Pediatr Surg Int (2009) 25:703–707
DOI 10.1007/s00383-009-2412-0

ORIGINAL ARTICLE

Conservative surgical management of catheter infections in children on peritoneal dialysis

Francesco Macchini · Sara Testa · Alberto Valadè · Maurizio Torricelli · Ernesto Leva · Gianluigi Ardissino · Alberto Edefonti

Accepted: 18 June 2009 / Published online: 2 July 2009

Abstract
Introduction Major indications for peritoneal dialysis catheter removal include chronic exit-site infection (ESI) or tunnel infection (TI). No consensus on the optimal treatment of these infections in children exists.
Patients During the last 10 years, 13 patients (7 females, mean age 56 months) on peritoneal dialysis were treated for recurrent ESI (*N*: 4) or TI (*N*: 9). *Staphylococcus aureus* (12 patients) and *Pseudomonas aeruginosa* (1 patient) were isolated. All patients had a double-cuff straight Tenchkoff catheter and underwent the shaving of the external cuff, with a new tunnel tightly adherent to the catheter, and an exit-site in the opposite abdominal region. A mean follow-up of 31 months/catheter demonstrated no recurrence of ESI and TI.
Discussion Little pediatric experience with cuff shaving exists: reported catheter salvage rates are 48–100%. In our experience, good results were obtained by shaving off the external cuff and re-creating a new tunnel, with a different course, strictly adherent to the catheter. This measure seems to guarantee an effective barrier against infections, while obviating the need of the external cuff.
Conclusions Sometimes, in case of recurrent ESI or TI, the external cuff may facilitate the persistence of bacteria. A conservative surgical treatment offers good results in children.

Keywords Peritoneal dialysis · Cuff shaving · Tunnel infection · Exit-site infection

Introduction

Chronic peritoneal dialysis (PD) is the first choice pediatric dialysis modality for end-stage renal failure. Catheter-related complications still represent an important cause of morbidity. In particular, infectious complications (tunnel infection: TI, exit-site infection: ESI and peritonitis) are frequently responsible for catheter removal. In childhood, the overall rate of infectious complications varies from 24.4 to 32.5/PD-months, with a consequent doubling of the risk of peritonitis [1–3].

So far, there is no consensus on the treatment of recurrent catheter infections, especially in the pediatric age. Some authors have proposed a simultaneous surgical removal and replacement of infected catheters, allowing for an immediate restart of PD, especially in children in whom dialysis cannot be interrupted for a long time and in those who present difficulties associated with vascular access [2]. Partial surgical re-implantations have been advocated too [4–6].

Shaving the external cuff as an alternative to catheter removal for persistent ESI and TI has been proposed [7–9], but only few experiences in the pediatric age are reported. The aim of the present study was to show the results of shaving and reconstruction of a new tunnel to treat ESI/TI in a single center.

F. Macchini (✉) · A. Valadè · M. Torricelli · E. Leva
Department of Pediatric Surgery, Fondazione IRCCS Ospedale Maggiore Policlinico, Mangiagalli e Regina Elena, via Commenda 10, 20122 Milan, Italy
e-mail: francesco.macchini@unimi.it

S. Testa · G. Ardissino · A. Edefonti
Department of Pediatric Nephrology and Dialysis, Fondazione IRCCS Ospedale Maggiore Policlinico, Mangiagalli e Regina Elena, via Commenda 10, Milan, Italy

Patients and methods

From 1996 to 2005, 13 patients (7 females), aged 4.5 years (1 month–14 years), with end-stage renal failure on PD were referred to our unit of pediatric surgery for recurrent ESI ($N = 4$; 2 males) and TI ($N = 9$; 4 males). *Staphylococcus aureus* (12 patients) and *Pseudomonas aeruginosa* (1 patient) were isolated in the external scrub cultures. Children with peritonitis infections were excluded from the study.

