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PERITONEAL DIALYSIS CUFF-SHAVING—A SALVAGE THERAPY FOR REFRACTORY EXIT-SITE INFECTIONS

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♦ ***Introduction:*** **Cuff-shaving has been described as a salvage technique for refractory exit-site infections, with conflicting data regarding infection and catheter outcomes. We describe our experience with cuff-shaving as a rescue therapy for exit-site infections unresponsive to systemic therapy.**

♦ ***Methods:*** **We retrospectively reviewed patients who underwent cuff-shaving between January 2012 and June 2017. Refractory exit-site infection was defined as purulent discharge from the exit site with no clinical response after 3 weeks of systemic antibiotic treatment.**

♦ ***Results:*** **Fifty-three cuff-shavings were included, mean age was 53.4 ± 13.4 years, 26 patients were male. Median dialysis vintage was 29 months (interquartile range [IQR] 14.3 – 38), and 39 (73.6%) were on continuous ambulatory peritoneal dialysis (CAPD). The exit-site infection rate before cuff-shaving was 1.12 episodes per patient-year and the median time from infection to shaving was 52 days (IQR 35 – 76). The most frequent agents were *Staphylococcus aureus* (34%), *Corynebacterium* spp. (17%) and *Pseudomonas aeruginosa* (15%). Median follow-up was 9 months (IQR 1 – 18.5), during which time 35 catheters were removed, 5 due to non-infectious reasons. Using the Kaplan-Meier survival analysis, median catheter survival was 24 months (95% confidence interval [CI] 4.17 – 43.83). At 12 months, the probability of catheter survival was 54% and was not statistically different between gram-positive and gram-negative agents, although it was significantly shorter for fungal agents.**

♦ ***Conclusion:*** **Cuff-shaving is a feasible rescue therapy to treat refractory exit-site infections. In our experience, it allowed resolution of infections in a significant proportion of cases, except for fungal agents, and therefore extended catheter survival time, besides being associated with a small rate of complications.**

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Peritoneal catheter-related infections remain the most common cause of peritoneal dialysis (PD) discontinuation and conversion to hemodialysis (1). Catheter removal is recommended for chronic exit-site infections (ESIs) that are unresponsive to prolonged antibiotic treatment (over 3 weeks) (2), which carries significant morbidity and disrupts the patient's quality of life. Removal of the catheter's external cuff, also referred to as shaving, was first described in the 1980s as a salvage technique for refractory ESIs in 2 patients (3). Since then, a small number of observational studies have reported the results of the procedure in terms of infection rates and catheter survival, with conflicting data (4–6). In this review, we describe our experience with cuff-shaving as a rescue therapy for ESIs unresponsive to systemic antibiotics.

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METHODS

Patients undergoing PD therapy in our unit who had been submitted to cuff-shaving due to refractory exit-site infection (ESI) between January 2012 and June 2017 were included. No patients were submitted to cuff-shaving for clinical reasons other than ESI, and there were no cases of concomitant peritonitis.

Refractory ESI was defined as purulent discharge from the exit site with no clinical response after 3 weeks of systemic antibiotic treatment.

The catheters were all double-cuffed, swan-neck coiled catheters (Fresenius Fast-flow swan neck, Fresenius medical care, Bad Homburg, Germany) placed using either laparoscopic or mini-laparotomy technique by a general surgeon, assisted by a nephrologist. Screening of *Staphylococcus aureus* nasal carriage was performed in all patients before initiation of PD and eradication with mupirocin was done if positive. Empirical treatment for ESI regimens consisted of trimetoprim-sulfametoxazol 800/160 mg once daily, or, if the patient had a previous history of gram-negative infection, ciprofloxacin 250 mg every 8 hours, adjusted according to the antibiotic sensitivity of the microbiological agents.

Clinical data were retrieved from the patients' medical records. The study was approved by our Hospital's Ethics Committee.

STATISTICAL ANALYSIS

Mean, median, standard deviation, interquartile range (IQR) and percentage were used for descriptive statistics.

Kaplan-Meier curves and log rank tests were used to calculate the catheter survival, censored for death or catheter removal due to reasons not related to infection. Tests were 2-tailed, and statistical significance corresponded to $p < 0.05$. Data were analyzed using SPSS IBM version 21 (IBM Corp., Armonk, NY, USA).

