

Guner Ogunc

Introduction

Catheter malfunction, defined as mechanical failure in dialysate inflow or outflow, is not uncommon in peritoneal dialysis (PD) patient. Outflow failure occurs in 4–34.5% of PD patients [1]. Ever since the first permanent silicone catheter was introduced in 1968, a wide variety of catheters and placement techniques have been developed to attempt to eliminate catheter malfunction. However, catheter-related problems are not fully resolved [2–6].

Catheter Flow Obstruction

The most common causes of catheter malfunction are omental wrapping and catheter tip migration. Catheter obstruction due to fibrin or blood clots within the catheter lumen, kinking of the catheter, small bowel wrapping, occlusion by fimbriae and intraperitoneal adhesions are other occlusive catheter problems in CAPD patients [7–9]. Prevention of these problems during the primary insertion has been a primary goal of surgeons who insert PD catheters. Our insertion technique, which is long tunnelling and routine omentopexy, is signifi-

cantly effective in preventing catheter-related problems, such as omental wrapping, catheter tip migration, pericatheter leakage and drain pain [10]. Since the laparoscopic technique was introduced and used for the placement of catheters and also salvage procedures for malfunctioning CAPD catheters in the early nineties of the last century, it has proven to be superior to the open surgical technique in many medical centers [11–14]. The advantages of laparoscopy over every other techniques are the adjunctive procedures enabled by this method, principally rectus sheath tunnelling, omentopexy, adhesiolysis, epiploectomy, salpigectomy, and colopexy. When these techniques are applied effectively, the laparoscopic approach can both prevent and resolve most of the common mechanical problems that complicate insertion of PD catheters [15]. Omentopexy is employed selectively since it may be unnecessary when the omentum is short or adherent to previous upper abdominal surgical site. An additional argument supporting preservation of the omentum by using omentopexy as opposed to its resection is that omental milky spots (clusters of leukocytes) appear to have a role in the peritoneal cavity immune response, especially in the pediatric age population [15].

Diagnosis and Management

In many cases, the diagnosis of outflow failure may be difficult because of a lack of noninvasive

G. Ogunc
University of Akdeniz, Faculty of Medicine, General
Surgery Department, Antalya, Turkey
e-mail: ogunc@akdeniz.edu.tr

methods. Change in body position, rapid saline infusion, cathartics, enemas, the classic use of fibrinolytics, and fluoroscopic manipulation are conservative measures often used in attempting to restore drainage in patients with poorly functioning catheters. However, laparoscopy is highly accurate in its diagnosis of CAPD complications caused by obstruction and is also therapeutic. Due to the need for continuous renal replacement therapy, the rescue procedures should not be delayed beyond a few days after noticing the malfunction if conservative treatments are ineffective.

Ideally, salvage surgery should be safe, with a high success rate, ease of performance, ability to prevent recurrence, and short recovery time. Open rescue surgery can lead to new adhesion formation and, therefore, restrictions in fluid distribution in the peritoneal cavity, as well as the development of incision-related complications and the additional stress of surgery for patients. In contrast, laparoscopic rescue procedures have many advantages: they leave smaller wounds with less tissue disturbance; they allow direct examination of the catheter and whole peritoneal cavity through the scope, allowing accurate identification of the cause of catheter malfunction as well as immediate intervention to restore its function; they enable diagnosis of other intra-abdominal pathology and treatment of other surgical problems such as symptomatic cholecystolithiasis and abdominal wall/inguinal hernia in the same operation; they avoid the need to replace the catheter; they enable immediate testing for overall peritoneal catheter function; they leave the patient with diminished postoperative pain, a shorter stay in hospital, and a quicker recovery of social and professional activities; they facilitate early resumption of PD and better functional survival; and the operation recordings can be used to share our knowledge and experience with nephrologists, our assistants, and our students. There are also a few disadvantages: the need for general anesthesia in most patients; requirement of an operating theater; the cost of equipment and instrumentation; the long duration of the operative procedure and the adverse physiologic effects of CO₂ pneumoperitoneum [11]. Cosmetic problems related to port site incisions which can be

eliminated with using the single port laparoscope surgical technique by expert surgeons [1].