In all children, the technique of implantation was similar: performed with open surgery under general anesthesia by a dedicated surgical team, with a paramedian entry site, a curved, downward orientation and a contralateral exit site. The external cuff was positioned above the rectus sheath, at least 5 cm from the exit site [10]. After catheter implantation, the patients were regularly followed by the pediatric nephrology unit and addressed to automated peritoneal dialysis, with different treatment schedules according to individual needs.

In the present paper, ESI, TI and peritonitis were defined according to the International Society of Peritoneal Dialysis (ISPD) guidelines/recommendations [11]. ESI is diagnosed in the presence of purulent discharge from the sinus tract, or marked pericatheter swelling, redness and/or tenderness with or without a pathogenic organism cultured from the exit site. TI is defined as the presence of pain and signs of inflammation along the subcutaneous tunnel, not necessarily associated with ESI.

Empiric diagnosis of peritonitis/inner cuff infections is made if two of the following criteria are present: (1) the peritoneal effluent is cloudy, the effluent white blood cell (WBC) count is greater than 100 mm^3 and at least 50% of the WBCs are polymorphonuclear; (2) symptoms of peritonitis, like abdominal pain and fever, are detectable; (3) culture of peritoneal fluid is positive for organisms. On the basis of the above-mentioned criteria, inner cuff infections and peritonitis were excluded in all patients.

In our hospital, the protocol for the management of ESI and TI, includes: (1) culture of ES secretion and daily disinfection with sodium hypochloride (0.05%); (2) local therapy, consisting in the instillation of an antibiotic solution, empirically determined, directly into the tunnel; (3) intraperitoneal antibiotic therapy, prescribed on the basis of culture, and administered for at least 15 days, in cases that did not respond to previous treatment; (4) surgery in case of chronic or recurrent ESI and TI.

Recurrent ESI and TI were always treated by a conservative approach to minimize surgical invasiveness and resume PD immediately (Figs. 1, 2, 3).

