Prevention of Damage to Cuffed Catheters

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Cuffed catheters, although not ideal for long-term use, are now used more frequently due to an increase in the aging population, in whom the vessels are not suitable for either arteriovenous fistulas or polytetrafluoroethylene (PTFE) grafts. Infections and thrombosis remain the major causes for removal or change of catheters.

We recently identified eight catheter defects that required replacement of catheters. Of these, two were due to patient negligence: one catheter was accidentally severed while the patient was shaving; the other was snipped during a haircut. One was believed to have a manufacturing defect. One catheter sustained needle-prick damage near the hub while irrigating the catheter. Two catheters were lost due to needle pricks during skin closure, and one catheter sustained similar damage while fixing the suture wing to the skin. The other two were damaged by suture material slicing through the lumen of the catheter as it expanded due to increased blood flow during repeated dialyses. Importantly, several of these injuries to the catheters were not immediately obvious and were detected only after repeated use of the catheters.

Delayed bleeding of cuffed catheters necessitating change or removal has not been reported. Such bleeding may be due to manufacturing defects, patient carelessness, or iatrogenic causes. Avoiding the use of sutures can minimize the latter. Skin closure strips and a double transparent dressing may serve the same purposes, such as securing the catheter and aiding wound healing. In addition, these dressings have the added advantage of being waterproof, bacteria-proof, and cost effective.

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Key words

Cuffed catheters, hemodialysis sandwich dressing, mesentery dressing, catheter damage, catheter complications, catheter care guidelines

Introduction

Native arteriovenous fistulas, followed by prosthetic arteriovenous grafts, are the preferred vascular accesses for long-term hemodialysis in patients with end-stage renal disease (ESRD). Central lines, however, are often the only source of temporary or long-term access when these accesses fail. Cuffed catheters are now being used more frequently for chronic hemodialysis patients. The 1997 USRDS (United States Renal Data System) estimated that 18.9% of the functioning vascular accesses, 60 days after the initiation of maintenance hemodialysis, were through cuffed catheters and 13% by temporary semistiff catheters either in the jugular, subclavian, or femoral veins [1]. In 1993 this percentage was 9.7 one month after dialysis initiation. This increase is likely due to an increase in the percentage of elderly patients, who lack adequate blood vessels for the construction of either arteriovenous fistulas or placement of polytetrafluoroethylene (PTFE) or bovine grafts. The emergence of slow nocturnal home hemodialysis has further established the use of cuffed catheters for long-term use even in younger patients [2].

Catheter-related thrombosis and infection are the most common complications of intravenous catheters for hemodialysis; however, other complications may occur, such as malposition and kinking. Delayed bleeding has not been reported as a complication of cuffed catheters necessitating change or removal. We identified several cases of delayed bleeding due to catheter damage. This paper discusses the mechanisms causing catheter damage and presents potential measures to prevent them.

Material and methods

Between July 1, 1997, and June 30, 1998, in our unit we placed 628 soft, intravenous catheters for hemodialysis. During this period, we observed seven instances of catheter damage resulting in catheter failure. We also noted damage of a catheter implanted earlier, which resulted in a fatal outcome.

Case reports

Case 1

A 78-year-old black male, with ESRD secondary to hypertensive renal disease and a history of recurrent clotted arteriovenous grafts, was dialyzed through a tunneled, cuffed catheter in the left internal jugular vein. He was admitted due to bleeding from the catheter insertion site. The catheter was a double lumen, soft, silicone, cuffed catheter (Hickman, BARD, Salt Lake City, UT, U.S.A.), placed approximately 6 weeks prior to the episode. The patient did not have a history of bleeding disorders or liver disease and was not taking any anticoagulant or antiplatelet medication. The physical examination was insignificant other than blood oozing from the exit site of the left-sided internal jugular

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catheter. The catheter was changed, and examination of the catheter revealed a small tear under the suture wing, which is presumed to be due to erosion of the catheter by the suture thread.

