Ten Lessons Learned in Peritoneal Dialysis

Expert observations aimed at improving quality of care and outcomes related to the use of peritoneal dialysis catheters.

BY PETER B. HATHAWAY, MD

Well-trained interventional physicians can readily learn to place peritoneal dialysis (PD) catheters, but applying additional knowledge to both the technical and nontechnical aspects of PD access can improve the quality of patient outcomes. This article describes 10 important observations to consider with PD.

PATIENT EVALUATION

Thorough preoperative planning and patient education can significantly improve both short- and long-term outcomes if implemented before scheduling a patient for PD catheter placement.[1] A principal goal of the preprocedural clinical evaluation is to identify factors that may result in unsuccessful PD or increase the likelihood of procedural complications. For example, problems found on a focused review of systems, such as chronic constipation, urinary retention, and poor personal hygiene, should be addressed. The location of any surgical scars should be noted, and any potential hernias should be identified. Anticoagulants and antiplatelet medications should be stopped for an appropriate time interval. Preprocedural abdominal imaging is usually unnecessary, but noncontrast CT scanning of the abdomen can be useful to identify the location of an implanted surgical mesh, confirm or exclude suspected hernias, and estimate residual peritoneal volume in patients with renal enlargement due to autosomal dominant polycystic kidney disease. Patients who have had the opportunity to meet their doctor and have their questions answered are more likely to be satisfied with their overall experience and have less periprocedural anxiety.

RECTUS MUSCLE IMPLANTATION OF THE DEEP PD CATHETER CUFF IS NOT REQUIRED

Early experience with percutaneous fluoroscopic placement using single-cuffed PD catheters resulted in unacceptable rates of pericatheter dialysate leakage.[2] Subsequent studies using modern double-cuffed PD catheters reported very low rates of leakage despite the absence of a suture anchor between the deep catheter cuff and the rectus abdominis muscle sheath in some series.[3-5] A recent meta-analysis comparing percutaneous and surgical catheter placement showed no difference in the incidence of leakage,[6] despite implantation of the cuff within or internal to the rectus abdominis muscle during surgery.

It is well known that biomaterial implants result in fibrous capsule formation at tissue-implant interfaces.[7] Tissue responses are particularly intense in the presence

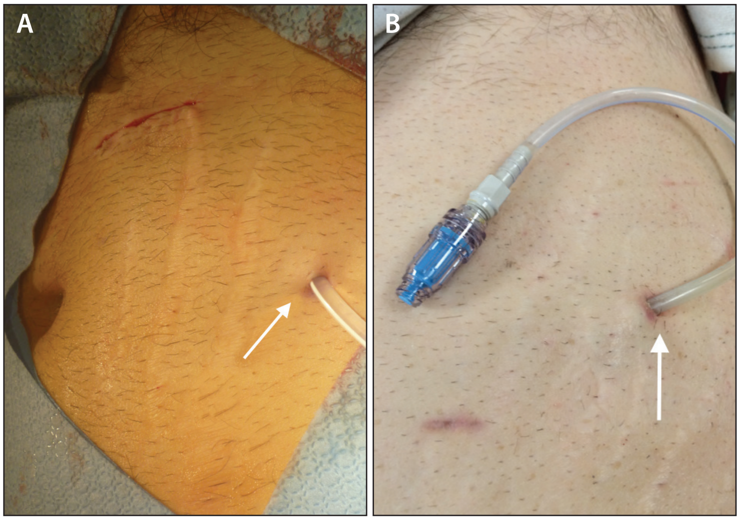

Figure 1. A preshaped gooseneck PD catheter with a downward-facing exit site (arrow) (A). A PD catheter placed with a lateral-facing exit site (arrow) (B).

of polyethylene terephthalate, a frequently used PD catheter cuff material.[8] A dense capsule of white fibrous connective tissue is commonly observed, anchoring the deep catheter cuff to the rectus muscle sheath during PD catheter removal, which may account for the reported low incidence of pericatheter leakage.

