**NEPHROLOGY** 2004; **9**, 348–352

Original Article

# Ultrasonography in the management of exit site infections in peritoneal dialysis patients

TZE-HOI KWAN,[1] MATTHEW KA-HANG TONG,[1] YUI-PONG SIU,[1] KAY-TAI LEUNG,[1] SAU-HAR LUK[2] and YU-KEUNG CHEUNG[2]

*Departments of [1]Medicine and [2]Diagnostic Radiology, Tuen Mun Hospital, Tuen Mun, Hong Kong, China*

***SUMMARY:***

***Aim:*** To assess the efficacy of using ultrasonography (USG) in monitoring the progress of exit site infection (ESI) in patients undergoing continuous ambulatory peritoneal dialysis (CAPD).

***Methods:*** Twenty-two cases of newly diagnosed ESI and 20 cases with normal exit sites as controls were assessed by using USG. The exit sites were reassessed by using USG after finishing a course of antibiotic therapy, and the sonographic findings were correlated with the clinical outcome.

***Results:*** Out of the 22 cases of ESI, 21 cases had definite sonolucent zones around the external cuffs, while one case had normal sonographic findings. Of the 20 control cases of normal exit sites, 16 had normal sonographic findings, and four had sonolucent zones around the external cuffs. Exit site infections correlated with positive sonographic findings as compared to normal exits ($P < 0.0001$). The 21 cases of ultrasonic-positive ESI were re-examined after antibiotic therapy, and 10 of these had a post-treatment sonolucent rim around the distal cuff ≤1 mm thick, while 11 cases were persistently >1 mm thick. The former group was shown to have a more favourable outcome ($P = 0.013$). And despite variable USG findings, all eight patients with *Pseudomonas aeruginosa*-related ESI had an unfavourable clinical outcome.

***Conclusion:*** Ultrasonography of the exit sites in CAPD patients is a useful adjunctive tool in the management of ESI. A sonolucent zone around the external cuff >1 mm thick following a course of antibiotic treatment and the involvement of the proximal cuff are associated with poor clinical outcome. In ESI caused by *Pseudomonas aeruginosa*, the clinical outcome was uniformly poor irrespective of the sonographic findings.

***KEY WORDS:*** **continuous ambulatory peritoneal dialysis, infection, ultrasonography.**

## INTRODUCTION

Assessing the effectiveness of the treatment of exit site infection (ESI) in continuous ambulatory peritoneal dialysis (CAPD) patients has been relying largely on clinical judgement. Exit site infection can present merely as erythema around the exit-sites or over the tunnel tract with or without coexistent purulent discharges.[1] Initiation of treatment was mainly based on the external appearance of the exit-sites and the skin overlying the subcutaneous tunnel.[2–4] Diaz-Buxo *et al.* and Holley *et al.* were among the first to propose using ultrasonography (USG) in assisting the management of ESI.[5,6] Recently, there have been a few more reports on the usefulness of USG in assessing ESI in CAPD patients.[7–9] However, the role of USG and the criteria used in assessing the progress of ESI is not clear and practice varies among individual centres. The International Society of Peritoneal Dialysis 2000 guidelines have not included USG as an integral part of the management of ESI nor made any recommendations on this.[10,11] The aim of this study is to evaluate the value of using USG in predicting the response to antibiotic treatment in CAPD patients with ESI.

Correspondence: Dr Tong Ka Hang, Department of Medicine, Tuen Mun Hospital, Tuen Mun, Hong Kong, China.
Email: khmtong@netvigator.com

Accepted for publication 13 August 2004.

## PATIENTS AND METHODS

Twenty-two CAPD patients who developed ESI from January to March 2002 in our dialysis unit were recruited into the present study. Exit site

infection is defined as the presence of purulent discharge ± erythema of the exit site. Ultrasounds were performed within 1 week of diagnosing ESI and repeated 1 week after the completion of antibiotic treatment. All cases of ESI were treated with antibiotics according to clinical findings and culture results. Another 20 patients who were free from clinical ESI within the past 12 months were selected as controls. Informed consent were obtained from all subjects who participated in the present study. The ultrasound examination was performed by using a Power Vision 6000 ultrasound machine (Toshiba Corporation Medical System Division, Otawarashi, Tochigi, Japan); a 7.5 MHz ultrasound probe was used and the following aspects were assessed: (i) presence or absence of sonolucent zone in relation to the Tenckhoff catheter tunnel and cuffs; and (ii) the maximum thickness of the peri-catheter or peri-cuff sonolucent zone measured in millimeters whenever present.