Case 2

A 59-year-old black male with hypertension, coronary artery disease, and ESRD had been receiving hemodialysis for 2 years without bleeding episodes. A Hickman catheter was placed in the right internal jugular vein due to a clotted arteriovenous graft. He received two hemodialysis treatments through this catheter without bleeding. Five days after insertion, bleeding was noted from the catheter site soon after initiating dialysis. This necessitated the cessation of hemodialysis and admission to the hospital. The patient was not using any anticoagulant medication.

Examination of the neck did not reveal bleeding. However, upon withdrawing blood from the catheter, oozing of a small amount of blood from the exit was noted. The catheter was replaced and no further bleeding was experienced. Examination of the defective catheter revealed a small pinhole in the area under the skin close to the Dacron cuff, possibly caused by a needle stick to the catheter while placing sutures during skin closure.

Case 3

A 68-year-old black male with a history of obstructive airway disease and ESRD was initiated on hemodialysis through a Hickman catheter in the right internal jugular vein for 2 months. Due to poor flow the catheter was replaced with a similar one. The following dialysis was uneventful. Soon after the initiation of the second hemodialysis, bleeding was observed from the catheter close to the suture wing. There were no prior episodes of bleeding, and the patient was not taking any anticoagulation or antiplatelet medications. Examination of the catheter revealed a small pinhole defect close to the suture wing, which may have been due to needle-prick trauma to the catheter sustained while anchoring the suture wing to the skin. The catheter was replaced, and the patient was dialyzed without further bleeding.

Case 4

A 70-year-old black male with a 3-year history of ESRD was dialyzed through a right internal jugular Hickman catheter after his PTFE graft had clotted. Two months after the placement of the catheter he had an episode of profuse bleeding from the catheter necessitating discontinuation of dialysis. The following morning he was dialyzed again without anticoagulation, but the bleeding recurred and the arterial port was noted to be pulling air into the line. The catheter was replaced and showed a small tear where the suture thread was gripping the catheter. The suture thread was clearly seen eroding through the catheter and was the cause of delayed bleeding. Further dialyses with a new catheter were uneventful.

Case 5

A 54-year-old black male was admitted for profuse bleeding from the catheter while on dialysis. He had ESRD secondary to type II diabetes mellitus and hypertension. His PTFE graft was removed due to infection. A soft cuffed catheter was placed into the left internal jugular vein for dialysis. He had no bleeding disorder. The physical examination was unremarkable. Examination of the catheter revealed a linear tear measuring 1 cm on the venous port at the hub where the catheter was connected to the lines from the machine. This tear was probably a manufacturing defect. After the catheter was replaced, the patient received dialysis without further incident.

Case 6

A 68-year-old white female with ESRD on hemodialysis with a cuffed catheter had to discontinue dialysis due to inadequate blood flow. Urokinase was instilled into both ports using a syringe and needle and was left overnight. A leak was noted from the port, just below the hub of the catheter when dialysis was restarted the following morning. The catheter was replaced, and examination of the leaking catheter revealed a pinhole defect under the hub, corresponding to the area of possible needle-prick damage from the urokinase injection (Fig. 1).

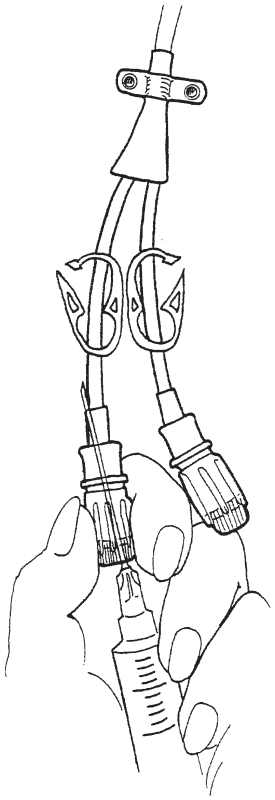

FIGURE 1 Needle damage to the port of the dialysis catheter.