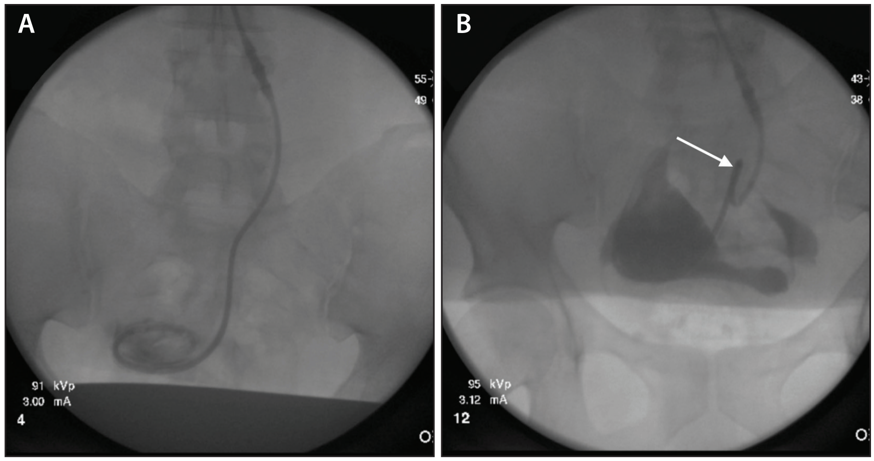

Figure 2. A fluoroscopic image of a malfunctioning PD catheter with an upper abdominal exit site in an obese patient (A). Contrast media has been injected into the catheter lumen. There is no apparent catheter problem with the patient in the supine position. A repeat image of the same patient in the upright position (B). Downward motion of the overhanging pannus results in kinking of the catheter (arrow), confirmed with oblique imaging (not shown). The catheter was successfully revised, and catheter function was restored after shortening the extended segment.

AVOID AN UPWARD-FACING EXIT SITE

Fewer exit site infections are reported with downward-facing exit sites when compared with upward-facing orientations.[9] This observation is attributed to the improved hygiene produced by downward exit sites, which passively shed skin cells and debris and resist imbibition of shower water and sweat (Figure 1A). Use of a preformed swan-neck catheter design helps to achieve both a downward exit site and a stable dependent position of the internal segment within the pelvis.[1] Unfortunately, swan-neck catheters are most readily placed through a generous horizontal incision over the planned location of the preshaped bend, which some interventionalists might tend to avoid.

In addition, swan-neck designs resist the passage of nonhydrophilic guidewires, and patients with swan-neck catheters often experience pain when the catheter curve is straightened during manipulation under fluoroscopy. A satisfactory compromise may be the lateral-facing exit site (Figure 1B), which requires a smaller incision for placement and is more accepting of guidewires and stiffening rods. However, it is reported to produce a risk of infection and mechanical complications equivalent to downward exit sites.[10]

OBESITY CAN BE CHALLENGING

Large body habitus can create difficulties to the successful delivery of all forms of renal replacement therapy. PD is often successful in obese patients, but achieving adequate solute clearance and ultrafiltration often requires larger dialysate volumes, more frequent daytime exchanges, and longer duration on an automated cycler at night. Achieving adequate creatinine clearance and Kt/V targets as defined by the Kidney Disease Outcomes Quality Initiative guidelines can be especially challenging in obese patients who are anuric.[11]

Offering PD to obese patients requires careful patient assessment and selection. Not all large patients are prohibitively obese, so physical examination of the patient is necessary before excluding percutaneous catheter placement. A positive history of sleep apnea or a high Mallampati classification on physical examination may indicate an increased risk of airway obstruction under conscious sedation. To maintain good hygiene, patients must be able to examine and clean the catheter exit site, so a large pannus may mandate upper abdominal or presternal extension of the catheter. Extended catheter techniques may be beyond the scope of many nonsurgeons and require additional attention to procedural details to avoid complications (Figure 2).

POSTPROCEDURE CARE IS CRITICAL

Inadequate communication and lack of follow-up can derail positive outcomes even after the most expert PD catheter placements. A secure dressing discourages handling of the catheter during the healing phase (Figure 3), but even the most robust adhesive cannot forestall a patient who is determined to remove the dressing or saturate the area with bath water. Providing a detailed printed instruction sheet that warns against these behaviors and encourages good hygiene can improve patient compliance. In our practice, patients are assigned to a PD nurse who then sees the patient in a home dialysis clinic at 1- and 2-week intervals postprocedure. It is important to ensure that the patient is

Figure 3. A stable dressing constructed with absorbent gauze, breathable hypoallergenic tape, and elastic netting.

