PERCUTANEOUS PERITONEAL DIALYSIS CATHETER INSERTION BY A NEPHROLOGIST: A NEW, SIMPLE, AND SAFE TECHNIQUE

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◆ **Background:** Insertion of the peritoneal dialysis (PD) catheter by a nephrologist has been encouraged by several studies. The ultimate goal is to provide safe, timely, and effective catheter insertion without an unduly long wait time or delay. The success of PD depends partly on the ease of catheter insertion. We developed a new technique for percutaneous PD catheter insertion by nephrologists. Our new technique, in addition to being easy, proved to be safe and to eliminate the need for the peel-away sheath.

◆ **Methods:** Data were collected prospectively on all patients having a PD catheter inserted by a nephrologist using our new technique (40 catheters in 38 patients). All catheters were evaluated for infectious and mechanical complications.

◆ **Results:** The mean duration of the procedure from skin sterilization to the end of insertion was 24 ± 3 minutes. No bowel perforation or serious hemorrhage was recorded. Poor initial drainage was recorded in 12.5% of the catheters ($n = 5$) during the 4 weeks after insertion. The incidence of early exit-site leakage was 2.5% (1 catheter). Episodes of exit-site infection occurred in 5.0% and 12.5% of catheters (within 1 month and by the end of study period respectively). Two episodes of peritonitis were reported by the end of the 12-month period. Catheter survival was 95.0% and 87.5% at 6 months and 12 months respectively.

◆ **Conclusions:** Percutaneous bedside placement of PD catheters using our new technique is safe and carries less morbidity in terms of bowel perforation, catheter-related infection, and exit-site leak. In addition, our new technique appears to have a high success rate and to offer considerable savings in terms of operating time.

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The success of PD depends on uncomplicated access to the peritoneum, which may be created using an open surgical, peritoneoscopic, laparoscopic, fluoroscopic, or percutaneous Seldinger approach. Emphasis has therefore increasingly been placed on establishing the optimal method of catheter placement. However, little evidence is available evaluating the efficacy of the most minimally invasive of all techniques: percutaneous Seldinger catheter insertion (1). A single study by Ozener *et al.* (2), reporting a single-center experience of 215 PD catheter insertions in Turkey, showed no difference in outcomes between a percutaneous and a surgical approach for PD catheter insertion.

Percutaneous catheter insertion represents a bedside intervention predominantly performed by nephrologists. It requires only local anesthesia, sedation, and minimal transcatheter access. Insertion of the PD catheter by the nephrologist has therefore been encouraged by several studies. The ultimate goal is to provide timely and effective catheter insertion without an unduly long wait time or delay, during which potential candidates for PD may lose interest in the modality.

Several worldwide reports have suggested that insertion of PD catheters by nephrologists from centers with more experience in PD results in more effective control of infectious complications and peritoneal access creation (2–5). The practice of PD catheter insertion by nephrologists substantially contributed to better treatment outcomes. Nevertheless, the blind Seldinger technique was suggested to be responsible for some complications, especially bowel perforation, and to be an unacceptable method for obese patients and for those with previous abdominal surgery. Those concerns may be justified with the traditional technique using a solid, pointed-tip introducer. The peel-away sheath is another obstacle, because that item may be unavailable in some PD centers.

At King Fahd University Hospital, we developed a new technique for percutaneous PD catheter insertion by

the nephrologist. This new method uses a blunt, hollow introducer and also blunt dilators that permit guidewire insertion through the introducer and that eliminate the need for the peel-away sheath. The new technique has proved to be easy for the nephrologist and safe for PD patients. In the present paper, we report our experience with percutaneous PD catheter insertion using the new technique over a 12-month-period.

METHODS

Using the new technique, we placed 40 PD catheters in 38 patients with end-stage renal disease from March 2011 to April 2012 at King Fahd University PD center. Five patients had previous abdominal surgeries (2 post-kidney transplantation, 2 post-appendectomy, and 1 with an old cesarean section). Table 1 summarizes the patient characteristics.

The study was conducted in accordance with the revised Declaration of Helsinki, and the study protocol was approved by the local Research Ethics Committee. All patients were required to give written informed consent before participation.

