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MALFUNCTIONING PERITONEAL DIALYSIS CATHETER AND ACCOMPANYING SURGICAL PATHOLOGY REPAIRED BY LAPAROSCOPIC SURGERY

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♦ ***Objectives:*** **To review the laparoscopic salvaging of malfunctioning peritoneal dialysis (PD) catheters, and to present our experience with laparoscopic repair of dysfunctional Tenckhoff catheters and the treatment of accompanying surgical pathologies.**

♦ ***Design:*** **Malfunctioning peritoneal catheters were repaired using laparoscopic rescue techniques. Accompanying surgical problems were treated in the same operation. The effectiveness of these approaches was validated by comparison with other remedial techniques described previously.**

♦ ***Patients:*** **Malfunctioning PD catheters were salvaged by laparoscopic surgery in 8 patients, and accompanying surgical problems were treated in the same operation in 3 of the 8 patients.**

♦ ***Main Outcome Measures:*** **Outcome was measured by the successful return to adequate PD and effective treatment of surgical problems.**

♦ ***Results:*** **Eight patient studies show laparoscopic correction of malfunctioning catheters and the treatment of accompanying surgical pathologies with the return to successful PD.**

♦ ***Conclusion:*** **The salvaging of malfunctioning PD catheters by laparoscopic surgery is an ideal method. This procedure permits simultaneous identification and correction of other surgical problems that could otherwise complicate dialysis therapy.**

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KEY WORDS: Tenckhoff catheter; laparoscopy; omental wrapping; catheter tip migration; adhesions; hernia.

Continuous ambulatory peritoneal dialysis (CAPD) is an effective therapy widely used in the management of patients with end-stage renal disease. Catheter malfunction prevents adequate dialysate drainage, causing an interruption in treatment (1–4). Unfortunately, following placement of the catheter, mechanical complications are all too common and usually result in unnecessary catheter removal or replacement (2,5–8). Obstruction to flow and resultant impairment of dialysate drainage through the catheter may result from debris and fibrin clots within the catheter lumen, catheter tip migration, omental wrapping, and encasement of the catheter by various structures in the abdominal cavity (1,7, 9–16). Failure to restore catheter drainage by conservative treatment necessitates repositioning or replacement of the catheter (6,17–20). Laparoscopic surgery has recently been introduced to remedy malfunctioning CAPD catheters (6,7,10–14,16,18, 19,21–30). These procedures have several advantages (9,14,20,25,31–39) but also a few disadvantages (17,23,25,40–44). We have also used laparoscopic surgery to remedy malfunctioning CAPD catheters and to treat, simultaneously, accompanying surgical pathologies. Our experiences and a review of the relevant literature are presented.

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MATERIALS AND METHODS

Between March 1997 and August 2001, 8 consecutive patients (5 female, 3 male; average age 49.8 years, range 32 – 66 years) with malfunctioning peritoneal dialysis (PD) catheters underwent laparoscopic procedures at Akdeniz University Hospital to restore function. The causes of end-stage renal disease were hypertension in 3 patients, diabetes mellitus in 2, chronic glomerulonephritis in 1, and unknown in 2. All but one patient had previously undergone open implantation of catheters (Tenckhoff, 47 × 13 cm, 5F, radiopaque polyurethane, two fixed cuffs), inserted through the right lateral paramedian approach. The remaining patient's Tenckhoff catheter had been implanted using laparoscopic omental fixation technique. In seven cases, dysfunction began 2 – 8 months after catheter insertion. In 1 patient, the catheter never functioned well after laparoscopic placement. The signs of catheter dysfunction observed in all patients included normal or only slightly reduced inflow with slow or

no drainage of infused dialysate. There were no signs of peritonitis and no acute discomfort was associated with the infusion of fluid.

Conservative treatment of the catheter malfunction failed in all patients. Abdominal x ray taken before the operation showed that the catheter had migrated to the left upper quadrant in 2 patients, and to the right upper quadrant in 1 patient. The other 5 patients' x rays showed the approximate intra-abdominal catheter location. Physical examination showed a large right inguinal and umbilical hernia in one patient; umbilical hernia was diagnosed in another case. Abdominal examination was normal in the other 6 patients. Because of the malfunction, a laparoscopic diagnostic and therapeutic operation was performed. All the patients were considered suitable for general anesthesia and gave informed consent.

