Original Article :

Evaluation of Laparoscopic-assisted insertion of the peritoneal dialysis catheter in high-risk cases

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Abstract

Background and Aims:
More than 100,000 patients (15% of the population) of end-stage renal disease (ESRD) are treated by peritoneal dialysis (PD) globally.

Methods:
Patients with ESRD requiring renal transplant, were referred to the author for inserting the PDC. The patients were fit for general anesthesia with an average of 2.4 anesthetic risk score. The standard double-port laparoscopy used to treat most of the patients. Additional port(s) were used in case of previous surgery, abdominal disease, or redundant omentum. Rectus sheath tunneling and catheter insertion were accomplished under laparoscopic visualization. The demographic, operative and post-operative outcomes were analyzed by SPSS-19.

Results:
The mean age was 46 years. The average body mass index (± SD) was 31.5 ± 6.6 kg/m2. The surgical risk was reported as abdominal surgery in 7 cases, pelvic surgery in 10 cases, and abdominopelvic infections in 6 cases. In 25 out of 31 patients (80.6%), the laparoscopic technique was implemented via the recommended double ports. After the management of these complications, a final twenty-nine patients (93.5%) were still maintained on PD. Two (6.4%) cases had peritonitis; the catheters were removed and the cases were shifted to hemodialysis.

Conclusions:
The LA-PDC insertion was a good and easy approach. It minimized surgical trauma, allowed accurate pelvic catheter positioning and provided a visualized access to handle the omentum and existing adhesions. It was associated with a few catheter-related complications that were easily treated. Long term compliance was excellent.

Keywords:
Laparoscopy, Dialysis, Catheter, Peritoneoscopy, End-stage renal disease.

Introduction

PD is used to treat ERSD patients worldwide of those who are on dialysis (15% populations). PD is sought after therapy for ERDS patients over other methods of dialysis [1–4]. The functional peritoneal dialysis catheter (PDC) plays a key role in the success of PD method [3]. The PDC insertion could be accomplished in different ways such as with open surgery, laparoscopic-assisted insertion and blind insertion with or without radiologic assistance. A few possible difficulties may arise including, bleeding, catheter blockage, infection, visceral injuries, and catheter dispalcement leads to unsuccessful dialysis [5–7]. Al-Hwiesh et al. compared laparoscopic and percutaneous approaches. He concluded that the percutaneous approach done by nephrologists was comparable with the laparoscopic insertions done by surgeons, provided that the high-risk patients were avoided [8].

Three systematic reviews compared the percutaneous versus the surgical approaches of PDC placement. Obesity and prior abdominal surgery were not included in the percutaneous groups. Studies depend mainly on the personal willingness to publish and highlight the nature of their centers in the PD. The authors of these reviews expressed this bias as a great limitation. Regardless of this, the reviews visualized that the percutaneous technique was safe, and effective with satisfactory outcomes as the surgical technique in low-risk populations[9–11].

In this study the efficiency and obstacles of the LA insertion of PDC was evaluated in high-risk patients having ESRD. This research would like to answer three questions; 1) why the laparoscopic approach was used? 2) what are the operative findings? and 3) what are the outcomes and complications?

Methods

The study was a prospective single-arm clinical trial; where all participants who have an end-stage renal disease (ESRD) were subjected to a single exposure (laparoscopy) with no control arm. They underwent peritoneal dialysis (PD) by laparoscopic catheter placement. It was carried out at King Fahad Hospital, Al-Ahsa, Kingdom of Saudi Arabia, during 2014 to 2018 period.

All the patients under the care of the nephrology unit were referred to the author for inserting the peritoneal dialysis catheter (PDC). The enrolled patients were the risky cases [12] (obesity, previous abdominal or pelvic surgery, and history of abdominal condition or infections which might predispose to adhesions). All PDCs were

placed under general endotracheal an¬esthesia. Patients refusing any procedure under local anesthesia were also enrolled.