All catheters were evaluated for infections and mechanical complications. Overall technical survival was analyzed separately with regard to insertion technique. The PD catheter used was a 42-cm double-cuffed straight Tenckhoff catheter, with a coiled intraperitoneal segment (Quinton Instrument Company, Seattle, WA, USA). The blunt hollow introducer (Finsin Industries, Sialkot, Pakistan) is made of stainless steel and was designed

and manufactured at our request. It is 62 cm in length, with varying diameters.

Exit-site infection was defined as exit-site edema, erythema, and purulent discharge. Ultrasound examinations were performed when tunnel infection was suspected. Catheter leakage was defined as dialysate drainage from the exit site or main wound. Diminished outflow was defined as drainage of less than 50% of the fill volume. Catheter migration, when suspected, was diagnosed by plain abdominal radiography. Peritonitis was identified as turbid dialysate with more than 100 white blood cells per cubic millimeter, with at least 50% being polymorphonuclear, with or without a positive effluent culture. All PD catheters were inserted by one of two nephrologists.

PERCUTANEOUS PD CATHETER INSERTION BY THE NEW TECHNIQUE

The PD catheters were inserted under fluoroscopic guidance by the nephrologist in the day surgery room with the patient under local anesthesia and parenteral sedation (all patients received intravenous midazolam and 1% lignocaine). We used blind placement based on the Seldinger technique.

A 2-cm paramedian incision was made 1 – 2 cm below the umbilicus, followed by blunt dissection of the subcutaneous tissue with an artery forceps until the fascia anterior to the rectus muscle was reached. The peritoneum was then punctured using a 16-gauge needle [Figure 1 (A,B)]. A guidewire (straight, 120 cm long and 2 mm thick) was inserted into the peritoneal cavity through the 16-gauge needle [Figure 1(C)]. The needle was then removed, leaving the guidewire in place. A hollow dilator (20-gauge) was introduced over the guidewire [Figure 1(D,E)] and used to dilate the passage (larger dilators can be used if necessary). The PD catheter was then inserted over the guidewire, overlapping and surrounding the hollow introducer [without the peel-away sheath; Figure 1(F,H)], and directed toward the Douglas pouch [Figure 1(I,J)]. The guidewire was then removed [Figure 1(K)]. Finally, the PD catheter was gradually advanced towards its goal, while the hollow introducer was removed [Figure 1(L, N)].

A subcutaneous tunnel was created using an artery forceps, and the PD catheter was adjusted through it. The inner cuff of the PD catheter was secured with a purse-string suture on the fascia anterior to the rectus muscle. The original incision was then closed and the PD catheter was flushed several times with a total of 2 L heparinized 0.9% saline (500 mL each fill) to confirm catheter patency and to check for intra-abdominal bleeding.

TABLE 1
Demographic Characteristics of the Study Patients

Characteristic	Value
Patients (n)	38
Catheters (n)	40
Sex [n (%) women]	18 (47.4)
Body mass index	
Mean	25.9±1.17
Range	24.5–28.2
Primary disease [n (%)]	
Diabetic nephropathy	16 (42.1)
Hypertensive nephropathy	11 (28.9)
Glomerulonephritis	9 (23.7)
Others	2 (5.3)
Blood urea nitrogen (mg/dL)	72.7±11.1
Creatinine (mg/dL)	9.4±3.4
Hemoglobin (gram/dL)	9.3±2.8
Albumin (gram/dL)	3.4±1.1
Mean duration of procedure (min)	24±3

Figure 1 — (A) Equipment for the new peritoneal dialysis (PD) catheter insertion technique: 16-gauge needle, hollow blunt introducer, hollow dilator, guidewire, and the PD catheter. (B) The 16-gauge needle inside the peritoneal cavity. (C) The guidewire inserted through the 16-gauge needle. (D) The hollow dilator advanced along the guidewire to dilate the passage. (E) The guidewire inside the hollow dilator. (F) The hollow blunt introducer (front view). (G) The PD catheter (outside) and the hollow blunt introducer (inside). (H) The hollow blunt introducer inside the PD catheter, and the guidewire protruding from the hollow blunt introducer. (I) The PD catheter on the hollow blunt introducer inserted along the guidewire into the peritoneal cavity (operator's view). (J) The PD catheter on the hollow blunt introducer inserted along the guidewire into the peritoneal cavity (fluoroscopic view). (K) Removal of the guidewire leaves the hollow blunt introducer surrounded by the PD catheter in place. (L) The guidewire is then removed. (M) The PD catheter is gradually advanced while the hollow blunt introducer is simultaneously removed. (N) Post-procedure plain abdominal radiography shows the PD catheter in place.

