Balancing Precision and Risks: Exploring the Impact of Laparoscopic-Assisted Peritoneal Dialysis Catheter Placement

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ABSTRACT

Background: The laparoscopic-assisted (LA) insertion of peritoneal dialysis catheters (PDC) **is economically advantageous due to reduced hospital duration and precise placement, hence minimizing difficulties linked to alternative methods. This study sought to assess the efficacy and complications associated with the laparoscopic insertion of peritoneal dialysis catheters for peritoneal dialysis therapy in patients with end-stage renal failure.**

Methods: Categorical variables were presented as frequencies and percentages. The complications were categorized into early and late that occurred within two weeks or afterwards respectively.

Results: A total of 31 patients underwent LA insertion of PDC. In 25 patients (80.6%), the laparoscopic surgery was conducted via a single port. Six patients (19.6%) necessitated supplementary ports. The duration of the procedure was 12 to 40 minutes, with a mean of 23 minutes. The duration of hospitalization was 1 to 3 days. Success was observed in 23 patients (74.2%), but complications arose in eight patients (25.8%). Diagnostic laparoscopy revealed catheter obstruction due to significant omental adhesions, necessitating omentopexy and the insertion of a replacement PDC. Another late consequence observed was infection, which occurred in four patients. Two patients (6.4%) experienced port site infections, with Staphylococcus aureus identified as the isolated pathogen in both cases. They had effective conservative treatment. The remaining two patients (6.4%) had peritonitis three- and eight-months post-operation, with Pseudomonas aeruginosa identified as the isolated bacterium in both cases. The individuals who developed peritonitis had type II diabetes mellitus. The management involved catheter removal, a two-week course of intravenous antibiotics, and transition to haemodialysis.

Conclusion: successful conservative treatment for port site infections and transition to haemodialysis in cases of peritonitis would therefore intimate the importance of tailored postoperative care in optimizing outcomes for such cases, especially among high-risk patients.

Keywords: Catheter; Effectiveness; Safety; Laparoscopy; Peritoneal Dialysis

INTRODUCTION

Peritoneal dialysis (PD) is a recognized alternative to haemodialysis, demonstrating safety and efficacy as a modality of renal replacement therapy for patients with end-stage renal disease. It affords patients greater autonomy in doing everyday activities relative to haemodialysis. The installation of peritoneal catheters, initially introduced in 1968, was seen as essential for the success of peritoneal dialysis (1). Meticulous attention during the catheter insertion for peritoneal dialysis can reduce the necessity for transfers to hemodialysis. Therefore, it is essential for the nephrology team to participate in the process to guarantee the proper insertion of the PD catheter. Traditionally, PD catheters have been introduced via a minor laparotomy with blind insertion into the pelvic cavity. This approach has been linked to catheter blockage rates reaching 36%. Subsequent approaches utilizing fluoroscopy, peritoneoscopy, and laparoscopy have been delineated. Nonetheless, the literature exhibits a lack of consensus over the recommended procedure (2). Numerous research publications have examined the merits and drawbacks of open versus laparoscopic insertion of PD catheters, yielding varying conclusions. Some authors identified advantages associated with laparoscopic insertion, however others demonstrated that it was comparable in terms of complications and catheter longevity (3, 4). Notwithstanding varying expert perspectives and disparate outcomes from randomized clinical studies and meta-analyses, laparoscopic insertion of the PD catheter is becoming recognized as a standard approach for achieving peritoneal access. The majority of peritoneal dialysis catheters are fabricated from silicone, which is less abrasive to the peritoneum. The Cruz catheter is constructed from polyurethane, which is more robust than silicone, enabling the catheter to possess thin walls and big lumens (5). The PD catheter is segmented into three parts. The intraperitoneal segment resides within the peritoneal cavity, the extraperitoneal or intramural portion is situated within the abdominal wall, and the external segment is visible externally (5).