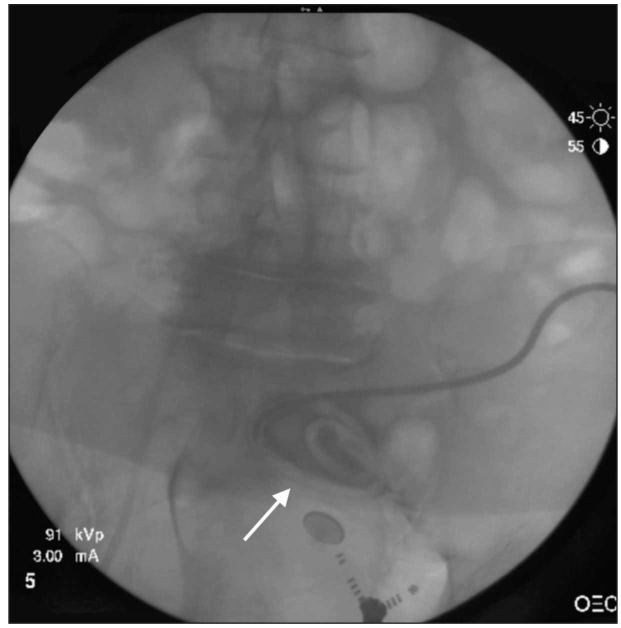

Figure 4. A fluoroscopic image after contrast injection for evaluation of a malfunctioning PD catheter. A filling defect representing a fibrin plug obstructs the catheter coil (arrow). Catheter function was restored after a 4-mg tissue plasminogen activator infusion over 30 minutes followed by guidewire manipulation to successfully dislodge the plug (not shown).

aware of the need to follow-up with their nurse and the clinic location.

PROMPTLY EVALUATE PATIENTS WITH A MALFUNCTIONING PD CATHETER

Risk of failure is intrinsic to all forms of renal replacement therapy, including PD. Overall 1-year PD dropout rates are reported to be as high as 51%.[12] PD catheter malfunction represents one of the major causes of technique failure, with as many as 20% of catheters malfunctioning within the first year.[13] Outflow obstruction and other mechanical problems often become apparent gradually, resulting in unplanned transfers to hemodialysis and increased mortality.[14] Prompt evaluation and intervention can sometimes restore catheter function before acute hemodialysis is required.

Abdominal radiography is commonly used to evaluate malfunctioning catheters but is unhelpful in the absence of malposition. Fluoroscopic evaluation with contrast injection through the catheter into the peritoneal space is much more useful for diagnosing malposition, fibrin plugs, omental wraps, kinks, and perforations. Methods to correct catheter malfunction can also be simultaneously attempted with the fluoroscopic evaluation. For example, migrated PD catheters can be repositioned using a guidewire,[15] Fogarty catheter,[16] or trocar[17] manipulation under sterile conditions, with initial technical success rates of 74% to 85% and long-term success rates of 47% to 55%.[15,16] Intracatheter thrombolytics,[18] guidewire manipulation, and subsequent use of intraperitoneal heparin (500–1,500 units/bag) can be used to treat obstructing fibrin plugs (Figure 4).[19]

THE EXIT SITE CAN BE PRESERVED

PD catheter removal and replacement are required to correct catheter kinks, perforations, omental wraps, and malpositioned catheters that fail fluoroscopic manipulation.[20] Superficial cuff extrusion (Figure 5) increases the risk of exit site infection and often mandates catheter replacement. Exit site granulation tissue (Figure 6) can be treated without catheter removal using silver nitrate applicators. A new exit site is sometimes desirable, such as when the existing exit site lies under the belt, but a healthy, comfortable exit site can also be preserved during catheter replacement. An incision is made above the intercuff segment, and the two cuffs are dissected free with cautery. After catheter removal, the wound, tunnel, and exit site are irrigated with saline to remove debris, foreign material, and clot, which often contain bacteria. Bacterial contamination may not be completely removed with irrigation, so use of a topical antibiotic solution is a reasonable consideration. Triple-antibiotic solution (neomycin, polymyxin, and bacitracin) provides broad coverage, or a cefazolin solution may be used. After thorough irrigation, a new catheter can be reinserted into the peritoneal space through the previous rectus muscle tract over a guidewire or placed through a new access site near the previous rectus tract using a standard percutaneous technique. The external catheter segment