CASE 7

A 65-year-old African-American male with ESRD due to hypertension was dialyzed using a Hickman catheter that had been placed 4 months prior due to clotting of a left forearm PTFE graft. He presented to the emergency department due to bleeding from his cuffed catheter, which had sustained damage from a razor blade while shaving his beard. He pinched the catheter with his fingers and came to the emergency department, where the catheter was clamped and removed. Luckily, he did not bleed much and had no overt signs of air embolization.

CASE 8

A 61-year-old Latin-American female with ESRD was on hemodialysis using a left-sided Hickman catheter with the exit above the clavicle; she was trying to trim her hair in the bathroom when she accidentally snipped the catheter. She died on her way to the emergency department. Autopsy revealed the cause of death to be exsanguination rather than air embolism.

Proposed methods to prevent catheter injury

Avoiding sutures at the exit

Adhesive sterile skin closure strips (Steri-strips, 3M Health Care, St. Paul, MN, U.S.A.) may be utilized to avoid suturing. This may virtually eliminate the possibility of needle-prick injuries to the areas close to the Dacron cuff shown in Fig. 2A.

Use of interlink cannula instead of needles

Case 6 had a clear needle-prick injury during instillation of urokinase (Fig. 1). Most of the catheters have a long hub or protective plastic material, which can resist the needle-prick damage. However, the use of needles can be avoided to prevent the damage, and a short plastic interlink (InterLink Vial Access cannula or Lever Lock cannula, Becton Dickinson, Franklin Lakes, NY, U.S.A.) cannula can be used instead.

The double transparent sandwich dressing

It usually takes several weeks for the fibrous tissue to ingrow and fix the Dacron cuff. Until it is fixed, a double transparent dressing using the "sandwich" technique would protect the catheter from accidental removal (Fig. 3). This dressing also gives excellent protection against bacterial contamination, is waterproof, gives a high degree of visibility of the exit site, and saves nursing time and costs. It requires less material and nursing time compared to the gauze dressings because the sandwich dressing is changed only once a week [3]. The double transparent sandwich dressing involves the use of two transparent adhesive dressings. The application is simple. After the successful insertion of the dialysis catheter, the area around the catheter is wiped dry using aseptic precautions. After removing the protective cover (leaving the outer frame intact), a transparent adhesive dressing is folded and placed

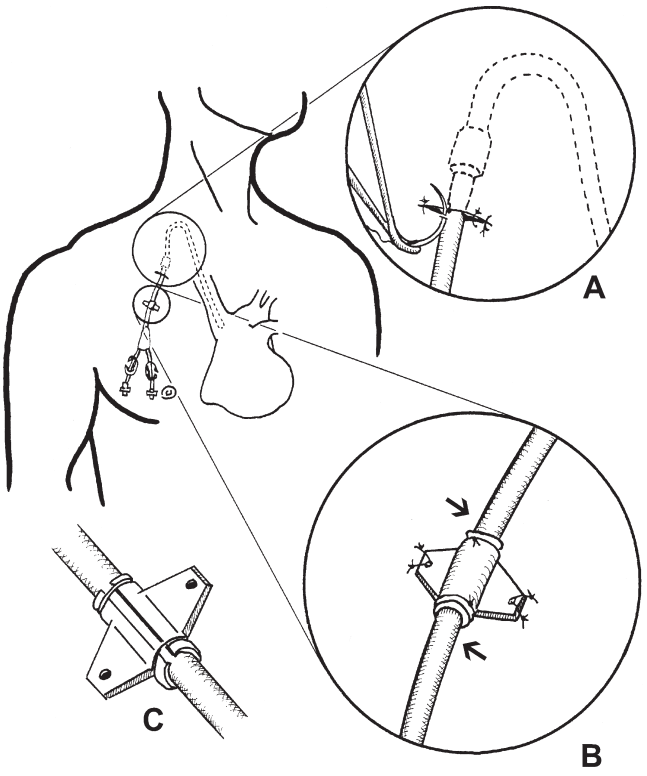

FIGURE 2 Areas that can be damaged during catheter placement. A. Skin closure by suturing may puncture the catheter area under the suture line. B. Fixing the suture wing to the skin may damage the catheter under and adjacent to the suture wing. C. Tightly wound suture material in the groove of the suture wing can slice through the soft catheter as the catheter expands with increasing blood flow.