Over 100,000 patients, constituting 15% of the dialysis population, with end-stage renal failure (ESRF) are administered peritoneal dialysis (PD) globally (3). Despite the existence of alternative dialysis modalities, peritoneal dialysis remains a valuable initial treatment for individuals with end-stage renal failure. A crucial factor in the effectiveness of peritoneal dialysis (PD) is the existence of a functional peritoneal dialysis catheter (PDC) (6, 7). Various techniques for the insertion of a PDC are documented, including open surgery, blind insertion with or without radiologic guidance, and laparoscopic-assisted insertion (8). Various consequences may arise from these methods, including the risk of visceral injury, infection, hemorrhage, catheter obstruction, and eventual catheter displacement, potentially leading to unsuccessful dialysis (9-11). The laparoscopic-assisted (LA) insertion of peritoneal dialysis catheters (PDC) is economically advantageous due to reduced hospital duration and precise placement, hence minimizing difficulties

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linked to alternative methods (1). Furthermore, LA insertion may assist in the control of dysfunctional PDC (6, 12-15). This study sought to assess the efficacy and complications associated with the laparoscopic insertion of peritoneal dialysis catheters for peritoneal dialysis therapy in patients with end-stage renal failure.

METHODOLOGY

Study design and population:

This cross-sectional retrospective observational study was conducted at King Fahad Hofuf Hospital in Al-Ahsa, Kingdom of Saudi Arabia, from December 2014 to November 2018, involving patients with end-stage renal failure who had peritoneal dialysis via the laparoscopic approach. Patients unfit for general anesthesia who experienced complications associated with pneumoperitoneum were excluded. Preoperative assessments included renal and liver function tests, hepatitis screening, and evaluations of bleeding and clotting profiles, in addition to standard investigations.

Outcome procedure:

The procedure was conducted in a supine position under general anesthesia with aseptic measures implemented. A standard approach was executed to establish pneumoperitoneum at a steady pressure of 10-12 mmHg utilizing a Veress needle (closed method). In 25 of 31 patients, the treatment was executed via a single port, put in the left hypochondrium, 2 cm beneath the costal border along the midclavicular line. In patients with adhesions resulting from prior surgery or substantial omentum requiring omentopexy, multiple ports were utilized. Omentopexy was conducted in two patients with bulky omentum prior to catheter implantation, involving the addition of a 5 mm port under direct visualization in the right hypochondrial region along the anterior axillary line. A percutaneous straight needle with 2-0 Vicryl or PDS suture was employed to secure the omentum to the abdominal wall at the right lumbar region.

A laparoscopic adhesiolysis was conducted on a patient with a history of tuberculosis, utilizing two additional ports: one positioned 5 cm to the left and the other 5 cm to the right of the umbilicus. The Tenckhoff catheter was introduced into the peritoneal cavity by a pull-apart sheath over a 90 cm stylet. The catheter's tip was positioned in the pelvis, directed towards the urine bladder. The catheter cuff was positioned within the rectus sheath. A subcutaneous tunnel was established for the catheter to emerge at a midpoint between the umbilicus and the iliac crest. The potential kinking or blockage of the catheter was assessed by flushing with normal saline. The dermal incisions were sutured. Lignocaine with adrenaline, diluted in normal saline, was administered at the incision site and within the tunnel area. Initial peritoneal dialysis commenced the following day utilizing a minimal volume of dialysate (about 500–1000 ml). Follow-up at the outpatient department commenced on a weekly basis, subsequently transitioning to a monthly schedule, extending to a maximum duration of 48 months (mean = 30 months). Postoperative complications of the implanted PD, including obstruction, misplacement, migration, omental adhesions, port-site hernia, and infection, were observed.

Statistical analysis:

Data were analysed using the Statistical Package for Social Science Software (SPSS), version 29. Descriptive statistics were used to present the data for this study. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as mean and standard deviation (SD) after checking the normality of the data using the histogram. The complications were categorized into early and late that occurred within two weeks or afterwards respectively.