Technique of Laparoscopic Catheter Salvage

In our institution, laparoscopic rescue procedures were performed under general anesthesia. The peritoneal cavity was emptied before surgery. Prophylactic antibiotic therapy (cefazolin sodium 1 g) was administered before surgery. A nasogastric tube was inserted. A 1-cm long slightly lateral subumbilical incision was made through the subcutaneous tissue, and the anterior rectus sheath. The rectus muscle fibers were then dissected bluntly down to the posterior rectus sheath. A 10-mm trocar was inserted on the opposite side of the previous catheter placement location. A pneumoperitoneum was established via this trocar, inflating to a pressure of 12 mmHg. If the patient was morbidly obese pneumoperitoneum was established through the existing PD catheter. If the catheter was completely obstructed pneumoperitoneum was established using the Veress needle in left upper quadrant on subcostal site in morbidly obese patients with slightly reverse Trendelenburg and slightly right side position. Two 5-mm working ports were used. Once the diagnosis of catheter dysfunction was made, corrective measures were undertaken.

Omental Wrapping

Peritoneal dialysis catheter obstruction is frequently caused by omentum blocking the side holes of the catheter tubing. Omental wrapping usually develops early after catheter placement. The incidence of omental wrapping of CAPD catheters has been reported from 4.5% to 15% [16]. Clinically, the inflow of dialysate decreases slightly, and drainage is obviously blocked. Wrapping may be a result of a bulky omentum [17]. Using laparoscopic salvage, the incidence of outflow failure by omental wrapping ranged between 57% and 92% in some series [18]. Advantages of laparoscopic surgery include

direct visualization of the state of obstruction and ability to lyse adhesions, and perform omental fixation after the stripping if necessary [11].

When omental wrapping is diagnosed at laparoscopy, usually only stripping is performed. This procedure can be easily done without the need for complicated laparoscopic instruments or advanced laparoscopic surgical experience. Reported series show that this simple laparoscopic stripping of the omentum from the catheter usually resolves a catheter obstruction due to omental wrapping with a high rate of success [19–21]. Some authors advocate omental fixation after the stripping procedure to prevent further omental wrapping [11, 22]. Laparoscopic partial omental resection has also been performed for recurrent catheter dysfunction due to omental wrapping [23, 24]. In our observation, the omentum was more likely to cause catheter obstruction in emaciated patients which can be related to the omentum being very thin in these individuals in contrast in obese patients. The omentum must be preserved in PD salvage procedures. The omentum possesses an inherent motility that allows it to seek out and arrest trouble that may arise within the peritoneal cavity. It has been referred to as the “police officer of the abdomen”. The potent lymphatic system of the omentum can absorb enormous amounts of edema fluids and remove metabolic wastes and toxic substances. The omentum is also widely used for the treatment of some pathologies in full surgical fields if necessary [25]. To completely overcome this problem related to omental wrapping prophylactic laparoscopic omental fixation is routinely performed during CAPD catheter placement in our series [10].

Catheter Tip Migration

Catheter tip migration still accounts for a substantial number of catheter failures in blind, open and laparoscopically placed CAPD catheters [3, 17]. Mechanical obstruction usually results from either misplacement during the initial insertion or catheter migration out of the pelvis. A coiled intra-abdominal segment is generally believed to

reduce catheter tip migration; however, the results of previous prospective randomized studies comparing straight and coiled catheters have been controversial [26]. Catheter tip migration is easily determined with abdominal x ray. Various noninvasive management techniques, including changing body position, enemas, and saline flushing, increase physical activity as much as possible have been described; however, the success rate is only about 25%. If such noninvasive techniques fail, before surgical revision, fluoroscopically guided manipulations using a rigid cannula, stiff metal rod, tip-deflecting wire, Lunderquist guidewire or double guidewire method may be used to reposition the catheter [7]. Different success rates of fluoroscopy-guided wire manipulation have been reported, ranging from 27% to 67% [27]. Advantages of fluoroscopy-guided wire manipulation are that it is relatively easy and safe, simple, does not require anesthesia, can be performed in radiology suite, can be attempted repeatedly, and has a relatively lower cost compared to laparoscopic surgery. Disadvantages of fluoroscopy-guided wire manipulation include a lower success rate and inapplicability of difficulty with certain special catheter design [27].

