Clinical Research

Outcomes of laparoscopic Tenckhoff catheter insertion with rectus sheath tunneling method: a retrospective study

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ABSTRACT

BACKGROUND Peritoneal dialysis is an alternative to hemodialysis in patients with end-stage kidney disease (ESKD). The laparoscopic technique for catheter insertion has been shown to be better than the open method. This study aimed to discuss the results of laparoscopic Tenckhoff catheter insertion by the rectus sheath tunneling (RST) procedure in adult patients with ESKD.

METHODS This retrospective investigation was conducted in an Indonesian tertiary hospital. Data were gathered from the medical records of 18-year-old or older patients with ESKD who underwent laparoscopic Tenckhoff catheter insertion between January 1, 2018 to December 31, 2022.

RESULTS Of 68 patients, 45 (66%) were male and 23 (34%) were female, with a mean age of 45.25 (standard deviation: 13.2) years. The catheter survival rates at 3 months, 1 year, 2 years, and 3 years were 97%, 91%, 82%, and 80%, respectively. The estimated blood loss was 5 (2–100) ml and the median operation time was 70 (40–150) min. The omentopexy maneuver was used in 10 (15%) patients. The most common catheter problems were malfunction (18%), peritonitis (21%), exit-site infection (7%), abdominal herniation (3%), and leakage (1%). Because of uncontrolled complications, 9 (13%) patients underwent revision surgery and 10 (15%) required catheter removal surgery. Catheter migration was not observed in any patient.

CONCLUSIONS Laparoscopic Tenckhoff catheter insertion using the RST technique is a practical method for adult patients with ESKD as it has a reasonably low rate of complications.

KEYWORDS complications, laparoscopic, peritoneal dialysis

Peritoneal dialysis (PD) is a viable alternative to hemodialysis in patients with end-stage kidney disease (ESKD). Its mobility and availability make it a cost-effective treatment that may improve quality of life. PD requires a permanent indwelling PD catheter, such as the Tenckhoff catheter, which is placed into the peritoneal cavity to allow dialysate exchange.[1] PD catheter insertion can be performed via open surgery, laparoscopy, or percutaneous insertion (blind or image-guided) using ultrasound and/or fluoroscopy.[2] The laparoscopic technique offers several advantages, including reducing morbidity, length of stay, and postoperative pain, making it the preferred technique.[3,4] Omentopexy, rectus sheath tunneling (RST), and pelvic catheter fixation can also be performed to reduce catheter malfunction.[5] Additionally, Crabtree[6] reported that appropriate tunneling techniques may facilitate better visualization

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of the pelvic space when performing adjunctive procedures such as omentopexy, salpingectomy, colopexy, and adhesiolysis during the laparoscopic procedures.

The success of PD depends on catheter performance and durability, which are affected by the insertion technique. However, as open *versus* laparoscopic methods are offer similar surgical outcomes (catheter survival and complications), the choice of technique should be made at the surgeon's discretion on a case-by-case basis.[4] The main complications of peritoneal catheters are infections, mechanical obstruction, abdominal hernias, and leakage.[7,8] A comparative study by Liu and Hooi[9] revealed several complications after open Tenckhoff catheter insertion with local anesthetic, including catheter migration (7.6%), exit-site infection (ESI) (6.3%), catheter obstruction without migration (5.7%), incisional infection (3.6%), leakage from the main incision (3.1%), peritonitis (2.9%), and hemoperitoneum (0.3%). Similar complications associated with laparoscopic insertion were reported by Bunker et al,[10] with the most common complication being peritonitis (10%), followed by postoperative hernia (8%), ESI (5%), cuff extrusion (2%), and a nonfunctional catheter (2%). Despite these documented complication rates, there remains a lack of definitive consensus on which specific advanced laparoscopic modifications—such as specific tunneling or fixation techniques—best preserve long-term catheter functionality while minimizing infectious risks across diverse patient cohorts. This study aimed to analyze the outcomes of laparoscopic Tenckhoff catheter insertion in patients with ESKD.

