Peritoneal Dialysis International, Vol. 28, pp. 163–169
Printed in Canada.

0896-8608/08 $3.00 + .00

FLUOROSCOPICALLY GUIDED PERITONEAL DIALYSIS CATHETER PLACEMENT: LONG-TERM RESULTS FROM A SINGLE CENTER

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♦♦*Objective:* Despite percutaneous fluoroscopy ensuring appropriate placement of peritoneal dialysis (PD) catheters, the efficacy of this method is not well known. Therefore, we evaluated our long-term experience with fluoroscopy-assisted placement of PD catheters.

♦♦*Patients and Methods:* We retrospectively reviewed 134 PD catheters in 114 PD patients that were treated in the PD center of a university-based hospital. We evaluated complications related to PD catheters, causes for catheter removal, and catheter survival. We used the multivariate Cox proportional hazard model to identify independent factors related to PD catheter survival.

♦♦*Results:* Early complications related to insertion included 1 case of pericatheter bleeding; there were no placement failures. Early complications occurred in 8.5% of patients. Most late complications were migration and leakage, which occurred in 10.4% and 9.7% of patients respectively. The most common cause for catheter removal was intractable and recurrent peritonitis. The 12- and 24-month survival rates of the catheters were 80.0% and 74.9%. The most significant prognostic factor of percutaneous fluoroscopy-assisted PD catheter survival was late leakage ($p < 0.01$).

♦♦*Conclusions:* In addition to the advantages of simplicity, minimal invasiveness, and relative safety, the survival rate of PD catheters placed using the percutaneous fluoroscopy-assisted method was comparable to that of more invasive methods. Percutaneous fluoroscopy-assisted placement of PD catheters should be considered when available, and may be preferred to other placement methods.

***Perit Dial Int* 2008; 28:163–169** **www.PDIConnect.com**

KEY WORDS: Methods of catheter replacement; percutaneous fluoroscopically guided placement; catheter.

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Received 10 June 2007; accepted 23 October 2007.

The method used for peritoneal dialysis (PD) catheter placement is important for stable initiation and maintenance of PD. The PD catheter may be inserted by blind percutaneous, surgical, laparoscopic, or fluoroscopy-assisted methods. Each of these methods has specific advantages and risks. The ideal method of PD catheter insertion depends on the circumstances of the patient and the treatment center. It has been suggested that the laparoscopic method of insertion may reduce the incidence of dialysate leakage and catheter migration (1,2); however, there is no consensus regarding this issue (3).

Most acute dialysis is initiated unexpectedly, and at least 30% of patients with chronic kidney disease begin dialysis due to rapid progression of disease and are late referrals. These patients are likely to start on hemodialysis because of a reluctance to perform acute PD catheter insertion. Additionally, most insertion techniques require a break-in period of at least 2 weeks before starting PD; this time allows for wound healing and reduces the risk of early and late leakage (4). Therefore, in most cases, it is easier to start with hemodialysis and, once started, this mode of dialysis is usually continued.

Percutaneous fluoroscopy-assisted placement of PD catheters is performed in order to ensure accurate placement of the catheter. This method has the benefit of little waiting time, a small incision, rapid wound recovery, less pain, and lower cost compared to surgical methods. This procedure was first described in the radiology literature in 1992 (5) but has not gained popularity in the nephrology community. Therefore, we report our long-term experience with percutaneous fluoroscopy-assisted placement of PD catheters.

SUBJECTS AND METHODS

We placed 134 PD catheters in 114 patients with end-stage renal disease from 2001 to 2006 at our university hospital. All patients initially underwent percutaneous fluoroscopy-assisted PD catheter placement. Patients with congestive heart failure and elderly diabetic patients with poor vasculature have a tendency to choose PD as the first modality of renal replacement therapy. Patients with previous major abdominal surgery were excluded from PD treatment. The patients' baseline characteristics were examined and assessed using the Davies comorbidity score (6). We evaluated all patients for mechanical and infectious complications of the catheters and analyzed the overall technical survival of the catheters. Mechanical complications were all catheter-related problems excluding infection-related causes. Infectious complications included exit-site infection, tunnel infection, and peritonitis. The definitions of infectious complications were taken from International Society for Peritoneal Dialysis (ISPD) guidelines (7). Initiation of PD was defined when at least 500 mL of dialysate volume was dwelled. Early and late complications were categorized as problems occurring before or after 2 weeks of PD respectively. Only removals related to either mechanical or infectious complications were included in the analysis of catheter survival. If a patient had catheter replacement, the second catheter was analyzed as a second event. The percutaneous fluoroscopy-assisted method was used in cases of reinsertion necessitated by peritonitis, catheter migration, or hernia as a cause of removal. In cases of late leakage or omental wrapping, surgical or laparoscopic methods were employed.