Antibiotic prophylaxis was given using first-generation cephalosporin, as recommended (6), administered intravenously 2 hours before the procedure.

POSTOPERATIVE COURSE

A low volume of dialysis solution with heparin was left in the peritoneum after catheter insertion. Periodic low-volume exchanges (up to 500 mL) were performed during the first week after insertion. Peritoneal dialysis was generally instituted 5 – 7 days after PD catheter placement using our new technique.

EXIT-SITE CARE

Routine exit-site care by the patient consisted of daily washing with anti-bacterial soap, thorough drying, cleaning with iodine solution, and application of a small amount of mupirocin ointment (a 6-mm dab, approximately 10 mg) around the catheter exit site using a cotton swab. Catheters were anchored with tape and a small gauze dressing to prevent exit-site trauma. The exit site was examined by the physician and a trained nurse at each clinic visit. Signs and symptoms of exit-site infection or peritonitis were explained to patients at each visit, and they were instructed to report to the unit if infection was suspected or occurred. Swabs and cultures were obtained from effluent, from around the catheter, and from any exit-site discharge.

REMOVAL OF CATHETERS

Only removals related to either mechanical or infectious complications of PD catheters were included in the analysis of catheter survival. The included reasons for removal were intractable peritonitis that did not respond after 5 – 10 days of appropriate antibiotic therapy and persistent catheter infection that did not resolve after multiple (at least 2) courses of antibiotic therapy. The excluded reasons for removal were transplantation, death unrelated to PD complications, and patient decision to switch to hemodialysis.

STATISTICAL ANALYSIS

In tables, categorical values are presented as numbers of catheters, with percentages given in parentheses. Continuous variables are presented as mean $\pm$ standard deviation. Chi-square analysis and, when indicated, Fisher exact tests were used for the analysis of categorical variables. Catheter survival was calculated from the day of insertion to the day of removal.

RESULTS

Table 2 outlines the details of PD catheter insertion using the new technique. For 95% of insertions ($n = 38$), the procedure was the first attempt at PD catheter insertion. The remaining 2 attempts were for re-insertion after catheter removal. The mean duration of the procedure from skin sterilization to the end of insertion was 24 ± 3 minutes. No patient experienced significant bleeding or bowel perforation, and none required blood transfusion. Transient complications occurring during the new percutaneous insertion technique included hypoventilation (managed by oxygen) and hypotension (treated with intravenous fluids). Poor initial drainage—recorded in 12.5% of catheters ($n = 5$) during the 4 weeks after insertion—was attributed to poor bowel preparation, because it resolved with laxatives. Early dialysate leakage (within 2 weeks) occurred in 1 patient (Table 3). Leaks were managed by temporary cessation of PD for 2 – 3 weeks. The time between the decision to start PD and the initial PD session was 6 ± 3.4 days.

Infection screening during the study period identified early exit-site infections in 5.0% of catheters and late infection in 12.5%. No tunnel infections were documented

TABLE 2
Indications for Catheter Insertion

Indication	Patients [n (%)]
First catheter insertion	38 (95.0)
Catheter reinsertion	2 (5.0)
Catheter repositioning	3 (7.5)
TOTAL (excluding re-positioning)	40 (100)

TABLE 3
Early^a Technical Complications

Variable	Value [n (%)]
Catheters	40
Failure on percutaneous insertion	1 (2.5)
Bowel perforation	0
Hemorrhage in rectus muscle or pelvic cavity	0
Diminished outflow	5 (12.5)
Catheter migration	3 (7.5)
Pericatheter early leakage (within 2 weeks)	1 (2.5)
Success rate	39 (97.5)

^a At 4 weeks or less.

(Table 4). Coagulase-negative *Staphylococcus aureus* was isolated in 5.0% of patients ($n = 2$), *S. epidermidis* in 5.0% ($n = 2$), and *Pseudomonas aeruginosa* in 2.5% ($n = 1$; Table 4). The overall incidence of peritonitis was 5.0% ($n = 2$) during the entire study period. The organisms isolated were coagulase-negative *S. aureus* in one case, and *P. aeruginosa* in the other (Table 4).