METHODS

Study design, patient population, and data collection

This retrospective observational study included adult patients (aged 18 years or older) with ESKD who underwent laparoscopic Tenckhoff catheter insertion at a tertiary hospital in India between January 2018 and December 2022. Patients with 3-month, 1-year, 2-year, and 3-year follow-up data were eligible. Patients with incomplete data were excluded. This study was approved by the Ethics Committee of the Faculty Medicine, Universitas Indonesia – Cipto Mangunkusumo Hospital (No: KET-969/UN2.F1/ETIK/PPM.00.02/2021). All the patients signed an informed consent form for catheter insertion surgery.

Patient characteristics and follow-up data including age, sex, comorbidities, complications associated with surgery or PD catheterization, and PD catheter insertion procedure reports were retrospectively extracted from electronic medical records.

Outcomes of interest

ESI was defined as erythema and purulent discharge at the catheter's exit site.[11] Peritonitis was defined as a peritoneal infection caused by peritoneal catheter placement, with two of three criteria present: a) clinical features of peritonitis (abdominal paint or cloudy dialysis effluent); b) white cell counts of dialysis effluents >100/ or >0.1 × 10^9 or >50% polymorphonuclear leukocytes; and c) positive dialysis effluent culture.[12] Catheter leakage was characterized as dialysis fluid leakage from the catheter exit location. Outflow or inflow failure of the dialysis fluid through the catheter was defined as a malfunction. Abdominal herniation was defined as a postoperative hernia of the abdominal wall, including the incision area. Catheter survival was defined as the period during which a PD catheter could be used before removal due to infection or mechanical issues after placement. Once inserted, catheter repositioning was considered successful. Complication incidence was also reported as Clavien-Dindo classification grades I to V based on severity.[13]

Surgical procedure

Multiple surgeons (consultant and senior urology resident) performed the surgeries under general anesthesia. All patients received prophylactic antibiotics (cefoperazone or cefazoline) and deep venous thrombosis prophylaxis (heparin) before surgery. Laparoscopic surgery for catheter insertion was performed using the RST method. The first incision was made in the upper left pararectal region (superolateral to the umbilicus) through the skin, subcutaneous layer, fascia, muscle, and peritoneum to insert an 11 mm bladeless trocar as the camera port. After inserting the camera, the peritoneal cavity was insufflated to 12–15 mmHg. A second incision was made on the right side parallel to the first incision through the skin, subcutaneous layer, and fascia. A 5 mm bladeless trocar was inserted below the fascia, and RST was performed caudally (4–6 cm in length).[5,6] The tunneling position (lateral to the inferior epigastric vessel) and utilization of a bladeless

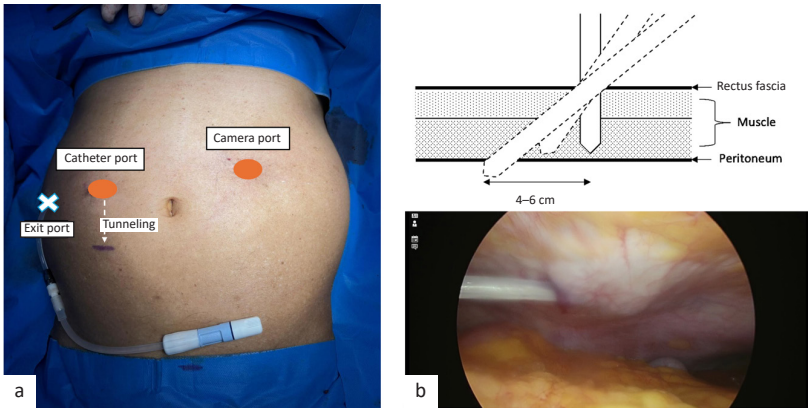


Figure 1. Intraoperative surgical landmarks. (a) Trocar placement during the procedure; (b) rectus sheath tunneling (RST)

Table 1. Patients characteristics

Characteristics	n (%) (N = 68)
Age (years), mean (SD)	45.25 (13.2)
Male sex	45 (66)
Comorbidities	
Hypertension	31 (46)
T2DM	3 (4)
Hypertension and T2DM	22 (32)
Renal inflammatory disease*	7 (10)
Urolithiasis	5 (7)

SD=standard deviation; T2DM=type 2 diabetes mellitus
*Renal inflammatory disease includes lupus nephritis (3), interstitial nephritis (2), nephrotic syndrome (1), and IgA nephropathy (1)

