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C. Reddy, P.E. Dybbro & S. Guest

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CLINICAL STUDY

Fluoroscopically guided percutaneous peritoneal dialysis catheter placement: single center experience and review of the literature

C. Reddy[1], P.E. Dybbro[2] and S. Guest[3]

[1] *Department of Nephrology, Kaiser Permanente, Santa Clara, CA, USA*

[2] *Kaiser Permanente, Hayward, CA, USA*

[3] *Renal Division, Baxter Healthcare, McGaw Park, IL, USA*

ABSTRACT

Experiences with minimally invasive techniques for peritoneal dialysis (PD) catheter placement are being increasingly described. Percutaneous placement of catheters using ultrasound and fluoroscopic guidance has reduced the risk of complications and has led to successful long-term catheter function. An interventional radiology catheter placement capability was established at our facility and it serves as the basis for this report.

We performed a retrospective analysis of patients in a tertiary care center in Northern California who required PD between July 2005 and October 2008. Patients underwent PD catheter placement in an interventional radiology suite by the radiologist using a percutaneous Seldinger technique that was guided by fluoroscopy.

Sixty-four patients between the ages of 25 and 90 were referred for fluoroscopic PD catheter placement by an interventional radiologist. If clinically indicated, PD was initiated within days of catheter placement. Minor complications were noted: four with minor bleeding, three with catheter migration, and one with temporary exit-site leakage. No bowel or bladder perforations were encountered.

Fluoroscopically guided PD catheter placement by interventional radiologists can be a safe and cost-effective strategy to initiate acute or chronic PD. This approach could reduce the need for temporary vascular access and expedite the initiation of PD therapy by eliminating the delays in catheter placement often associated with surgical consultation and operating room scheduling.

Keywords: fluoroscopy; radiology; percutaneous; peritoneal dialysis; Seldinger

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Correspondence: C. Reddy, MD, Kaiser Permanente Santa Clara, 710 Lawrence Expressway, Santa Clara, CA, USA; tel: +1-408-851-4600; fax: +1-408-851-4559; E-mail: chitra.reddy@kp.org

INTRODUCTION

Globally, the number of patients reaching end-stage renal disease (ESRD) continues to rise. Most nephrologists acknowledge that dialysis, whenever possible, should be started in the home setting to allow patients to maintain their independence, flexibility in scheduling and to encourage employment and personal productivity. Yet many patients are referred to nephrologists late in the course of their illness or for other reasons do not receive dialysis options education and are typically started on in-center hemodialysis (HD) by a temporary internal jugular catheter or tunneled catheter. These catheters have a high rate of infection and have been associated with bacteremia and subsequent increased cardiovascular events.[1] Strategies to reduce the use of acute intravenous HD catheters are clearly needed.

Studies have repeatedly shown that when patients reaching ESRD are given more extensive dialysis options education up to 45% of patients would choose peritoneal dialysis (PD) as their dialysis modality, and the present low utilization of PD in many countries suggests that this more extensive options education is not occurring in all centers.[2–4] Many nephrologists feel that a patient referred late to dialysis education or starts dialysis emergently without any options education, the "crash start" does not have the potential to start PD because of the lack of ability to start PD acutely. Most patients who elect to start PD are then referred to a surgeon, an operative date is established, there may be an anesthesiology consultation required, and then the catheter requires several weeks to heal before starting PD training. This would suggest that PD is not a therapy which can be easily initiated acutely in many centers.

However, there are extensive reports of placing PD catheters through the percutaneous Seldinger technique to initiate chronic PD and initiating PD within hours to days of catheter insertion if indicated.[5–9]

These reports almost uniformly suggest that the percutaneous technique is successful with low rates of complications such as bleeding, bowel or bladder perforation, and infection. To reduce the risk of complication even further, some authors have described using fluoroscopy to guide placement and confirm the desired location of the catheter in the peritoneal cavity and to document free flow of dialysate.[10–16] These authors note that should any complication arise during fluoroscopically guided percutaneous placement of PD catheters these complications are recognized quickly and managed conservatively. Most reports describe the use of pre-procedure antibiotics and the subsequent risk of infection has been minimal. So there is significant literature to suggest that acute or chronic PD catheter placement to initiate dialysis is practical and can be compared to the placement of a tunneled HD catheter for initiation of dialysis.