METHODS OF CATHETER INSERTION

In brief, 50 mg pethidine HCl was injected intramuscularly for pain control prior to the procedure. The PD catheter was usually placed at the left lower abdomen unless the patient had a prior catheter in that location or a surgical scar. After infiltrating the skin and the underlying tissue with 1% lidocaine with epinephrine as local anesthesia, the primary incision, about 2 cm in length, was made at least 2 – 4 cm superior and 4 cm lateral to the umbilicus to prevent injury to the inferior epigastric artery (Figure 1). Most bleeding was controlled by gauze compression; electrical cauterization was used in cases of severe bleeding. A 15-cm, 22-gauge needle (Cook, Bloomington, Indiana, USA) was advanced medially and inferiorly from the incision at a 45-degree angle into the patient's abdomen and directed toward the peritoneum [Figure 2(a)]. A small amount of contrast medium was then injected slowly into the peritoneal cavity under fluoroscopy. Injecting the contrast medium identified the tip of the needle in the peritoneal space [Figure 2(b)]. When the peritoneum is penetrated, there is a loss of resistance and the patient has a response to pain. If the contrast medium flow was along the intestinal outlines, a 0.018-inch guidewire was inserted through the puncture needle [Figure 2(c,d)]. The guiding sheath was then used to exchange the 0.018-inch guidewire for a 0.035-inch wire (Radiofocus M; Terumo, Tokyo, Japan) into the pelvis [Figure 2(e)]. Then, a 16F peel-away guiding sheath was advanced through the wire and the wire was removed. The peel-away sheath was removed while the PD catheter was placed deep in the pelvic cavity under fluoroscopic control [Figure 2(f,g)]. A subcutaneous tunnel was created using a tunneling stylet, forming an angle downward to the primary incision so that it faced anterior-superior to the iliac spine. The exit site was positioned to avoid the belt line, skin crease, adipose fold, and scar tissue.

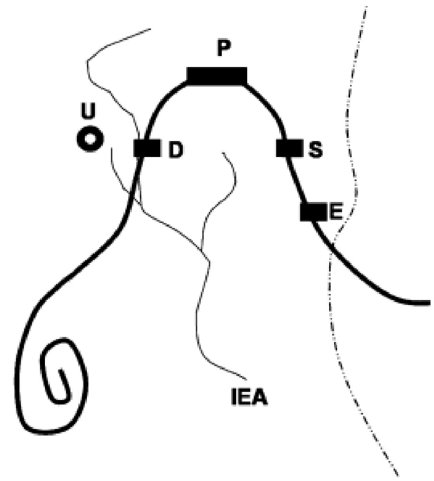

Figure 1 — Schematic representation of peritoneal dialysis catheter location. U = umbilicus; P = primary incision; D = deep cuff; S = superficial cuff; E = exit site; IEA = inferior epigastric artery.

PERITONEAL DIALYSIS

Following catheter insertion, the peritoneal cavity was irrigated with 1.5% glucose dialysate with heparin to prevent obstruction. Then 200 mL of dialysate was indwelled on the day of catheter insertion; the amount of dialysate was then increased gradually. The scheduled PD insertion takes place during a short hospital admission and is accompanied by patient education.