RESULTS

A total of 31 patients underwent LA insertion of PDC, comprising 23 males (74.19%) and 8 females (25.8%), resulting in a male-to-female ratio of 4:1. The patients' ages ranged from 17 to 65 years, with a mean age of 46 ± 11.2 years. In 25 patients (80.6%), the laparoscopic surgery was conducted via a single port. Six patients (19.6%) necessitated supplementary ports. The duration of the procedure was 12 to 40 minutes, with a mean of 23 minutes. The duration of hospitalization was 1 to 3 days. Success was observed in 23 patients (74.2%), but complications arose in eight patients (25.8%).

Twenty-nine patients (93.5%) continued on peritoneal dialysis following a follow-up time ranging from 16 to 48 months (mean=30), whereas the two patients who developed peritonitis were transitioned to hemodialysis. Two patients had hypotension during the establishment of pneumoperitoneum and were unable to endure general anesthesia. They were revived and subsequently excluded from the study. Four patients (12.9%) experienced catheter-related complications, including blockage, malposition, migration, and omental adhesions; consequently, the surgery was repeated for these individuals. Among the three patients, early complications arose in two (6.4%), and catheters were effectively re-adjusted through laparoscopic wire manipulation.

In one patient (3.2%), the catheter was removed and a fresh one was inserted on the opposite side. One patient (3.2%) reported to the emergency room after eight months with complaints of a nonfunctioning catheter. Diagnostic laparoscopy revealed catheter obstruction due to significant omental adhesions, necessitating omentopexy and the insertion of a replacement PDC. Another late consequence observed was infection, which occurred in four patients. Two patients (6.4%) experienced port site infections, with Staphylococcus aureus identified as the isolated pathogen in both cases. They had effective conservative treatment. The remaining two patients (6.4%) had peritonitis three- and eight-months post-operation, with Pseudomonas aeruginosa identified as the isolated bacterium in both cases. The individuals who developed peritonitis had type II diabetes mellitus. The management involved catheter removal, a two-week course of intravenous antibiotics, and transition to hemodialysis. No instances of port-site hernia were documented in Table I.

Diagnostic laparoscopy conducted at the commencement of each treatment identified adhesions in nine patients and a large omentum in two patients. In these individuals, limited adhesiolysis and omentopexy were conducted via the insertion of supplementary ports. In 25 patients (80.6%), the laparoscopic surgery was conducted via a single port. Six others (19.35%) necessitated supplementary ports (table II).

DISCUSSION

To prevent PD catheter malfunction during primary placement, it is essential to perform proper rectus sheath tunneling directed towards the pelvis and to position the intraperitoneal segment of the PD catheter between the parietal and visceral peritoneum, directed towards the pouch of Douglas. Additionally, the PD catheter must not be situated within the bowel loops or in direct contact with omental tissue. Securing the catheter tip to the pelvic organs is a viable method to avert dislocation; however, if the catheter is correctly inserted, both cuffs offer adequate support, rendering suturing unnecessary (16, 17). Certain surgeons execute omentopexy or partial omentectomy to prevent omental trapping of the catheter tip. According to SAGES standards, omentopexy or partial omentectomy should be utilized sparingly, as it may be superfluous when the omentum is short or attached to prior upper abdominal locations (16, 17).

Table I. Complications of Surgery

Complication	Frequency (%)	Early/Late	Second procedure	Result	Fate
Blockage	1 (3.2%)	Early	Repositioning by laparoscopic wire manipulation	Success	Still on PD
Malposition	1 (3.2%)	Early	Repositioning by laparoscopic wire manipulation	Success	Still on PD
Migration	1 (3.2%)	Early	Repositioning failed twice. New catheter inserted	Success	Still on PD
Omental adhesions	1 (3.2%)	Late	Lap aroscopic reimplantation + Omentopexy	Success	Still on PD
Port-site infection	2 (6.4%)	Late	Antibiotics	--	Still on PD
Peritonitis	2 (6.4%)	Late	Removal of the catheter + antibiotics	--	Shifted to hemodialysis
Total	8 (25.8%)				