over the skin. The catheter is centered as shown in Fig. 3A. The same procedure is repeated on the other side of the catheter, keeping the dressings in close proximity to each other (Fig. 3B). The remaining halves of both the dressings are placed together, positioning the catheter in the center (Fig. 3C). The catheter is thus sandwiched between the adhesive dressings and firmly secured to the skin, and the outer framework is ultimately removed.

Single transparent "mesentery" dressing

The other dressing technique that may serve a similar purpose of securing the catheter is single transparent "mesentery" dressing. This dressing has an added advantage of keeping the exit site exposed in those who need to apply antibiotics or antiseptics to the exit site. The corner portion of the transparent dressing is exposed by partially removing the cover as shown in Fig. 4A. The dressing is placed over the desired location of the skin. The cover is removed further, and the catheter is positioned in the center of the dressing as shown in Fig. 4B. The adhesive surfaces of the dressing are approximated while gradually peeling the cover back in such a way that the dressing encircles the catheter and leaves a desired margin of 2 – 3 cm,

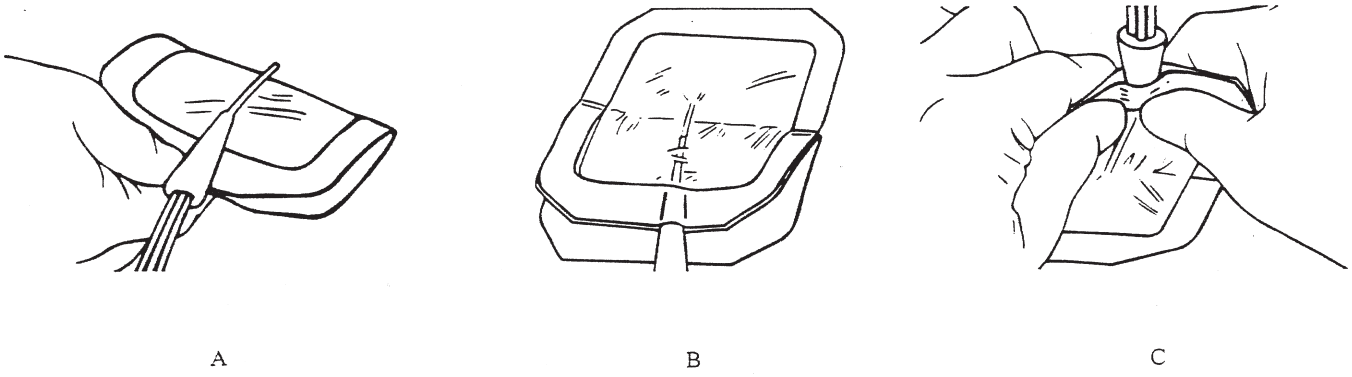

FIGURE 3 Technique of applying double transparent sandwich dressing. A. One folded transparent dressing in place, with the adhesive surface adhering to the skin and the catheter. B. Second transparent dressing on the opposite side adhering to the skin, catheter, and the transparent dressing placed earlier. C. Alignment of the dressing, positioning the catheter in the center.

as shown in Fig. 4C. The dressing is placed over the skin in such a way that the adhesive surface of the dressing comes in contact with the skin (Fig. 4D). The remaining cover is gently removed as the dressing is fixed to the skin.

Results with transparent dressings

We have used the double transparent sandwich dressing or single transparent mesentery dressing in over 250 patients. There has been no catheter loss in patients using these dressings.