STATISTICAL ANALYSIS

Continuous values are reported as mean ± standard deviation (SD) unless otherwise stated. Categorical variables are expressed as counts and percentages. Perito-

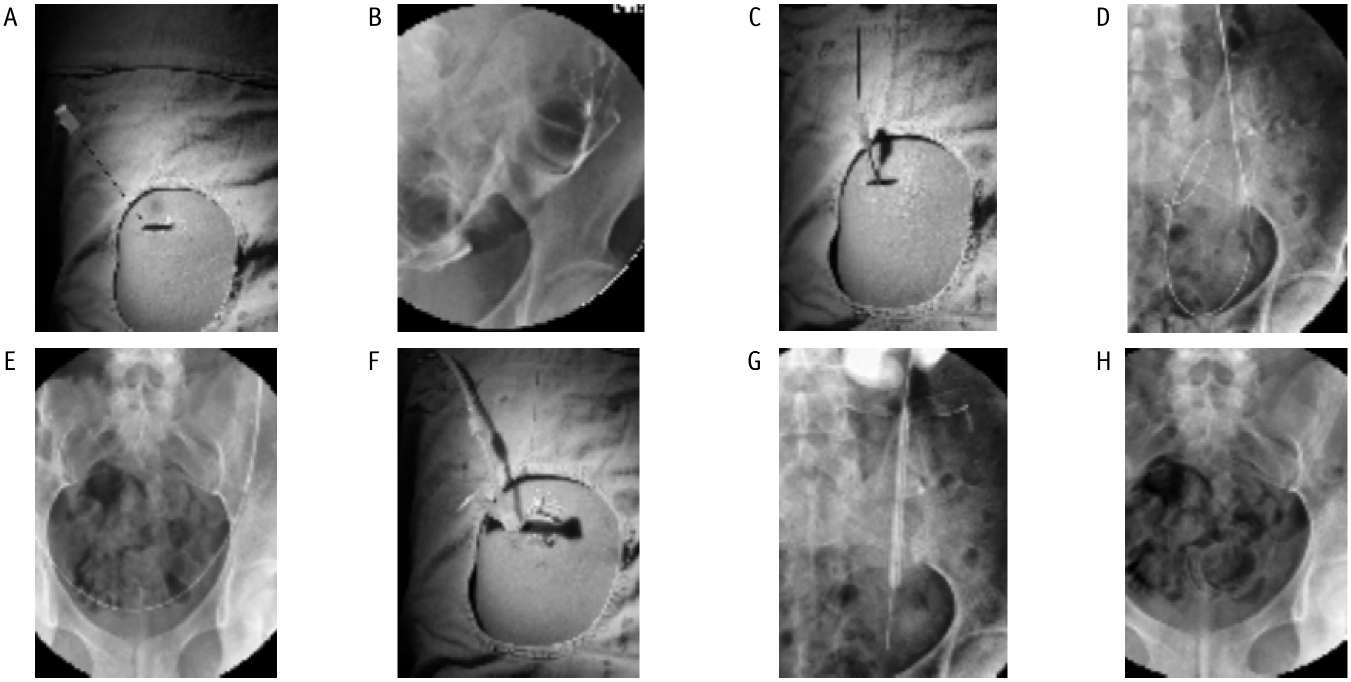

Figure 2 — Method of peritoneal dialysis catheter insertion.

nitis is expressed as episodes/patient-month. Catheter survival was calculated by Kaplan–Meier estimation. Patients were excluded from estimation of catheter survival if they had their catheter removed due to transplantation or transfer to another hospital, or if they died with a functioning catheter. Factors associated with PD catheter survival were analyzed using the multivariate Cox proportional hazard model.

RESULTS

BASELINE CHARACTERISTICS

In this study, 114 patients underwent 134 percutaneous fluoroscopy-assisted placements of PD catheters. Their mean age was 56.8 ± 13.1 years (Table 1); 61% of the patients were older than 60 years; 59% of the patients were men. Mean body mass index (BMI) of all patients was 23.3 ± 3.1 kg/m^2; 57.5% of the patients were overweight (BMI ≥23 kg/m^2) according to WHO criteria for the Asia-Pacific region (8). Eighty-three (61.9%) patients had diabetic nephropathy as the cause of end-stage renal disease; 78% of the patients had more than 1 comorbid disease. Mean follow-up time of patients with PD catheters was 21.1 ± 19.7 months. Straight two-cuff catheters were used in 21.6% of patients and coiled two-cuff catheters were used in 78.4% of patients. It took only 0.27 ± 0.48 days from consultation to fluoroscopy-assisted PD catheter placement. Mean duration of the break-in period was 7.4 ± 1.6 days; for elderly women with multiple parity, PD was started after 10 days. At discharge, mean dwell volume was 700 ± 200 mL.