The Kaiser Permanente facility in Hayward, California, USA has established a mechanism to place acute and chronic PD catheters in the interventional radiology suite using fluoroscopy to guide the percutaneous procedure. The procedure is done by multiple interventional radiologists. This report describes our experience with 64 patients and discusses other reports in the literature that have used fluoroscopy to guide percutaneous PD catheter placement for both acute and chronic PD.

METHODS AND MATERIALS

From July 2005 to October 2008, 64 patients underwent percutaneous placement of PD catheters using the Seldinger technique. Catheter position into the peritoneal cavity and final location of the distal end of the catheter into the peritoneum was confirmed by fluoroscopy. All catheters were placed in the radiology suite by interventional radiologists.

Peritoneal dialysis catheter insertion technique

After obtaining informed consent, including discussion of risks, benefits, alternatives, and possible complications, the patient is brought to the interventional radiology suite and asked to empty the bladder. The patient is asked to stand and the exit site and entrance site are stenciled with an indelible marker with care given to avoid the beltline. Then a peripheral intravenous line is established. Patient is given conscious sedation per protocol with midazolam and fentanyl. One gram of intravenous cephazolin is administered for antibiotic prophylaxis. The left lower quadrant abdominal wall is then prepped and draped. A stab incision is made at the level of the umbilicus in the mid rectus line. Utilizing a blunt tip 18-gauge needle, the peritoneum is punctured. This allows placement of 0.035 inch guide wire. Over the 0.035 inch guide wire, a 5-French angled catheter is inserted. Hand injection of contrast is performed to confirm intraperitoneal location. The angled catheter is then manipulated into the deep right hemipelvis. A larger guide wire is then placed to allow a peel away sheath to be inserted. This allows for insertion of the PD catheter. The swan-neck catheter is positioned deep in the right hemipelvis with the deep cuff directed into the rectus sheath with a Kelly clamp. Hand injection of contrast is performed to confirm good intraperitoneal location. A separate stab incision using an 11 blade is created approximately 4 cm inferiorly and 2–3 cm laterally. The Kelly clamp is inserted into the stab incision and used to tunnel subcutaneously toward the PD catheter insertion site. The clamp grasps the distal PD catheter and then withdraws the catheter through the newly created subcutaneous tunnel. Ideally the superficial cuff is positioned 2 cm from the exit site. No suturing is done at the exit site. Two hundred milliliters of normal saline is then rapidly filled and drained to ensure good flow. The wound is closed in two layers. The deep subcuticular tissues are closed with an interrupted 3–0 polysorb stitch. The superficial subcuticular tissues are closed with a running 4–0 polysorb stitch. Additional Benzoin Steri-Strips are applied to the skin edges. Sterile dressing is applied. The patient is then transported to the recovery room. Patient is discharged after an hour of observation.

Total fluoroscopy time is approximately 2–3 minutes. Total contrast utilized is approximately 15 mL of Omnipaque-300. Patients were given an appointment with the dialysis nurse within a week after catheter placement. At this appointment, the dressing is changed and the catheter flushed with dialysate. If not used acutely during the hospitalization, the catheter is used in 1–2 weeks after training. If the patient is deemed uremic, low-volume recumbent exchanges are instituted in the hospital or outpatient clinic.

RESULTS

A total of 64 catheters were placed in 64 patients (Table 1). Complications were limited to a leak in one patient and minor bleeding in four patients that responded to pressure hemostasis (Table 2). There were no bowel or bladder perforations. One patient presented with an inguinal hernia at 1 month of commencing PD. Of note an earlier computed tomography (CT) scan had not revealed a hernia or obvious patent processus vaginalis. One patient developed a pleuroperitoneal leak felt unrelated to catheter placement. Three patients developed catheter migration within

TABLE 1. Patient characteristics.

Patients	$n = 64$
Range in ages	24–90 years old
Gender	41 males, 23 females
Etiology of ESRD	DM 35, HTN 14, ATN 4, ADPKD 3, GN 5 Failed transplant 3

TABLE 2. Complications encountered within 1 month of catheter placement ($n = 64$).

Exitsite leakage	1
Bleeding – major	0
Bleeding – minor	4
Catheter migration	3
Exitsite infection	0
Tunnel infection	0
Peritonitis	0
Hydrothorax	1
Hernia	1
Bowel perforation	0
Bladder perforation	0

the first month of use necessitating repositioning by interventional radiology.