PROCEDURE

Laparoscopy was 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. The surgeon stood on the right side of the patient. A 1-cm long slightly lateral subumbilical incision was made through the skin, 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 (Versaport; Auto Suture, Norwalk, Connecticut, USA) with a grip was inserted and fixed on the opposite side of the previous catheter placement location (Figure 1). A pneumoperitoneum was established via this trocar, inflating to a pressure of 12 mmHg. The initial exploratory laparoscopy was conducted with a 30-degree videolaparoscope.

Peritoneal catheter obstruction due to omental wrapping was diagnosed at laparoscopy in 3 patients. Two 5-mm lateral rectus sheath reusable trocars were inserted. The catheter was set free from the omental adhesions with a 5-mm atraumatic grasper. The operating table was tilted to about 30 degrees for a Trendelenburg position.

In one patient, lateral inferior edges of the omentum were grasped and fixed onto the parietal peritoneum of the lateral abdominal wall at two points with a tacker (ProTack 5-mm; AutoSuture). In another patient, who had undergone insertion of a PD catheter with the laparoscopic omental fixation technique, catheter outflow dysfunction was noted one day after the implant procedure. Laparoscopic exploration revealed omental wrapping and obstruction. This turned out to be a technical error because the omentopexy had not been stretched enough between the two fixation points and, as a result, wrapping of the catheter occurred. The omentum was set free from the catheter and omentopexy was performed at the middle edge of the omentum on to the parietal peritoneum with intracorporeal 3-0 polydioxanone (PDS; monofilament long-term absorbable suture; Ethicon, Edinburgh, UK) suture laparoscopically at the level of the umbilicus (Figure 2).

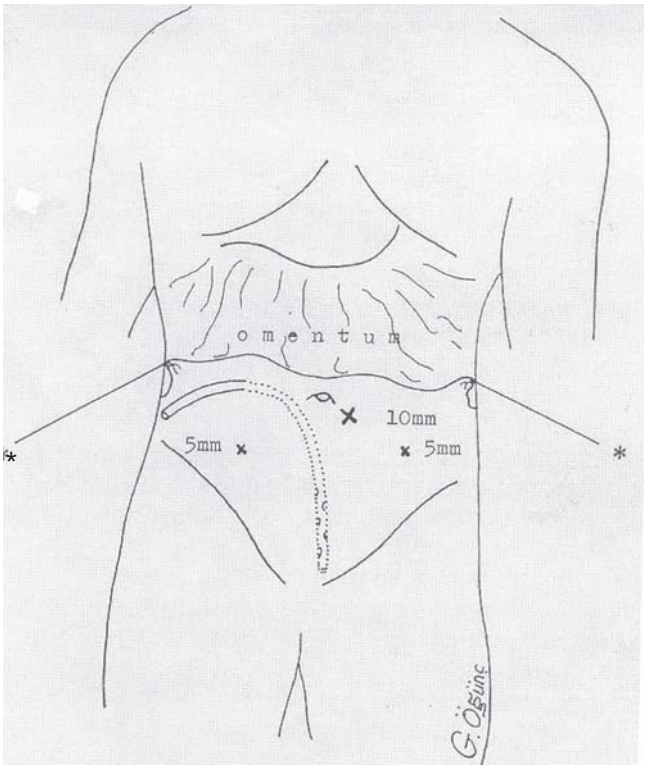

Figure 1 — Port sites in laparoscopic approach to salvaging a malfunctioning peritoneal dialysis catheter, and omental fixation points (*).

