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Prospective Randomized Study for Comparison of Open Surgery with Laparoscopic-Assisted Placement of Tenckhoff Peritoneal Dialysis Catheter—A Single Center Experience and Literature Review

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Background. **The ideal method for catheter placement in patients undergoing peritoneal dialysis remains debatable. This prospective study intends to clarify whether laparoscopic assisted percutaneous puncture is superior to open surgery.**

Materials and Methods. **From 2002 to 2006, 77 patients receiving first catheter placement were enrolled and randomized to either an open group of 40 patients or a laparoscopic group of 37 patients. Patient characteristics, operation-related data, procedural complications, and clinical outcome were compared by using the statistical software SPSS ver. 11.5 (SPSS, Chicago, IL).**

Results. **Laparoscopy had a longer operative time (68.32 ± 31.90 *versus* 46.68 ± 15.99 min; $P < 0.001$), shorter wound length (1.69 ± 0.46 *versus* 2.34 ± 0.84 cm; $P < 0.001$), and higher costs ($P < 0.001$) compared with open surgery. Laparoscopy tended to have a higher incidence of pericannular bleeding (21.6% *versus* 7.5%) and a lower rate of early catheter migration (2.7% *versus* 15.0%), but its early/late/overall complication rate did not statistically differ. No surgical mortality occurred. Rate and cause of overall mortality or catheter dropout did not statistically differ. Catheter longevity was equivalent in both groups.**

Conclusions. **Laparoscopic assisted percutaneous puncture exhibited no superiority to open surgery. As a matter of fact, open surgery's shorter operative time and reduced equipment requirement can increase cost-effectiveness. Therefore, conventional open surgery is recommended for most patients with primary catheter placement.**

Key Words: **prospective randomized; comparative study; open surgery; laparoscopic assisted; catheter placement; peritoneal dialysis.**

INTRODUCTION

Since its introduction by Popvich and Moncrief in 1976, peritoneal dialysis (PD) has been an effective alternative treatment for end-stage renal disease (ESRD). Despite its advantages, complications such as outflow obstruction, catheter-related infection, and dialysate leak remain problematic [1]. Various techniques and designs have been suggested to reduce morbidity for placing peritoneal catheters. A survey by Ash *et al.* [2] reviewed over 70 previous studies of incidences of serious complications after catheter placement. The study indicated that the success of PD depended more on placement technique than on catheter design. Therefore, catheter placement is thought to be the key to successful PD. Currently available methods for catheter placement are principally classified as: (1) bedside insertion or percutaneous implantation involving a trocar or guide wire inserted into the abdomen and advancement of the dialysis catheter into the abdomen without visualization; (2) surgical insertion or open dissection, in which small dissection of the peritoneum allows limited visualization of the peritoneal cavity; (3) peritoneoscopic insertion, in which a Y-TEC peritoneoscope is inserted to inspect the peritoneal cavity, thus identifying the best location for the dialysis catheter; (4) laparoscopic insertion, in which adhesiolysis or more sophisticated surgery is possible

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during catheter placement [3, 4]. Although percutaneous insertion is quick and simple, it is particularly contraindicated in patients with previous abdominal surgery due to the risk of visceral injury (1.3% to 2.5%) [5, 6]. Surgical insertion is most commonly used and often thought to have higher morbidity of catheter placement. Overall complication rates up to 56% have been reported [7–9]. Peritoneoscopic insertion was first introduced by Ash *et al.* [10] to avoid visceral injury under the visualization of peritoneoscope; nevertheless, it does not allow adhesiolysis or more sophisticated surgery in such a restricted field. Lately, laparoscopic surgery is being widely used in many operative fields, with its advantages of minimal invasion, direct vision, and adequate working space. Various laparoscopic techniques for catheter placement have been investigated [3, 4, 11–21]. Such reports have indicated laparoscopic surgery has a lower failed-insertion rate (0% to 2.4%), a lower short-term complication rate (0% to 9.5%), and a higher long-term catheter survival rate (63% to 85%) than that of open surgery. However, other studies have reported otherwise [22–25]. Comparative studies in English medical literature lack consensus [22–29]. The ideal method for inserting PD catheter remains debatable.

