Surg Endosc (1999) 13: 186–190

Surgical Endoscopy
Ultrasound and
Interventional Techniques

Videolaparoscopic implantation of long-term peritoneal dialysis catheters

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Received: 7 November 1997/Accepted: 11 February 1998

Abstract. Implantation of peritoneal dialysis catheters by traditional laparotomy or trocar/guidewire techniques leaves the operator blind to the actual location and configuration of the peritoneal catheter tubing; it is associated with drainage dysfunction from catheter obstruction in 10–22% of catheter placements. This report presents a laparoscopic technique that allows accurate tube placement with complete visualization of the implant procedure. The peritoneal dialysis catheter was implanted through a port inserted in a paramedian location. Videoscopic monitoring was performed through a second port inserted in a pararectus location on the opposite side of the abdomen. Nitrous oxide gas was utilized for peritoneal insufflation thus permitting the procedure to be accomplished under local anesthesia. Follow-up of ≤12.7 months (median, 4.4) for the first 28 patients revealed a high rate of successful catheter function with an outflow obstruction rate of 3.6%. The procedure was well tolerated by patients under local anesthesia on an outpatient basis. Videolaparoscopy is ideally suited for peritoneal dialysis catheter implantation. Visual conformation of proper catheter location and configuration during the implant process are associated with lower incidences of outflow failure.

Key words: Laparoscopy — Nitrous oxide insufflation — Peritoneal dialysis — Peritoneal dialysis catheter

Implantation of long-term peritoneal dialysis catheters by surgeons has traditionally been performed through small laparotomy incisions. Less frequently, catheter insertions have been accomplished percutaneously by blind trocar or guidewire placement. In the open surgical approach, a small laparotomy incision offers a limited view of the peritoneal cavity and a restricted area available for digital exploration. As in the trocar and guidewire insertion methods, the operator is usually blind to the actual location and configuration of the implanted catheter tubing. As a consequence, the incidence of catheter outflow failure is about the same for both open surgical and blind approaches, constituting 10–22% of catheter placements [6, 11, 14, 15].

The addition of peritoneoscopy to the implant procedure has reportedly lowered the catheter outflow failure rate to about half of that associated with other methods [1, 4, 7–9]. Peritoneoscopic-assisted implantation of dialysis catheters is a technique developed and largely practiced by nephrologists. The technique permits percutaneous introduction of a peritoneoscope, which is advanced to a visually identified clear space in the peritoneal cavity. It is then removed to leave a surrounding guide sheath through which a catheter is passed to the selected location. As with the other insertion techniques, the operator is blind to the actual location and configuration of the inserted catheter; however, outflow obstruction complications are reportedly lower. Proponents of the peritoneoscopic-assisted catheter insertion also report the lowest incidences of catheter infection and subcutaneous leak problems, as compared to surgical and blind guidewire/trocar approaches. Peritoneoscopic dialysis catheter implant systems are commercially available; however, the moderately expensive equipment is procedure-specific and may not be practical except for major referral centers with a sufficient volume of patients to justify the expenditure.

More useful to the community general surgeon is a laparoscopic approach that utilizes equipment and methods abundantly familiar to the surgeon who frequently performs laparoscopic biliary, intestinal, and hernia surgery. This report presents a laparoscopic technique that allows accurate tube placement with complete visualization of the entire implant procedure, low complication rates comparable to peritoneoscopic-assisted implant methods, and the flexibility of using existing materials available at any institution that regularly performs laparoscopic surgery. Herein we present our clinical experience with chronic renal failure

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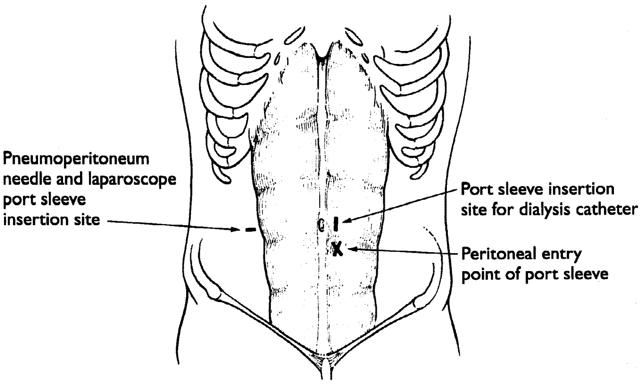

Fig. 1. Primary placement sites of pneumoperitoneum needle, and laparoscope and dialysis catheter port sleeves.