The rate of catheter misplacement has been dramatically reduced because in recent years it has been possible to place catheters more accurately under direct vision with laparoscopic insertion [10]. Surgical revision is mandatory in the treatment of peritoneal catheter malfunction due to catheter tip migration when conventional methods fail. Open repositioning of the catheter is not only more invasive, but may result in the creation of adhesions. In addition, open catheter revision inhibits immediate use of the catheter because the abdominal incision must first heal. A secondary means of dialysis is required, that is, hemodialysis (HD) which involves further cost, inconvenience, and the risks associated with HD catheters.

Catheter tip migration without adhesions, requiring only laparoscopic redirection, can be expected to be restored to normal function in a high percentage of cases. Laparoscopic surgery is also used to adhesiolysis if needed with redirection of catheter [27]. PD catheters can be safely

positioned in patients with previous abdominal surgery [28].

In 1995, Julian et al. recommended the additional step of laparoscopic suturing of the catheter to the anterior abdominal wall to prevent further catheter malposition [29]. In recent years, laparoscopic repositioning and catheter fixation onto the parietal peritoneum has become an increasingly popular method of restoring the CAPD catheter due to catheter tip migration. A number of laparoscopic catheter fixation techniques have been reported. The techniques advocated for saving catheters have also been used during the initial placement for prophylaxis. Some authors have also preferred minilaparotomy and catheter fixation to the anterior abdominal wall for the treatment of malfunctioning PD catheter related to catheter tip migration [17, 30]. To prevent the catheter tip migration, rectus sheath tunnellig effectively keeps the catheter oriented toward the pelvis during the PD catheter placement [15].

Fibrin or Blood Clots Within the Catheter

Catheter obstruction due to fibrin or blood clots within the catheter lumen is another problem in CAPD patients. Obstruction by blood clot or fibrin coating usually presents with blood-tinged dialysate drainage. When the catheter is blocked with fibrin/clots there is usually absent inflow and outflow. Forcibly flushing the catheter with heparinized saline, the classic use of fibrinolytics, such as urokinase, or mechanical interventions may resolve the obstruction. The channel-cleaning brush and fluoroscopy guidance can be used to restore patency with potential risks [31, 32].

Salvage surgery is required when primary non-invasive management fails. However, most of these methods are not effective in the long run. Removal of the catheter is the usual outcome [33]. Laparoscopic rescue procedure should be safe, with a high success rate, ease of performance, ability to prevent recurrence, and quick recovery time.

The obstructed catheter is examined through a laparoscope to identify the cause of obstruction. The catheter is pulled out from the abdominal

cavity through the 5-mm channel in the abdominal wall with atraumatic forceps. All obstructing elements inside the lumen are removed by milking the catheter by hand. The catheter is then flushed clean with heparinized saline and pushed back into the peritoneum [19]. The fibrin and blood clots are also cleared by milking the catheter with atraumatic laparoscopic forceps and flushing intraperitoneally with heparinized saline under pressure from a 50-ml syringe [33]. This procedure is an easy task for the surgeon to perform using two ports. It does, of course, involve a longer time in the operating theater. The intraperitoneal laparoscopic cleaning minimizes the risk of catheter contamination that may occur if it is exteriorized. The reutilization of the original catheter is beneficial in that it avoids the need for additional work to remove the old catheter and reimplant a new catheter [21].

Pericatheter Leakage

Pericatheter leakage of dialysis fluid occurs in 4–36% of treated patients. Regardless of the implantation approach used, a break-in procedure for 2–4 weeks has been recommended to avoid pericatheter leakage [34]. In some reports, PD was started immediately after surgical implantation and the incidence of pericatheter leakage was less than 2% [35]. The dialysate volume which is gradually increase to allow complete wound healing, and thus promotes formation of a tight catheter passage at the beginning of CAPD [36]. To treat leakage, it is recommended to have a break-in period of 7–14 days for commencement of PD [37]. Catheter replacement is mandatory in the treatment of dialysate leakage when conventional methods fail [38]. One method of prevention is to create the long tunneling which reduces the risk of pericatheter leaks during the PD catheter placement [10, 15].