In the present study, basic laparoscopy with laparoscopic assisted percutaneous puncture using a modified Seldinger technique was employed to avoid the learning effect of sophisticated procedures in advanced laparoscopy. This prospective randomized study also compared open surgery with basic laparoscopy in patients requiring primary PD to treat ESRD.

MATERIALS AND METHODS

Patients

From December 2002 to October 2006, all patients undergoing first PD catheter placement in our unit were considered eligible candidates unless they were intolerant to spinal/general anesthesia or unwilling to participate in this randomized clinical trial. After giving informed consent, each enrolled patient was randomly assigned to either the open group or the laparoscopic group. The open group received catheter insertion by conventional surgical dissection, and the laparoscopic group received catheter insertion by laparoscopic-assisted percutaneous puncture. An experienced surgeon, who is a senior attending physician of the General surgery department of the Chang Gung Memorial Hospital and is familiar with laparoscopic/conventional abdominal surgery and catheter placement of PD for more than 15 y [21], performed all surgical procedures during this study. This surgeon was not involved in the randomized classification process.

Catheter Placement Technique

Open Group

Under spinal anesthesia without a urinary catheter *in situ*, 500 mg of cefazolin, a prophylactic antibiotic, was given intravenously before surgical dissection by mini right paramedian longitudinal incision immediately below the umbilicus. Dissection using the transrectus muscle-splitting technique [7] was performed to the peritoneum that was opened just enough for catheter passage within the circle formed by two purse string sutures using 3-0 Dexon. The distal tip of a straight double-cuff Tenckhoff catheter was advanced by feel toward the pelvic cavity using an intraluminal stylet. Previously prepared purse string sutures were used to seal the small peritoneal inlet for the catheter insertion. The distal (internal) cuff was placed within the abdominal muscular layer adjacent to the peritoneum. Incised anterior sheath of rectus abdominis muscle was closed using 1-0 Dexon. The longitudinal intramuscular portion of catheter was positioned obliquely to maintain distal catheter with a natural and aligned position in the pelvis. The proximal catheter was tunneled subcutaneously in an inverse U-shape and exited from the skin at the lateral side of the right abdomen. The proximal (external) cuff was buried in the Scarpa's layer more than 2 cm away from the exit site. The inserted catheter was irrigated on-table with 50 mL of saline to ensure adequate function. The surgical wound was closed using 4-0 Dexon suture subcutaneously and skin adhesive tape. No additional surgery such as omentectomy or salpingectomy was performed. The catheter system was lavaged again in the postoperative room by PD nursing with 1 L of saline to remove any possible intraperitoneal blood and clots. The inserted catheter was then heparin-locked, and PD was started at 7 d postoperatively.