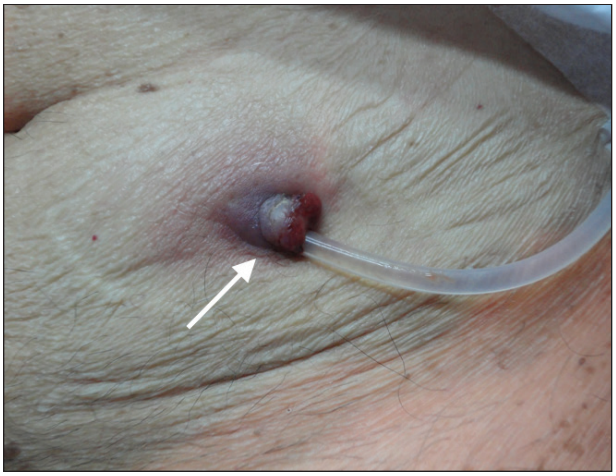

Figure 5. An extruded cuff protrudes from the exit site (arrow).

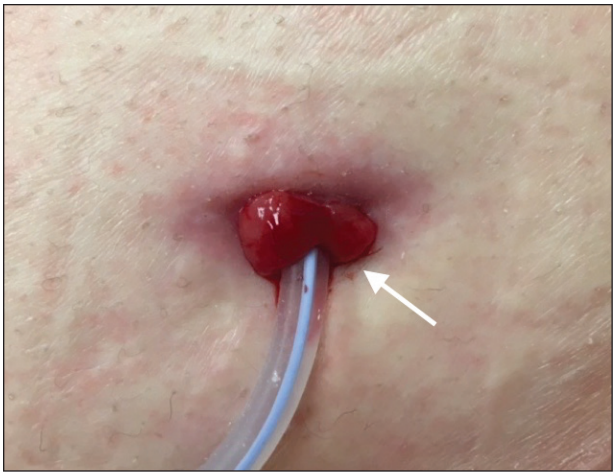

Figure 6. Painful granulation tissue at a PD catheter exit site (arrow).

is then brought out through the existing exit site using a curved clamp, and the procedure is completed.

PD INTERRUPTION IS NOT REQUIRED FOR CATHETER REPLACEMENT

After elective placement of a PD catheter, it is customary to delay full-volume dialysate exchanges for 2 weeks until water-impermeable encapsulation of the catheter cuffs and tract have developed. An exception to this practice is urgent-start PD, where dialysis is started immediately after percutaneous catheter placement using a modified protocol that includes the use of an automated cycler and recumbent bed rest.[21] To further reduce intra-abdominal pressure during the 2-week healing process, low dialysate volumes of 500 to 1,000 mL are ordered based on body surface area calculation.[22] The urgent-start strategy can be adopted after catheter replacement and used in both home-based or in-center settings to prevent leaks and temporary transfers to hemodialysis. Patients who are permitted to use an unsupervised, home-based, nighttime, low-volume protocol are cautioned to drain until dry before arising from bed to use the restroom.

AGGRESSIVELY TREAT TUNNEL INFECTIONS

Catheter infection is defined as an infection of the exit site, the tunnel (catheter segment between the deep and superficial cuffs), or both.[23] Although both exit site and tunnel infections are associated with increased risk of peritonitis, exit site infections are generally easily recognized and treated, whereas tunnel infections are often occult and difficult to eradicate. Ultrasound can help diagnose tunnel infection by depicting fluid in the catheter tunnel.[24] A negative result on ultrasound examination indicates a high likelihood of success with antibiotic management alone, but the risk of peritonitis and catheter loss is markedly increased when ultrasound indicates a tunnel infection, especially in the presence of virulent organisms such as *Pseudomonas aeruginosa*.[24] A persistent tunnel infection that cannot be eradicated

Figure 7. Skin breakdown resulting from an antibiotic-resistant chronic tunnel infection.