CUFF-SHAVING PROCEDURE

Cuff-shaving was performed as an outpatient ambulatory procedure under local anesthesia (lidocaine 2%), cefazolin 2 g intravenous (IV) single dose, and systemic analgesia (paracetamol 1 g IV). The external cuff was identified by palpation and a small superficial skin incision was made parallel near the subcutaneous cuff. A blunt instrument (14-cm Kelly curved forceps) was used to debride the fibrous tissue surrounding the cuff, releasing it, and then the cuff was separated from the catheter. According to the antibiogram, if the isolated agent was susceptible, gentamicin 80 mg single-dose was instilled toward the subcutaneous tunnel. The incision was finally sutured, local dressing was made, and antibiotics were kept until the infection was resolved.

RESULTS

During the study period, 48 patients had 53 cuff-shavings (5 patients had 2 shaving procedures). The demographic data are described in Table 1.

Among the etiological agents of the ESIs, the majority—62.2%—were gram-positive (n = 33), whereas 26.4% (n = 15) were gram-negative, and 7.6% (n = 4) were fungal agents. In 1 case, no agent was identified despite multiple swabs. *Staphylococcus aureus* accounted for the majority of infections (34%), followed by *Corynebacterium* spp. (17%) and *Pseudomonas aeruginosa* (15.1%). The microbiological agents responsible for the refractory ESIs are listed in Table 2.

The median time from the diagnosis of the ESI to the date of the shaving was 52 days (interquartile range [IQR] 35 – 76). The procedure solved 39 out of 53 infections (73.6%) (Table 2). In the remaining 14 patients, the catheter was removed because of persistent infection (n = 13) and post-shaving leak (n = 1). During a median follow-up of 9 months (IQR 1 – 18.5), 29 patients (74.4%) had a subsequent ESI, on average 4 months after the shaving procedure (IQR 1 – 7). In one-third of the cases (n = 10), the subsequent infection was caused by the same agent that led to the removal of the cuff (5 *Staphylococcus aureus*, 2 *Staphylococcus epidermidis*, 1 *Corynebacterium* spp., 1 *Candida parapsilosis*, 1 *Klebsiella pneumoniae*). At 1 month after the shaving, no cases of peritonitis were reported, and at 6 months after the shaving procedure, there were 10 cases of peritonitis, occurring on average 7 weeks after the shaving (IQR 6 – 12.25), resulting in a peritonitis rate of 0.15 episodes/patient-year.

Three complications occurred after the shaving procedure: 1 accidental catheter laceration and 2 peritoneal dialysate leaks. Laceration was solved by shortening the catheter and adapting a new extensor, and the patient resumed PD. One of the leaks had to be corrected immediately; the other one, due to its small size, was corrected electively.

TABLE 1
Baseline Demographic and Clinical Characteristics of the Patients Submitted to External Cuff-Shaving

	n=53
Age, years (mean±SD)	53.4±13.4
Male, n (%)	26 (49.1)
Time on PD, months (median, IQR)	29 (14.3–38)
CAPD, n (%)	39 (73.6)
Diabetes, n (%)	10 (19)
Exit-site infection rate, episodes/patient-year	1.12

SD = standard deviation; PD = peritoneal dialysis; IQR = interquartile range; CAPD = continuous ambulatory PD.

TABLE 2
Etiological Agents Accounting for Refractory Exit-Site Infection

Agent	n (%)	Cure rate after shaving, n (%)
Gram-positive (n=33)		
Staphylococcus aureus	18 (34.0)	15 (83.3)
Corynebacterium spp.	9 (17.0)	6 (66.7)
Staphylococcus epidermidis	5 (9.4)	3 (60)
Staphylococcus hominii	1 (1.9)	1 (100)
Gram-negative (n=15)		
Pseudomonas aeruginosa	8 (15.1)	5 (62.5)
Proteus mirabilis	2 (3.8)	2 (100)
Burkholderia cepacia	2 (3.8)	1 (50)
Klebsiella pneumoniae	2 (3.8)	2 (100)
Achromobacter xylosoxidans	1 (1.9)	1 (100)
Fungal agents (n=4)		
Candida parapsilosis	4 (7.5)	3 (75)
Others (n=1)		
Negative cultures	1 (1.9)	0 (0)
Total	53 (100)	39 (73.6)

CATHETER SURVIVAL

During the follow-up period, 35 catheters were removed, 5 due to non-infectious reasons, which were censored for survival analysis, leaving 30 to further analysis, presented in Figure 1.