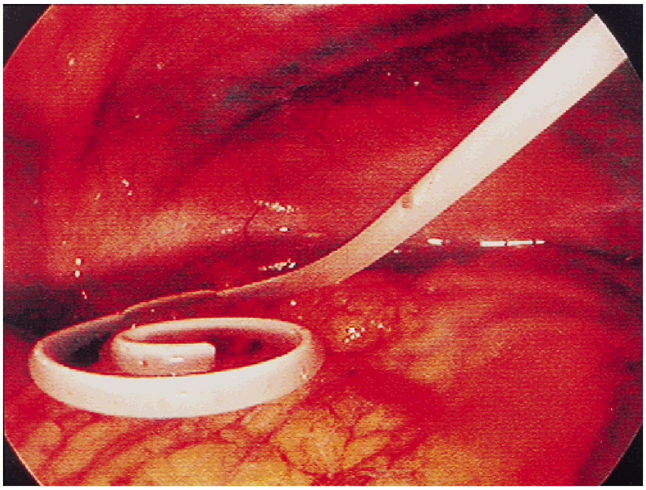

Fig. 2. Laparoscopic view of curled-tip peritoneal dialysis catheter positioned in the pelvis.

patients who underwent laparoscopic implantation of long term peritoneal dialysis catheters utilizing this approach.

Materials and methods

Between July 1996 and July 1997, 28 chronic renal failure patients underwent laparoscopic implant of double-cuffed, coiled-tip, silicone peritoneal dialysis catheters with or without a preformed swan-neck bend. Prophylactic antibiotics, usually consisting of a cephalosporin or vancomycin, were administered prior to the procedure.

During the initial period of development of this technique, laparoscopic implants were performed under general endotracheal anesthesia because a pneumoperitoneum with CO_2 gas was not well tolerated by patients under local anesthesia. Subsequently, the procedure was modified to utilize N_2O gas for the pneumoperitoneum, which does not produce pain with insufflation [12, 13]. This modification permitted the procedure to be performed under local anesthesia—bupivacaine–HCl 0.5% and lidocaine–HCL 1% mixed in equal volumes—with intravenous sedation.

A pneumoperitoneum needle was inserted through a small skin incision just lateral to the rectus sheath at the level of the umbilicus on the side opposite to the intended catheter insertion site (Fig. 1). With the patient under local anesthesia, pneumoperitoneum needle placement was facilitated by having the patient tense and push out the abdominal wall. The pneumoperitoneum was created and maintained at 8–15 mmHg by insufflation of N_2O gas. The pneumoperitoneum needle was replaced by an appropriate-size port sleeve for the scope through the same incision, and the gas insufflation tubing was transferred to this port. Different sizes of laparoscopes were utilized and included 10-mm, 5-mm, 4-mm, 2.2-mm, and 1.7-mm scopes attached to a standard light source and remote television monitoring and recording equipment. The 5-mm laparoscope became the preferred instrument because of the satisfactory balance between the quality of the picture and the small puncture in the abdominal wall.

A 7–8-mm port device was used for the dialysis catheter placement because it was the smallest port that would allow easy passage of the Dacron catheter cuffs. During the initial development period, a 7-mm trocar port device was used. The procedure was modified to utilize a radially expandable sleeve passed through the abdominal wall over a pneumoperitoneum needle through which a 7/8-mm dilator/cannula assembly was inserted (InnerDyne, Salt Lake City, UT, USA). This device permitted insertion of a port through the rectus muscle with greater control and safety, and less trauma to the tissue trace with a smaller resultant hole than with the standard trocar instrument. The site of abdominal wall placement of the peritoneal dialysis catheter with laparoscopy was the same as that of the standard paramedian approach for open surgically placed catheters (Fig. 1). The site of peritoneal entry was at a point 2–3 cm below the umbilicus and 2–3 cm lateral to the midline, preferably on the left side.

Laparoscopic port sites and catheter insertion points should be shifted to the opposite side or otherwise away from preexisting surgical scars. It was helpful to use a surgical marking pen to indicate reference points and planned incisions. A 1–2-cm vertical incision was made 3–4 cm above the anticipated point of peritoneal entry. The point of intended peritoneal entry was visualized laparoscopically while depressing the abdominal wall with a finger over the previously marked site. With the patient in the Trendelenburg position, the needle/expandable sleeve assembly was inserted into the incision and angled ~45° in the caudal direction.