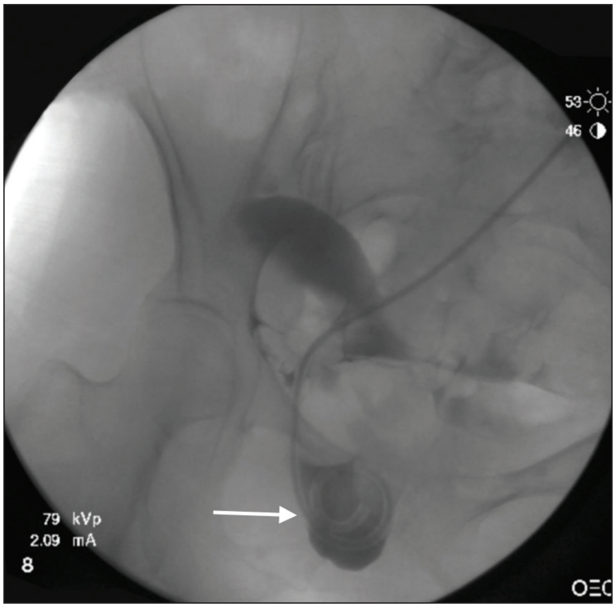

Figure 8. A fluoroscopic image after catheter contrast injection showing migration of the PD catheter into an inguinal hernia sac (arrow). The catheter was externally manipulated from the hernia sac into the pelvis during surgical repair, allowing PD to continue without interruption.

with antibiotics invariably leads to skin breakdown, chronic drainage, or peritonitis (Figure 7). Simultaneous catheter removal and replacement to the opposite side of the abdomen without an interruption of PD can successfully be used to manage tunnel infections, in addition to persistent or recurrent peritonitis.[25]

DON'T FORGET SURGERY

Percutaneous PD catheter placement offers several advantages over surgical insertion, including increased availability, reduced cost, and decreased invasiveness.[1] But laparoscopic PD catheter placement creates opportunities for additional ancillary techniques including lysis of adhesions, omentopexy, and simultaneous hernia repair.[26] Although head-to-head studies show no difference in complication-free catheter survival between fluoroscopically and surgically placed catheters,[6] patients with large or symptomatic hernias should be referred to a qualified surgeon for hernia repair prior to PD catheter placement or for simultaneous hernia repair and catheter insertion.

Moreover, some patients undergoing PD will invariably experience complications that cannot be remedied by percutaneous means, including recurrent omental wraps, tenacious epiploic appendages, remote peritoneal leaks, and acquired hernias (Figure 8). There are perhaps few areas in medicine where a cohesive multidisciplinary team is more impactful than in the care of patients with end-stage renal disease. In this context, interventionalists placing PD catheters should recognize that prompt referral to a skilled surgeon, when indicated, can minimize interruptions in PD and prevent unplanned transfers to hemodialysis. ■