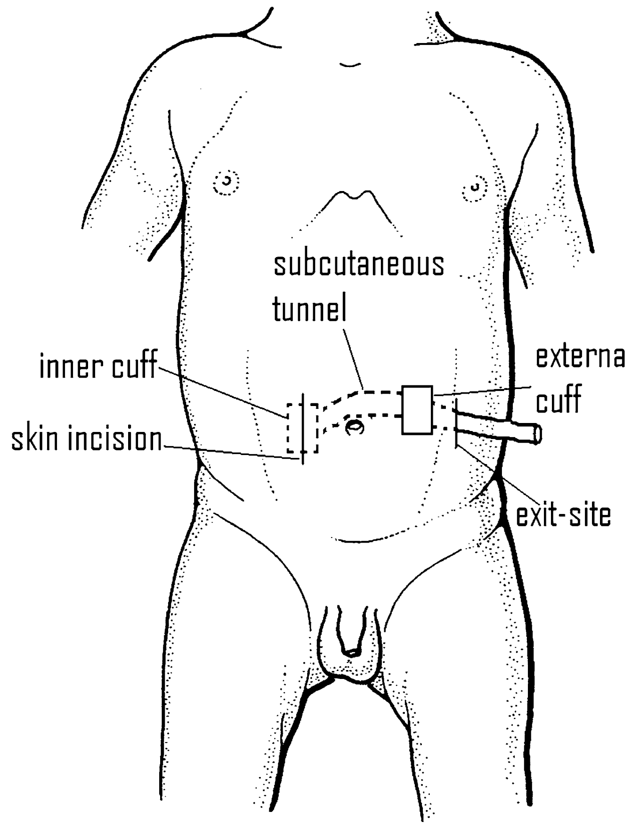

Fig. 1 Step 1: Cutaneous incision above the inner cuff

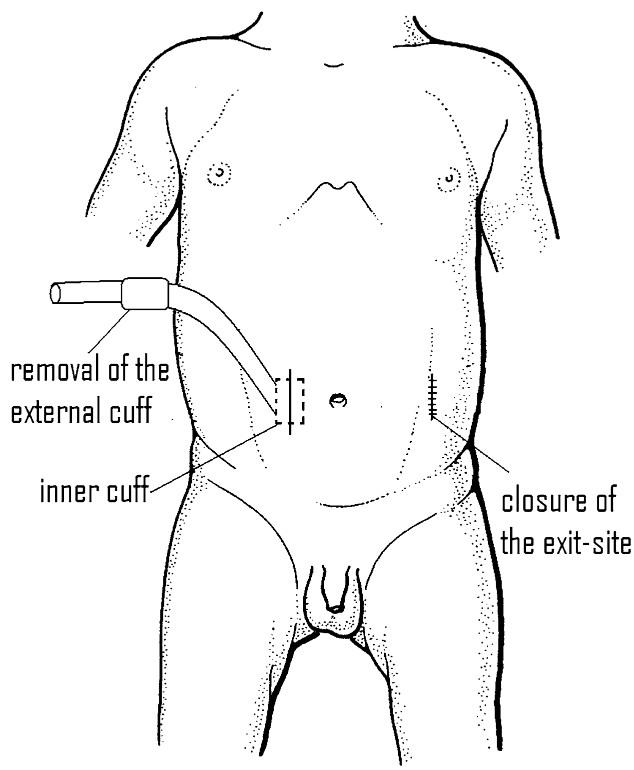

Fig. 2 Step 2: Removal of the external cuff

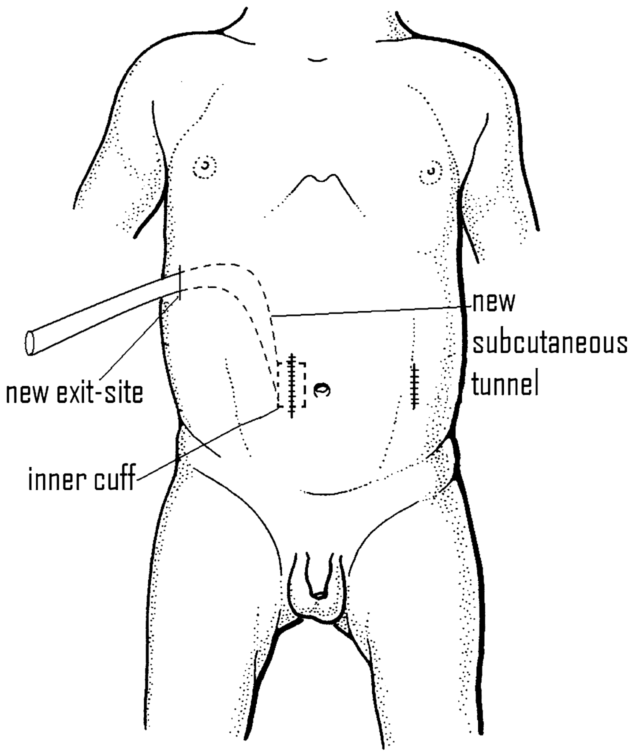

Fig. 3 Step 3: Creation of a new subcutaneous tunnel and abdominal wall closure

Results

The characteristics of the infected catheters, tunnel course and exit-site orientation are reported in Table 1.

The conservative approach consisted in the complete removal of the external cuff (cuff shaving) and in the reconstruction of a new subcutaneous tunnel, with a contralateral course and an exit site positioned in the opposite abdominal region. Germs isolated in the removed cuffs were always the same as that found on the external scrub culture. The peritoneal membrane was never opened, and neither was the internal cuff taken off. The tunnel was made with a thin tunneller, to create a tunnel tightly adherent to the catheter. The infected tunnel was closed after careful curettage and iodopovidone instillation combined with a broad-spectrum antibiotic. The procedure was performed under general anesthesia and was followed by antibiotic therapy. PD was started 8 h after surgery. The technique was performed only after the exclusion of peritonitis. The isolated infectious agent did not modify the choice of surgical treatment.