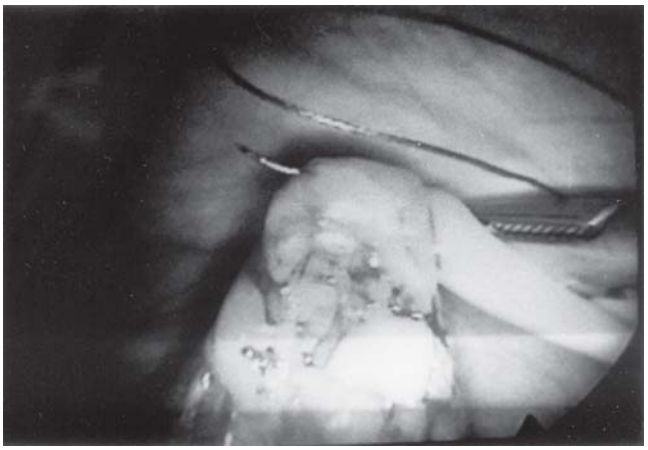

Figure 2 — The omentum has been stripped from the catheter, which is fixed onto the peritoneum of the lateral abdominal wall with a suture.

In another patient, partial omentectomy was performed by eviscerating the gastrocolic omentum through the enlarged umbilical incision and ligating its vascular supply. Care was taken to avoid bleeding from the omental stump to prevent occlusion of the catheter by clots.

Catheter tip migration (the catheter was in the subhepatic region), omental wrapping, and right occult inguinal hernia were diagnosed in 1 patient. Catheter tip migration (the catheter was in the left upper quadrant), omental wrapping, right inguinal hernia, and a lipoma of 8 × 6 cm in the neighborhood of the internal ring were found in another patient. Omentum was then set free from the catheter and fixed to the parietal peritoneum on the lateral abdominal wall (described above). The catheter tip was then pulled down into the pelvis with a 5-mm atraumatic grasper and fixed to the parietal peritoneum with 3-0 PDS suture in this region. The lipoma was totally excised. Hernioplasty was performed via a transabdominal preperitoneal approach using Prolene mesh graft (Ethicon) with tacker fixation in 1 patient (Figure 3). A curved prosthesis (3DMax mesh; Cardial-Bard, Saint-Etienne, France) was used without fixation in another patient who had an occult inguinal hernia. The peritoneum was closed with sutures (3-0 vicryl). The excised lipoma was removed through the umbilical port site. The subumbilical incision was enlarged and umbilical hernioplasty was performed at the end of the operation in 1 patient. The surgeon stood on the side opposite to the hernia and a video monitor was placed on the hernia side, at the foot of the operating table, when hernioplasty was performed. The CAPD catheter tip was visualized in the left upper quadrant in one patient. The catheter tip was pulled down into the true pelvis and fixed to the parietal peritoneum with 3-0 PDS suture (Figure 4).

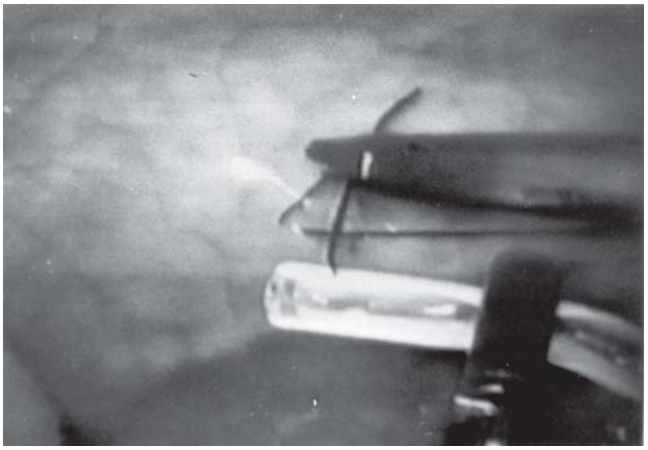

Figure 4 — The catheter has been repositioned into the pelvis and fixed to the peritoneum with 3-0 PDS suture.

An additional cause of obstruction was fibrin clotting inside the catheter, which was diagnosed in one patient who also had an umbilical hernia. The debris and fibrin clots were soon dislodged by milking the catheter with atraumatic forceps and flushed using 0.9% saline under pressure (from a 50-mL syringe). An umbilical herniography was performed on this patient (described above). The ports were removed and the pneumoperitoneum was allowed to deflate. Lidocaine-HCl 1.0% and bupivacaine-HCl 0.5% mixed in equal volumes was injected at each trocar site. Then the fascia was closed with 2-0 vicryl sutures at the 10-mm trocar site, and the skin incisions were closed with silk. Patency of the PD catheter was verified by a rapid in-and-out exchange before the patient was sent to the ward (Figure 5). The operating time was

Figure 3 — The lipoma has been totally excised. Hernioplasty was performed by means of transabdominal preperitoneal approach. The catheter is repositioned and fixed to the peritoneum with a suture.