Laparoscopic Group

A catheter placement combining the simplicity of percutaneous puncture using a Y-TEC instrument assisted with the visualization of laparoscopy was performed in patients in the laparoscopic group. Laparoscopic (wide-angled videolaparoscope) percutaneous placement was performed under general anesthesia without a urinary catheter *in situ*. Five hundred mg of cefazolin was given intravenously 30 min before the operative procedure. In patients with previous midline laparotomy, an open method using Hasson trocar was performed; otherwise, a closed method using a Veress needle puncture was performed to establish the carbon dioxide pneumoperitoneum insufflation to 15 mm Hg. A supra-umbilical 10 mm port was created to introduce the videolaparoscope. The whole abdomen was inspected with the patient in the 30° Trendelenburg position. Laparoscopic adhesiolysis was performed for those who had peritoneal adhesion due to previous abdominal surgery or pelvic inflammatory disease. No additional sophisticated procedure other than adhesiolysis was performed. Percutaneous puncture over the right paramedian port site was performed under videolaparoscopic guidance using a modified Seldinger technique with a suite of Y-TEC VP-210 STD Pac. A coiled catheter guide was left in the penetrated tract of the abdominal wall to allow straight double-cuff Tenckhoff catheter advancement toward the pelvic cavity [10] under visualization by a videolaparoscopic system. The puncture tract was required to be as oblique as possible through the abdominal wall to ensure sufficient tissue to maintain catheter direction toward the pelvis so that a secured suture would not be necessary. Using the Y-TEC cuff implanter (content of a suite of VP-210 STD Pac), the distal Dacron cuff was placed in the musculature adjacent to the peritoneum without a peritoneal suture. The proximal catheter was then tunneled subcutaneously and curved to allow the tip to exit at the lateral abdomen via another incision. The inserted catheter was irrigated on-table with 50 mL of saline to ensure adequate function. Supra-umbilical port was closed in fascia using 1-0 Dexon. The surgical port and puncture hole were closed subcutically using 4-0 Dexon. The postoperative care of the laparoscopic group was identical to that of the open group.

Data Record

Patient characteristics, operation-related data, positive findings in procedural complications, and clinical outcome were recorded and compared between the two study groups. Analyzed factors included: (1) patient demographics, such as gender, age, body height, body weight, body mass index, causes of renal failure, underlying medical disease, severity of APACHE II [30], and history of previous abdominal surgery; (2) operation-related data, such as operative type, operative time, postoperative pain, usage of analgesic, cosmetic wound length, length of hospital stay, operative costs, incidence of overall/early/late procedural complications, delay in start of PD, and mean catheter longevity; (3) types of early/late complications, such as catheter migration, dialysate leak, exit site infection, peritonitis, bleeding, and hernia; and (4) clinical outcomes, such as patient mortality, causes of catheter dropout, and overall/true catheter survival rate.

Definitions

- Body mass index (BMI): body weight/body height^2 = kg/m^2.
- Operative time: duration from skin detergent preparation to skin wound closure, including instrument preparation, time for carbon dioxide pneumoperitoneum insufflation to 15 mm Hg, and adhesiolysis in laparoscopy.
- Postoperative pain evaluated with pain score: 0 = nil; 1 = intolerable during strenuous work; 2 = intolerable during daily activity; and 3 = intolerable during rest.
- Analgesic use: oral analgesics such as acetaminophen as a first-line treatment for mild pain and IM Demerol injection as needed for severe cases.
- Delay in start of peritoneal dialysis (PD): first PD occurring more than 7 d after surgery is considered unusual and exceeds expectant routine.
- Procedural complications: early complications within 4 wk of surgery are usually related to catheter placement; late complications occurring beyond 4 wk after surgery are usually related to multiple factors other than the surgical procedure.
- Dialysate leak: exit-site leak, wound leak, or extra-abdominal dialysate outflow (such as diaphragmatic, genital leak, etc.).
- Pericannular bleeding: bleeding, oozing, or subcutaneous hematoma from incision wound, puncture site, or penetrating tract for catheter placement.
- True catheter survival rate: catheter survival excluding patients with catheter dropout due to clearly unrelated causes such as renal transplantation, renal recovery, or death from unrelated underlying diseases.

Statistical Analysis

The Statistical Package for Social Science ver. 11.5 (SPSS, Chicago, IL) was used for statistical analyses. An independent sample t-test was used to compare group differences in continuous variables, and Pearson's χ^2 or Fisher's exact test was used to compare nominal variables. Overall or true cumulative catheter survival was expressed by the Kaplan-Meier curve, and the differences between the two study groups were compared by the log-rank test. A P value < 0.05 was considered statistically significant.

RESULTS

Of the 77 patients enrolled in this study, 40 received open insertion and 37 received laparoscopic placement of first Tenckhoff catheter.