All cases were followed up for their clinical outcome. Possible outcomes were defined as follows: (i) complete resolution of ESI without relapse or recurrence within 3 months after completion of antibiotic treatment; (ii) temporary resolution of ESI but clinical relapse with the same organism within 3 months of stopping treatment; and (iii) persistent ESI despite antibiotic treatment.

### Statistics analysis

Statistical analysis was performed by using SPSS, version 10.0 for Windows software (SPSS Inc., Chicago, IL, USA). Continuous values are presented as mean ± SD unless otherwise stated. Continuous variables were compared by using the Mann–Whitney *U*-test, and categorical variables were compared by using the Fisher's Exact test. A *P* value of less than 0.05 was considered to be statistically significant.

## RESULTS

From January to the end of March 2002, 22 patients with ESI were included in the present study. All patients used double-cuff Tenckhoff catheters. The average age was 56.8 ± 12.6 years; the male to female ratio in this category was 12:10 and 10 patients were diabetic. Concerning the 20 subjects in the control group, the average age was 59.5 ± 9.8 years; the male to female ratio was 9:11 and six were diabetic. There was no statistical differences in the demographic characteristics between the two groups (Table 1).

On USG examination of patients with ESI, besides one case that had normal sonographic findings, the remaining 21 (95.5%) had definite peri-distal-cuff sonolucent zones and three patients also had concomitant proximal cuff involvement (Table 2). For the 20 control group patients, 16 (80%) had normal sonographic findings, four had minimal sonolucent zones (maximum thickness <1 mm) around the Tenckhoff catheter at the sinus tract distal to the distal cuffs (20%), and none had sonolucent zones involving the proximal cuffs. Among the 16 cases with normal USG, 14 remained asymptomatic in subsequent follow ups. One case developed a culture negative ESI episode 2 months later and the other patient developed *Actinomyces odontolyticus* ESI. Concerning the four cases with minimal sonolucent zones around the catheter and distal cuffs, all remained asymptomatic throughout the study period. Patients with ESI had significantly more abnormal USG findings than patients with clinically normal exit sites ($P < 0.0001$). The positive and negative predictive values for using baseline USG in diagnosing ESI were 84.6 and 94.1%, respectively. Illustrative USG images from four selected patients are shown in Fig. 1.

The 21 cases of ESI had a follow-up USG performed after completing a 2-week course of antibiotics. They were divided according to the maximal baseline thickness of the sonolucent zone and their clinical outcomes at 3 months are listed in Fig. 2. A baseline sonolucent rim that was >1 mm thick was detected in 12 patients while the other nine patients showed a rim of ≤1 mm thickness, and there was no significant difference in terms of clinical outcome between these two groups ($P = 0.075$).

Eleven patients had a persistent post-treatment sonolucent rim >1 mm thick, and none showed complete resolution of the ESI within 3 months, and for the remaining 10 cases who had a post-treatment sonolucent rim ≤1 mm thick, five of them showed

**Table 1** Baseline demographic data of enrolled patients

| | ESI ($n = 22$) | Normal exit sites ($n = 20$) |
|---|---|---|
| Age (year) | 56.8 ± 12.6 | 59.5 ± 9.8 |
| Sex (male : female) | 12:10 | 9:11 |
| Underlying renal disease | | |
| Glomerulonephritis | 6 | 8 |
| Diabetic nephropathy | 10 | 6 |
| Hypertensive nephrosclerosis | 5 | 5 |
| Gouty nephropathy | 1 | 0 |
| Obstructive uropathy | | 1 |
| Duration of dialysis (months) | 19.2 ± 13.4 | 27.1 ± 26.5 |
| Diabetes mellitus | 10 | 6 |

ESI, exit site infection.

**Table 2** Comparison of baseline sonographical findings between cases with exit site infection (ESI) and those with normal exit sites

| | ESI ($n = 22$) | Normal exit sites ($n = 20$) |
|---|---|---|
| Normal USG | 1 | 16 |
| Abnormal USG | | |
| Sonolucent zone around distal cuff | 21 | 0 |
| Sonolucent zone around proximal cuff | 3 | 0 |
| Sonolucent zone peri-catheter distal to the distal cuff | 0 | 4 |

