, straighter occluded or collateral veins. These vessels are most appropriate for catheter insertion. The author typically starts with a curved catheter (e.g., multipurpose angled catheter) and a stiff hydrophilic guidewire. If the superior vena cava is occluded, a long guiding sheath is often used to provide more of a "backbone" for the catheter to push forward. In general, occlusions are approached aggressively as long as the interventionalist is cephalad to the lower superior vena cava; small guidewire perforations are generally very well tolerated above this point. This is particularly true from a retrograde approach because central venous pressure is typically quite low. However, if the lower superior vena cava is occluded, it is best not to be overly aggressive because right atrial or pericardial perforation might result in hemopericardium and cardiac tamponade.

As a rule of thumb, the catheter tip must be anterior in the chest or neck and cephalad to the level of the clavicles for successful catheter placement. Often the catheter will preferentially enter posterior paraspinal veins. Generally, the author will not attempt catheter placement in these veins because of their close proximity to the brachial plexus. Entry into such veins with a 5-French catheter often elicits pain from the patient and can be recognized on lateral fluoroscopy. Once a relatively straight vein has been catheterized, a lateral view should be obtained to confirm anterior location. The size of the vein is relatively unimportant; the dialysis catheter can be inserted in veins smaller than the catheter itself; in fact, using such veins is probably desirable because occlusion is unlikely to be of significance.

The puncture site should be chosen with the catheter tunnel in mind. Given the caliber of a dialysis catheter and the need for high flow rates, it is important to choose a site that allows a gentle, curved tunnel. Midline neck veins might be difficult because the catheter tends to kink if tunneled laterally. Puncture sites more than 2 to 3 cm above the clavicles might be problematic for the same reason. Occasionally, it might be possible to advance a 5-French catheter to the level of the clavicles but not above. In this instance, a sharp recanalization technique can be employed. This technique usually is used after all attempts at catheterization with a hydrophilic guidewire have failed. If the patient complains of pain, it usually indicates that the catheter has perforated the vein. Although this is not optimal, it is usually well tolerated unless the catheter has exited the vein into an adjacent artery or into the pleural space. On rare instances, the author has intentionally created a short tract from the vein into the subcutaneous

supraclavicular tissues and then inserted a catheter through this longer tract.

Once a catheter has been advanced to the level of the desired puncture site, a cursory ultrasound examination should be performed of the area to identify and avoid puncturing any overlying arteries. In larger veins, sonographic-guided puncture is performed. In smaller veins, the catheter is exchanged over a rigid guidewire (e.g., Rosen) for a snare that is then opened at the planned puncture site. The author favors a 10-mm snare because the loop can be formed even in very small veins

or in subcutaneous tissue. Using fluoroscopic guidance, a 21-gauge needle is passed through the loop of the snare and the snare is closed to confirm position. The needle is removed over an 0.018-in. guidewire and the snare is used to pull the wire into the central veins. Coaxial 3- and 5-French dilators are advanced over the 0.018-in. guidewire into the central veins and the 3-French dilator is removed.

A side-arm adaptor is attached to the 5-French dilator and both are slowly retracted through the subcutaneous tissues while nonionic contrast material is

Figure 2 Catheterization of occluded left external jugular vein. (A) Initial central venogram from antegrade puncture in right neck reveals complete occlusion of subclavian and jugular veins. (B) Fluoroscopic image shows retrograde recanalization of occluded left external jugular vein. (C) Fluoroscopic image shows loop snare opened in recanalized vein. (D) Fluoroscopic image shows 21-gauge needle passed through opened loop snare.

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Figure 2 (continued) (E) Fluoroscopic image shows guide wire access of occluded left external jugular vein.

injected. This maneuver allows identification of inadvertent through-and-through arterial puncture. Once inadvertent through-and-through arterial puncture has been excluded, the dilator is advanced back into the central vein and the 0.018-in. guidewire is exchanged for a conventional 0.035-in. guidewire. The dialysis catheter is then inserted in standard fashion. As mentioned above, it is sometimes helpful to insert the catheter over a stiff hydrophilic guidewire. For especially difficult deployments, the wire can be pulled out of the femoral access site, securing through-and-through access.

In our published experience using the retrograde technique, technical success was achieved in 22 (88%) of 25 attempts (one patient underwent two procedures).⁶ All failures occurred in patients with chronic central vein occlusions with complete obstruction at the level of the upper right atrium. There were two procedural complications: a vasovagal episode requiring intravenously

administered atropine sulfate, and an episode of respiratory distress requiring intubation. There were no instances of pneumothorax, nerve injury, or bleeding complications. Catheter malfunction requiring exchange occurred at a rate of 0.67 per 100 catheter-days. Infection requiring catheter removal occurred at a rate of 0.06 per 100 catheter-days. Primary patency was 90% at 1 month, 71% at 6 months, and 25% at 12 months. Secondary patency was 100% at 6 months and 70% at 12 months. We have now performed this procedure more than 50 times. It has become our preferred technique for patients with difficult central access and can be repeated many times in some patients. Our patients uniformly choose recanalized or collateral vein sites instead of other access sites because these catheters are the easiest to maintain and are the most comfortable.

ACCESS CHOICE

In our hospital, after the internal and external jugular veins have been exhausted, we use the following veins in order of preference: recanalized or collateral veins, femoral veins, translumbar inferior vena cava, and hepatic veins. Of course, the subclavian veins also are used preferentially if the ipsilateral upper extremity is unfit for shunt creation. We favor the femoral veins over the translumbar inferior vena cava despite a higher thrombosis rate because inserting catheters in the former does not jeopardize the latter. Conversely, catheters inserted into the translumbar inferior vena cava might cause stenosis or occlusion of this vein, precluding the use of femoral veins for access.

CONCLUSION

Catheter-based dialysis is an unfortunate, necessary evil in patients with end-stage renal disease. Some patients simply have no other options. As is true with all forms of dialysis, access preservation and survival are critical.

Table 2 Recanalization Procedure

1. Femoral venipuncture and 6- or 7-French guiding sheath insertion
2. Advance end hole catheter and stiff hydrophilic guidewire via inferior vena cava to superior vena cava
3. Catheterize any anterior vein and advance catheter above level of clavicles
4. Perform cursory ultrasound to identify any adjacent, superficial arteries at the intended puncture site
5. Exchange catheter over stiff guidewire for 10-mm loop snare
6. Open loop at intended puncture site
7. Infiltrate subcutaneous tissues with lidocaine at puncture site; using fluoroscopic guidance, advance 21-gauge needle through loop
8. Exchange needle for 0.018-in. guidewire and use snare to pull wire into superior vena cava
9. Advance coaxial 3- and 5-French dilators over 0.018-in. guidewire into superior vena cava
10. Remove 3-French dilator and attach side-arm adaptor to 5-French dilator; retract 5-French dilator through subcutaneous tissues over 0.018-in. guidewire while continuously injecting a small volume of contrast to exclude through-and-through arterial puncture
11. Advance 5-French catheter back into superior vena cava
12. Insert hemodialysis catheter in standard fashion

Using recanalized or collateral veins is the best manner in which to adhere to this principle and best serves our patients.

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