Peritoneal Dialysis

Mohammed Al-Natour, MD¹ Dustin Thompson, MD¹

¹ Department of Radiology, Cleveland Clinic, Cleveland, Ohio

Semin Intervent Radiol 2016;33:3–5

Address for correspondence Dustin Thompson, MD, Department of Radiology, Cleveland Clinic, 9500 Euclid Avenue, L10, Cleveland, OH 44195 (e-mail: mnatour85@msn.com).

Abstract

Keywords

- peritoneal dialysis
- peritoneal catheters
- percutaneous placement
- fluoroscopic guidance
- interventional radiology

Peritoneal dialysis is becoming more important in the management of patients with end-stage renal disease. Because of the efforts of the “Fistula First Breakthrough Initiative,” dialysis venous access in the United States has become focused on promoting arteriovenous fistula creation and reducing the number of patients who start dialysis with a tunneled catheter. This is important because tunneled catheters can lead to infection, endocarditis, and early loss of more long-term access. When planned for, peritoneal dialysis can offer patients the opportunity to start dialysis at home without jeopardizing central access or the possibilities of eventual arteriovenous fistula creation. The purpose of this review is to highlight the indications, contraindications, and procedural methods for implanting peritoneal dialysis catheters in the interventional radiology suite.

Objectives: Upon completion of this article, the reader will be able to describe the advantages of peritoneal dialysis over hemodialysis; describe the technique of fluoroscopically guided peritoneal dialysis catheter placement; and outline methods of catheter troubleshooting and salvage.

Accreditation: This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Tufts University School of Medicine (TUSM) and Thieme Medical Publishers, New York. TUSM is accredited by the ACCME to provide continuing medical education for physicians.

Credit: Tufts University School of Medicine designates this journal-based CME activity for a maximum of **1 AMA PRA Category 1 Credit™**. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The science and technique of peritoneal dialysis (PD) was developed and refined throughout the 20th century. Georg Ganter is considered a pioneer of the field, publishing the first animal trials investigating the use of PD in 1923.¹ Odel et al published a review of human clinical experience in 1950, including 101 patients treated with PD. Early efforts were complicated by mortality secondary to uremia, pulmonary edema, and peritonitis.² During the following years, many

individuals (too numerous to catalog here) contributed to the advancement of PD, refining catheter design, decreasing complications, manipulating the timing of fluid exchanges, and improving home dialysis equipment. The most recent data (2012) from the United States Renal Data System indicate that of 110,932 new patients with end stage renal disease (ESRD), 9,175 (8.3%) had dialysis initiated by PD. The majority of new patients (98,954 [89.2%]) began with hemodialysis (HD), and a smaller portion (2,803 [2.5%]) received a preemptive kidney transplant. Among prevalent patients in 2012, a total of 40,605 out of 402,514 patients were receiving PD. Younger age groups, white races, and Asian patients were more likely to utilize PD compared with black/African American and Native American groups.³

Advantages of Peritoneal Dialysis

Proponents of PD argue that patients will lead more productive lives because they will not have to go to a dialysis center three times per week. Patients will have a more convenient schedule, can keep a regular day job, and have more flexibility for travel than if they were using HD. Patients will also have less pain because venipuncture for HD is not required. This makes PD a popular choice particularly for the pediatric population.

There is some evidence that mortality rates are also lower for patients receiving PD compared with HD. Fenton et al

found an increased mortality rate for patients on HD that was most prevalent in the first 2 years postinitiation of dialysis, with a crude death rate per 1,000 patient-years of 229.3 for HD and 150.7 for PD.⁴ Mortality risk while on PD was 73% that of patients on HD, after controlling for other prognostic factors.

Technique of Peritoneal Dialysis Catheter Placement

Initial PD treatments were performed using catheters inserted into the peritoneal cavity using the trocar technique. This technique gradually evolved into a surgically placed tunneled peritoneal catheter, as described by Palmer, Quinton, and Gray in 1964. As surgical technology developed further, laparoscopy became the favored method of placement, allowing direct visualization of the catheter position and adhesiolysis if necessary. Omentopexy has also been described as a technique to avoid catheter obstruction. In this operation, during laparoscopy the omentum can be pulled cranially out of the pelvis and sutured superiorly so that it will not entangle the PD catheter and contribute to adhesion formation.