Patient Demographics

The two groups did not significantly differ in gender, age, body height, body weight, body mass index, causes of renal failure, APACHE II score, or history of previous abdominal surgery. However, one incidental finding was a higher prevalence of liver cirrhosis in the laparoscopic group (Table 1).

Operation-Related Data

The two groups did not significantly differ in pain score, analgesic use, length of hospital stay, incidence of overall/early/late complications, delay in start of PD, or mean catheter longevity. However, the laparoscopic group had a longer operative time ($P < 0.001$), shorter wound length ($P < 0.001$), and higher operative costs ($P < 0.001$) (Table 2).

Positive Findings in Procedural Complications

In early complications, the laparoscopic group had a higher incidence of pericannular bleeding and a lower incidence of catheter migration with outflow obstruction than that of the open group, but the differences did not reach statistical significance. Nevertheless, all bleeding or migration in early complications of both groups were corrected successfully by external compression or conservative treatments (such as enema, change body position, and saline flushing) without further surgery. No exit site infection or peritonitis was presented in the early stage. Likewise, the two groups did not significantly differ in late complications, including catheter migration with outflow obstruction, dialysate leak, exit site infection, peritonitis, and hernia (Table 3).

Clinical Outcome

The two groups did not statistically differ in overall patient mortality or catheter dropout rate. No surgical mortality was noted in either group. They did not significantly differ in cause of patient mortality or catheter dropout (Table 4). The Kaplan-Meier plot of overall catheter survival also did not significantly differ between the open group and the laparoscopic group ($P = 0.4854$) (Fig. 1). Excluding deaths unrelated to catheter, renal recovery, and renal transplantation (accounting for nine patients in the open group and 12 patients in the laparoscopic group), the Kaplan-Meier plot of true catheter survival rate also showed no significant difference between the open group and the laparoscopic group ($P = 0.6863$) (Fig. 2).

TABLE 1

Patient Demographics

	Open group $n = 40$	Laparoscopic group $n = 37$	*P* value
Gender, M/F	18/22	12/25	0.259
Age, y (range)	54.43 ± 16.49 (15–79)	56.65 ± 13.39 (21–80)	0.520
Body height, cm (range)	157.94 ± 8.24 (147–173)	156.42 ± 8.44 (134–173)	0.428
Body weight, kg (range)	57.01 ± 12.21 (33–77)	56.36 ± 12.58 (37–110)	0.818
BMI, kg/m^2 (range)	22.73 ± 4.07 (15.1–31.0)	22.99 ± 4.44 (16.2–37.3)	0.788
Causes of renal failure			0.867
CGN (%)	6 (15.0)	4 (10.8)	0.739
DM (%)	13 (32.5)	17 (45.9)	0.227
Hypertension (%)	8 (20.0)	6 (16.2)	0.667
Others (%)	4[a] (10.0)	4[b] (10.8)	1.000
Unknown (%)	9 (22.5)	8 (21.6)	0.926
Underlying systemic disease			0.133
Hypertension (%)	31[c] (77.5)	28 (75.7)	0.850
DM (%)	12 (30.0)	14 (37.8)	0.467
Heart disease (%)	8 (20.0)	7 (18.9)	0.905
Liver cirrhosis (%)	1 (2.5)	8 (21.6)	0.012
APACHE II[30] (range)	15.85 ± 3.17 (10–22)	16.70 ± 2.79 (11–23)	0.215
Previous abdominal surgery (%)	5 (12.5)	4 (10.8)	1.000

n = patient number, CGN = chronic glomerular nephritis; DM = diabetes mellitus.
[a]Included one systemic lupus erythematosus, one gouty nephritis, one renal cell carcinoma. and one congestive heart failure.
[b]Included one herb abuse, two gouty nephritis, and one Alport's syndrome.
[c]Included two patients with old cerebral vascular accident.