The routine checkup followed by pre-operative renal, liver functions, hepatitis, bleeding, and clotting profiles were investigated. The physical status and anesthetic risk were scored as per the American Society of Anesthesiologists (ASA) scale [13]. The patients who were liable to respiratory complications related to the pneumoperitoneum and unsuitable for general anesthesia were excluded. Demographic data will be presented in table I. All patients were counseled about different procedures and informed consent was taken. The catheter was placed in the patient with proper care so that it should not disturb, the exit was planned at seated position, and it was easily visible to the patient. All patients were given cefazolin, 2 g as prophylactic antibiotics before starting the procedure in the operating room.

A 2-port tech¬nique of the laparoscopic procedure was implemented: During the initial introduction the Veress needle, the port site of 5-mm laparoscope served as the point for initial contact. The Veress needle's closed insertion was attained at lateral border of the rectus sheath below the costal margin preferably in the left upper quadrant at Palmer's point. A 0-degree scope was inserted and a standard method was followed to create CO2 pneumoperitoneum at a gradual pressure of 10-12 mmHg. All the procedure steps have been previously described in detail [14, 15].

Rectus sheath tunneling

The rectus sheath tunnel was prepared by a tiny 2-cm paramedian opening on the rectus and explored the anterior fascia, which was electrocautery incised. The rectus sheath tunnel was created with verses needle guarded with a plastic sleeve under the assistance of laparoscopic visualization. The risk of trauma to the intramus¬cular vasculature was decreased by using a perpendicular passage which has the shortest distance through the muscle. The blunt tip of the needle was easily seen through the laparoscope as it tented down the posterior rectus sheath. The needle was then angled toward the pelvis. A 4-6 cm tract is created in the rectus muscle before entering the peritoneal cavity near the bladder reflection. The visualized location avoid epigastric vasculature and allows the catheter to pass via the rectus sheath. After retracting the Veress needle, a 7/8- mm-dilator-cannula assembly is used to expand the plastic sleeve to a size large enough for catheter insertion [16].

Peritoneal dialysis catheter

A coiled tip, 2-cuff Tenckhoff catheter was used. The catheter was continued to the

peritoneal cavity across the plastic sleeve of the Veress needle with a 90 cm stylet. The saline was used to soak the PD catheter before insertion and was positioned over a straight stylet to aid in its passage. The catheter inserted by the port into the abdomen until it is visually confirmed, the stylet was withdrawn after ensuring the catheter was passed through the rectus muscle and sheath. With the guidance of laparo¬scopic visualization, the catheter could be withdrawn until the distal cuff is placed within the rectus muscle and the superfi¬cial cuff is placed in the subcutaneous tissue. The catheter is manipulated, so that, the junction between the coiled and straight parts will be over the sym¬physis pubis and the curled part with the tip will be in the pelvis (in the retrovesical space in males or Douglas pouch in females) [17]. The pneumoperitoneum is released so that the subcuta¬neous tract can be created with the abdomen in normal contour without the distortion that occurs with insuffla¬tion. The remaining catheter is tunneled subcutaneously using a stylet to the planned exit site. This stylet and the catheter exit from the skin without an incision. The tunnel was created for the catheter to exit at a point midway between the umbilicus and the iliac crest. Normal saline was used to dilute the mixture of lignocaine and adrenaline which was used to inject at incision area and tunnel place.

The patient is placed in reverse Trendelenburg po¬sition, and the catheter is tested by infusion of 500 mL of isotonic saline through the cath¬eter and return of this fluid by gravity. A residual of 250- 300 mL was left in the abdomen toward the end of the drainage to decrease the likelihood of si¬phoning up against the catheter. After completion of this test, Trendelenburg po¬sition was done and the case was again insufflated with CO2 to visualize and con¬firm the placement of the catheter tip and check for any bleeding, and then the trocar and scope were removed. In order to prevent clot formation the catheter was flushed with 50 mL of heparinized saline. To prevent the infection the exit site was covered with a necessary dressing [17].

Additional laparoscopic procedures supportive of im¬proved catheter outcomes were performed based on ab¬dominal pathology, using a 30-degree scope. Care was taken to avoid the tendency for the Veress needle plastic sheath to kink in the tissue track of obese patients [16]. The pa¬tient is put into a reverse Trendelenburg position to see if the omentum falls into the pelvis and therefore requires a plication procedure. Redundant omentum was prophylactically plicated with a 2-0 Vicryl or fixed to the abdominal wall at the level of the right lumbar area. Intra¬peritoneal adhesions

that may cause compartmentalization or block the way of the catheter or impede dia-lyzate drainage should be removed by laparoscopic adhesiolysis. Ampu¬tation of excessively long epiploic appendices of the colon (epiploectomy) [16, 18].