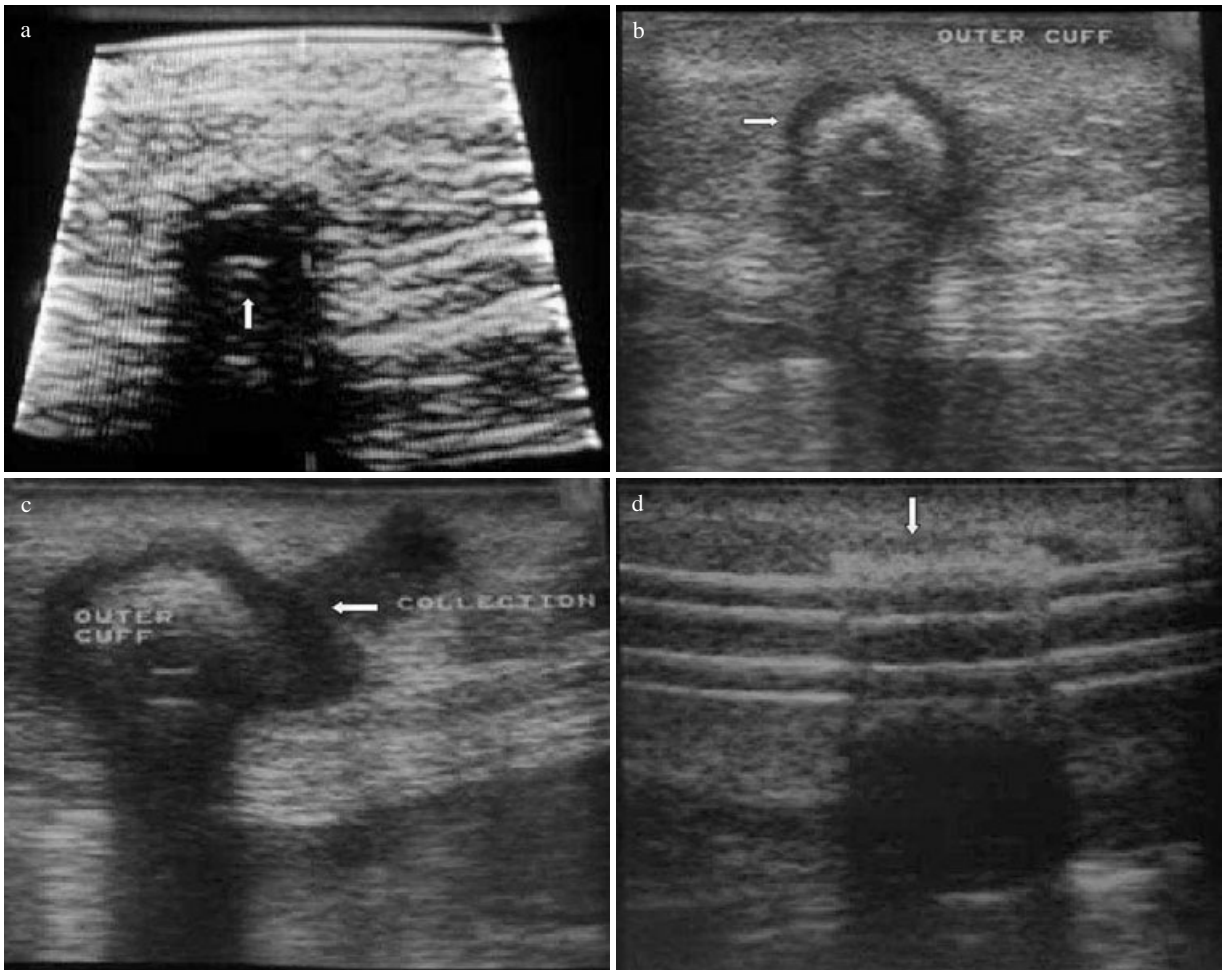


**Fig. 1** (a) A normal ultrasonography (USG) with absence of a sonolucent zone or collection between the distal cuff of the Tenckhoff catheter (arrow) and the surrounding subcutaneous tissue. (b) Abnormal USG with a sonolucent zone around the distal cuff (arrow). (c) Spread of the peri-cuff collection (arrow) towards skin surface. (d) Tenckhoff catheter with peri-cuff sonolucent zone (arrow), longitudinal view.

complete resolution of ESI. Those ESI patients with post-treatment sonolucent rim ≤1 mm showed a significantly better outcome as compared to those with a post-treatment sonolucent rim >1 mm ($P = 0.013$). Three cases had their Tenckhoff catheter removed within 3 months of ESI, and the underlying causative organisms included *Pseudomonas aeruginosa*, *Diphtheroid* species, *Acinetobacter iwoffii and Mycobacterium tuberculosis*. The three cases that had simultaneous involvement of the proximal and distal cuffs resulted in either Tenckhoff catheter removal or clinical relapses.