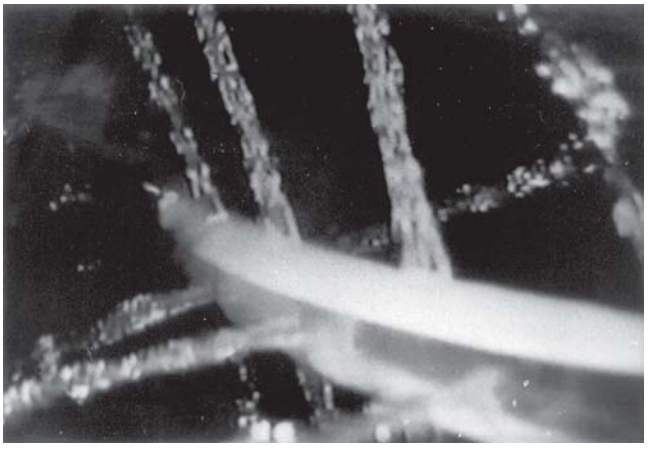

Figure 5 — After the catheter side holes and lumen had been cleared of tissue debris, the tubing was tested with saline solution into the abdominal cavity under direct vision.

30 – 120 minutes. Peritoneal dialysis in the supine position was initiated within 24 hours of surgery, using 1-L volumes dialysis solution for the first supine PD; heparin 1000 U was added to each liter.

RESULTS

All patients experienced an uneventful recovery from the laparoscopic operation and all were able to resume oral feeding within 6 hours of the operation. Postoperative pain was mild to moderate and readily controlled with oral analgesics. Two of the 8 patients (who had undergone the catheter revision and herniography) were temporarily put on hemodialysis (HD) through percutaneously placed subclavian venous catheters until adequate PD could be restored. Patients were discharged on the first day following the operation. Resumption of PD with standard 2-L exchanges was accomplished within 2 – 10 days of the laparoscopy in all eight reported cases. This time was 7 – 10 days in the case of patients with laparoscopic hernioplasty. At the time of this report, postoperative follow-up checks of PD catheters following laparoscopic recovery had taken place for 10 days to 52 months for all patients.

DISCUSSION

Continuous ambulatory PD is an effective form of treatment for patients with end-stage renal disease. Mechanical obstruction of the catheter usually results from misplacement at operation, omental wrapping, migration out of the pelvis, or adhesions. These problems may cause the catheter to malfunction immediately or several months after insertion (2,6,8,9,12, 15–18,22,23,27,33,41,45,46). Catheter outflow failure follows open surgical and blind guidewire/trocar methods in 10% – 34.5% of placements (2,17,33,47,48), whereas laparoscopic placement techniques are complicated by flow dysfunction in 4% – 13% of patients (33,49). Unfortunately, outflow obstruction is a complication found in up to 60% of patients in some investigative series (2,5,22,33,50–53), increasing the cost of dialysis and possibly causing other problems, such as the need for temporary HD and intraperitoneal adhesion formation due to repeated surgery. Up to 20% of patient transfers to HD are directly related to catheter problems (26). 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 (1,7,53).

When conservative measures fail to obtain a response, either an open or a laparoscopic procedure will be necessary to rescue the catheter (10,23,24, 26,45). In most patients, catheter malfunction is due to omental wrapping, catheter tip migration, fibrin obstruction, or adhesions; therefore, laparoscopic surgery can be applied to remedy the situation. Laparoscopy is highly accurate in its diagnosis and is an effective method of treatment of CAPD complications caused by obstruction. Open 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 (2).

In our study, general anesthesia was preferred in all cases for catheter rescue procedures and the treatment of accompanying surgical procedures, because it makes the procedure easier for both the patient and the surgeon. Whenever possible, reusable instruments are used to reduce the cost of the laparoscopic salvaging procedure to a level comparable with that of the open procedure. We used reusable instruments except for a 10-mm umbilical trocar in all cases.