TABLE 1
Baseline Characteristics of Patients and Catheters (*n*=134)

Age	56.8±13.1 years
Male:Female	79:55
Body mass index	23.3±3.1 kg/m^2
Body surface area	1.67±0.17 m^2
Cause of end-stage renal disease	
Diabetic nephropathy	83 (61.9%)
Hypertensive nephropathy	24 (17.9%)
Glomerulonephritis	8 (6.0%)
Others	6 (4.5%)
Unknown	13 (9.7%)
Davies comorbidity score	
None	30 (22.4%)
Intermediate	83 (61.9%)
Severe	21 (15.7%)
Type of catheter	
Straight two-cuff	29 (21.6%)
Coiled two-cuff	105 (78.4%)
Mean duration of follow-up	21.1±19.7 months
Range	0.7–71.9 months

EARLY AND LATE COMPLICATIONS OF PD CATHETERS

We observed no cases of insertion failure and only 19 (14.2%) patients needed analgesics for pain control after insertion. Early complications occurred in 8.5% of patients (Table 2). Complications related to insertion included 1 case of pericatheter bleeding; there were no cases of visceral perforation. Among the early complications, there were 4 cases of leakage, 2 migrations, and 1 obstruction. Early leakage manifested as pericatheter leakage and PD was restarted after 1 week of PD rest. Early migrations manifested as delay in dialysate inflow or outflow and inadequate drainage. Early migrated catheters were repositioned into the true pelvis by fluoroscopically guided manipulation but 1 case failed. One case of catheter obstruction was resolved by irrigating with heparin mixed with dialysate.

Late migrations manifested as poor outflow or pain. Three cases were found incidentally in asymptomatic patients; these patients continued PD with no flow problems. Seven cases of late migrations were repositioned by fluoroscopically guided manipulation; 6 of these cases were repositioned successfully. Peritoneal dialysis catheters were reinserted in 4 patients using fluoroscopic guidance. One patient who experienced repeated migration was converted to hemodialysis. Late leakages manifested as scrotal swelling, abdominal wall swelling, or pericatheter leakage. Leakage was confirmed by CT peritoneography. Four patients restarted PD after resting for 1 or 2 weeks. Five patients underwent surgical PD catheter reinsertion following catheter removal. Two late leakage patients were converted to hemodialysis. Two patients had their catheters removed due to other causes. Two cases of inguinal hernia occurred and these patients restarted PD after surgical repair of the hernia. Two patients with omental wrapping manifested outflow failure, which was confirmed by fluoroscopic tubogram. These patients underwent laparoscopic omentectomy and PD catheter reinsertion. The peritonitis rate was 1 episode per 21.1 patient-months; 16 patients had more than 1 episode of peritonitis.

REASONS FOR REMOVAL OF PD CATHETERS

Table 3 lists the reasons for catheter removal after excluding patient death with a functioning catheter, transplantation, and transfer to another hospital. The most common cause of catheter removal was intractable and recurrent peritonitis (9 cases). Mechanical causes of catheter removal included late leakage (7 cases), 5 late and 1 early migration (6 cases), and omental wrapping (2 cases). Twenty-four (18.0%) catheters were removed; 14 (58%) of these were reinserted using the same fluoroscopy-assisted procedure.

CATHETER SURVIVAL AND PROGNOSTIC FACTORS

The 12- and 24-month survival rates of the catheters were 80.0% and 74.9% respectively (Figure 3). There was only 1 case of catheter removal after 24 months. We used the multivariate Cox proportional hazard model to analyze the independent factors related to PD catheter survival. Late leakage, late migration, and late tunnel infection were statistically significant predictors of PD catheter survival. Peritonitis was the most common reason for catheter removal but it was not prognostic for PD catheter survival.

TABLE 3
Peritoneal Dialysis (PD) Catheter Removals (*N*=24)

Reinserttion of PD catheters by fluoroscopy-assisted method	14 (58%)
Reasons for removal (134 catheters: 24 removals)	
Infection	9 (6.7%)
Leakage	7 (5.2%)
Migration	6 (4.5%)
Omental wrapping	2 (1.5%)