DISCUSSION

In the present study, laparoscopic placement was associated with a longer operative time, shorter wound length, and higher costs. Similar results were obtained when patients who had undergone laparoscopic adhesiolysis were excluded (operative time, 65.85 ± 30.03 *versus* 46.68 ± 15.99 min, $P = 0.0008$; wound length,

TABLE 2

Operation-Related Data

	Open group ($n = 40$)	Laparoscopic group ($n = 37$)	*P* value
Operative time, min (range)	46.68 ± 15.99 (23–97)	68.32 ± 31.90 (20–143)	<0.001
Postoperative pain score, *n* (%)			0.392
0	12 (30.0)	10 (27.0)	
1	16 (40.0)	11 (29.7)	
2	10 (25.0)	10 (27.0)	
3	2 (5.0)	6 (16.3)	
Requirement of pain control, *n* (%)			0.399
Nil	5 (12.5)	6 (16.2)	
Oral analgesics[a]	32 (80.0)	25 (67.6)	
Parenteral narcotics[b]	3 (7.5)	6 (16.2)	
Wound length, cm (range)	2.34 ± 0.84 (1.5–6)	1.69 ± 0.46 (1–2.5)	<0.001
Hospital stay, d (range)	13.08 ± 6.80 (2–34)	14.81 ± 5.61 (4–27)	0.227
Operative cost, NT dollars (range)	8577.05 ± 1884.48 (3750–12370)	11269.84 ± 3830.53 (5820–26501)	<0.001
Procedural complications, *n*[c] (%)			
Overall	25 (62.5)	26 (70.3)	0.703
Early	15 (37.5)	14 (37.8)	0.838
Late	13 (32.5)	17 (45.9)	0.227
Delay in star of PD, *n* (%)			
Nil	35 (87.5)	31 (83.8)	0.642
Dialysate leak	4 (10.0)	6 (16.2)	0.637
Catheter migration	1 (2.5)	0 (0.0)	0.959
Mean catheter longevity, d (range)	485.90 ± 358.88 (26–1358)	491.49 ± 351.12 (14–1341)	0.945

Note. Nominal data are expressed as numbers (%); continuous data are expressed as mean ± standard deviation (range); n = patient numbers.
[a]Oral acetaminophen.
[b]IM Demerol.
[c]Number of patients who had one or more procedural complications.

TABLE 3

Positive Findings in Procedural Complications.

	Open group	Laparoscopic group	P value
Early, *n* (%)			
Catheter migration	6 (15.0)	1 (2.7)	0.110
Dialysate leak	6 (15.0)	7 (18.9)	0.646
Pericannular bleeding	3[a] (7.5)	8[b] (21.6)	0.077
Late, *n* (%)			
Catheter migration	1 (2.5)	3 (8.1)	0.346
Dialysate leak	1 (2.5)	1 (2.7)	1.000
Exit site infection	5 (12.5)	6 (16.2)	0.642
Peritonitis	6 (15.0)	10 (27.0)	0.194
Hernia	1[c] (2.5)	2[d] (5.4)	0.605

n = complication incidence; (%) = percentage of group number.
[a]Two cases of exit sites and one case of subcutaneous tunnel.
[b]Six cases of exit sites and two cases of puncture port sites.
[c]One inguinal hernia.
[d]One femoral and one umbilical hernia.

1.69 ± 0.45 *versus* 2.34 ± 0.84 cm, $P = 0.0002$; cost, 10928.79 ± 2984.19 NTD *versus* 8577.05 ± 1884.48 NTD, $P = 0.0001$) or when patients with previous abdominal surgery were excluded from both groups (operative time, 65.85 ± 30.03 *versus* 47.29 ± 16.25 min, $P = 0.0021$; wound length, 1.69 ± 0.46 *versus* 2.19 ± 0.56 cm, $P = 0.0002$; cost, 10928.79 ± 2984.19 NTD *versus* 8481.63 ± 1834.51 NTD, $P = 0.0001$). A higher incidence of pericannular bleeding and a lower rate of catheter migration were noted in early stage of the laparoscopic group, but they did not statistically differ. All the incidences of pericannular bleeding in both the groups occurred within 4 wk after surgery, indicating