A lateral subumbilical trocar with a grip was inserted using open technique through the rectus fibers. The initial exploratory laparoscopy was conducted under 12 mmHg pressure. This pressure was then decreased and all operations were easily performed under 7 – 10 mmHg pressure. Two 5-mm lateral rectus sheath reusable trocars were placed under direct vision. An umbilical trocar (if necessary for the first cuff placement area) and a 5-mm trocar site (if necessary for the exit site) were determined before surgery in light of the possible need to replace the catheter with a new Tenckhoff catheter (Figure 1). Blind entry with a Veress needle or other penetrating instrument after establishing a pneumoperitoneum using an installed Tenckhoff catheter carries the risk of vascular and visceral injury (14,25, 48,54).

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 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 (9,14,20,25, 31–39). There are also a few disadvantages: the need for general anesthesia in most patients; the require-

ment of an operating theater; the cost of equipment and instrumentation; the long duration of the operative procedure; leakage from the stump of the duct after laparoscopic cholecystectomy; and the adverse physiologic effects of CO_2 pneumoperitoneum.

OMENTAL WRAPPING

Peritoneal dialysis catheter obstruction is frequently caused by omentum blocking the side holes of the catheter tubing (1,17,55). The incidence of this complication has been reported as 4.5% – 15% (56). Our results show that the commonest cause of catheter malfunction is omental wrapping: 183 of 578 (31.6%) patients receiving treatment for catheter placement with the open technique in PD in a 12-year period (57). Repeat laparotomy, or repeat laparotomy with partial omentectomy, has been performed on these patients to resolve the problem. Omental wrapping was observed in 1 of 25 (4%) patients receiving treatment for catheter insertion with the laparoscopic omental fixation technique in a 3-year period (58). This problem can be accurately determined with diagnostic laparoscopy — also with laparotomy, but laparotomy is not used absolutely to diagnose the reason for CAPD catheter malfunction.

When omental wrapping occurs, a partial omentectomy is usually performed to resolve catheter obstruction through a minilaparotomy (6,44). Also, prophylactic omental resection can be performed at the time of catheter insertion, significantly improving the life of the catheter in PD patients (17,46,55). In 27 of 183 (14.7%) patients, partial omentectomy was performed with the open technique. Most reported laparoscopic procedures involved simply releasing the catheter from obstructing tissues, such as omentum, epiploic appendix, small intestine, mesentery, bladder, fimbriae of the fallopian tube, adnexa, or appendix vermiformis (17,46).

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 (2,6,11,15,16,21,25,45,52). Some authors advocate omental fixation after the stripping procedure to prevent further omental wrapping (6,9,28).

Laparoscopic partial omental resection has been advocated for recurrent catheter dysfunction due to omental wrapping (6,44,59–61). This procedure is performed after eviscerating the gastrocolic omentum through the enlarged umbilical port site and ligating its vascular supply. Care is taken to avoid bleeding from the omental stump and to prevent clot occlusion of the catheter. The fascia of the port site is closed tightly with interrupted sutures (46,61). Therapeutic laparoscopic omental resection can be performed in PD patients (13,16,18,46,52,59,61). Laparoscopic partial omentectomy to treat dysfunctional PD catheters has been successfully performed by an experienced surgical team using hook cautery, endoloop ligatures, endoscopic linear cutter, or harmonic scalpel (2,8,13, 16–19,46,52,59,61).

Laparoscopic omentectomy seems effective but not the most suitable procedure. The duration of the operative procedure is too long, three or more large-size ports are required, and additional laparoscopic surgical instruments are needed in laparoscopic omentectomy (2,8,17,18). Omental resection by laparoscopy is also more expensive (18). Renal failure patients frequently are poor risks for lengthy general anesthesia and they commonly have severe coexisting medical problems. Therefore, operative procedures to solve catheter obstruction due to omental wraps should, ideally, be short and simple, effective in resolving the problem, and permit early return to PD (17). Review of current practices and outcomes demonstrates that laparoscopic catheter rescue with omental stripping or added omentopexy are the procedures that best satisfy these criteria (2,6,11,15,16, 21,25,30,32,45,52). If necessary, following accurate laparoscopic diagnosis of recurrent obstruction due to omental wrapping, omental resection can easily be performed through the umbilical port or enlarged port site (19,46,55).