The frequency of microbiological agents responsible for the initial cuff-shaving and the global percentage of catheter removal are listed in Table 3.

From the 30 catheters listed in Table 3, 14 were removed due to persistent infection (same agent), and 17 due to new/subsequent infection (Supplemental Table 1). In 10 of 17 cases, the catheter was removed due to a subsequent infection from a

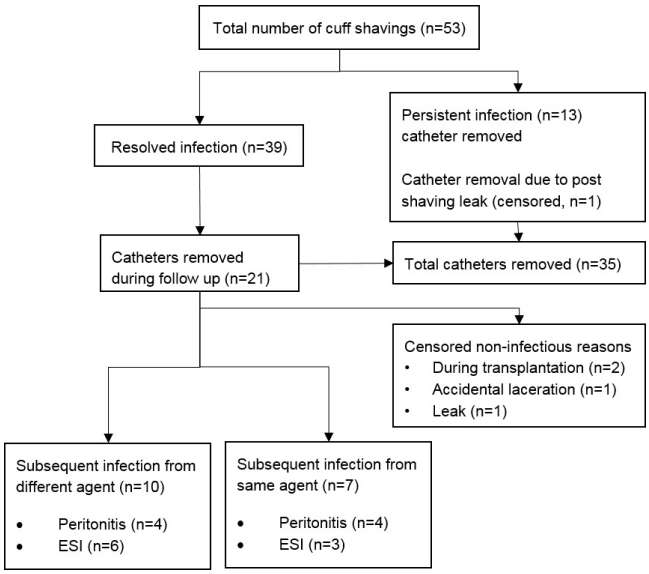

Figure 1 — Patient outcomes following cuff-shaving.

TABLE 3
Agents Responsible for Refractory Infection, with Rates of Catheters Requiring Removal Due to Infection

ESI agent responsible for cuff-shaving	*n*	Catheter removed due to infection, *n* (%)	Total
Gram-positive (*n*=33)			
Staphylococcus aureus	18	10 (55.6)	54,5
Corynebacterium spp.	9	5 (55.6)	
Staphylococcus epidermidis	5	3 (60)	
Staphylococcus hominii	1	0 (0)	
Gram-negative (*n*=15)			
Pseudomonas aeruginosa	8	3 (37.5)	46,7
Proteus mirabilis	2	1 (50)	
Burkholderia cepacia	2	1 (50)	
Klebsiella pneumoniae	2	1 (50)	
Achromobacter xylosoxidans	1	1 (100)	
Fungal (*n*=4)			
Candida parapsilosis	4	4 (100)	100
Others (*n*=1)			
Negative cultures	1	1 (100)	100
Total	53	30 (56.6)	

ESI = exit-site infection.

different agent than that which led to the shaving (peritonitis in 4 cases, exit-site infection in 6 cases).

Using the Kaplan-Meier survival analysis, the median survival of the catheter was 24 months (95% confidence interval 4.17 – 43.83). At 12 months after shaving, the probability of catheter survival was 54% (Figure 2).

There was also no difference in median survival between gram-positive and gram-negative agents (30 vs 34 months, $p = 0.611$, log rank test). Using the log rank test, there was