Patients with *Pseudomonas aeruginosa*-related ESI had a trend of having a worse prognosis than non-*Pseudomonas aeruginosa*-related ESI, although it was not statistically significant ($P = 0.063$; Table 3). All eight cases with *Pseudomonas aeruginosa*-related ESI resulted in an unfavourable outcome.

## DISCUSSION

Treatment of ESI in CAPD is notoriously difficult. Primary treatment failure and relapses are commonly reported.[1–4] Thus, ESI is one of the major reasons behind technique failure in CAPD patients. In the past decade, several reports have looked into the use of USG to assist in or prognosticate the treatment of ESI.[5–9] Most studies suggested a correlation between the size of peri-catheter and peri-cuff collection, as visualized in USG, and the treatment outcome. However, the prognostic value of tunnel sonography in patients with double cuff instead of single cuff catheters had not been specifically assessed.[9] The latest treatment guidelines for ESI published in the year 2000 have not adopted USG as part of the routine investigation, and there are no common consensus or recommendations concerning the use of USG in the management of ESI.[10] Hence, there is a need for further

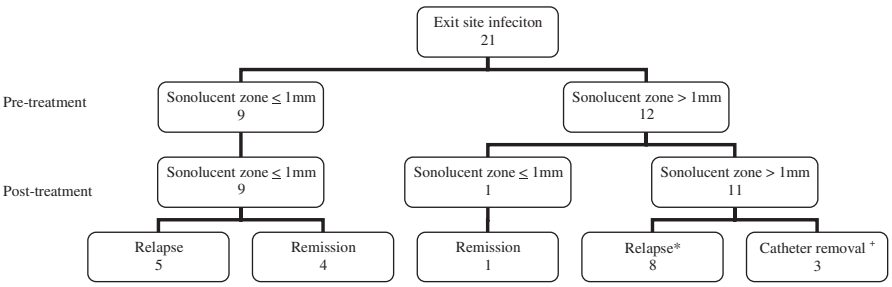


**Fig. 2** Outcomes of the 21 exit site infection patients according to pre- and post-treatment size of the ultrasound sonolucent zone; *2 patients and +1 patient with concomitant proximal and distal cuff involvements.

**Table 3** Comparison between the treatment outcomes of exit site infection according to the thickness of the post-treatment sonolucent rim and causative organisms

| Treatment outcome | Post-treatment sonolucent rim ≤1 mm | Post-treatment sonolucent rim >1 mm | *Pseudomonas aeruginosa* related ESI | Non-*Pseudomonas aeruginosa* related ESI |
|---|---|---|---|---|
| Unfavourable: | | | | |
| Tenckhoff catheter removal | 0 | 3 | 1 | 2 |
| Relapse | 5 | 8 | 7 | 6 |
| Favourable: | | | | |
| Remission | 5 | 0 | 0 | 5 |

clarification of the role of USG in the management of ESI in CAPD patients.

We compared the USG findings of a group of patients with purulent ESI to another group of patients who had clinically normal exit sites. Our data suggest that there is a statistically significant relationship between the clinical status of ESI and the USG appearance (Table 2). However, Plum *et al.* reported a negative USG in approximately 20% of cases of ESI and Vychytil *et al.* even reported that up to 55.2% of cases with clinical ESI showed no ultrasonic evidence of tunnel infection.[8,9] In our series of 22 cases of ESI, abnormal USG was seen in all but one patient (95.5%). This discrepancy may be explained by the fact that our definition of ESI requires the presence of purulent discharge that signifies a more advanced stage of ESI, while those mild or early stage ESI, which manifests as erythema or a crust around the exit sites are excluded. It should be noted that four of our control patients with clinically normal exit sites had abnormal sonographic findings with a sonolucent zone distal to the distal cuff. In this part of the tunnel tract (from the exit site to the first cuff), which is usually called the sinus tract, the catheter is often not in close contact with the surrounding tissue, therefore, the presence of sonolucent zones in this part of the tunnel may be difficult to interpret and does not necessarily represent the presence of abnormal fluid collections. This emphasizes the importance of associated clinical symptoms when interpreting the transcutaneous ultrasound findings.