A mean follow-up of 31 (1–80) months/catheter demonstrated no recurrence of ESI or TI. No episodes of peritonitis were observed. Three patients were still on PD treatment, five patients had their catheter removed after kidney transplantation and five had to stop PD for reasons unrelated to the catheter (Table 2). The good results obtained with the present approach prompted us to modify the original study design: a control group was not recruited.

Table 1 Characteristics of implanted PD catheters

	N	Percentage
Catheter		
Tenckhoff double-cuff straight catheter	13	
Entry site		
Midline	4	31
Paramedian	9	69
Tunnel		
Swan neck	10	77
Straight	3	23
Exit-site orientation		
Downward	10	77
Lateral	3	23

Discussion

Despite the recent advances in catheter design and dialysis technique, catheter-related infections remain an important cause of patient morbidity and a significant cause of technique failure [1].

The true incidence of TI is difficult to ascertain, as ESI and TI are often grouped together. In fact, ESI and TI often coexist: ESI is a documented risk factor for the development of TI and the treatment of TI is similar to that of chronic ESI [12]. Exit-site infections may result in catheter loss through the primary infection itself or due to recurrent peritonitis [13].

While some authors report a lower ESI rate with double-cuff catheters and significantly more resistant infections with single-cuff catheter [14, 15], in other studies no differences were found [14, 15].

In adult series, 39–53% of patients developed ESI and the estimated incidence varied from 0.05 to 1.1 episodes per patient/year [12, 16]. The reported prevalence of ESI in children varies from 25 to 69% [17, 18], while the incidence ranges from 1.1 to 1.98 episodes per patient/year [19], thus higher than in adult series. In children, *S. Aureus* and *P. Aeruginosa* are most likely to have associated peritonitis episodes that result in catheter replacement, similar to the adult experience. ESI alone is responsible for catheter removal in 10.8% of cases [19].

General indications for catheter surgery include chronic ESI and TI, treatment-resistant TI and ESI, ESI or TI associated with Gram-negative peritonitis, tuberculous or fungal peritonitis and relapsing peritonitis [20, 21].

Some authors have stressed the possibility of performing a simultaneous surgical removal of infected catheters and

Table 2 Follow-up and causes of catheter removal

Patient (sex, age in years)	Follow-up (months)	Reason for catheter removal
1. F, 1.5	45	Transplant
2. M, 2	9	Transplant
3. F, 1	3	No catheter-related complication
4. F, 4	60	Still on CPD
5. M, 4	60	No catheter-related complication
6. F, 1 month	1	No catheter-related complication
7. M, 9	80	No catheter-related complication
8. M, 6	17	No catheter-related complication
9. F, 6 months	54	Still on CPD
10. M, 14	48	Still on CPD
11. M, 8	10	Transplant
12. F, 9	1	Transplant
13. F, 1.5	12	Transplant

replacement with a new catheter, but PD cannot be immediately resumed [22]. This is an important consideration, especially in young patients, where PD cannot be interrupted for a prolonged time and a vascular access for hemodialysis cannot be obtained [23]. Some authors have proposed a partial re-implantation of infected catheter: the subcutaneous portion of the catheter is removed and the external portion of a new Tenckhoff catheter is connected with an internal stent, sealed with a medical adhesive silicone glue to the remaining portion of the implanted catheter [4–6]. The tunnel course and the exit site are built in the opposite abdominal region. The procedure seems to be effective, and PD can be resumed immediately after reimplantation. In our opinion, the disadvantage of this technique consists in the manipulation and modification of the original catheter structure.

Shaving the external cuff, as an alternative to catheter removal, was proposed in the early 1980d [7–9]. Reported catheter salvage rates are 48–100%. On the contrary, Piraino [12] reported a 73% failure rate after cuff shaving. A single pediatric experience with cuff shaving exists, consisting in raising out of the body the catheter and the outer cuff, removing the infected tissues and suturing the injury to form a new exit site [24]. The authors conclude that cuff shaving in children can be a useful alternative treatment in selected patients. With this technique, the tunnel is shorter with an unmodified course, and this can explain the unsatisfactory results obtained in their experience.