TABLE 4

Causes of Patient Mortality and Catheter Dropout

	Open group *n* = 40	Laparoscopic group *n* = 37	P value
Overall patient mortality	7 (17.5)	10 (27.0)	0.464
Catheter-related sepsis	1 (2.5)	0 (0.0)	
Catheter-unrelated sepsis	4 (10.0)	2 (5.4)	
Cardiac failure	0 (0.0)	4 (10.8)	
Respiratory failure	1 (2.5)	1 (2.7)	
Hepatic failure	0 (0.0)	2 (5.4)	
Uncertain origin	1 (2.5)	1 (2.7)	
Overall catheter dropout	14 (35.0)	17 (45.9)	0.456
Catheter-unrelated	9 (22.5)	12 (32.4)	0.470
Renal transplantation	2 (5.0)	2 (5.4)	
Renal recovery	1 (2.5)	0 (0)	
Mortality	6 (15.0)	10 (27.0)	
Catheter-related	5 (12.5)	5 (13.5)	0.836
Inadequate dialysis	0 (0.0)	1 (2.7)	
Peritonitis	0 (0.0)	1 (2.7)	
Hydrocele	1 (2.5)	0 (0.0)	
Hydrothorax	1 (2.5)	1 (2.7)	
Change to HD voluntarily	2 (5.0)	2 (5.4)	
Mortality	1 (2.5)	0 (0.0)	

Note. Data are expressed as *n* (); *n* = patient number, () %.

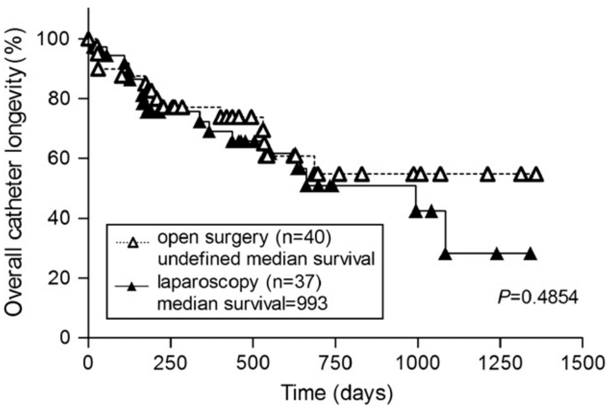

FIG. 1. Kaplan-Meier plot of overall catheter survival based on placement technique. Survival did not significantly differ between the open surgery and laparoscopy groups.

that bleeding is closely related to the surgical procedure used; its higher incidence in the laparoscopic group may be due to the puncture procedure without sufficient monitoring of bleeding. None of the bleeding cases were associated with liver cirrhosis in this study. On the other hand, the lower incidence of catheter migration in the early stages of laparoscopic procedure in the laparoscopic group may be due to better initial catheter position under direct laparoscopic vision. The total time needed for laparoscopy, including the time for assembling the complex instrument, and for pneumoperitoneum insufflation with carbon dioxide to 15 mmHg was longer than the time for minimal dissection required in an open surgery. Previous comparative reports (Table 5) have also noted a longer operative time for laparoscopy in three prospective studies [23, 26, 28], but data for wound length or operative cost are unavailable. Early and late complications did not statistically differ in the present study. Similar results were also shown in previous comparative studies [22, 23, 25], although others have reported reduced outflow

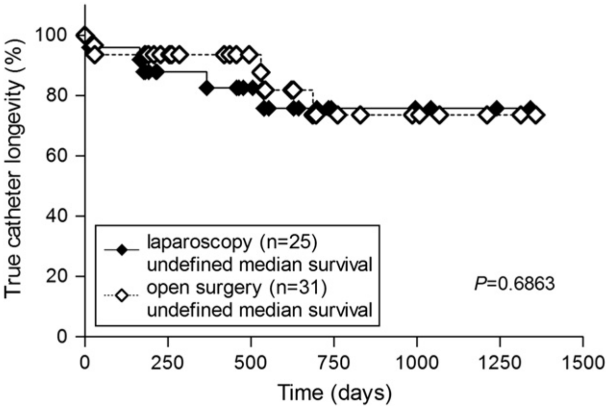

FIG. 2. Kaplan-Meier plot of true catheter survival according to placement technique. Survival did not significantly differ between the open surgery and laparoscopy groups.

