

# Chronic Hemodialysis Catheters

An overview of the recent history, design elements, and current issues surrounding this therapeutic option.

BY THOMAS VESELY, MD

**T**here are approximately 350,000 patients with chronic renal failure in the US. The majority (60%) of these patients undergo outpatient hemodialysis treatment as their primary renal replacement therapy. Approximately 25% of patients receive a kidney transplant, and the remaining 15% receive peritoneal dialysis treatment.

Hemodialysis requires a reliable and durable vascular access conduit. Although the arteriovenous fistula is the preferable form of vascular access, only 30% to 35% of hemodialysis patients have a well-functioning native fistula. The majority (60%) of patients continue to rely upon a polytetrafluoroethylene (PTFE) graft as their vascular access for hemodialysis and 15% of patients receive hemodialysis treatment using a chronic (tunneled) central venous catheter.

## RECENT HISTORY: A SLOW PROGRESSION

The National Kidney Foundation's Dialysis Outcomes Quality Initiative (DOQI) guidelines were originally published in 1997. One of the primary tenets of these guidelines was the recommendation for use of native fistulae as the vascular access of choice for hemodialysis. However, despite these recommendations, there has been only a slight increase in the prevalence of native fistulae in the US during the past 7 years. Nationally, only 30% to 35% of chronic renal failure patients have a native fistula. Interestingly, the prevalence of native fistulae has a geographical distribution; some areas of the US have a substantially higher number of patients with fistulae when compared to other regions.

The lack of progress toward increasing the prevalence of arteriovenous fistulae is multifactorial. One reason is reimbursement; surgical implantation of a PTFE hemodialysis graft has better reimbursement when compared to creating a native fistula. In addition, many surgeons in the US were not trained in the various techniques for creating and repairing native fistulae. The unfamiliarity with these surgical techniques has created a lag time for surgeons to enthusiastically

adopt this form of vascular access for hemodialysis. Despite the DOQI recommendations, very little progress has been achieved in increasing the prevalence of native fistulae.

## Fistula First

The Fistula First program, which is targeted at nephrologists and surgeons, is an important next step for the implementation of a more aggressive approach. It is a program separate from the K/DOQI guidelines that specifically addresses the need for increased fistula use in patients with end-stage renal disease. The Fistula First initiative aims at placing fistulae in at least half of new hemodialysis patients with a long-range goal of maintaining fistulae in 40% of eligible patients who remain on hemodialysis.

## THE MATURATION PERIOD

The maturation period is the time required for a vascular access graft or fistula to heal and the blood flow to adjust to the appropriate rate. The maturation period for a PTFE graft is 3 to 4 weeks but this period is much longer (2 to 3 months) for a native fistula. Although 95% of PTFE grafts will mature into a functional vascular access, approximately 30% to 40% of fistulae will fail to adequately develop during the maturation period.

The increased use of native fistulae will consequently



Figure 1. Photograph of a step tip catheter (above) and a split tip catheter (below).



Figure 2. Photograph of a fibrin sheath surrounding a hemodialysis catheter. The fibrin sheath does not extend over the split catheter tips.

increase the prevalence of chronic (tunneled) catheters in our hemodialysis patient population. Patients awaiting the maturation of a PTFE graft need a hemodialysis catheter for 1 month or less, whereas patients with fistulae require a catheter during the entire 3-month maturation period. For this reason, we are beginning to see more catheter-related complications in these patients. Anecdotal reports have suggested that central venous stenoses and catheter-related thrombosis are more frequent in patients with fistulae as a result of prolonged catheter use.

### CHRONIC HEMODIALYSIS CATHETERS

Hemodialysis catheters are the Ferraris of central venous catheters. The design and construction of tunneled hemodialysis catheters are superior to other types of central venous catheters. Hemodialysis catheters are optimized for the delivery of high blood flow rates. Hemodialysis treatment requires the ability to sustain a blood flow rate of 450 mL/min for at least 3 hours. Despite their sophisticated designs, few catheters are able to routinely provide this high level of performance.

### CATHETER DESIGN

The shift from silicone to polyurethane materials for the construction of chronic hemodialysis catheters has substantially improved the performance of these products. Polyurethane is stronger than silicone, enabling the catheter's walls to be made thinner. This provides a larger inner luminal diameter to improve blood flow while maintaining the same outer diameter of the catheter. New blends of polyurethane are comfortable for the patient and provide other advantageous characteristics as well.

The majority of chronic hemodialysis catheters fall into one of two categories: the step tip design or the split tip design (Figure 1). The step tip catheter was originally designed to decrease the recirculation of blood flow between the arterial and venous lumens. However, the orientation of the distal catheter tip is critical for optimal catheter performance. This type of catheter will not work well if the arterial lumen is positioned against a vascular wall. The split tip catheter was designed to decrease the catheter

tip's positional dependence. In addition, the movement of the split tips within the central veins was thought to decrease the buildup amount of fibrin and thrombus around the catheter tips (Figure 2). Although both of these designs have their advantages and disadvantages, both types of catheters work well, and their clinical performances are considered equivalent.

The most recent design change has been toward catheters with larger outer diameters. The new generation of tunneled hemodialysis catheters has outer diameters ranging from 14.5 F to 16 F. Although these larger-diameter catheters can provide higher blood flow rates, many physicians are concerned that such large-caliber catheters may incite more complications such as central venous stenosis and thrombosis. However, there have been no published reports describing an increased incidence of complications associated with these large-diameter hemodialysis catheters.

### PLACEMENT OF THE CATHETER TIP

Ideal placement of the catheter tip is a controversial subject. As previously mentioned, the specific positioning of a catheter tip can substantially affect the catheter's function. There are data suggesting that placing the catheter tip into the upper right atrium can provide better performance when compared to catheter tips positioned within the superior vena cava. However, this continues to be a highly debated topic. The US FDA has stated that "the catheter tip should not be placed in, or allowed to migrate into the heart."<sup>1,2</sup> Yet, the instructions-for-use documents of several chronic hemodialysis catheters recommend positioning the catheter tip into the upper right atrium. Not only is the FDA confused about this issue, but so are many physicians (and lawyers too!).

### CONCLUSION

Chronic hemodialysis catheters continue to serve an important role in our management of patients with end-stage renal disease. Recent design improvements have increased the performance and reliability of these sophisticated central venous catheters. However, the incidence of catheter-related complications increases with prolonged use. The native fistula remains the preferred method for obtaining vascular access for hemodialysis. ■

*Thomas Vesely, MD, is with Vascular Access Services, LLC. He has disclosed that he is a paid consultant for Datascope and Spire Biomedical, and has a royalty agreement with Angiodynamics. Dr. Vesely may be reached at (314) 367-2436; tmvesely@aol.com.*

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