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SHORT REPORTS

Unroofing Surgery with *en Bloc* Resection of the Skin and Tissues Around the Peripheral Cuff

KEY WORDS: Tunnel infection; exit-site infection; unroofing; catheter replacement; catheter splicing.

Peritoneal catheter infection is a common and significant problem in maintaining peritoneal dialysis (PD). Although the incidence rate of peritonitis related to exit-site and catheter infection has diminished with the increasing use of exit-site antibiotic prophylaxis (1), persistent exit-site infection can lead to infection of the superficial cuff in two-cuff devices. Intractable cuff infection leads directly to catheter loss and withdrawal from PD. In fact, PD-related infections are the major cause of withdrawal from PD (2,3). Therefore, once intractable superficial cuff infection has occurred, the proper strategy should be pursued.

Unroofing of the tunnel tract and removal of the superficial cuff ("unroofing surgery") is a strategy widely used to treat superficial cuff infection (4). It is simpler and less costly than other strategies, such as catheter removal with (simultaneous or delayed) catheter replacement (5) or replacement of the infected external tubing segment by catheter splicing (6). Although the published results of unroofing surgery are generally favorable (7,8), infection still recurs in some cases.

We hypothesized that recurrent infection after unroofing surgery is partly attributable to the persistence of causative micro-organisms in the wound. Standard unroofing surgery consists of

- making an elliptical incision around the exit site,
- making an extended incision through the skin and subcutaneous tissues along the course of the catheter until the superficial cuff is identified, and
- resecting inflammatory tissue.

This procedure might permit the dissemination of causative organisms from infected tissue to uninfected tissue in the course of the second and third steps. Thus, we have been performing unroofing surgery accompanied by *en bloc* resection of the skin and tissues around the peripheral cuff (unroofing-BR), and here we report the results of this new catheter salvage technique.

METHODS

All catheters used for the 7 maintenance PD patients who underwent unroofing-BR under local anesthesia (Table 1) were two-cuffed, straight-tipped, swan-neck abdominal catheters (JB-1: Hayashidera, Kanazawa, Japan). These patients had exit-site infections suspected to be limited to the superficial cuff and symptoms that did not respond to adequate systemic antibiotic therapy and frequent (twice daily or more) sanitization of the exit site with povidone iodine.

Patients suspected of having an infected deep cuff by computed tomography were not involved in the study, because unroofing-BR would not resolve such infections. Those patients underwent catheter removal and insertion of a new catheter during the same procedure under local anesthesia.

In the 7 study patients, the skin from above the superficial cuff to the exit site was incised in a teardrop shape [Figure 1(A)]. The tissue around the catheter segment containing the superficial cuff was exteriorized *en bloc* to minimize exposure of the open wound to infected material [Figure 1(B)]. Using an electrosurgical knife, the infected tissue was removed, together with the covering teardrop-shaped section of skin [Figure 1(C)]. Inspection was made to determine if the infection extended toward the deep cuff within the rectus sheath. Extended infection was suspected in the presence of pigmented (reddish) subcutaneous tissue or subcutaneous abscess, or both. A scalpel blade applied parallel to the cuff surface was used to excise the cuff in repetitive slices until the wet or pigmented layer of the cuff material was perfectly removed. The wound was sanitized with povidone iodine and then irrigated with saline. An absorbent monofilament thread was used to repair the subcutaneous tissue, and the skin was sutured [Figure 1(D)].

The sutured skin was dressed with a hydrocolloid (Karayahesive: Alcare, Tokyo, Japan), over which a semipermeable film (IV3000: Smith and Nephew, London, UK) was placed. At the superficial skin, the PD

TABLE 1
Profile of the Patients with Chronic Exit-Site or Tunnel Infection in Chronological Order

Patient	Age	Sex (M/F)	Primary kidney disease	PD duration[a] (months)	Position of catheter	Causative organism	Prescribed antibiotic	Catheter survival (months)
1	79	M	Nephrosclerosis	<1	Midline	MRSA	Vancomycin	23[b]
2	60	F	Interstitial nephritis	16	Pararectal	Gram-positive rod	Cefazolin	21[c]
3	66	M	Nephrosclerosis	90	Pararectal	*Pseudomonas aeruginosa* and *Enterococcus faecalis*	Ceftazidime	43[c]
4	59	M	Nephrosclerosis	119	Pararectal	*Corynebacterium* species	Cefotiam	39[d]
5	61	M	Diabetic nephropathy	22	Pararectal	Negative for culture	Ceftazidime	39[d]
6	71	M	Nephrosclerosis	114	Pararectal	Gram-positive rod	Ceftazidime	12[d]
7	61	F	Diabetic nephropathy	8	Midline	MRSA	Vancomycin	5[d]