TABLE 5

Summary of Previous and Present Comparative Studies

	Author, year [refence]								
	Draganic, 1998 [22]	Wright, 1999 [23]	Tsimoyiannis, 2000 [26]	Crabtree, 2000 [27]	Daschner, 2002 [24]	Batey, 2002 [25]	Ogunc, 2003 [28]	Crabtree, 2005 [29]	Present study
Design	R	PR	PR	PNR	PNR	R	PNR	PNR	PR
No. procedure	30 OP/30 L	24 OP/21 L	25 OP/25 L[a]	63 OP/150 L[b]	23 OP/25 L[c]	12 OP/ 14 L[d†]	21 OP[b†]/21 L[e†]	63 OP/78 L/200 AL	40 OP[†]/37 L[f†]
Operative time (min)	57/41*	14.3/21.9*	22/29*	–	–	55.7/41.7*	30.9/45.4*	–	46.7/68.3*
Postoperative pain	OP > L*	OP = L	–	OP > L*	–	OP > L*	OP > L*	–	OP = L
Wound length (cm)	–	–	–	–	–	–	–	–	2.3/1.7*
Hospital stay (d)	–	2.4/3.1	–	–	–	1.5/0.14*	3.1/1.1*	–	OP = L
Operative cost	–	–	–	–	–	–	–	–	OP<L*
Major complications	Overall	Early|Late[g]	Overall	Overall	Early[h]	Overall	Early|Late[h]	Overall	Early|Late[h]
a. Ob (%)	10.0/3.3	0.0/0.0|0.0/0.0	20.0/0.0*	17.5/6.7*	8.7/8.0	8.3/21.4	23.8/0.0*|–/0.0	17.5/12.8/0.5*	15.0/2.7|2.5/8.1
b. D leak (%)	0.0/3.3	0.0/9.5|0.0/0.0	32.0/0.0*	1.6/1.3	21.7/8.0	41.7/7.1	0.0/0.0|0.0/4.7	1.6/1.3/2.0	15.0/18.9|2.5/2.7
c. E-s infect (%)	16.7/16.7	16.7/9.5|16.7/28.6	–	–	–	–	38/19*|9.5/4.7	–	0.0/0.0|12.5/16.2
d. Peritonitis (%)	23.3/16.7	4.2/14.3|45.8/28.6	20.0/12.0	–	–	–	38/9.5*|14.2/4.7*	–	0.0/0.0|15.0/27.0
Overall comp rate	OP = L[‡]	OP = L	–	–	OP > L	OP = L	OP > L*	OP = L > AL*	OP = L[§]
Mean FU (m)	16.2/9.8	–	–	19.6/15.2	–	–	–	23.3/26.9/21	16.2/16.4
Catheter longevity	OP = L	OP = L	–	OP < L*	–	–	OP < L*	–	OP = L
Comments	Equivalent	Equivalent	Positive	Positive	Equivalent	Equivalent	Positive	Positive	Equivalent

R = retrospective; PR = prospective randomized; PNR = prospective non-randomized; No. procedure = case numbers and procedure of catheter placement; OP = conventional open surgery; L = laparoscopic catheter placement; AL = advanced laparoscopy including rectus sheath tunneling, selective prophylactic omentopexy, and selective adhesiolysis; – = data is not available; Ob = outflow obstruction or migration; D leak = dialysate leak including exit site leak or extra-abdominal dialysate outflow; E-s infect = exit site infection; comp = complication; Mean FU (m) = average period of follow-up (mo).