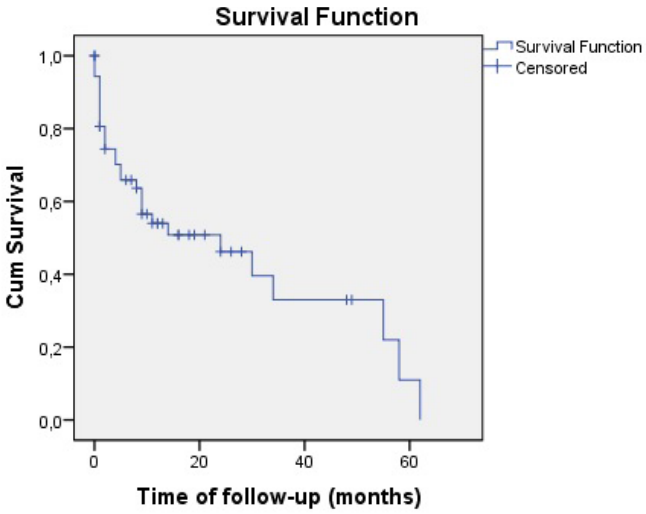

Figure 2 — Kaplan-Meier survival curves for peritoneal dialysis catheter survival.

also no difference in median catheter survival when comparing ESIs caused by *Staphylococcus aureus* (catheter survival 29.9 vs 25.5 months, $p = 0.547$), *Corynebacterium* spp. (27.1 vs 27.5 months, $p = 0.904$) and *Pseudomonas aeruginosa* (25.8 vs 26.9 months, $p = 0.77$). However, median survival for fungal agents was significantly shorter, at 3 vs 28.9 months ($p = 0.004$).

DISCUSSION

In our study, external cuff-shaving allowed a median 12-month survival of 54%, similar to that reported by Scalamogna *et al.* (5). This procedure allowed the median survival to be extended to 24 months for an otherwise refractory infection with indication of catheter removal, with a very low rate of complications. We believe that the technique used has contributed to the overall success of the shaving procedure. Piraino *et al.* (4) reported a reduced survival rate, probably due to the high accident rate associated with scalpel use. In our center, we use a blunt instrument to dissect the cuff in order to avoid accidental catheter laceration. The occurrence of leakage has been previously described; when the external cuff, which provides additional anchorage to the catheter, is removed, the catheter only relies on the abdominal muscular wall cuff for support, increasing the risk for dialysate leakage. In both cases, clinical signs of peritoneal leak were already present before the shaving, and in 1 patient, the leak had already been confirmed by scintigraphy, both exacerbated by the shaving procedure.

Debowski *et al.* (7) reported 5 cases of cuff-shaving in patients who had developed cuff-extrusion. Although the reason for the procedure was extrusion of the external cuff, it had developed secondary to repeated ESIs in 4 patients and the cuff was likely to be infected, as none of the 5 patients experienced new ESIs after cuff-shaving had been performed. No complications associated with the technique were reported.

Contrary to what was reported by Scalamogna *et al.* (5), who postulated that the shaving could facilitate translocation of the bacteria into the subcutaneous tissue and inner cuff, causing development of secondary peritonitis, the fact that there were no episodes of peritonitis up to 1 month after the procedure, the time within which they could be considered a direct complication of the shaving, supports the low rate of complications associated with our technique. At 6 months, our peritonitis rate was 0.15 episodes per patient-year. While we postulate that removing the additional support of the external cuff might theoretically increase the risk of peritonitis due to microorganism translocation, our peritonitis rate in this subgroup was similar to the peritonitis rate in our PD program, ranging between 0.20 and 0.35 episodes per patient-year, which stands below the current recommended limit of 0.5 episodes per patient-year (8).

In our center, soft tissue ultrasound is only performed when there is clinical suspicion of tunnel infiltration of the infectious process. The use of routine ultrasound in ESI could help define the extent of infection, by showing infiltration of the tunnel and involvement of the internal cuff, and therefore identify patients who are at higher risk of cuff-shaving failure and would benefit from catheter removal (9,10). Nevertheless, while some authors have proposed predictors of catheter failure such as a sonolucent zone around the external cuff > 1 mm thick following a course of antibiotic treatment and the involvement of the proximal cuff (11), further studies are needed to clarify the best approach following the results of the ultrasound (2). This is a limitation of our study, since by not performing routine ultrasounds, we might have missed deeper involvement in some cases that were not clinically apparent and this way, might have submitted patients with inner cuff involvement to cuff-shaving, which resulted in persistent/recurrent infection and subsequent catheter loss.