1. Abdel-Aal AK, Dybbro P, Hathaway P, et al. Best practices consensus protocol for peritoneal dialysis catheter placement by interventional radiologists. Perit Dial Int. 2014;34:481-493.
2. Jacobs IG, Gray RR, Elliott DS, et al. Radiologic placement of peritoneal dialysis catheters: preliminary experience. Radiology 1992;182:251-255.
3. Maher E, Wolley MJ, Abbas SA, et al. Fluoroscopic versus laparoscopic implantation of peritoneal dialysis catheters: a retrospective cohort study. J Vasc Interv Radiol. 2014;25:895-903.
4. Voss D, Hawkins S, Poole G, et al. Radiological versus surgical implantation of the first catheter for peritoneal dialysis: a randomized non-inferiority trial. Nephrol Dial Transplant. 2012;27:4196-4204.
5. Reddy C, Dybbro PE, Guest S. Fluoroscopically guided percutaneous peritoneal dialysis catheter placement: single center experience and review of the literature. Ren Fail. 2010;32:294-299.
6. Tullavardhana T, Akranurakkul P, Ungkitphaiboon W, et al. Surgical versus percutaneous techniques for peritoneal dialysis catheter placement: a meta-analysis of the outcomes. Annals Med Surg. 2016;10:11-18.
7. Anderson JM. Biological responses to materials. Annu Rev Mater Res. 2001;31:81-110.
8. Keselowsky BG, Bridges AW, Burns KL, et al. Role of plasma fibronectin in the foreign body response to biomaterials. Biomaterials. 2007;28:3626-3631.
9. Flanigan M, Gokal R. Peritoneal catheters and exit-site practices toward optimum peritoneal access: a review and current developments. Perit Dial Int. 2005;25:132-139.
10. Crabtree JH, Burchette RJ. Prospective comparison of downward and lateral peritoneal dialysis catheter tunnel-tract and exit site directions. Perit Dial Int. 2006;26:677-683.
11. Salim SA, Akula Y, Kandhuri S, et al. Successful peritoneal dialysis in large-weight subjects: clinical features and comparisons with normal-weight subjects. Adv Perit Dial. 2016;32:61-67.
12. Hodges JC, Fillinger MF, Zwolak RM, et al. Longitudinal comparison of dialysis access methods: risk factors for failure. J Vasc Surg. 1997;26:1009-1019.
13. McCormick BB, Bargman JM. Noninfectious complications of peritoneal dialysis: implications for patient and technique survival. J Am Soc Neph. 2007;18:3023-3025.
14. Boissinot L, Landru I, Cardineau E, et al. Is transition between peritoneal dialysis and hemodialysis really a gradual process? Perit Dial Int. 2013;33:391-397.
15. Kwon YH, Kwon SH, Oh JH, et al. Fluoroscopic guide wire manipulation of malfunctioning peritoneal dialysis catheters initially placed by interventional radiologists. J Vasc Int Radiol. 2014;25:904-910.
16. Gadallah MF, Arora N, Arumugam R, et al. Role of Fogarty catheter manipulation in management of migrated, nonfunctional peritoneal dialysis catheters. Am J Kid Dis. 2000;35:301-305.
17. Simons ME, Pron G, Voros M, et al. Fluoroscopically-guided manipulation of malfunctioning peritoneal dialysis catheters. Perit Dial Int. 1999;19:544-549.
18. Zorzanello M, Fleming W, Prowant B. Use of tissue plasminogen activator in peritoneal dialysis catheters: a literature review and one center's experience. Neph Nurs J. 2004;31:534-537.
19. Maaz DE. Troubleshooting non-infectious peritoneal dialysis issues. Neph Nurs J. 2004;31:521-533.
20. Gokal R, Alexander S, Ash S, et al. Peritoneal dialysis and exit-site practices toward optimum peritoneal access: 1988 update. Perit Dial Int. 1998;18:11-33.
21. Ghafarri A. Urgent-start peritoneal dialysis: a quality improvement report. Am J Kid Dis. 2014;59:400-408.
22. Ghaffari A, Kumar B, Guest S. Infrastructure requirements for an urgent-start peritoneal dialysis program. Perit Dial Int. 2013;33:611-617.
23. Gupta B, Bernardini J, Piraino B. Peritonitis associated with exit site and tunnel infections. Am J Kidney Dis. 1996;28:415-419.
24. Plum J, Sudkamp S, Grabensee B. Results of ultrasound-assisted diagnosis of tunnel infections in continuous ambulatory peritoneal dialysis. Am J Kidney Dis. 1994;23:99-104.
25. Swarz R, Messana J, Reynolds J, et al. Simultaneous catheter replacement and removal in refractory peritoneal dialysis infections. Kidney Int. 1991;40:1160-1165.
26. Crabtree JH, Fishman A. A laparoscopic method for optimal peritoneal dialysis access. Am Surg. 2005;71:135-143.

Peter B. Hathaway, MD
Utah Vascular Clinic
Salt Lake City, Utah
pete.hath@comcast.net
Disclosures: Paid consultant to Merit Medical Systems.