[a]Laparoscopy with fixation of catheter tip to pelvis.

[b]Under local anesthesia.

[c]Laparoscopic catheter placement in children.

[d]Catheter placement using mini-laparoscopy.

[e]Laparoscopic omental fixation technique for catheter placement.

[f]Wide-angled laparoscopy with Y-TEC VP-210 percutaneous catheter placement.

[g]Early: <6 wk postoperatively, Late: >6 wk postoperatively.

[h]Early: <4 wk postoperatively, Late: >4 wk postoperatively.

[*]$P < 0.05$: Significant difference in study.

[†]Performed by a single surgeon.

[‡]Including one port site bleeding in laparoscopic group.

[§]Including mild pericannular bleeding, three in open surgery and eight in laparoscopic group.

obstruction when using laparoscopy [26–29]. One portsite bleeding was noticed by Draganic *et al.* in thirty laparoscopic placements [22]. Dialysate leak did not significantly differ in all of the previous comparative studies except for the study by Tsimoyiannis *et al.* who reported significantly higher leakage in the open group [26]. Exit site infection or peritonitis was only reported significantly lower rate in laparoscopic placement by Ogunc *et al.* [28]. Although catheter longevity in the laparoscopic group was reportedly higher than in the open group in two non-randomized studies [27, 28], longevity in both groups was equivalent under the present study and two other comparative studies as well [22, 23], including one prospective randomized study by Wright *et al.* [23].

Unlike most previous studies [22, 25, 27, 28] with the exception of that by Wright *et al.* [23], in this study, postoperative pain and the requirement of analgesics did not differ between the laparoscopic and open groups. A likely explanation is that the pain caused by a limited dissection via mini wound in the open group was equivalent to the mild pain produced by carbon dioxide pneumoperitoneum during the laparoscopic procedure [31]. Further, hospital stay did not significantly differ between the two study groups, which was also reported by Wright *et al.* [23]. The operative cost of the present study, precluding Y-TEC VP-210 STD Pac, was significantly higher in the laparoscopic group. Given the lack of a clear advantage in complication rate or catheter survival, the basic laparoscopic technique was not cost-effective, which is in disaccord with Crabtree *et al.* [32]. This study yielded comprehensive data using a prospective randomized design to eliminate selection bias, and it is superior to most previous comparative studies [22, 24, 25, 27–29]. Although patient number of the present study is larger than that of most previous studies including Wright *et al.* [22–26, 28], it would be better to increase this number in future studies to avoid type II statistical error [33].

The obvious advantages of laparoscopic placement are the accuracy of initial position under direct vision and the possibility of other sophisticated abdominal management. Crabtree *et al.* further classified laparoscopic catheter placement into basic laparoscopy and advanced laparoscopy according to accessory procedures of rectus sheath tunneling, selective prophylactic omentopexy, and selective adhesiolysis. The comparison of complications in Crabtree showed that overall complication rate in basic laparoscopy was equivalent to that of open surgery but much higher than that of advanced laparoscopy [29]. However, this conclusion requires further confirmation by prospective randomized studies. In the present study, laparoscopic technique using percutaneous puncture assisted by direct laparoscopic vision is similar to basic laparoscopy [29] or the usage in most of previous studies [22–27], showed no superiority in complication rate or catheter survival but required a longer operative time and higher operative costs than the open group. Accordingly, no evidence suggests that simple laparoscopic assisted technique should be used routinely for all primary catheter placements. As a matter of fact, the shorter operative time and simpler equipment requirement of open surgery are more cost-effective. Therefore, conventional open surgery is recommended for most patients with primary catheter placement. Although laparoscopic surgery is more expensive and time-consuming than open surgery, advanced laparoscopy using more sophisticated procedures may be further investigated for selected patients with other abdominal management simultaneously or relapsing complications during catheter placement.

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