Four of the catheters were used to initiate urgent PD (PD started within 24–48 hours). There were no differences in the rate of leak or other complications in this group. In the urgent start group, PD was initiated with lower solution volumes of 1 L and the patient was maintained in the recumbent position during the dwells.

DISCUSSION

It is critical to the growth of a PD program that nephrologists have consistently successful catheter placements.[17] PD catheters can be placed by a variety of methods including the blind Seldinger technique, open laparotomy, peritoneoscopic placement, and basic or advanced laparoscopic placement.[18,19] There are advantages and disadvantages to all placement techniques and all procedures are operator dependent and of varying success based on local experiences. Surgical techniques typically require general anesthesia in the operating room setting, are more cumbersome to arrange and schedule, and are more costly.

Many authors have described their experiences with percutaneous catheter placement.[5–8] Percutaneous placement of presternal PD catheters has also been described.[20] Blind percutaneous placement raises the risk somewhat of perforation of viscera or malposition of the catheter. A variation of the blind percutaneous placement method is the use of a rigid peritoneoscope (Y-Tec) that enters the peritoneum and allows for inspection of the peritoneal space to avoid adhesions and to better direct the pigtail catheter into the pelvis.[21] At many large medical centers used by nephrologists, the interventional radiologists or interventional nephrologists have been invaluable in the placement of tunneled HD catheters for the initiation of dialysis. This tunneling of the HD catheter usually employs fluoroscopic guidance for ideal placement of the catheter. At the Kaiser Permanente Hayward facility, it was reasoned that these same techniques involving the Seldinger technique with fluoroscopic guidance could be used to successfully place a PD catheter for use in acute or chronic PD. This technique proved to be technically straightforward, easy to schedule – usually on the same day or within a day – required only local anesthesia with no required operating room, recovery room, or admission to the hospital, and was therefore quite cost-effective.

After placement of the PD catheters, dialysis initiation could take place immediately using low volume exchanges in the recumbent position, if required, but more typically we initiated PD after 1 week post-procedure. Our complications were limited to a transient minor leak and minor bleeding that responded to conservative treatment.

Other reports of using fluoroscopy to guide the percutaneous placement of PD catheters confirm that this is a safe and cost-effective procedure (Table 3). Jacobs and colleagues described 45 catheters placed percutaneously in 32 patients.[12] The catheters were placed in the Radiology Department's special procedure room with fluoroscopic guidance. In their series, dialysis was initiated within 24 hours of catheter placement using low volumes of dialysate. Over the next 1–2 weeks, the volumes were increased to full dose PD. Prophylactic antibiotics were routinely used. They noted that the procedure was operator dependent with a learning curve that resulted in a higher rate of complications initially that led to a modification of the procedure to employ a blunt 18 g needle to lessen the risk of bowel perforation and then employment of a swan-neck-shaped catheter instead of a straight catheter because of higher initial rates of superficial cuff extrusions. After these modifications their results were excellent. The immediate function of the catheters was documented in all patients and during continued dialysis complications were seen in 13% of patients including infections in one, bowel perforation in two (one major and one minor), and abdominal hematomas in three patients. Transient leaks occurred in 9% and resolved with

TABLE 3. Other clinical experiences with percutaneous fluoroscopically guided PD catheter placement.

Author	Vaux[10]	Rosenthal[16]	Moon[14]	Maya[23]	Jacobs[12]	Zaman[15]	Savader[11]
Catheters attempted	209	52	134	32	45	36	19
Success rate (%)	97.6	100	100	97	96	94	95
Early complications							
Bladder perforation	0/200	NR	0/134	0/32	0/45	0/34	0/19
Bowel perforation	0/200	NR	0/134	1/32	2/45	0/34	0/19
Early leaks	10/200	2/52	4/134	0/32	3/45	1/34	0/19
Exit-site infections	13/200	1/52	11/134	0/32	NR	0/34	0/19
Peritonitis	3/200	0/52	4/134	0/32	7/45	2/36	1/19
Catheter dysfunction	14/200	5/52	3/134	1/32	9/45	1/34	0/19
Bleeding	N.R.	1/52	1/134	0/32	3/45	1/34	1/34

Note: NR, not reported.

either a reduction in dialysate volume or a temporary cessation of PD.