M/F = male or female; PD = peritoneal dialysis; MRSA = methicillin-resistant *Staphylococcus aureus*.
[a] Until occurrence of the tunnel infection.
[b] Deceased because of dementia.
[c] Converted to hemodialysis.
[d] Patient still on PD (at May 2012).

catheter was also dressed with a semipermeable film to avoid mobilization [Figure 1(E)]. Catheter-anchoring sutures were not used because stitch abscesses can be a cause of persistent infection (9). The dressing was changed if bleeding occurred; otherwise, the dressing was unchanged for 1 week.

RESULTS

No dialysate leaks occurred after the procedure, and PD was immediately resumed. The procedure cured the infection in all patients. Wound healing was complete by 1 month after the procedure in all cases [Figure 1(F)]. No catheters were lost within the observation period. One patient (patient 1 in Table 1) died from noninfectious causes (dementia) 23 months later. Two patients (patients 2 and 3 in Table 1) were converted to hemodialysis therapy 21 and 43 weeks after the unroofing-BR surgery without development of a new catheter infection. Four patients (patients 4 – 7 in Table 1) continued on PD at 39, 39, 12, and 5 months after the unroofing-BR surgery.

DISCUSSION

Unroofing-BR for chronic exit-site and tunnel infection is an effective and economical means of achieving long-term salvage of the PD catheter. In our present experience, unroofing-BR successfully treated 7 patients with catheter infection, including infections with gram-negative bacteria (*Pseudomonas aeruginosa*) and methicillin-resistant *Staphylococcus aureus*. Compared with catheter replacement and splicing procedures, unroofing-BR requires no extra catheter materials. Unlike catheter replacement, unroofing-BR allows the patient to continue PD uninterrupted, thereby avoiding the expense and inconvenience of temporary hemodialysis. The patient is also not subjected to the risks of mechanical obstruction or leak that accompany new catheter placement.

Unroofing-BR holds some advantages compared with the splicing method of catheter translocation using a titanium extender (5). First, there is no risk of obstruction at the extender site where the new distal catheter connects with the old proximal catheter. Second, in cases of catheter displacement, unroofing-BR allows the patient to undergo transluminal replacement of a displaced catheter tip using an alpha-replacer guidewire (10). (A titanium extender interrupts transluminal passage of the alpha-replacer.) Third, there is no potential risk of latent infection ascribable to the subcutaneous titanium extender, which might harbor bacteria in its areas of contact with the catheter tubing.

The success of unroofing-BR can partly be assured by attention to specific details of the procedure. In the procedure described here, all granulation tissue and the infected superficial cuff are completely excised. Immobilization with the semipermeable film dressing helps to avoid catheter motion, which can impair wound healing. A favorable result is also partly a result of most of the contaminated tubing being placed outside the skin surface.