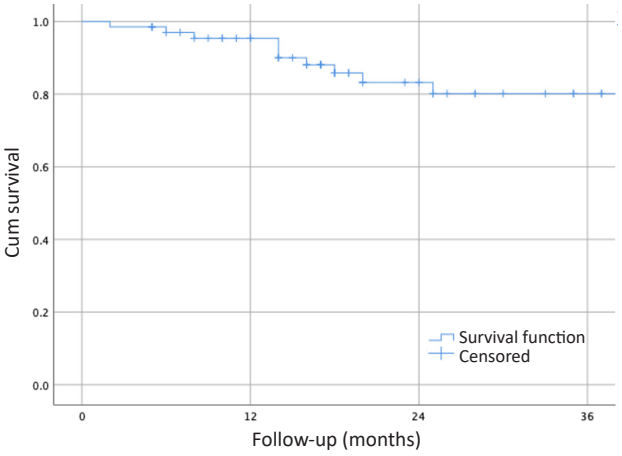


Figure 2. Three-years catheter survival rate during follow-up

trocar were selected to reduce the risks of inferior epigastric vessel injury.[14] A Tenckhoff catheter was inserted via the second port guided by a 5 mm (lens) laparoscopic camera 3CCD Olympus HD (Olympus Medical Systems Corp., Japan). The catheter tip was then directed towards the pelvic cavity, and the proximal tip was removed via the right hemiabdomen. Selective omentopexy was performed in the presence of a redundant omentum. Finally, the trocars were removed and the peritoneal cavity was deflated (Figure 1).

The proximal cuff was placed above the rectus sheath, whereas the distal cuff was placed in the extraperitoneal area. The rectus sheath incision defects were fixed using 2-0 polyglactin sutures and the catheter was pierced to the exit point. The skin was closed with 3-0 absorbable monofilament sutures. Based on the nephrologist's recommendation, the PD catheters were cleansed 14–30 days after surgery and prepared for dialysis.

Statistical analysis

The catheter survival rate was analyzed using the Kaplan–Meier survival analysis and the surgical characteristics were analyzed using descriptive analysis (using SPSS software version 25 [IBM Corp., USA]).

RESULTS

Patient characteristics

In total, 68 adult patients underwent Tenckhoff catheter insertion between January 2018 and December 2022. However, a total of two patients were not finished the 3-month follow-up due to mortality unrelated to Tenckhoff catheter implantation. Thus, only 66 patients completed the 3-month follow-up, 64 patients completed the 1-year follow-up, 34 patients completed the 2-year follow-up, and 18 patients completed the 3-year follow-up. The leading causes of

Table 2. Surgical characteristics

Outcome	n (%) (N = 68)
Surgery duration (min), median (min-max)	70 (40–150)
Estimated blood loss (ml), median (min-max)	5 (2–100)
Omentopexy maneuver	10 (15)
Conversion to open surgery	0 (0)
Intraperitoneal injury	0 (0)

renal failure were hypertension and diabetes mellitus (Table 1).

Surgical procedures

All catheter placements were performed laparoscopically using the RST technique. There were no deaths and no operations were converted to open procedures. The catheter survival rates at 3 months', 1-year', 2-years', and 3-years' follow-up were 97%, 91%, 82% , and 80%, respectively (Figure 2). No intraoperative complications occurred and the estimated blood loss was minimal. Omentopexy was performed in 10 patients (15%) due to a massive omentum in the pelvic region. The surgical outcomes are presented in Table 2.

Postoperative complications

Postoperative complications, including malfunction, peritonitis, ESI, abdominal herniation, bloody transfer set, and leakage, occurred in 15 of the 68 patients (22%) (Table 3). No cases of catheter tip migration were reported. All identified malfunctioning catheters were managed by direct observation and flushing with normal saline (Clavien-Dindo grade I); however, (9/12) revision surgery was required (Clavien-Dindo grade III). Peritonitis occurred in 14 patients and was treated with antibiotics (Clavien-Dindo grade II) (14/14) and catheter removal surgery (Clavien-Dindo grade III) (5/14), then change into hemodialysis. Two patients (2/14) required catheter reinsertion (Clavien-Dindo grade III) using the same technique but a different exit site. Abdominal hernias were noted in two patients with umbilical hernias, but no intervention was required. Catheter removal was performed (10/68) in patients with recurrent peritonitis (5/10) according to personal preferences (5/10). No severe complications were observed (Clavien-Dindo grade IV or V).