The intent was to pass the needle/sleeve assembly through the rectus sheath and muscle so that the point of penetration through the anterior rectus sheath was more cranial than the penetration point of the posterior rectus sheath. The caudally angulated passage through the abdominal wall would encourage the peritoneal dialysis catheter to remain oriented in a pelvic direction. The needle/sleeve assembly was pushed through the abdominal wall under laparoscopic visual control, avoiding waving or dissecting motions with the needle tip. The needle was then withdrawn, leaving the expandable sleeve to serve as the conduit for insertion of the 7/8-mm dilator/cannula assembly under laparoscopic control.

The peritoneal dialysis catheter was prepared by rinsing the tubing in normal saline solution and flushing the lumen to remove particulates. The air bubbles were squeezed from the Dacron cuffs before insertion to promote better tissue ingrowth. Catheter preparation was performed at the beginning of the procedure so that it could continue to soak until the time it was needed. The catheter was loaded on a stylet, keeping the alignment of the radio-opaque guide stripe straight. Under laparoscopic control, the catheter/stylet assembly was advanced to the desired pelvic location. The stylet was partially withdrawn to a point sufficient to allow the coiled tip to assume proper configuration (Fig. 2). The catheter/stylet assembly was advanced so that the deep cuff was just visible within the peritoneal cavity through the laparoscope (Fig. 3A). The port device was then withdrawn from the abdominal wall up onto the shaft of the catheter/stylet assembly. Under laparoscopic visual control, the catheter/stylet assembly was removed so that the Dacron cuff just disappeared above the peritoneum (Fig. 3B). The stylet was then carefully removed from the catheter, and the pneumoperitoneum was allowed to deflate, but the laparoscope port was left in place.

The subcutaneous tunnel path and catheter exit site were best estimated with the abdomen in normal contour, without the deformity of a pneumoperitoneum. In catheters without a preformed bend, the external portion of the catheter was laid out over the skin to assist in marking the exit site. The tunnel was shaped in an arcuate configuration, so that the catheter made a gentle bend in the subcutaneous tract and exited the skin in a downward direction with the superficial cuff no closer than 2 cm from the skin exit site (Fig. 3C). An intermediate incision along the planned subcutaneous course was sometimes employed to protect against excessively acute angulation of the catheter. Proper alignment of the catheter was maintained with the assistance of the radio-opaque stripe as the catheter was passed through the subcutaneous tunnel. Care was taken not to alter the catheter position in the transabdominal wall tract during the subcutaneous tunneling process.

The peritoneal dialysis catheter was subjected to a trial irrigation at the time of placement. A standard 1-L bag of normal saline for intravenous administration with heparin (1,000 U/L) was observed for unimpeded in-