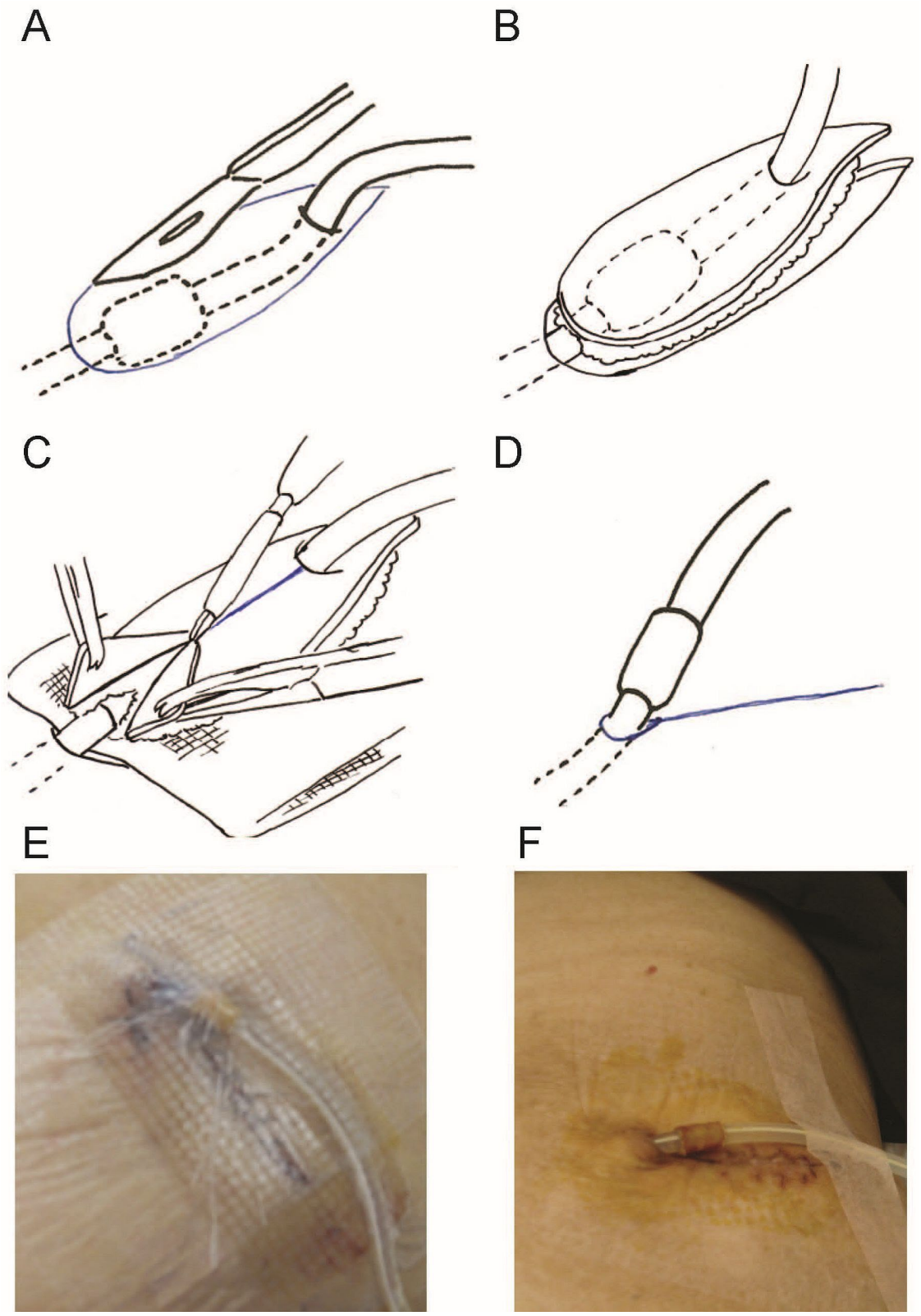

Figure 1 — Schematic of the unroofing surgery with *en bloc* resection of the skin and tissues around the peripheral cuff. (A) A skin incision in a "teardrop" shape is made immediately above the catheter. (B) The tissue around the catheter is resected, together with the catheter. (C) The infected tissue is removed, together with the covering "teardrop" of skin. (D) After removal of the infected tissue and skin, the wound is repaired. (E) Wound just after unroofing (patient 7). The sutured skin is dressed with a hydrocolloid dressing and covered with a semipermeable film dressing. (F) Wound 1 month after unroofing (patient 6). Wound healing is complete.

Although we consider unroofing-BR safe, convenient, and effective, some limitations to our study remain. The first limitation involves indications. Deep cuff involvement is a contraindication to the unroofing method (including unroofing-BR). In our experience, preoperative computed tomography is useful in diagnosing deep cuff infection. Also, if the extent of the patient's subcutaneous fat tissue is such that the superficial cuff of the catheter cannot be brought through the skin after the *en bloc* resection, then the unroofing procedure (including unroofing-BR) may not work well. Another limitation is that the number of treated patients in the present study is relatively small, and the observation period is relatively short. Studies with a larger population are warranted to allow for a statistical analysis.

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We declare that no financial conflict of interest exists.

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