TABLE 2
Complications Related to Peritoneal Dialysis Catheters

Early complications		Late complications	
Pericatheter bleeding	1 (0.7%)	Hernia	2 (1.5%)
Visceral perforation	0 (0%)	External cuff extrusion	0 (0%)
Obstruction	1 (0.7%)	Obstruction	0 (0%)
Leakage	4 (3%)	Leakage	13 (9.7%)
Migration	2 (1.5%)	Migration	14 (10.4%)
Omental wrapping	0 (0%)	Omental wrapping	2 (1.5%)
Exit-site infection	0 (0%)	Exit-site infection	11 (8.2%)
Tunnel infection	0 (0%)	Tunnel infection	6 (4.5%)
Peritonitis	3 (2.2%)	Peritonitis	1 episode/21.1 patient-months

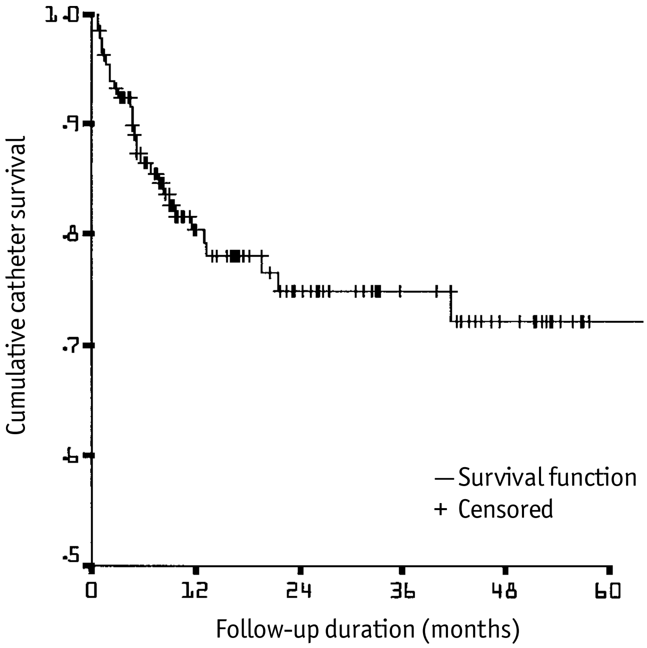

Figure 3 — Kaplan–Meier plot of peritoneal dialysis catheter survival.

DISCUSSION

Frequent hospital visits are the main cause of reduced quality of life for dialysis patients compared with transplant patients. Therefore, adequate function of PD catheters is important in order to minimize the number of admissions and maintain the quality of life for PD patients. In 1968, Tenckhoff and Schechter designed a silicone rubber catheter with a polyester cuff for treating acute renal failure and with two cuffs for treating chronic renal failure. These were important developments for peritoneal access (9). Since then, multiple attempts have been made to eliminate the remaining complications associated with PD catheters. The rate of transfer of patients to hemodialysis after peritoneal access failure has now been reduced to approximately 5% – 10% (10). One-year PD catheter survival has increased to over 80%, and this success rate is reasonably attainable for most treatment centers (11). Therefore, in order to improve their catheter survival rate, each PD center must consider the strengths and weaknesses of PD catheter insertion methods.

Surgical insertion is the classic and most widely used method for catheter insertion. The reported 1-year survival rate for surgically placed catheters is between 62.5% and 83% (3,12), depending on the operators. Where the operators are senior surgical residents under the supervision of 1 attending surgeon, 38% of the patients develop peritonitis and 24% experience mechanical dysfunction of the catheter within 4 weeks of surgery (12,13). Laparoscopic insertion may reduce the incidence of dialysate leakage and migration (1,14); however, these results have been inconsistent (3). Laparoscopic insertion requires general anesthesia and a long break-in period, and is expensive. The most significant problem for both methods is the long break-in period. With a break-in period of 2 weeks, the wound usually heals well and the risk for early and late leaks is reduced. However, PD cannot begin immediately following these procedures. A modified technique has been developed to overcome this delay in starting PD (15).

In 1988, Allon *et al.* reported PD catheter survival of 64.6% at 1 year and 48.6% at 2 years after percutaneous placement (16). In 2001, Ozener *et al.* reported excellent survival (90% at 1 year and 82% at 2 years) using the percutaneous method, demonstrating superior catheter survival compared to the surgical method (17). However, even in this study, there occurred 1 case of wound hematoma and 4 cases of pericatheter bleeding related to insertion. Colon perforation related to catheter insertion has been reported in association with the peritoneoscopic method (18).