Several studies have been published on the technique for placing PD catheters without the use of laparoscopy. A peritoneoscopic approach is possible, using a much smaller device to visualize the pelvis. A completely percutaneous technique without the use of a peritoneoscope has also been used by some practitioners without the aid of fluoroscopy. The more favored method for interventional radiologists is to perform percutaneous placement with ultrasound and fluoroscopic guidance. Abdel-Aal et al published a detailed consensus for the technique of PD catheter placement by interventional radiologists.⁵

Prior to the procedure, the patient is interviewed and examined to determine if there are any potential contraindications to PD catheter placement or any warning signs that a percutaneous approach may be difficult. Clinical contraindications include inflammatory abdominal processes such as Crohn disease, ulcerative colitis, current clostridium difficile infection, and end-stage liver disease with ascites. The main anatomic contraindication to PD is an unrepaired hernia that would potentially increase in size with the use of PD. Relative anatomic contraindications include the presence of ostomies or feeding tubes. Patients with a history of complex abdominal surgery with a high risk for adhesion formation would be better served with laparoscopic placement to allow for direct visualization and management of adhesions. The patient's skin is marked prior to the procedure and a catheter exit site is chosen such that it does not overlap the patient's belt line or lie within a skin fold. A straight or curved catheter is chosen depending on body habitus. Ideally, the catheter exit site will be easily visible to the patient; patients with a large pannus may require an extended catheter tunneled to the presternal area.

The day prior to the procedure, patients at the authors' institution receive a bowel preparation consisting of Miralax 17 g po with 8 oz of water; Senna 15 mg po, repeat one more

time if no bowel movement in 4 hours; and Dulcolax suppository, one per rectum. Bowel preparation is meant to decrease the risk of peritonitis if a bowel perforation occurs during catheter placement, and also to decrease the volume of the colon to allow for better fluid filling in the pelvis. A nasal swab is also performed for MRSA testing. Patients who are MRSA negative receive cefazolin preprocedure, while those who are positive receive vancomycin. Patients are instructed to shower the night prior to the procedure with antibacterial soap. The urinary bladder should be emptied just before the procedure.

The anterior abdominal wall is evaluated with ultrasound to determine the location of the inferior epigastric artery to avoid puncturing it. Ultrasound can also visualize the intestinal loops. If there are adherent nonmobile loops of intestine, then a different site of peritoneal entry should be chosen. Some practitioners use a standard micropuncture set for peritoneal access while others chose an 18G Hawkins-Akins needle (Cook, Bloomington, IN) with the blunt inner trocar to reduce the risk of bowel perforation.

Practice pattern differs as to the exact technique used to confirm entry into the peritoneum. A guidewire may be introduced and observed under fluoroscopy to see if the wire is easily placed into the pelvis. The operator can also feel for resistance while advancing the wire to determine if it is truly within the peritoneal space; puncture into the peritoneum will result in very little resistance. Alternatively, a small amount of contrast can be injected through the needle or through the micropuncture introducer to determine whether peritoneal puncture has been successful. After confirming that the peritoneal cavity has been safely accessed and no bowel puncture has occurred, a wire is advanced into the pelvis. At this point, the tract can be dilated and the catheter placed through a peel away sheath. It is also an option to place a sheath over the wire and partially distend the peritoneal space with sterile saline to allow for easier positioning of the catheter. Placing the catheter over a wire also helps ensure positioning of the catheter tip deep within the pelvis. The deep cuff of the catheter is subsequently implanted into the rectus muscle. The external portion of the catheter is tunneled using a curved plastic or stainless steel tunneling device to the previously marked exit site, taking care to direct the catheter caudally at the exit site. Fluoroscopy is used to confirm that the catheter is positioned in the pelvis and that there are no kinks along the catheter course. Fluid is instilled into the peritoneal cavity to test the function of the catheter. The initial incision is closed with absorbable suture; however, there is no suture placed at the catheter exit site. A transfer set is attached and the catheter is flushed with heparin. The type of dressing placed depends on how soon the catheter will be used; for routine placement, the catheter is completely covered and is not used for 2 weeks post-placement to prevent fluid leak. If PD is planned acutely then the end of the transfer set is left outside of the dressing to allow for immediate use; to avoid fluid leak, PD is performed with the patient supine and with a modified dialysis prescription.