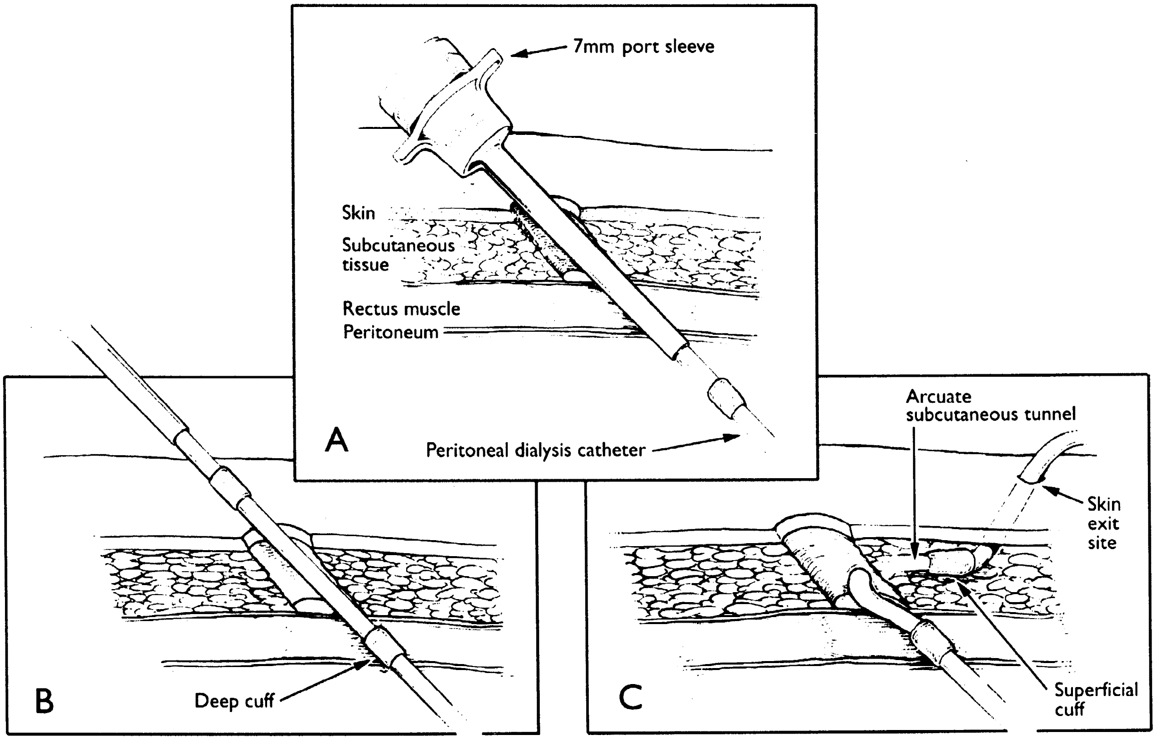

Fig. 3. Steps of abdominal wall placement of dialysis catheter. **A** Caudally angled port sleeve inserted through abdominal wall. Catheter-stylet assembly is advanced to pelvic location through port sleeve with deep cuff visible. **B** With port sleeve previously withdrawn, catheter-stylet assembly is withdrawn until deep cuff just disappears above peritoneum. **C** With stylet removed, catheter is passed subcutaneously to designated exit site with superficial cuff properly positioned.

fusion and drainage by gravity. A residual of 250–300 ml was left in the abdomen to reduce the likelihood of intraperitoneal structures sucking up against the catheter toward the end of the drainage process. The dialysis catheter connector and transfer set were assembled to the catheter at the time of surgery, and the entire system was flushed with heparin (100 U/ml).

A chlorhexidine gluconate–impregnated patch (Johnson & Johnson Medical, Arlington, TX, USA) was placed around the catheter at the exit wound. To reduce the risk of infection, no sutures were used at the exit site. The catheter was stabilized near the exit site with tincture of bezoin and sterile adhesive strips. At the conclusion of a successful trial irrigation, the laparoscope port was removed. The fascia of a 10-mm laparoscope site was closed with a heavy, absorbable suture; otherwise, the fascial holes of smaller scopes were not sutured. Intracuticular closure of skin wounds with absorbable suture supported with sterile adhesive strips was favored. Wounds were covered with a combination of gauze and polyurethane adhesive film dressings.

Postoperatively, the protocol for catheter care included a 1-L heparinized saline in-and-out flush performed the day following surgery and weekly thereafter until peritoneal dialysis was instituted. Peritoneal dialysis with standard 2-L exchanges was delayed for 2 weeks to permit complete wound healing. Unless excessive drainage was present, the chlorhexidine gluconate patch was left undisturbed for 2 weeks, at which time the patient began a routine of exit site cleansing with antibacterial soap and hydrogen peroxide solution. Patients were permitted to resume showering after 1 month if wound healing had been uncomplicated. A sterile gauze dressing over the exit site was encouraged.

Results

Between July 1996 and July 1997, 29 consecutive renal failure patients underwent laparoscopic procedures to implant a peritoneal dialysis catheter. One patient required conversion to the traditional open implant technique and control of bleeding after recognized trocar injury to the inferior epigastric artery. Characteristics of the 28 patients undergoing successful laparoscopic implant of peritoneal dialysis catheters are presented in Table 1.

Immediate postoperative complications were limited to two episodes of intraperitoneal hemorrhage that was sufficient to require transfusion therapy but did not produce hemodynamic instability. Bleeding occurred from a 5-mm camera trocar port in one patient and the abdominal wall site of a simultaneously removed nonfunctional peritoneal dialysis catheter in a second patient. Both episodes of bleeding were believed to have been aggravated by heparinization during postoperative hemodialysis; both cases resolved spontaneously without operative intervention.

Short-term follow-up of the laparoscopically implanted catheters as of July 31, 1997 came to a median of 4.4 months (range, 0.1–12.7), with a total of 149.8 patient months of experience. No catheters have been lost, and all have remained functional up to the time of this report or until death or elective transfer to hemodialysis. There were six episodes of exit site infection and one episode of exit site/tunnel tract infection in seven patients (0.56 infections per patient year of observation). There was one episode of peritonitis (0.08 infections per patient year of observation). All infections were successfully resolved. One catheter leak occurred 24 days postoperatively and resolved with use of low-volume exchanges. One episode of outflow obstruction occurred 33 days postimplant, resulting from adherent epiploic appendices of the sigmoid colon, and was resolved by laparoscopic rescue of the catheter using techniques previously described [5].