In our hospital, treatment consisting of removing the subcutaneous cuff associated with re-tunnelization guaranteed a successful outcome in all the patients. The new tunnel was created with a different course and was strictly adherent to the catheter. This simple measure, performed with a thin tunneller, was able to avoid infections, while obviating the need for the external cuff. This, in particular, while representing a valid barrier against bacteria [25], in case of recurrent ESI and TI, may predispose to the growth of germs, so that infections cannot be eradicated by medical therapy alone. The conservative surgical management guarantees minimal discomfort, a reduced operating time and an immediate resuming of PD [4, 26]. In fact, not removing the catheter offers some advantages: no modifications of the original intraperitoneal camera of exchanges, no risks of leakage or bleeding, no manipulations of the original catheter and preservation of peritoneal sterility. The same salvage procedure can be performed even in catheters laparoscopically implanted. Infectious complications are the most common causes of catheter loss [27, 28], with a peritonitis rate of 1:13.2 months of PD [29]. In the present study, an increased incidence of infectious complications was not registered.

Our data, while waiting for larger multicentric series, seem to suggest that in children a conservative surgical treatment represents a valid alternative in the treatment of recurrent TI or ESI unresponsive to medical therapy. Postoperative discomfort is low and peritoneal dialysis can be restarted a few hours after surgery.

In conclusion, we believe that every effort must be taken to avoid catheter reimplantation in case of recurrent ESI/TI.

References

1. Burkart JM (1996) Significance, epidemiology, and prevention of peritoneal dialysis catheter infections. Perit Dial Int 16(Suppl 1):S340–S346
2. Bernardini J, Bender F, Florio T, Sloand J, Palmmontalbano L, Fried L, Piraino B (2005) Randomized, double-blind trial of antibiotic exit-site cream for prevention of exit-site infection in peritoneal dialysis patients. J Am Soc Nephrol 16(2):539–545
3. Mc Chiu, Tong PC, Lai WM, Lau SC (2008) Peritonitis and exit-site infections in pediatric automated peritoneal dialysis. Perit Dial Int 28(3):S179–S182
4. Goldraich I, Mariano M, Rosito N, Goldraich N (1993) One-step peritoneal catheter replacement in children. Adv Perit Dial 9:325–328
5. Chao SH, Tsai TJ (1996) Partial replantation of Tenckhoff catheters to treat intractable exit-site/tunnel infection. J Am Soc Nephrol 7(7):1085–1087
6. Wu YM, Tsai MK, Chao SH, Tsai TJ, Chang KJ, Lee PH (1999) Surgical management of refractory exit-site/tunnel infection of Tenckhoff catheter: technical innovations of partial replantation. Perit Dial Int 19(5):451–454
7. Khanna R, Twardowski ZJ (1996) Recommendations for treatment of exit-site pathology. Perit Dial Int 16(Suppl 3):S100–S104
8. Helfrich GB (1982) Results and expectations of renal transplantation. JAMA 247(23):3187
9. Gloor HJ, Nichols WK, Sorkin MI, Prowant BF, Kennedy JM, Baker B, Nolph KD (1983) Peritoneal access and related complications in continuous ambulatory peritoneal dialysis. Am J Med 74(4):593–598
10. Lewis MA, Smith T, Roberts D (1996) Peritonitis, functional catheter loss and the sitting of the Dacron cuff in chronic

