Issues Germane to Tunneled Catheters

The specialist's experience.

BY GREGG MILLER, MD; KONSTANTIN KHARITON; AND NAVEEN GOEL, MD

Using hemodialysis catheters in patients with end-stage renal disease leads to higher costs and more frequent complications than alternates, such as arteriovenous (AV) fistulas or grafts. The Medicare cost for hemodialysis patients with central catheter accesses was $69,893 per year in 2003 as opposed to $61,929 for patients with grafts and $52,751 for patients with fistulas.[1] These costs are associated with higher rates of complications in tunneled hemodialysis catheters, which are reflected in the risk of death being the highest in patients with catheter access. Diabetics with catheter accesses show a risk of death almost twice that of diabetics who receive hemodialysis through an AV fistula; nondiabetics with hemodialysis catheters show a slightly higher chance of death than their nondiabetic AV fistula counterparts.[1] Due to the higher risk of complications, catheters should be avoided whenever AV fistulas or synthetic grafts can be used as hemodialysis accesses. However, when relegated to using a catheter as a long-term dialysis access, it is important to choose the appropriate catheter design and advanced features to minimize risk of placement and maximize efficiency of the access.

SELECTING A CATHETER

Today's medical marketplace is overflowing with catheter designs being pitched by various medical technology representatives. To pick the best possible catheter, it is important to evaluate the various options in catheter material, body design, and tip design, as well as the available advanced catheter features. Furthermore, it is essential to remember the optimal catheter design will vary for each patient and must be considered on a case-by-case basis.

Material

Traditionally, hemodialysis catheters were made of one of two materials: silicone or polyurethane. However, each of these materials presented a serious problem with catheter care. Silicone is greatly weakened by iodine; polyurethane is resistant to iodine but significantly structurally degraded by alcohol. In the past, when using catheters of these materials, caregivers had to be careful not to expose the given catheter to its respective nemesis. Over time, structural degradation has led to torn catheter tips, which may break free and travel into the pulmonary artery.[2] The newest advance in catheter material is carbothane, which has all the advantages of its predecessors but is resistant to both iodine and alcohol. It is stronger than polyurethane, allowing it to have thinner walls and retain the same physical properties as polyurethane catheters. Most catheters on the market today are made of carbothane and have proven enhanced biocompatibility.[3]

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Body Design

There are several types of body designs for catheters, such as double-lumen oval, double-lumen round, and single lumen. The double-lumen oval design is favorable because oval-shaped catheters bend naturally without kinking. Double-lumen round catheters are well known to kink if the angle of the tunnel to the internal jugular is too steep. **[AU: PREVIOUS SENTENCE OKAY AS EDITED?]** Single-lumen round catheters, such as the Bio-Flex Tesio catheter (Medical Components, Inc., Harleysville, PA) **[AU: PLEASE CONFIRM CATHETER NAME]** are highly resistant to kinking and tend to be favored when ultrasound guidance is not used for low internal jugular punctures. They,

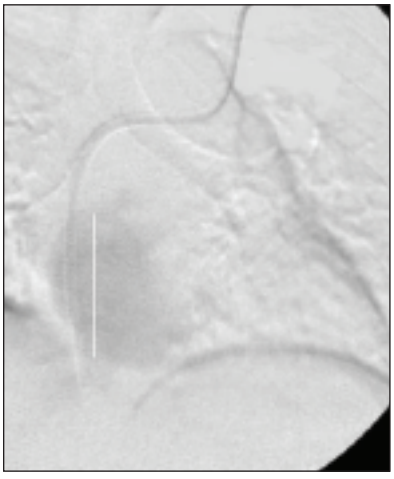

Figure 1. Long axis of the atrium is axial. This configuration favors stepped-tip design.

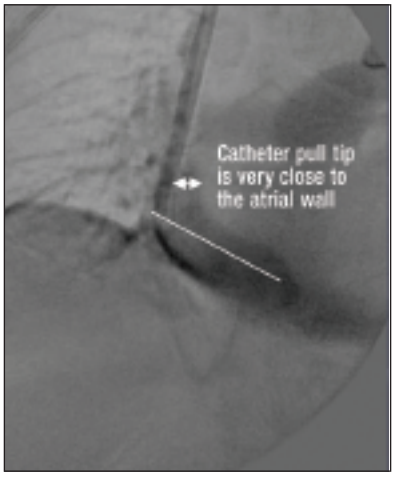

Figure 2. Long axis of the atrium is lateral. This configuration leads to the pull port sucking up against the atrial wall.

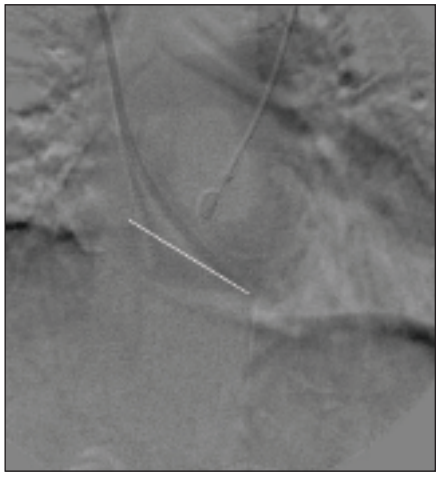

Figure 3. Split-tip design catheters conform better when the long axis of the atrium is in the lateral position.

however, also require twice the work because two catheters are needed to perform dialysis.