Log-rank analysis revealed that the median time from PD catheter insertion to the first peritonitis episode was 3.9 months. Catheter survival was 95.0% and 87.5% at 6 and 12 months respectively (Figure 2).

DISCUSSION

Peritoneal dialysis is an established form of renal replacement therapy for patients with end-stage renal disease. The key to successful PD is a permanent and safe access to the peritoneal cavity. Percutaneous PD catheter placement is a well-tolerated, quickly performed bedside procedure that allows for rapid initiation of PD and avoids the need for operating room time and a larger peritoneal incision. The principal major complications of percutaneous placement as a “blind” technique are the risk of inadvertent puncture of the abdominal viscera and the possibility of major bleeding. However, the very low frequency of perforation reported in previous percutaneous studies (0% – 1.3%) argues against the magnitude of this complication (1,6–9).

Referral to a surgeon and scheduling of an operating theatre for surgical or laparoscopic PD catheter insertion has become the rate-limiting step for initiating PD. In addition, committed surgical teams having a keen interest in peritoneal catheter placement are lacking in most dialysis centers. A lengthy wait list for catheter insertion is demoralizing for physicians and patients alike, ultimately eroding confidence in PD. In this context, catheter insertion by nephrologists is a critical component of a successful PD program. There is ample evidence to suggest that catheter insertion by nephrologists improves potential dialysis utilization and increases the PD growth rate (10–13). For instance, initiation of catheter insertion by nephrologists in 3 centers in the United States was associated with a 22% – 32% increase in the number of PD patients, and a return to catheter insertion by surgeons led to a decline in the PD population (10). Recently, the modified Seldinger technique (14), using a peel-away introducer sheath, seems to have reduced the incidence of bowel perforation. The technique gained popularity among nephrologists and achieved results comparable to those with laparoscopic insertion (14). However, the modified Seldinger technique uses a pointed-tip introducer, and the dilators

TABLE 4
Organisms Causing Infectious Complications

Organism	Infection type [n (%)]		
	Exit-site	Tunnel	Peritonitis
Coagulase-negative <i>Staphylococcus</i>	2 (5.0)	0 (0)	1 (2.5)
<i>Staphylococcus epidermidis</i>	2 (5.0)	0 (0)	0 (0)
<i>Pseudomonas aeruginosa</i>	1 (2.5)	0 (0)	1 (2.5)
<i>Acinetobacter</i> species	0 (0)	0 (0)	0 (0)
<i>Enterococcus</i> species	0 (0)	0 (0)	0 (0)
Fungus	0 (0)	0 (0)	0 (0)

Figure 2 — Technical survival of peritoneal dialysis (PD) catheters inserted by the nephrologist using the new percutaneous technique.

are introduced along the track created by the guidewire and not along the guidewire itself. In the hands of non-expert nephrologists or trainees, those two drawbacks contribute to an increase in the chance of bowel perforation and hemorrhage. In addition, peel-away sheath kits have not been available in some countries because of low domestic needs or because of problems with financial support (15).

We introduced a novel technique of percutaneous PD catheter insertion that uses a blunt hollow introducer and blunt hollow dilators that are inserted to the desired location along a guidewire with the help of fluoroscopy, thus completely avoiding the risk of bowel perforation and serious hemorrhage. Our findings demonstrate that, compared with the classical trocar technique, our technique is associated with a significantly higher success rate and a significantly lower rate of major complications.

Mechanical complications are still the major cause of PD catheter removal in both the surgical and the percutaneous catheter insertion techniques (2). The major mechanical complication of percutaneous placement as

a “blind” technique is the risk of inadvertent puncture of the abdominal viscera. However, the very low frequency of perforations reported in previous percutaneous studies (0% – 1.3%) argues against the magnitude of this complication (1,7,8,16). Nonetheless, we encountered no such complications (0%) using our new technique of PD catheter insertion.