DISCUSSION

These findings indicated that catheter survival over 3 years was favorable and no major intraoperative adverse events were observed. The overall complication rate was 25%, with catheter malfunction and catheter-related infections being the most common complications. This pattern of complications is similar to previously studies of laparoscopic insertion, although postoperative hemorrhage and catheter migration were not observed in our cohort.[10] These findings support the suggestion that RST provides a stable extraperitoneal course that may reduce tip displacement and pericatheter leakage while maintaining procedural safety.

These results demonstrate that after a technically successful placement, subsequent outcomes are

Table 3. Catheter-related complications and outcomes

Complications and outcomes	Incidence				Management
	3-month follow up (N = 68)	1-year follow up (N = 64)	2-year follow up (N = 34)	3-year follow up (N = 18)	
Malfunction, n (%)	8 (12)	3 (5)	1 (3)	0 (0)	Spooling and revision surgery
Peritonitis, n (%)	6 (9)	1 (2)	3 (9)	4 (22)	Antibiotics and catheter removal in recurrent cases
Leakage, n (%)	0 (0)	0 (0)	1 (3)	0 (0)	Exit-site care
Exit-site infection, n (%)	1 (2)	3 (5)	0 (0)	1 (6)	Antibiotics and catheter hygiene
Abdominal herniation, n (%)	0 (0)	1 (2)	0 (0)	1 (6)	Observation and hernia correction surgery if needed
Bloody transfer set, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	-
Migration of catheter tip, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	-

determined primarily by (1) the mechanical function of the catheter and (2) infectious complications during PD use.[6,11] The most frequent mechanical complication was malfunction. Flow dysfunction after PD catheter placement is commonly attributed to inflow/outflow obstruction, including omental trapping and fibrin-related blockage.[15] In this study, conservative management resolved the malfunction in only three cases (25%); most malfunctions ultimately required revision, and omental trapping was identified intraoperatively. This may explain the higher malfunction rate than that reported in previous cohorts that used a broader set of advanced laparoscopic adjuncts to reduce mechanical failure.[15,16] The relatively low rate of selective omentopexy in this study may also have contributed to supporting a more risk-stratified approach to omental management during the index procedure (e.g., a lower threshold for adjunctive omental maneuvers in patients with a redundant omentum).

Infectious complications remain a central determinant of PD technique failure and often lead to catheter removal.[17] In this study, the infection rate was 21% for peritonitis and 7% for ESI, and approximately 50% of cases ultimately required catheter removal. These infection rates are in line with those of earlier laparoscopic studies.[10,18] All patients with suspected peritonitis underwent systemic laboratory evaluation and peritoneal effluent assessment, including culture when indicated, in line with the International Society for Peritoneal Dialysis (ISPD) peritonitis guideline recommendations.[19] In this study, peritonitis was relatively frequent in the first 3 months of follow-up and again later in 2nd and 3rd year follow-ups. This pattern is compatible with two vulnerable periods: early technique acquisition and later complacency or technique fatigue.[11,19] As aseptic techniques during exchanges are highly behavior-dependent, this finding emphasizes the importance of structured initial education and scheduled reinforcement, including hand hygiene, for patients and caregivers rather than one-time training alone.[11,17,19]

No instances of catheter migration were noted, but pericatheter leakage occurred in one patient. Pericatheter leakage most commonly occurs during the immediate post-insertion period and is associated with factors such as an inadequate tunnel and early increases in intra-abdominal pressure.[16,20] We postulate that the low rates of catheter migration and leakage in this study were related to the RST technique, which provides greater protection against catheter movement. The timing of PD initiation after catheter implantation (the break-in period) varies considerably in practice. Previous cohorts evaluating urgent-start protocols (<14 days) show that initiating therapy within 48 to 72 hours of surgical placement is associated with a minor but notable increase in early mechanical complications. These primarily present as pericatheter dialysate leaks, outflow failure, and catheter tip migration.[20]