Table I I : Diagnostic Laparoscopy Findings (Adhesions)

Cause	Frequency (%) (n=31)	No. of ports used
Splenectomy	1 (3.2%)	02
Abdominal T.B	1 (3.2%)	03
Appendectomy	3 (9.6%)	01
Laparoscopic cholecystectomy	2 (6.4%)	01
C/section	2 (6.4%)	02
Total	9 (29%)	-
Bulky omentum (Requiring omentopexy)	2 (6.4)	02

Recent articles on optimal peritoneal access procedures have focused on enhancing patient care and reducing complication rates (18-20). The laparoscopic insertion of peritoneal dialysis catheters has become more favored due to its minimal incidence of catheter-related complications and extended catheter longevity (21). Nonetheless, laparoscopic surgery is conducted under general anesthesia, and certain difficulties may arise from the technique itself. Our study included patients who experienced hypotension during pneumoperitoneum or were unable to tolerate general anesthesia. The operation was terminated in these instances. No intraoperative complications occurred. In prior investigations, 5% of patients developed perioperative or postoperative bleeding, with half requiring surgical re-exploration (3). Catheter malfunction ranks as the second most prevalent complication of the operation. Consequently, the catheter is extracted in around 20% of these individuals. Various factors may contribute to this issue, including obstruction by bowel, omentum, or clot, as well as adhesions and the displacement of the catheter tip beyond the pelvis (22).

The present study attained a 100% success rate in rectifying catheter-related complications with laparoscopic intervention. A research indicated a success rate of 96% for laparoscopy in managing malfunctioning catheters (23). In this investigation, catheter-related complications (blockage, malposition, and migration) were observed in three patients (9.6%). This exceeds the 1.3% catheter migration observed in prior research (24). In the current investigation, catheter obstruction and dislocation caused by the larger omentum were detected in just one case (3.2%) of omental wrapping. Adhesiolysis was necessary in only two instances within this cohort, involving a patient with a history of splenectomy and treated abdominal TB who presented with extensive adhesions.

Laparoscopy is the optimal method for assessing the appropriateness of the abdominal cavity for peritoneal dialysis in patients with adhesions and peritonitis (25). Most laparoscopic procedures utilize two to four ports, which may result in the disadvantage of each port entry potentially creating a vulnerable abdominal site for future hernias or leaks (26-28). The single-port technique has recently been implemented for the treatment of obstructed catheters and the insertion of fresh catheters into the abdomen (29, 30). This was the preferred procedure in our investigation. In six situations (19.35%), it was regarded essential to utilize additional port(s) for the execution of adhesiolysis or omentopexy. These factors included a prior splenectomy, treated abdominal tuberculosis, cesarean sections, and bulky omentum. Incisional hernias predominantly arise through incisions made for larger ports (>10 mm). The utilization of smaller ports (5-mm) significantly diminishes the likelihood of port-site hernia. Furthermore, the duration of the procedure correlates positively with the chance of developing hernias (31). Port site infection and peritonitis manifested in 6.4% of cases. The occurrence of both complications was 2.5% in other trials (21).

This study has limitations. This is a single centre study which restrict the generalisability of the study findings. This is a cross-sectional study which restrict the ability of follow-up the patients and examine causality across the study variables.

CONCLUSION

Laparoscopic-assisted PDC insertion was effective for most subjects, as the procedure took on average 12 to 40 minutes. However, catheter obstructions and infections did occur as complications. Omental adhesions, which caused malfunction of the catheter, required omentopexy and catheter replacement; therefore, an intraoperative evaluation is important. Infection incidents were important, especially in patients with type II diabetes mellitus, and stressed the need for improved infection prevention. In this regard, successful conservative treatment for port site infections and transition to hemodialysis in cases of peritonitis would therefore intimate the importance of tailored postoperative care in optimizing outcomes for such cases, especially among high-risk patients.

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