Among percutaneously inserted PD catheters, early leakage has varied from 2.6% to 22% (7,9,17,18). Moreiras *et al.* (7) reported that 15.3% of their mechanical complications were related to the insertion technique, and 6%, to early leakage. In the study by Smith *et al.* (8), the most common early complications were leakage (13%) and bleeding (15.4%). Allon *et al.* (9) reported that early complications occurred with 19 of 154 percutaneously placed catheters, and early leakage was observed in 2.6%. Swartz *et al.* (18) reported early leakage to be as high as 21.6%. The low incidences of early and late leakage with our novel technique—1 of 40 catheters (2.5%) and 0 of 40 catheters (0%) respectively—is probably a result of the small incision and the simple use of a hollow blunt dilator along the guidewire, avoiding unnecessary damage to the rectus muscle. In addition, with our new technique, no forceful action is needed during catheter insertion; this important factor eliminated hemorrhage as a complication.

Catheter-related malfunction causing drainage failure may arise after obstruction of the catheter or migration of the catheter tip from the pelvis into the upper abdomen. The incidence of catheter-related malfunction in the literature varies from 0.9% to 17% for surgical (19–28) and 4% to 21% for percutaneous studies (1,7–9,16–18). Although it has been argued that surgical catheter placement is preferable to percutaneous placement because of direct visualization during positioning (29), several studies have shown that surgical placement holds no advantage in regard to catheter-related malfunction (5,9). Our data support that view: We observed diminished outflow in 12.5% of catheters (corrected by repositioning), an incidence comparable to the rate seen in percutaneous studies. The practice of leaving a low volume of dialysis solution with heparin after catheter insertion, the periodic performance of low-volume exchanges (up to 500 mL) during the first week after insertion, early institution of PD (5–7 days after catheter insertion), and strict instructions to avoid constipation may explain the low incidence.

Infectious complications have been repeatedly reported as the major reason for catheter removal for both surgically and percutaneously placed catheters (8,23,28). The development of peritonitis has a significant effect on PD catheter survival, including direct effects on function,

increased complications, need for alternative dialysis, and thus prolongation of hospitalization. Interventions that might prevent peritonitis have therefore been widely considered (in addition to prophylactic antibiotics). No randomized controlled trials comparing peritonitis rates for percutaneous and surgical placement groups have been conducted. Retrospective comparisons of percutaneous and surgical groups have demonstrated a 6% peritonitis incidence in percutaneous patients (17,30). Our overall results showed a 5.0% incidence of peritonitis (2 of 40 catheters) within 12 months of percutaneous insertion. Avoidance of exit-site and central wound infections is additionally important, but may still occur despite adequate prophylaxis. Nonetheless, our overall incidence of wound infection was low and did not affect the outcome of our PD catheter insertions. We believe that the minimally invasive nature of our new PD catheter approach, as described here, is an inherent advantage that minimizes the incidence of catheter infections.

Survival of the PD catheter remains the main Achilles’ heel of a successful PD program in developed and developing countries alike. It has previously been demonstrated that catheter insertion by nephrologists improves PD penetration in centers where it is practiced (10,31,32). Similarly, in our study, we were able to achieve a PD catheter success rate of 95.0% (38 of 40 catheters) and a PD catheter survival of 100%, 95.0%, and 87.5% at 2, 6, and 12 months respectively.

The present study has some limitations. The number of patients is small, the patients had been on PD for varying lengths of time, and the follow-up period was not very long. On the other hand, our new technique has the following advantages: first, the peel-away sheath, with its associated drawbacks, is avoided. Second, the use of a guidewire protects the bowel and internal organs, and eliminates the need for intraperitoneal fluid infusion. Third, our technique is applicable with or without fluoroscopic assistance. Fourth, the introduction of the reusable blunt hollow introducer—the cornerstone of our technique—helps to avoid complications such as bowel perforation. Fifth, in addition to being less costly, our technique minimizes the procedure time.

CONCLUSIONS

Our new technique of PD catheter insertion appears to have a high success rate, to avoid serious complications, and to offer considerable savings in terms of operating time. Thus, it seems to be a good alternative to the traditional peel-away sheath method. Importantly, we believe that adoption of this method is likely to encourage nephrologists to perform PD catheter insertion

percutaneously. However, a larger series is needed to verify the safety and usefulness of our technique.

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DISCLOSURES

The author has no financial conflicts of interest to declare.

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