CATHETER TIP MIGRATION

Catheter tip migration still accounts for a substantial number of catheter failures in both open and laparoscopically placed CAPD catheters; surgical rescue is required in 85% – 90% of these cases (8,26). Mechanical obstruction usually results from either misplacement during the initial operation or catheter migration out of the pelvis. 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 (8,22,33,46). Catheter tip migration is easily determined with abdominal x ray. Reoperative exploration to reposition the catheter may not be required as interventional radiologists have developed a fluoroscopic technique to manipulate the catheter (53). This technique, if successful, flips the catheter using a wire. Induction of active peristalsis by enema is another conventional approach. However, this is generally not effective in the long run (19,45).

Surgical revision is mandatory in the treatment of peritoneal catheter malfunction due to catheter tip

migration when conventional methods fail (10,23). 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, HD, which involves further cost, inconvenience, and the risks associated with HD catheters (45). Catheter tip migration without adhesions, requiring only laparoscopic redirection, can be expected to be restored to normal function in a high percentage of cases.

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 (26). 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 (8,22,29,46). 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 (22,46,62). The catheter tip was grasped via the laparoscope, repositioned into the true pelvis, and fixed onto the parietal peritoneum with 3-0 PDS suture laparoscopically in three of our cases where there was outflow obstruction due to catheter tip migration. Migration of the catheter tip may be associated with outflow obstruction. Most authorities on the subject agree that this usually signifies omental wrapping (13,16); this was true in 2 of 3 of our patients.

ADHESIONS

Adhesion formation is another troublesome problem in CAPD patients (63,64). Reoperative explorations to reposition the catheter can lead to severe intraperitoneal adhesion formation in CAPD patients (2,47). Laparoscopic adhesiolysis is the most commonly used procedure to salvage catheters malfunctioning due to adhesions (2,16,19,45). The goal of laparoscopic surgery for peritoneal adhesions is to mobilize the catheter and establish a dialyzable space through adhesiolysis (17,52). Laparoscopic techniques for rescuing PD catheters malfunctioning due to adhesions usually require basic laparoscopic surgical experience and a minimum number of intraperitoneal instruments (32). Ordinarily, a laparoscopic dissector with electrocautery and scissors are used to clear adhesions.

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. Forcibly flushing the catheter with heparinized saline, the classic use of fibrinolytics, such as urokinase, or mechanical interventions may resolve the obstruction. However, most of these methods are not effective in the long run. Removal of the catheter is the usual outcome (19).

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 (2). The fibrin or 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 (19). 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. We prefer intraperitoneal laparoscopic cleaning to minimize the risk of catheter contamination. 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 (11).

ACCOMPANYING SURGICAL PATHOLOGIES

The laparoscopic approach to a malfunctioning CAPD catheter offers solutions to several problems within a single procedure. Transfer to HD is often required in cases of patients on CAPD undergoing a long abdominal surgery. In addition, these surgical procedures often necessitate prolonged hospitalization because of impaired wound healing due to chronic renal insufficiency and nutritional deficiencies (65). Laparoscopy has been successfully used in PD patients requiring catheter salvage and treatment of such surgical problems as symptomatic cholecystolithiasis (65,66). Laparoscopic cholecystectomy may represent an invaluable alternative to open cholecystectomy, particularly since CAPD can be started immediately after the operation (67,68). Laparoscopic appendectomy and adnexectomy have been well established in patients on CAPD (20,69).

Abdominal wall hernia is a common PD-related complication that causes difficulties in CAPD and requires surgical treatment (14,20,23,70). To the best of our knowledge, the present report is the first of its kind in that it sets out details of our experience with laparoscopic inguinal herniography and rescue of malfunctioning CAPD catheters, both performed in the same operation.

Authorities of laparoscopic technique have advocated a number of different methods in the past. We

are of the opinion, however, that in light of the increased number of reported cases there will be a decline in the diversity of methods applied. Postoperative follow-up checks take time, so the long-term results will not be known for some time. When we have these results, we will be able to make a well-informed judgment as to which method to adopt.

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