The epidemiology of our case series differs from the previous series described in the 1980s and 1990s (4,5). The universal eradication of *Staphylococcus aureus* nasal carriage has decreased the prevalence of *Staphylococcus aureus* ESIs, and use of topical antibiotics at the exit site has lead to a change in the organisms causing ESIs, with an increasing prevalence of other gram-positive agents, such as *Corynebacterium* species, and also fungal agents (12). Despite this, *Staphylococcus aureus* was the most frequent agent in our series of refractory ESIs, albeit with an excellent response to cuff-shaving. Successful eradication of *Staphylococcus aureus* ESI has also been reported by others (5,13), with resolution rates of infection in approximately half of the cases.

Corynebacterium species, once thought to be contaminant flora of the human skin, have been increasingly recognized as pathogenic and responsible for peritoneal catheter-related infections (14,15). In our series, *Corynebacteria* were responsible for 17% of refractory ESIs (27% within gram-positive), with a response rate of 67% after shaving. Catheter survival (27.1 months) was not statistically different from other agents, namely other gram-positives such as *Staphylococcus aureus* (29.9 months) or overall catheter survival (24 months). We recognize this is higher than the incidence of PD catheter-related infections due do *Corynebacteria* described in the literature, ranging from 1.8% to 2.4% for peritonitis (14,16–18) and 9% to 12.4% for ESIs (15,16). One possible explanation is that due to the high rate of ESIs previous to the cuff-shaving procedure, patients were exposed to multiple antibiotics, thereby increasing the susceptibility and incidence of *Corynebacteria* ESIs. Nevertheless, we cannot assure that our rate might not also have been overestimated by the presence of *Corynebacteria* as colonizers instead of causal pathogens for ESI. While *Corynebacteria* still remains an uncommon peritonitis agent, previous reports have shown a need for catheter removal in 21% of patients and relapse rates of 18% to 30% (14,17). In those cases, in the absence of other identified causal agents and the presence of clinical signs of ESI, we chose to direct our therapy against the *Corynebacteria*.

Fungal infections are a rare cause of ESIs, and knowledge regarding the best approach to these is limited. Our experience shows that despite cuff-shaving, all the catheters were removed due to subsequent infections and the procedure did not extend the catheter survival in fungal ESIs (overall survival being only 3 months). While the number of cases is small and therefore needs careful interpretation, removal of the catheter probably constitutes a safer option in fungal ESIs.

Pseudomonas ESIs were historically associated with a high rate of failure with conservative therapy, requiring removal of the PD catheter in a large percentage of cases despite prolonged antibiotherapy (19,20). Previous studies have reported a failure rate of the cuff-shaving procedure close to 100% to eradicate *Pseudomonas* infections (4–6). Despite our small number, our series shows a 62.5% resolution rate after cuff-shaving and a catheter survival of 25.8 months, no different from other agents. Cuff-shaving might therefore constitute a salvage option in refractory ESIs, especially if the infection has not spread to the tunnel and inner cuff. Notwithstanding these results, the small number of cases warrants careful interpretation, and these patients should be carefully followed to exclude complications such as tunnel infection or secondary peritonitis.

Also, due to the small number of cases, our data do not allow us to draw conclusions about other gram-negative agents.

Due to the small sample number of ESIs in each group (*Staphylococcus aureus*, *Corynebacterium* spp., and *Pseudomonas aeruginosa*) and the small variation in success rates obtained with cuff-shaving, it is possible that the non-statistical difference in catheter survival results from the lack of power of the sample size, or partly from overestimation of *Corynebacteria* ESIs.

The standard recommended approach for refractory ESIs is simultaneous PD catheter removal and replacement (SCR) (2). It has the advantage of keeping the patient on PD, avoiding the temporary need for hemodialysis, and saving the need for a second surgery to reinsert the PD catheter.