Discussion

Central lines are often the only source of access for either temporary or long-term use when other accesses fail. The complications associated with semistiff catheters have prompted a shift toward soft catheters [4–7]. Cannulation of the subclavian vein for hemodialysis increases the likelihood of stenosis and thrombosis of the subclavian vein, causing swelling of the ipsilateral arm, and jeopardizing the use of that limb for future vascular accesses [6,7]. The incidence of damage to the vein is less frequent when these catheters are placed percutaneously into internal jugular veins [8]. Therefore, soft catheters are preferred over the semistiff catheters for dialysis purposes, and the internal jugular vein has emerged as the preferred central vein for hemodialysis catheter placement [9]. In an earlier clinical trial we showed that these soft catheters can be safe and effective for long-term use [10]. Schwab *et al.* [11], in their prospective study, have also shown that the cuffed catheters can be safely used as a long-term vascular access for hemodialysis.

The Dacron cuff affixed to the catheter reduces tunnel infection rates and anchors the catheters securely by generating a fibrous reaction. Catheter loss can be due to several factors, such as infections, thrombosis, malfunction due to malposition or kinking, and accidental loss. Catheter complications cause delays in dialysis, underdialysis, and increases costs. Bleeding from a catheter is not a usual cause for catheter change, and when it occurs, it is usually due to a defect in the catheter. This may be a manufacturing defect, as seen in Case 5, or an iatrogenic defect caused during the placement or handling of the catheter. Catheter damage can happen accidentally at home as happened in our patients 7 and 8. The patient may exsanguinate, as happened with our Case 8, or may develop air embolus; therefore, the patients should have a clamp or hemostat at home in case of emergency.

The placement procedure for cuffed catheters involves three main steps: (1) location of the vein and the insertion of catheter; (2) implantation of Dacron cuff under the skin; and (3) tunneling a portion of the catheter. The current practice is to secure the catheters by firmly applying sutures that are anchored either to the skin by using a suture wing (Figs. 2B C) if placed outside the exit site or to the subcutaneous tissue by using a grommet (Fig. 5), if placed on the inner side of the exit site.

Unfortunately, none of these devices guarantee fixation of the catheter. Once the suture wing is attached and fixed to the skin, it is extremely difficult to detach from the catheter without causing damage to the catheter. The sutures cannot be placed directly over the catheter because such placement fails to achieve an adequate grip. If placed too tightly, the sutures may occlude the lumen, impeding the blood flow. If this happens, it may not be readily recognized. On the contrary, if the sutures are looser, they may not prevent the catheter from slipping.

When cuffed catheters are placed in the internal jugular vein after tunneling under the skin, an incision is required at the site of insertion to bury the Dacron cuff. This incision is frequently closed by suturing. The catheter loop lies superficially under the suture line and can easily sustain needle-prick damage in the area close to the Dacron cuff (Fig. 2A). Such punctures can easily be missed. Since the incision site may be covered with a pressure dressing, the needle-prick damage may not be obvious during the first dialysis. Even if early bleeding is observed, it is attributed to