References

1. Yamada A, Hiraiva T, Tsuji Y, Ueda N. Single-port laparoscopy for salvaging outflow failure from omental wrapping. *Perit Dial Int.* 2012;32(6):669–71.
2. Zhu W, Jiang J, Zheng X, Zhang M, Guo H, et al. The placement of peritoneal dialysis catheters: a

- prospective randomized comparison of open surgery versus 'Mini-Perc' technique. *Int Urol Nephrol*. 2015;47:377–82.
3. Kang SH, Jy D, Cho KH, Park JW, Yoon KW. Blind peritoneal catheter placement with a tenckhoff trocar by nephrologists: a singlcenter experience. *Nephrology*. 2012;17:141–7.
 4. Paolo ND, Capotondo L, Sansoni E, Romolini V, Simola M, et al. The self-locating catheter: Clinical experience and follow-up. *Perit Dial Int*. 2004;24:359–64.
 5. Ash SR, Wolf R. Placement of the Tenckhoff peritoneal dialysis catheter under peritoneoscopic visualization. *Dial Transplant*. 1981;10:383–6.
 6. Li JR, Chen CH, Cheng CL, Yang CK, Ou YC, et al. Five-year experience of peritoneal dialysis catheter placement. *J Chin Med Assoc*. 2012;75:309–13.
 7. Lee CM, Ko SF, Chen HC, Leung TK. Double-guidewire method: a novel technique for correction of migrated Tenckhoff peritoneal dialysis catheter. *Perit Dial Int*. 2003;23:587–90.
 8. Numanoglu A, McCulloch MI, Van der Pool A, Millar AJW, Rode H. Laparoscopic salvage of malfunctioning Tenckhoff Catheters. *J Laparoendosc Adv Surg Tech*. 2007;17:128–30.
 9. Liu WJ, Hooi LS. Complications after Tenckhoff catheter insertion: a single-centre experience using multiple operators over four years. *Perit Dial Int*. 2010;30:509–12.
 10. Ogunc G. Minilaparoscopic extraperitoneal tunnelling with omentopexy: a new technique for CAPD catheter placement. *Perit Dial Int*. 2005;25:551–5.
 11. Ogunc G. Malfunctioning peritoneal dialysis catheter and accompanying surgical pathology repaired by laparoscopic surgery. *Perit Dial Int*. 2002;22:454–62.
 12. Kimmelstiel FM, Miller RE, Malinelli BM. Laparoscopic management of peritoneal dialysis catheters. *Surg Gynecol Obstet*. 1993;176:565–70.
 13. Amerling R, Macic DV, Spivak H, Lo AY, White P, et al. Laparoscopic salvage of malfunctioning peritoneal catheters. *Surg Endosc*. 1997;11:249–52.
 14. Ovnat A, Dukhno O, Pinski I, Peiser J, Levy I. The laparoscopic option in the management of peritoneal dialysis catheter revision. *Surg Endosc Other Interv Tech*. 2002;16(4):698–9.
 15. Crabtree JH. Development of surgical guidelines for laparoscopic peritoneal dialysis access: down a long and winding road. *Perit Dial Int*. 2015;35:241–4.
 16. Hughes CR, Agnotti DM, Jubelirer RA. Laparoscopic repositioning of a continuous ambulatory peritoneal dialysis (CAPD) catheter. *Surg Endosc*. 1994;8:1108–9.
 17. Li J, Cheng C, Chiu K, Cheng C, Yang C, et al. Minilaparotomy salvage of malfunctioning catheters in peritoneal dialysis. *Perit Dial Int*. 2011;33:46–50.
 18. Goh YH. Omental folding: a novel laparoscopic technique for salvaging peritoneal dialysis catheters. *Perit Dial Int*. 2008;28:626–31.
 19. Zadrozny D, Niemierko ML, Drackowski T, Renke M, Liberek T. Laparoscopic approach for dysfunctional Tenckhoff catheters. *Perit Dial Int*. 1999;19:170–1.
 20. Fukui M, Maeda K, Sakamoto K, Hamada C, Tomino Y. Laparoscopic manipulation for outflow failure of peritoneal dialysis catheter. *Nephron*. 1999;83:369.
 21. Chao S, Tsai T. Laparoscopic rescue of dysfunctional Tenckhoff catheters in continuous ambulatory peritoneal dialysis patients. *Nephron*. 1993;65:157–8.