Table 1. Clinical details of 28 patients having laparoscopically implanted peritoneal dialysis catheters

Subject age: 53.6 ± 13 yr (Ave. ± SD), range: 22–77 yr	
No. of subjects: Male 17 Female 11	
Cause of renal failure:	
Diabetic nephropathy	16
Nephrosclerosis	5
Polycystic kidney	2
Chronic glomerulonephritis	2
Goodpasture's syndrome	1
Obstructive uropathy	1
Multiple myeloma	1
Previous abdominal surgery (31 procedures in 17 patients):	
Gastrectomy	1
Cholecystectomy	5
Appendectomy	3
Gynecological pelvic surgery	6
Renal transplant	1
Incisional hernia repair	1
Perit. dial. cath. implants	11
Misc. laparoscopic surgery	3
Hospitalization status at the time of laparoscopic catheter implant procedure:	
Inpatient	7
Outpatient	21
Anesthesia for the laparoscopic implant procedure:	
General anesthesia	15
Local anesthesia	13
Associated surgical procedures (12 procedures in 10 patients):	
Temporary hemodialysis access	8
Abdominal wall hernia repair	4
Clinical outcome:	
Continuing on peritoneal dialysis	24
Died (nonsurgical causes)	3
Elective transfer to hemodialysis	1

Discussion

Laparoendoscopic surgery is ideally suited for the implantation of peritoneal dialysis catheters because flow function is dependent on the proper intraperitoneal location and configuration of the catheter tubing. Clinical experiences with the surgical laparoscopic approach to peritoneal dialysis catheter insertion have recently been reported [3, 10, 16]. Our laparoscopic procedure has a number of advantages over other techniques. It can be performed routinely under local anesthesia; it uses fewer, smaller-caliber, and/or less traumatic port devices; it does not involved dissection and repair of abdominal wall fascia and muscle; and it does not require intraperitoneal anchoring of the catheter. The techniques described here and used in other surgical laparoscopic approaches differ from peritoneoscopic-assisted catheter placement in that a second port site is employed for continuous videolaparoscopic monitoring during the insertion process. The outflow obstruction in one of 28 patients (3.6%) observed in our series was lower than that reported with peritoneoscopic-assisted techniques, which yielded incidence rates of 4–12.5% [1, 4, 7–9]. The highest incidences of outflow dysfunction—10–22%—are associated with the open surgical and blind guidewire/trocar techniques [6, 11, 14, 15]. Our experience and the reports of others support the observation that implant methods permitting greater visualization during the catheter insertion process are rewarded with lower incidences of subsequent flow failure.

Pericatheter dialysate leak occurred in one of 28 patients (3.6%) in our series, a rate comparable to that reported with peritoneoscopic-assisted techniques (1–14.5%) [1, 4, 7–9] and better than that seen with the open surgical and blind guidewire/trocar approaches (7–28%) [6, 11, 14, 15]. To minimize pericatheter leak or hernia and to reduce risk of rectus muscle bleeding, the smallest caliber port sleeve that permits passage of the catheter tubing and cuff should be used. The Dacron cuffs of commercially available peritoneal dialysis catheters will not pass freely through a port size <7 mm. The use of a radially expandable sleeve over a pneumoperitoneum needle was favored for passing through the rectus muscle. Its advantages included better control over the angle of passage through the abdominal wall and less risk of hemorrhage than with a standard trocar device. The pneumoperitoneum needle was removed, permitting dilatation of the expandable sleeve with insertion of a 7/8-mm dilator/cannula assembly. A radially expanded tissue tract leaves a smaller hole than that produced by the cutting blades of a trocar device, thus reducing the risk of postoperative leaks [2]. Once placed, twisting or rotation of the port sleeve should be kept to a minimum. If laparoscopic lysis of adhesions or dissection is required, it may be advisable to insert an operating port at another location.

The location of the laparoscope port site should permit visual monitoring of both the paramedian port site and the destination of the dialysis catheter tip. The periumbilical site was not a satisfactory location for the laparoscopic camera, because it is too close to the insertion point of the dialysis catheter port sleeve. A point just lateral to the rectus sheath at the level of the umbilicus on the side opposite to the catheter insertion was found to be most advantageous in our experience. This location was also the point of initial needle access for insufflation.