peritoneal dialysis catheters in children. Eur J Pediatr Surg 6(5):285–287
11. Warady BA, Schaefer F, Holloway M, Alexander S, Kandert M, Piraino B, Salusky I, Tranaeus A, Divino J, Honda M, Mujais S, Verrina E, International Society for Peritoneal Dialysis (ISPD) Advisory Committee on Peritonitis Management in Pediatric Patients (2000) Consensus guidelines for the treatment of peritonitis in pediatric patients receiving peritoneal dialysis. Perit Dial Int 20(6):610–624
12. Piraino B, Bernardini J, Sorkin M (1986) The influence of peritoneal catheter exit-site infections on peritonitis, tunnel infections, and catheter loss in patients on continuous ambulatory peritoneal dialysis. Am J Kidney Dis 8(6):436–440
13. Piraino B, Bernardini J, Sorkin M (1989) Catheter infections as a factor in the transfer of continuous ambulatory peritoneal dialysis patients to hemodialysis. Am J Kidney Dis 13(5):365–369
14. Thodis E, Passadakis P, Lyrantzopooulos N, Panagoutsos S, Vargemezis V, Oreopoulos D (2005) Peritoneal catheters and related infections. Int Urol Nephrol 37(2):379–393
15. Twardowski ZJ, Prowant BF, Nichols WK, Nolph KD, Khanna R (1992) Six-year experience with swan neck catheters. Perit Dial Int 12(4):384–389
16. Vas SI (1994) Treatment of peritonitis. Perit Dial Int 14(Suppl 3):S49–S55
17. Watson AR (1996) Chronic renal failure in childhood. Br J Hosp Med 55(6):329–331
18. Warady BA, Hébert D, Sullivan EK, Alexander SR, Tejani A (1997) Renal transplantation, chronic dialysis, and chronic renal insufficiency in children and adolescents: the 1995 annual report of the North American Pediatric Renal Transplant Cooperative Study. Pediatr Nephrol 11(1):49–64
19. Levy M, Balfe JW, Geary D, Fryer-Keene S, Bannatyne R (1990) Exit-site infection during continuous and cycling peritoneal dialysis in children. Perit Dial Int 10(1):31–35
20. Neu AM, Kohaut EC, Warady BA (1995) Current approach to peritoneal access in North American children: a report of the Pediatric Peritoneal Dialysis Study Consortium. Adv Perit Dial 11:289–292
21. Oreopoulos DG, Khanna R, Williams P, Vas SI (1982) Continuous ambulatory peritoneal dialysis: 1981. Nephron 30(4):293–303
22. Lui SL, Li FK, Lo CY, Lo WK (2000) Simultaneous removal and reinsertion of Tenckhoff catheters for the treatment of refractory exit-site infection. Adv Perit Dial 16:195–197
23. Majkowski NL, Mendley SR (1997) Simultaneous removal and replacement of infected peritoneal dialysis catheters. Am J Kidney Dis 29(5):706–711
24. Yoshino A, Honda M, Ikeda M, Tsuchida S, Hataya H, Sakazume S, Tanaka Y, Shishido S, Nakai H (2004) Merit of the cuff-shaving procedure in children with chronic infection. Pediatr Nephrol 19(11):1267–1272
25. Lewis MA, Smith T, Postlethwaite RJ, Webb NJ (1997) A comparison of double-cuffed with single-cuffed Tenckhoff catheters in the prevention of infection in pediatric patients. Adv Perit Dial 13:274–276
26. Schröder CH, Severijnen RS, de Jong MC, Monnens LA (1993) Chronic tunnel infections in children: removal and replacement of the continuous ambulatory peritoneal dialysis catheter in a single operation. Perit Dial Int 13(3):198–200
27. Holley JL, Bernardini J, Piraino B (1994) Infecting organism in continuos ambulatory peritoneal dialysis patients on the Y-set. Am J Kidney Dis 23:569–573
28. Piraino B (1996) Exit-site care. Perit Dial Int 16(Suppl 1):336–339
29. Macchini F, Valadè A, Ardissino G, Testa S, Edefonti A, Torricelli M, Luzzani S (2006) Chronic peritoneal dialysis in children: catheter related complications. a single centre experience. Pediatr Surg Int 22(6):524–528