Several retrospective studies have shown that SCR is a safe procedure, not associated with an increased risk of infectious or mechanical complications in ESIs. Swartz *et al.* (21) successfully performed SCR in 30 out of 36 patients in

PD-related infectious complications, of which 5 were due to tunnel infection, with a catheter survival of 4 to 62 months. Cancarini *et al.* (22) reported on 68 infectious complications of PD, including 26 tunnel infections, all of which resolved with SCR. Posthuma *et al.* (23) did 40 SCR, 22 of them due to refractory ESI. The most common agents were *Staphylococcus aureus* (55%) and *Pseudomonas aeruginosa* (27%). All but 3 patients resumed PD (the 3 patients who had SCR due to refractory peritonitis chose to temporarily switch to hemodialysis instead of assisted automated PD), and SCR resolved the ESIs. Majkowski reported 34 SCR in pediatric PD patients, 8 of which due to refractory ESI. Simultaneous catheter replacement resolved all but one ESI (due to *Staphylococcus aureus*), and all patients managed to stay on PD after the procedure (24). Crabtree *et al.* (25) described 55 SCR, performed due to peritonitis, mechanical issues, and refractory tunnel infection (12 cases, of which 6 patients with *Pseudomonas aeruginosa,* 2 with *Corynebacterium* and 1 with *Staphylococcus aureus*). The 1-year global catheter survival rate was 85%, and PD survival was 5.1 years. These results need careful interpretation since SCR was performed for both non-infectious and infectious reasons and none of these studies reported survival rates exclusively for SCR performed for refractory ESI/tunnel infection. Lui *et al.* (26) retrospectively reviewed the outcomes of SCR in 37 *Pseudomonas aeruginosa* ESIs. All patients were able to resume PD, and at 1-year follow-up, 46% (17 patients) had developed ESIs (3 cases of *Pseudomonas aeruginosa* ESI), with no episodes of catheter loss. Thus, contrary to what has been reported from earlier observations (21), the technique might be feasible for *Pseudomonas aeruginosa* ESIs.

Unfortunately, SCR does not constitute standard practice in refractory ESIs in our center, and therefore we have no available data regarding the success rates of this procedure in refractory ESIs. Patients who do not respond to conservative therapy (antibiotics) are submitted to external cuff-shaving, and only if this procedure fails do we refer them to catheter replacement. This therefore constitutes a limitation of our study, as we do not have a control group to compare our catheter survival rates of the cuff-shaving procedure with success rates of SCR. Direct comparison with other reports would lead to bias since every center has its unique epidemiological data, and the majority of studies reported global survival rates of peritonitis, ESI, and non-infectious complications after SCR altogether, not focusing exclusively on ESIs. Nevertheless, we still believe that cuff-shaving has a place as a rescue therapy, as a minimally invasive procedure, especially for patients who are not suitable candidates for general anesthesia for catheter replacement, or if, due to logistic reasons, catheter replacement cannot be scheduled in a timely manner.

Despite these limitations and the retrospective nature of our review, this is the largest case series of cuff-shaving reported in the literature, and no prospective studies exist.

In our series, all catheters used were double-cuff, swan-neck coiled catheters. While there was an initial enthusiasm from early observational data toward double-cuff catheters as these appeared to be associated with a lower rate of peritonitis (27,28), subsequent studies, including a randomized controlled trial (29), failed to prove this hypothesis. Most recent data show a trend of lower rates of *Staphylococcus aureus* peritonitis, albeit only on the subset of patients who began PD before 2001 (30). Double-cuff catheters might provide an added barrier to periluminal movement of organisms into the peritoneal cavity, although consistent evidence to recommend one type over the other is still lacking.

Other salvage techniques have been proposed in refractory ESIs. Surgical unroofing of the tunnel tract, coupled with cuff-shaving (31,32), and catheter diversion at a new exit site (33,34) have been described in small case series, with positive results. Further studies are needed to determine the roles and to compare the effectiveness between these 3 techniques.

CONCLUSIONS

In conclusion, the cuff-shaving procedure is a feasible rescue therapy in refractory ESIs. In our experience, it allowed resolution of infections in a significant percentage of cases, except for fungal agents, and therefore extended catheter survival time, besides being associated with a small rate of complications. While some cases still do not respond to cuff-shaving and will need catheter removal, the procedure is associated with minimal morbidity and the extended time that allows the patient to remain on PD can be used to plan for a deferred catheter removal, this approach being especially useful in centers where catheter placement is done by general surgeons, as well as construction of an autologous vascular access.

DISCLOSURES

The authors have no financial conflicts of interest to declare.

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