In summary, we described a laparoscopic technique for insertion of peritoneal dialysis catheters that allows for accurate tube placement with complete visualization of the entire implant process and utilizes existing equipment available at any institution that regularly performs laparoscopic surgery. The procedure is well tolerated by patients under local anesthesia on an outpatient basis. Although our current follow-up is short, the early results indicate a high rate of successful catheter function and lower incidences of outflow and leak complications than other methods.

Acknowledgments. We are indebted to Isan Huen, R.N., Clinical Coordinator, General/G.U. Services, Operating Room, for her invaluable assistance during this project. We thank Jessie Sierra, Library Technician, for her research assistance; the staff of the Peritoneal Dialysis Service; Beth Scognamillo, R.N.; Linda Hadnott, R.N.; Erlinda Valbuena, R.N.; Emma Sison, R.N.; and Ed Chico for their excellent patient care. We also thank Steve Beebe and the staff of Audio-Visual Services for providing the medical illustrations.

References

1. Ash SR, Handt AE, Bloch R (1983) Peritoneoscopic placement of the Tenckhoff catheter: further clinical experience. Perit Dial Bull 3: 8–12
2. Bhoyrul S, Mori T, Way LW (1996) Radially expanding dilatation: a superior method of laparoscopic trocar access. Surg Endosc 10: 775–778
3. Brandt CP, Franceschi D (1994) Laparoscopic placement of peritoneal dialysis catheters in patients who have undergone prior abdominal operations. J Am Coll Surg 178: 515–516
4. Copley JB, Lindberg JS, Back SN, Tapia NP (1996) Peritoneoscopic

placement of swan neck peritoneal dialysis catheters. Perit Dial Int 16: S330–332
5. Crabtree JH, Fishman A (1996) Laparoscopic epiplopexy of the greater omentum and epiploic appendices in the salvaging of dysfunctional peritoneal dialysis catheters. Surg Laparosc Endosc 6: 176–180
6. Cronen PW, Moss JP, Simpson T, Rao M, Cowles L (1985) Tenckhoff catheter placement: surgical aspects. Am Surg 51: 627–629
7. Kriger FL, Montenegro J, Amerling R, Cruz C (1991) Use of a single delivery system for peritoneal dialysis: results of a multicenter trial. J Am Soc Nephrol 2: 364
8. Maffei S, Bonello F, Stramignoni E, Forneris G, Iadarola GM, Borca M, Quarello F (1992) Due anni di esperienza e 119 cateteri per dialisi peritoneale posizionati con controllo peritoneoscopico e sistema Y-TEC®. Minerva Urol Nefrol 44: 63–67
9. Nahman NS, Middendorf DF, Bay WH, McElligott R, Powell S, Anderson J (1992) Modification of the percutaneous approach to peritoneal dialysis catheter placement under peritoneoscopic visualization: clinical results in 78 patients. J Am Soc Nephrol 3: 103–107
10. Nijhuis PHA, Smulders JF, Jakimowicz JJ (1996) Laparoscopic introduction of a continuous ambulatory peritoneal dialysis (CAPD) catheter by a two-puncture technique. Surg Endosc 10: 676–679
11. Olcott C, Feldman CA, Coplon NS, Oppenheimer ML, Mehigan JT (1983) Continuous ambulatory peritoneal dialysis: technique of catheter insertion and management of associated surgical complications. Am J Surg 146: 98–102
12. Peterson HB, Hulka JF, Spielman FJ, Lee S, Marchbanks PA (1987) Local versus general anesthesia for laparoscopic sterilization: a randomized study. Obstet Gynecol 70: 903–908
13. Phillips RS, Goldberg RI, Watson PW, Marshall JR, Barkin JS (1987) Mechanism of improved patient tolerance to nitrous oxide in diagnostic laparoscopy. Am J Gastroenterol 82: 143–144
14. Ponce SP, Pierratos A, Izatt S, Matthews R, Khanna R, Zellerman G, Oreopoulus DG (1982) Comparison of the survival and complications of three permanent peritoneal dialysis catheters. Perit Dial Bull 2: 82–86
15. Swartz R, Rocher L, Messana J, Reynolds J, Lees P, Starmann B (1989) The curled catheter: optimal access choice for chronic peritoneal dialysis (CPD). ASAIO Trans 18: 77
16. Watson DI, Paterson D, Bannister K (1996) Secure placement of peritoneal dialysis catheters using a laparoscopic technique. Surg Laparosc Endosc 6: 35–37