Patients are prescribed stool softeners postprocedure to prevent constipation that may lead to decreased space within the pelvis, and incomplete fluid entry and return.

Complications

Potential complications of the procedure can be categorized into infectious or mechanical. Infectious complications include bowel perforation, peritonitis, tunnel infection, or exit site infection. Mechanical complications include failure of patency, fluid leak, and hernia. In patients with a body mass index (BMI) >35, the omentum can fall into the pelvis, causing obstruction of the catheter that can limit its flow. This can easily be managed laparoscopically with omentopexy, where the surgeon places a stitch in the omentum to adhere it to the abdominal wall. Finally, if the tunnel is placed too caudally in an obese patient, movement of the abdomen may pull the catheter out of the pelvis. In these cases, it may be of benefit to tunnel the catheter above the patient's abdomen using an extension of the catheter into the peritoneal cavity.

Narayan et al described a method of explanting the deep cuff while leaving the superficial cuff in place and the intraperitoneal portion of malfunctioning PD catheters to allow clearance of debris and redirection of the catheter. Management of PD catheter dysfunction due to migration, fibrin plugging, or omental wrapping can be attempted via a percutaneous fluoroscopic-guided approach offering PD salvage at a lower cost than surgical interventions, while also avoiding general anesthesia.⁶ These advantages suggest radiologic treatment of malfunctioning catheters as a primary step, with more invasive surgical options performed if less invasive means are unsuccessful.

Success Rates

Both radiologic and surgical techniques for placement of PD catheters have been described with comparable results.^{7,8} The radiologic technique of catheter placement under fluoroscopic and ultrasound guidance incurs a lower cost; in addition, this technique can be performed under moderate sedation and local anesthesia, thereby avoiding gen-

eral anesthesia. These advantages make radiologic placement a preferable method in patients with medical comorbidities labeling them unsuitable for general anesthesia. Conversely, surgical placement of PD catheters, whether laparoscopic or open, should be the procedure of choice in patients who are overweight (BMI >35 kg/m²) or those requiring simultaneous complicated surgical interventions such as hernia repairs and lysis of adhesions.⁷ Overall the decision for placement of PD catheters should be individualized and made by a multidisciplinary team involving nephrologist, surgeon, interventional radiologist, and anesthesia practitioners.⁷

References

- 1 Palmer RA. As it was in the beginning: a history of peritoneal dialysis. *Perit Dial Int* 1982;2:16–22
- 2 Odel HM, Ferris DO, Power MH. Peritoneal lavage as an effective means of extrarenal excretion; a clinical appraisal. *Am J Med* 1950; 9(1):63–77
- 3 Saran R, Li Y, Robinson B, et al. US Renal Data System 2014 annual data report: epidemiology of kidney disease in the United States. *Am J Kidney Dis* 2015;66(1, Suppl 1):S1–S305
- 4 Fenton SS, Schaubel DE, Desmeules M, et al. Hemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. *Am J Kidney Dis* 1997;30(3):334–342
- 5 Abdel-Aal AK, Dybbro P, Hathaway P, Guest S, Neuwirth M, Krishnamurthy V. Best practices consensus protocol for peritoneal dialysis catheter placement by interventional radiologists. *Perit Dial Int* 2014;34(5):481–493
- 6 Narayan R, Fried T, Chica G, Schaefer M, Mullins D. Minimally invasive fluoroscopic percutaneous peritoneal dialysis catheter salvage. *Clin Kidney J* 2014;7(3):264–268
- 7 Maher E, Wolley MJ, Abbas SA, Hawkins SP, Marshall MR. Fluoroscopic versus laparoscopic implantation of peritoneal dialysis catheters: a retrospective cohort study. *J Vasc Interv Radiol* 2014;25(6):895–903
- 8 Voss D, Hawkins S, Poole G, Marshall M. Radiological versus surgical implantation of first catheter for peritoneal dialysis: a randomized non-inferiority trial. *Nephrol Dial Transplant* 2012; 27(11):4196–4204