Hernia is a recognized complication of PD that occurs at or away from port sites, with prevalence varying widely across studies.[21] The signs and symptoms include nausea, vomiting, abdominal pain, and a palpable or tender mass.[21] Local and systemic factors, particularly sustained increases in intra-abdominal pressure and reduced abdominal wall integrity, contribute to hernia formation. Contributing factors include anatomically weak sites, poor nutrition, obesity, uremia, anemia, and prior abdominal surgery.[22] We observed one case of umbilical hernia in this study; the hernia was surgically treated, and PD catheterization was continued based on the patient's clinical status and postoperative course.[21–23]

From a procedural standpoint, laparoscopic Tenckhoff catheter implantation demonstrates excellent surgical efficiency and reproducibility in a tertiary center setting, as evidenced by short median operative times and minimal estimated blood loss. The complete absence of conversions to open surgery or intraoperative visceral injuries in this cohort underscores the safety of standardized laparoscopic entry. Specifically, mapping epigastric vessel trajectories and utilizing anatomical 'safe zones' drastically minimizes the catastrophic vascular and visceral risks often associated with blind percutaneous placement.[14] Furthermore, because current guidelines recommend laparoscopy as the optimized method for PD access, these findings confirm that a structured laparoscopic approach not only ensures immediate perioperative safety but also provides the necessary platform for simultaneous adjunctive procedures, such as hernia repairs or adhesiolysis, without adding undue surgical burden.[5,6]

The discrepancies in catheter complication rates between these findings and previous cohorts likely reflect fundamental differences in surgical technique and reporting methodologies.[13–15] First, while our

laparoscopic program utilizes standardized anchoring maneuvers, previous studies vary widely in how consistently adjunctive techniques—such as routine *versus* selective omentopexy—are applied to prevent mechanical obstruction.[13,15] Second, regional practice variations dictate baseline risk; for instance, resource-limited settings often rely on simplified local insertion approaches like the Bandung method. While this percutaneous approach drastically lowers immediate barriers to care and theater costs, it lacks the direct intraoperative visualization of catheter placement, inherently altering comparative rates of catheter migration and early leakage. Finally, direct comparisons are frequently confounded by heterogeneous outcome definitions, such as patient-level *versus* episode-level reporting and varying early *versus* late event windows, which must be accounted for when assessing the generalizability of laparoscopic programs.[20]

Clinically, these findings support laparoscopic RST as a practical access strategy aligned with guideline-based principles for reducing key mechanical failures while highlighting that outcomes remain strongly influenced by post-implantation behaviors and program-level infection prevention. The updated ISPD guidelines emphasize standardized prevention practices for peritonitis and catheter-related infections, including ongoing technique training and monitoring.[11,19] Hand hygiene is a foundational component of these preventive behaviors, and international guidelines consistently stress that hand hygiene remains central to preventing microorganism transmission and that glove use does not replace hand hygiene.[24,25] In this study, the early and late clustering of peritonitis underscores the need for structured initial education, scheduled refreshers, competency reassessment, and technique audits over time.

This study has limitations arising from its single-center retrospective design. The study encountered three main issues due to participant dropout, resulting in missing information regarding prior abdominal surgery, body weight, health conditions, and differences in operator performance. Future research should include (1) multicenter studies employing standard definitions for mechanical failures and infection rates; (2) studies comparing selective *versus* complete omental treatment methods and additional treatments for specific patient groups; and (3) studies evaluating structured PD training programs that use hand hygiene checks, regular skills testing, and customized safety training and report results as episodes per patient year and technique survival.

In conclusion, laparoscopic Tenckhoff catheter insertion represents a simple, rapid, effective, and minimally invasive procedural choice. Techniques such as RST and selective omentopexy are highly favored, yielding a relatively low incidence of postoperative complications. Nevertheless, catheter malfunction and catheter-related infections—specifically peritonitis and ESI—remain the most prevalent challenges encountered in this study population. To further optimize patient outcomes, future large-scale, prospective studies are warranted to refine these surgical techniques, establish standardized infection-prevention protocols, and evaluate long-term catheter survival.

Conflict of Interest
The authors affirm no conflict of interest in this study.

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