Percutaneous fluoroscopy-assisted placement of PD catheters is not a popular method in the nephrology community. Previous studies of fluoroscopy-assisted placement showed 1-year and 2-year survival rates of 81% for PD catheters (19); others have reported a 1-year survival rate of 89% (20). Compared to other insertion methods, these catheter survival rates are high. However, these previous studies did not report the details of catheter-related complications and both were small-scale studies. This is the first report concerning a large number of patients and long-term experience with percutaneous fluoroscopy-assisted placement of PD catheters. This method has many beneficial features, including little pre-procedure waiting, a small incision, reduced pain, a short break-in period, and low cost. Another important consideration is that, compared to other percutaneous methods, this method is not blind and there is little risk of organ perforation. In our study, insertion-related complications included 1 case of pericatheter bleeding; there were no cases of visceral perforation or hemorrhage from inferior epigastric artery injury, and no placement failures. The early complications of fluoroscopy-assisted placement were few, even though our patient population was older and had a higher rate of comorbid disease. Therefore, this method might benefit higher-risk patients that start acute renal replacement therapy.

This simple and painless method was well tolerated. The PD catheter reinsertion rate was 58%. The PD failure rate due to catheter-related infectious or mechanical causes was only 2.2%. Our results show that the 1-year, 2-year, and 5-year survival rates for the PD catheters were 80%, 74.9%, and 71.1%, respectively. The catheter survival rate found in this study is comparable to that achieved by surgical, laparoscopic, and other percutaneous placement techniques.

Factors potentially related to dialysate leakage can be divided into three categories: those related to the PD catheter insertion technique, those related to the way PD is initiated, and those related to any weakness of the abdominal wall (4). Reported early leakage rates range from 0.9% to 11.1% in surgical studies (3,21,22), and from 1.3% to 22% in percutaneous studies (16,17, 23–25). Tzamaloukas *et al.* reported a 5.7% incidence of early leakage, and all early leakages developed in patients that started PD immediately after insertion of the PD catheter (90% within 10 days, more than half within 24 hours); also, most of their cases of early leakage were associated with the median surgical approach (26). In our study, the incidence of early leakage was 3% and these patients were able to restart PD after rest, possibly because the mean duration of the break-in period was relatively short (7.4 ± 1.6 days) and dissection of the rectus muscle was avoided.

Reports about late leakage have been more variable than reports about early leakage. The reported incidence of late leakage in surgical studies varies between 3.1% and 12% (4,26,27) and in a percutaneous study it is reported as 6.7% (17). Late leakage is the leading reason for removal of PD catheters. Two studies reported incidence of late leakage as a cause for catheter removal as 0% and 8.3% for a surgical approach and as 0% and 2% for a percutaneous approach (18,25). Both early and late leaks were uniformly associated with conditions that adversely affect tissue healing and tensile strength; however, hernia, straining, and previous peritonitis were associated only with late leakage (26). Interestingly, Rodriguez–Perez and Hirsch and Jindal (28,29) reported that these risk factors for the development of leakage were not found in their respective groups of 5 and 8 patients with late leakage. In our study, most cases of late leakage developed around the first year of PD (351 ± 133 days), and these patients were older than the patients with no leakages (61.8 ± 7.5 vs 56.3 ± 13.5 years, $p < 0.05$). None of these patients had a history of early leakage. Seven PD catheters were removed due to late leakage; 4 of these patients were elderly women with a history of multiple pregnancies. One of these women developed late leakage after severe coughing and two had late leakage combined with exit-site infection. More than 80% of our patients with late leakage had at least one predisposing medical condition contributing to abdominal wall weakness, such as advanced age, exit-site infection, multiple pregnancies, abdominal obesity, and straining.

Every PD treatment center should have the best technique available for use, and the easy accessibility of PD catheter insertion is directly related to an increase in the PD population. In our center, we performed percutaneous fluoroscopy-assisted PD catheter placement for all patients that underwent their first catheter placement. Our results using this method are comparable to those of other more invasive methods, except for their high risk of late leakage. Furthermore, we experienced a low early complication rate and the initial success rate was 100%. In conclusion, our results show that percutaneous fluoroscopy-assisted placement of PD catheters is simple, minimally invasive, and relatively safe. Therefore, percutaneous fluoroscopy-assisted PD catheter placement may be the preferred method for the initial placement of PD catheters.

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