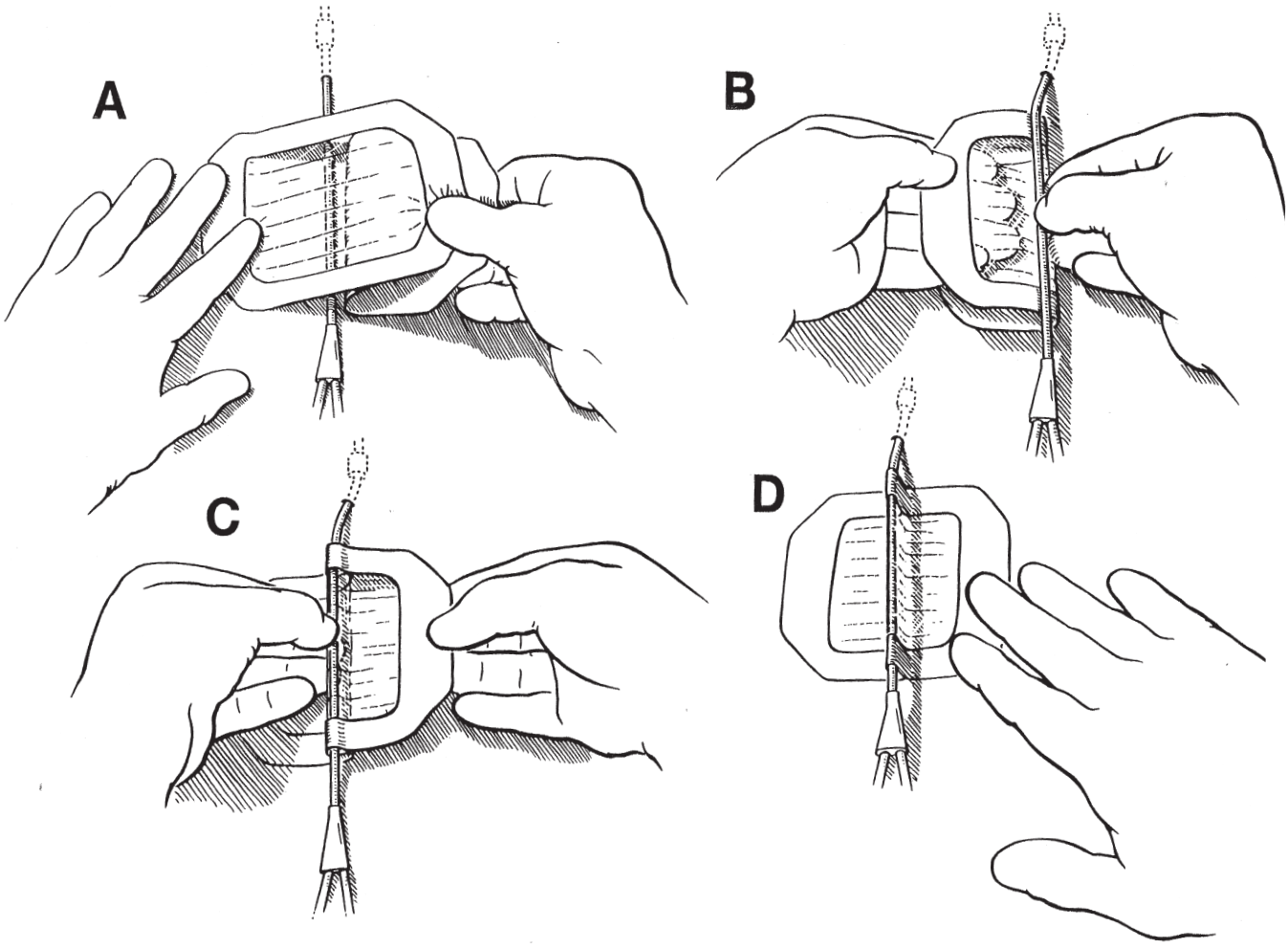

FIGURE 4 Application of a single transparent mesentery dressing. A. Fixation of one end of the dressing to the skin. B. Fixation of the catheter in the center of the dressing. C. Creation of mesentery by approximation of the dressing. D. Fixation of the other end of the dressing to the skin.

the surgical incision at the exit site. Once the pressure dressing is taken off and the flow is increased, the increased pressure may expand the catheter causing overt bleeding or hematoma.

While the suture wing is being fixed to the skin, the catheter under and adjacent to the suture wing can sustain damage (arrows in Fig. 2B). These defects can bleed during the first dialysis. We believe patient 3 had such a defect. Patients 1 and 4 had defects close to the suture wings. In these cases the suture material tightly encircled the catheter.

The pressure inside the catheter depends on the blood flow and the resistance:

$$P = Q_b \times R,$$

where P is intraluminal pressure, Q_b is blood flow, and R is resistance.

When blood flow increases, so does the intraluminal pressure causing distension of the catheter. The suture material is static and gradually erodes through the soft distending elastic material. This may take several weeks to several months, causing delayed bleeding as seen in these two patients.