Inadvertent bowel perforation would be one of the most concerning complications of percutaneous catheter placement and this complication has been noted to be infrequent.[22] In our series there were no incidences of bowel perforation and Zaman and colleagues similarly reported that no bowel perforations occurred when using fluoroscopy to guide in the placement of 34 catheters (see Table 3).[15] In the large series reported by Moon et al., no visceral perforations were reported in 147 percutaneous procedures; in other rare reports of inadvertent bowel entry the procedure was terminated, the catheter was removed, and the patient was given antibiotics and observed conservatively. The authors felt that bowel injuries were small and were felt to seal over promptly without further intervention.[14] Our experience and the above descriptions would suggest that the concern over bowel or bladder entry during a fluoroscopically guided percutaneous procedure is a rare and manageable occurrence and should not be considered as a reason to not adopt the technique.

Maya described a modification of the fluoroscopic approach by using initial ultrasound guidance to gain access to the peritoneal cavity.[23,24] Ultrasound allows for direct visualization of landmarks such as the subcutaneous tissue, the rectus sheath, and the peritoneal cavity, and the color flow Doppler capability helps to identify and avoid vessels such as the epigastric artery. We did not use ultrasound guidance, yet we did not encounter significant bleeding complications. Review of the literature confirms that bleeding complications are rare and usually responded to direct pressure (see Table 3). Vaux and colleagues published the largest percutaneous fluoroscopically guided PD catheter placement experience to date.[10] They also used ultrasound guidance to gain entry to the peritoneum. The authors described 204 catheter placements with technical survival of their catheters at 1, 2, and 5 years of 77, 66, and 31%, respectively.

As mentioned, Zaman and colleagues described their experiences with fluoroscopically guided percutaneous catheter placements in 36 consecutive patients.[15] Their patients were given a bowel prep before the procedure and prophylactic antibiotics. At the time of the procedure, a Foley catheter was placed to decompress the bladder. Fluoroscopy was used to confirm the entrance to the peritoneal cavity and confirmation of the pigtail catheter into the pelvis. All catheters were placed in their Interventional Nephrology vascular suite and patients were admitted overnight for observation. The mean body mass index of the patients was 27.5 ± 4.6. Complications were limited to a transient leak, minor bleeding, and one catheter flow dysfunction. The 1-year survival of the catheters was 89%. An additional 12 patients were evaluated but not felt to be candidates for percutaneous placement due to the presence of pre-existing hernias, and suspected adhesions due to extensive prior surgery or prior PD catheters that had been placed in the operating room.

Ideally, even patients initiating fairly urgent or acute dialysis should have the option of considering PD as their initial dialysis modality. After options education, to initiate acute dialysis a tunneled permacath could be considered or a tunneled PD catheter – one placed by either interventional radiology or interventional nephrology. Establishing a capability to place PD catheters in this fashion represents a major step in the ease of initiation of PD and has been associated with rapid growth in the local PD population.[25–27] Having the capability of placing percutaneous PD catheters in an interventional suite avoids the longer waiting times associated with surgical placement and

the delays in placement that often result in need for acute vascular access and possible loss of interest in pursuing PD. Fluoroscopically guided percutaneous PD catheter placement has been proven to be safe, cost-effective, and allows for more urgent initiation of PD without the requirement of surgical or anesthesia consultation. Overall complications such as dialysate leaks or infection seem to be comparable to those placed laparoscopically or by open laparotomy.

Having a nonsurgical, percutaneous catheter placement capability has been shown to stimulate the growth of PD programs. Asif and colleagues described rapid growth in the number of patients starting PD after interventional nephrologists began placing catheters at three different medical centers.[28] At the Kaiser Permanente facility in Hayward, the PD population expanded threefold after the establishment of this interventional radiology-driven catheter placement program.[29] Additionally Goh and colleagues recently described the establishment of an integrated care model, interventional nephrologists placed catheters, and a "PD first" strategy raised the PD penetration to 44.9% of their patients – 4.5 times the national USA average.[30]

Finally, the so-called "assisted PD" is gaining popularity in which a patient who is deemed not able to perform PD themselves is assisted at home by a visiting nurse or other caregiver.[31] Up to 50% of PD patients in France, for example, are on PD with assistance. Others have advocated an intermittent PD (IPD) program in a dialysis center.[32] Having the capability of placing a PD access acutely, with a percutaneous procedure, followed by assisted PD in the home or in-center IPD, could allow for a cost-effective approach to the patient presenting with ESRD.

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