 22. Crabtree JH, Fishman A. Laparoscopic epiploxy of the greater omentum and epiploic appendices in the salvaging of dysfunctional peritoneal dialysis catheters. *Surg Laparosc Endosc*. 1996;6:176–80.
 23. Crabtree JH, Fishman A. Laparoscopic omentectomy for peritoneal dialysis catheter flow obstruction: a case report and review of the literature. *Surg Laparosc Endosc Percutan Tech*. 1999;9:228–33.
 24. Campisi S, Cavatorta F, Ramo E, Varano P. Videolaparoscopy with partial omentectomy in patients on peritoneal dialysis. *Perit Dial Int*. 1997;17:211–2.
 25. Alagumuthu M, Das BB, Pattanayak SP, Rasananda M. The omentum: a unique organ of exceptional versatility. *Indian J Surg*. 2006;68(83):136–41.
 26. Ouyang CJ, Huang FX, Yang QQ, Jiang ZP, Chen V, et al. Comparing the incidence ocatether-related complications with straight and coiled Tenckhoff catheters in peritoneal dialysis patients- a single-center prospective randomized trial. *Perit Dial Int*. 2015;35:443–9.
 27. Kim HJ, Lee TW, Ihm CG, Kim MJ. Use of fluoroscopy-guided wire manipulation and/or laparoscopic surgery in the repair of malfunctioning peritoneal dialysis catheters. *Am J Nephrol*. 2002;22:532–8.
 28. Santarelli S, Zeiler M, Marinelli R, Monteburini T, Federico A, et al. Videolaparoscopy as rescue therapy and placement of peritoneal dialysis catheters: a thirty-two case single centre experience. *Nephrol Dial Transplant*. 2006;21:1348–54.
 29. Julian TB, Ribeiro U, Bruns F, Fraley D. Malfunctioning peritoneal dialysis catheter repaired by laparoscopic surgery. *Perit Dial Int*. 1995;15:363–6.
 30. Kim SH, Lee DH, Choi HJ, Seo HJ, Jang YS, et al. Minilaparotomy with manuel correction for malfunctioning peritoneal dialysis catheters. *Perit Dial Int*. 2008;28:550–4.
 31. Cumvenda MJ, Wright FK. The use of channel-cleaning brush for malfunctioning Tenckhoff catheters. *Nephrol Dial Transplant*. 1999;14:1254–7.
 32. Hummeida MA, Eltahir JMA, Ali HM, Khalid SE, Mobarak AI, et al. Successful management of an obstructed Tenckhoff catheter using an endoscopic retrograde cholangiopancreatography (ERCP) cytology brush. *Perit Dial Int*. 2010;30:482–4.
 33. Leung LC, Yiu MK, Man CW, Chan WH, Lee KW, et al. Laparoscopic management of Tenckhoff catheters in continuous ambulatory peritoneal dialysis. A one-port technique. *Surg Endosc*. 1998;12:891–3.
 34. Jo YI, Shin SK, Lee JH, Song JO, Park JH. Immediate initiation of CAPD following percutaneous catheter placement without break-in procedure. *Perit Dial Int*. 2007;22:179–83.
 35. Stegmayr B. Various clinical approaches to minimise complications in peritoneal dialysis. *Int J Artif Organs*. 2002;25:365–72.

36. Meier CM, Poppleton A, Fliser D, Klingele M. A novel adaptation of laparoscopic Tenckhoff catheter insertion technique to enhance catheter stability and function in automated peritoneal dialysis. *Langenbeck Arch Surg.* 2014;399:525–32.
37. Ponce D, Banin VB, Bueloni TN, Baretta P, Caramori J, et al. Different outcomes of peritoneal catheter percutaneous placement by nephrologists using a trocar versus the Seldinger technique: the experience of two Brazilian centers. *Int Urol Nephrol.* 2014;46:2029–34.
38. Bergamin B, Senn O, Corsenca A, Dutkowski P, Weber M, et al. Finding the right position: A three-year, single-center experience with the “self-locating” catheter. *Perit Dial Int.* 2010;30:519–23.