Conclusion

Based on our experience in these patients, we would like to propose that delayed bleeding in cuffed catheters used for dialysis can be due either to manufacturing defects or iatrogenic causes.

Avoiding sutures can minimize the latter. Skin closure strips and double transparent dressings may serve the same purpose securing the catheter and aiding wound healing. In addition, these dressings have an added advantage of being waterproof, bacteria-proof, and cost effective. In circumstances where open wound care is desired, the single transparent dressing using the mesentery technique may be used. We therefore propose that use of sutures may be abandoned in cuffed central vein catheters used for dialysis.

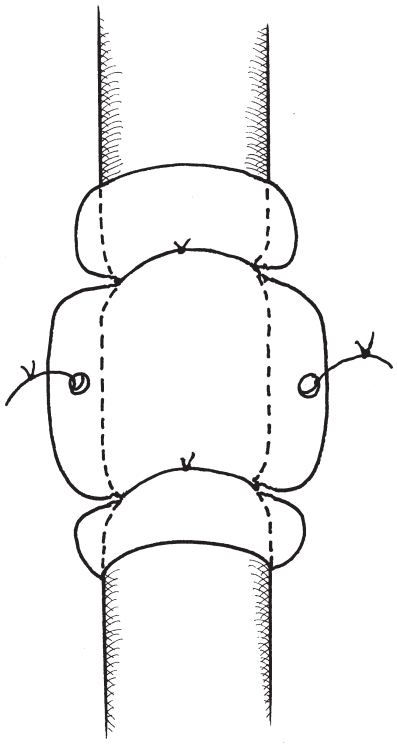

FIGURE 5 The grommet is usually placed under the skin to fix the catheter.

References

1 United States Renal Data System (USRDS) 1997 Annual Data report: dialysis access; USRDS dialysis morbidity and mortality (wave 2). 1997: 58–60.

2 Pierratos A. Ouwendyk M. Francoeur R. Vas S. Raj D. Ecclestone A-M. Langos V. Uldall R. Nocturnal hemodialysis: three-year experience. J Am Soc Nephrol. 9: 859–68. 1998.

3 Ouwendyk M. Helferty M. Central venous catheter management: how to prevent complications. ANNA J. 23: 572–7. 1996.

4 Merrill RH. Raab SO. Dialysis catheter-induced pericardial tamponade. Arch Intern Med. 142: 1751–3. 1982.

5 Hansbrough JF. Narrod JA. Steigman GV. Cardiac perforation and tamponade from a malpositioned subclavian dialysis catheter. Nephron. 32: 363–4. 1982.

6 Glaze RC. MacDougall ML. Weigmann TB. Thrombotic arm edema as a complication of subclavian vein catheterization and arteriovenous fistula formation for hemodialysis. Am J Kidney Dis. 7: 439–41. 1986.

7 Fant GF. Dennis VW. Quarles LD. Late vascular complications of the subclavian dialysis catheter. Am J Kidney Dis. 7: 225–8. 1986.

8 Agraharkar M. Isaacson S. Mendelssohn D. Muralidharan J. Mustata S. Zevallos G. Besley M. Uldall R. Percutaneously inserted Silastic jugular hemodialysis catheters seldom cause jugular vein thrombosis. ASAIO J. 41: 169–72. 1995.

9 Cimochowski GE. Sartain JA. Worley E. Blandin J. Harter H. Clear superiority of internal jugular access route over the subclavian vein for temporary dialysis: an angiographic study in 52 patients with 102 venograms. Nephron. 54: 154–61. 1990.

10 Mustata S. Less P. Agraharkar M. Muralidharan J. Uldall RP. Further experience with a percutaneously inserted double-lumen Silastic catheter for end stage renal failure patients with refractory vascular access problems. ASAIO J. 42: 244–5. 1986.

11 Schwab SJ. Buller GL. McCann RL. Bollinger RR. Stickel DL. Prospective evaluation of a Dacron cuffed hemodialysis catheter for prolonged use. Am J Kidney Dis. 11: 166–9. 1998.