In the present study, we cannot demonstrate that monitoring the thickness of the peri-cuff hypoechogenic area at the time of diagnosis offers additional benefits when assessing the disease progress. In contrast, we noticed that using a post-treatment thickness of a peri-cuff sonolucent zone ≤1 mm was a better prognostic marker. We have shown that if the post-treatment thickness of a peri-cuff sonolucent zone was >1 mm, the clinical outcome is much worse with no complete remission, compared to those ≤1 mm (50% complete remission). Simultaneous involvement of the proximal and distal cuff is also a poor prognostic marker; one out of three patients have their Tenckhoff catheters removed while the remaining two had relapses. However, these prognostic markers do not hold for *Pseudomonas aeruginosa*-related ESI, which had a poor clinical outcome at 3 months, irrespective of the pharmacological treatment or sonographic appearances. This could be related to the notorious propensity of *Pseudomonas aeruginosa* to form treatment-resistant biofilms.[11] We hypothesize that the biofilm may predispose the patient to relapse despite apparent sonographic resolution. In our series, a significant proportion of ESI was caused by *Pseudomonas aeruginosa* (38%). This may be the result of our study selection criteria, which included patients with the more advanced stage of ESI with purulent discharge; or it may reflect an increasing trend for *Pseudomonas aeruginosa* to cause ESI in CAPD patients in our locality.

The regimen that we used was simple and with good prognostic value. The number of sonographical examinations needed per ESI episode is minimized and serial USG is not needed. We would recommend routinely performing USG of the exit site after the completion of a course of antibiotic treatment to assess the progress. In case the post-treatment thickness of peri-cuff sonolucent zone is >1 mm, we would advocate to prolong the anti-

biotic therapy for another 2 weeks. If there is still no clinical sign of improvement, more aggressive treatment including debridement or early removal of the Tenckhoff catheter should be seriously considered.

## CONCLUSIONS

Ultrasonography of the exit sites in CAPD patients is a useful adjunctive tool in the management of ESI. The thickness of the sonolucent zone around the external cuff being more than 1 mm following a standard 2–3-week course of antibiotic treatment and simultaneous involvement of the proximal and distal cuffs correlated with a poor clinical outcome. In ESI related to *Pseudomonas aeruginosa*, the clinical response remains poor even in the absence of the above-mentioned adverse ultrasonographical findings.

## ACKNOWLEDGEMENTS

The authors wish to thank all the nursing staff of the Renal Unit, Tuen Mun Hospital, Hong Kong. Without their wholehearted support and assistance, this study would not have been accomplished.

## REFERENCES

1. Abraham G, Savin E, Ayiomamitis A *et al*. Natural history of exit-site infection in patients on CAPD. *Perit. Dial. Int*. 1988; **8**: 211–16.
2. Luzar MA, Brown C, Balf D *et al*. Exit-site care and exit-site infection in CAPD: Results of a randomized multicenter trial. *Perit. Dial. Int*. 1990; **10**: 25–9.
3. Flanigan M, Hochstetler LA, Langholdt D, Lim VS. CAPD catheter infections: diagnosis and management. *Perit. Dial. Int*. 1994; **14**: 248–54.
4. Piraino B. Management of catheter-related infections. *Am. J. Kidney Dis*. 1996; **27**: 754–8.
5. Diaz-Buxo JA, Black EB, Tyroler J. Ultrasonography in the diagnosis of peritoneal dialysis catheter tunnel abscess. *Perit. Dial. Int*. 1988; **8**: 218–19.
6. Holley JL, Foulks CJ, Moss AH, Willard D. Ultrasound as a tool in the diagnosis and management of exit-site infections in patients undergoing continuous ambulatory peritoneal dialysis. *Am. J. Kidney Dis*. 1989; **14**: 211–16.
7. Korzets Z, Erdberg A, Golan E *et al*. Frequent involvement of the internal cuff segment in CAPD peritonitis and exit-site infection: An ultrasound study. *Nephrol. Dial. Transplant*. 1996; **11**: 336–9.
8. Plum J, Sudkamp S, Brabensee B *et al*. Results of ultrasound-assisted diagnosis of tunnel infections in continuous ambulatory peritoneal dialysis. *Am. J. Kidney Dis*. 1994; **23**: 99–104.
9. Vychytil A, Lorenz M, Schneider B, Horl WH, Haag-Weber M. New criteria for management of catheter infections in peritoneal dialysis patients using ultrasonography. *J. Am. Soc. Nephrol*. 1998; **9**: 290–6.
10. Keane WF, Bailie GR, Boeschoten E *et al*. ISPD guidelines/recommendations. *Perit. Dial. Int*. 2000; **20**: 396–411.
11. Innes A, Burden RP, Finch RG, Morgan AG. Treatment of resistant peritonitis in CAPD with intraperitoneal urokinase: A double blind clinical trial. *Nephrol. Dial. Transplant*. 1994; **9**: 797–9.