Tip Design

Paying close attention to the anatomy of the particular patient is paramount to selecting the ideal catheter-tip design. There are three catheter-tip designs available on hemodialysis catheters: stepped, split, and slotted. The two most commonly used are the stepped-tip and split-tip designs. When the long axis of the atrium is in the axial plane, the stepped-tip design is ideal (Figure 1). If the long axis of the atrium is in the lateral plane, then split-tipped catheters have an advantage of conforming better to the shape of altered anatomy commonly seen in obese patients (Figures 2 and 3). Using the appropriate tip design based on the spatial orientation of the catheter in the atrium is important to minimize the pull port from sucking up against the wall of the atrium. The split-tip design has an additional advantage of partially preventing the formation of a fibrin sheath from the point of the split down. Most catheters are measured to have 2% to 20% recirculation. Up to 30% recirculation can occur if the lumens are reversed. Slotted-tip design catheters, such as the Palindrome catheter (Kendall Vascular Therapy, Tyco Healthcare Group LP, Mansfield, MA), appear to have an advantage of having less recirculation when lines are reversed.

Advanced Features

There are several advanced features that are essential to the safe and effective use of hemodialysis catheters. One important innovation is the valved anti–air-embolism peel-away sheath dilator, which allows safe catheter insertion while avoiding the common problems of bleeding and air embolism. The valved sheath is extremely useful in patients with communication barriers who cannot participate with breath holding.

Another important available feature is the stiffened stylet that facilitates single-wire exchanges and over-the-wire catheter insertions. The stiffened stylet is threaded through both ends of the split-tip wire in a way that binds them together, allowing for easy insertion.

Heparin-coated catheters are new to the market. Intuitively, it makes sense to utilize heparin-coated materials to prevent catheter thrombosis. The main questions are, "How long does the coating last?" and "Will this coating prevent the formation of fibrin sheath and prevent central venous complications?" Preliminary *in vitro* results are promising. Spire Biomedical (Bedford, MA) is the manufacturer of the Decathalon Gold catheter. It is currently the only heparin-coated catheter on the market.

COST

Catheter kits can be obtained as the catheter alone or the catheter with dilators, tunneler, wire, and peel-away sheath. The full kit is more expensive. For catheter exchanges, individually packed catheters are more cost effective compared to the whole kit, which is more appropriate for new catheter insertions. There are many brands to choose from, and pricing differs greatly between vendors. Some manufacturers of catheters and catheter components offer competitive factory-direct pricing. An investment in time spent looking for the best price will usually generate significant cost savings. This is important because medical devices are not reimbursable in the outpatient setting.

CATHETER PERILS

Infection, the most common complication of tunneled hemodialysis catheters, is the leading cause of morbidity and the second biggest killer among hemodialysis patients. Catheter infection is divided into three categories: catheter-related bacteremia (CRB), tunnel infection, and exit site infection. In the event of severe systemic infection, the catheter should be removed and only be replaced after the infection subsides with appropriate antibiotics. If there is a tunnel infection, which is usually associated with systemic symptoms or CRB, the catheter needs to be removed and replaced after adequate treatment with antibiotics. If there is only CRB with mild-to-moderate symptoms, the catheter could be exchanged over the wire with antibiotic treatment for 48 hours to 72 hours. An exit site infection, if local, can be treated with local antibiotics. If the infection is systemic, it should be treated as tunnel infection.[4]

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Another complication of indwelling catheters is the creation of a fibrin sheath surrounding the catheter. When this happens, the catheter is removed and angioplasty is performed to disrupt the fibrin sheath. A new catheter can be placed in the same tunneled access site over a guidewire. Any time a catheter exchange is performed, the fibrin sheath should be diagnosed with a superior venacavogram and disrupted using angioplasty to maintain the particular catheter access site and therefore save venous "real estate." **[AU: POSSIBLE TO PROVIDE ALTERNATE WORD FOR REAL ESTATE?]**

A focus on preservation of venous real estate in dialysis patients is essential. Central venous stenosis is a common complication of long-term hemodialysis catheters. Correctly placing the catheter becomes extremely important to prevent complications, such as stenosis, thrombosis, and occlusion of the central venous circulation. Catheter placement should be performed under ultrasound guidance and with fluoroscopic imaging assistance. All options should be exhausted on either the left or right side before changing sides and causing bilateral obstructions. Catheters should be placed in the internal jugular position preferentially. If, however, the internal jugular is thrombosed from previous catheters, then the external jugular or brachiocephalic veins should be sought on the same side of the upper extremity for catheter placement whenever possible. Placement in the subclavian vein should be avoided because it is linked to a high rate of central venous stenosis.[5] Using access veins such the internal jugular, external jugular, or brachiocephalic expands the number of options for a given patient and helps to avoid complications of long-term femoral catheterization while allowing for preservation of venous real estate.

CONCLUSION

Consideration of catheter cost and design is essential when selecting the optimal catheter to fit each patient. Even though the advancing technology has greatly improved the safety and efficiency of catheters, catheter use is associated with much higher morbidity and mortality rates than other forms of dialysis access, such as AV fistulas and synthetic grafts. Whenever possible, it is best to create AV fistulas as long-term hemodialysis accesses. Whenever catheters are used to deliver long-term dialysis, it is important to preserve venous real estate by using a single-access site through the internal jugular, external jugular, or brachiocephalic vein while avoiding the subclavian vein. With attention to these details, we can optimize safety and efficacy for this fragile segment of our population. ■

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1. www.cms.hhs.gov. **[AU: PLEASE PROVIDE ARTICLE TITLE AND AUTHOR NAME IF THERE IS ONE. PLEASE PROVIDE DATE ACCESSED.]**
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