Early training of the patient to use the catheter was started the following day by using a little amount of dialysis solution of about 500 to1000 mL as a test. The patients should foresee atleast 2 weeks prior using their catheter for PD to avoid the risk of early leaks and allow their wounds to heal. The patients were referred back to the nephrology unit where they were followed up weekly at the outpatient facility, then monthly up to the maximum duration of 48 (mean of 30 months). Those patients who developed any complications were immediately referred back to the surgeon (the author) and they were managed accordingly. The effectiveness of PD such as blockage, malposition, migration, omental adhesions, port-site hernia, and infections was assessed post operation. The complications were categorized as early if they existed within two weeks and post which arose afterwards (Table-III).

Statistical analysis

It was performed using SPSS version 19 for Windows (IBM, USA). Categorical variables were presented as counts and percentages. Continuous varia¬bles were presented as mean ± standard deviation.

Results

Demographic data were presented in table-I

LA PDC was inserted in aa total of 31 patients. Out of which, 23 (74.19%) were males and 8 (25.8%) were females (M: F = 4:1). The patients age was ranged from 17 to 65 with a mean of 46 years (Std. Deviation = 11.2). The average body mass index (± SD) was 31.5 ± 6.6 kg/m2. Overweight cases were 8 (25.8%) while obese cases were 9 (29.1%). The ASA patient physical classification ranged from 1-3 with an average of 2.4; ASA-1 in 10 cases, ASA-2 in 13 cases & ASA-3 in 8 cases. Any patient with an ASA of more than 3 was excluded from the study.

The previous surgical risk was reported as previous abdominal surgery in 7 cases (22.6%) (splenectomy in 2 cases and cholecystectomy in 5 cases), previous pelvic surgery in 10 cases (32.3%) (appendectomy 6 cases and Cesarean section 4 cases) and previous abdominopelvic infections in 6 cases (19.4%) (PID 2 cases and TB 4 cases). In cases of splenectomy, the camera port was inserted at the right hypochondrium. That patient revealed extensive adhesions in the left hypochondreal area. Moderate to severe adhesions were seen in other patients.

Table 1: Demographic data of the included cases.

Characteristic	(n=31)
Age (mean ± SD) (y)	46 ± 11.2
Male (%)	23 (74.19%)
Female (%)	8 (25.8%)
Body mass index (mean ± SD) (kg/m2)	31.5 ± 6.6
Normal weight (%) [BMI =18.5-24.9]	14 (45.2%)
Over weight (%) [BMI =25-29.9]	8 (25.8%)
Obese (%) [BMI =>=30]	9 (29.1%)
Previous surgical risk	
Previous abdominal surgery, n (%)	7 (22.6%)
Splenectomy	2
Cholecystectomy	5
Previous pelvic surgery, n (%)	10 (32.3%)
Appendectomy	6
Cesarean sections	4
Previous abdominopelvic infection n (%)	6 (19.4%)
Pelvic inflammatory disease	2
TB	4
Average ASA patient physical class	2.4 (1-3)
Class ASA -1, n (%)	10 (32.2%)
Class ASA -2, n (%)	13 (42%)
Class ASA -3, n (%)	8 (25.8%)

Operative data were presented in table-II

The recommended double ports of laparoscopic procedures were used in 25 (80.6%) out of 31 patients. The other six (19.6%) required additional ports (some cases of treated abdominal tuberculosis (TB) and previous Cesarean section, for doing limited adhesiolysis/omentopexy). Diagnostic laparoscopy earlier to opeartion, revealed adhesions in nine patients (29%) where adhesiolysis was done, redundant omentum in 7 patients (22.6%) where omental plication was done, and resection of epiploic appendices in 4 cases (12.9%).

Recurrent catheter replacement was done in 5 cases (16.1%). When there are certain situations where complaints about the nonfunctional catheter or its blockage due to the severe omental adhesions detected by diagnostic laparoscopy which further omentopexy and replacement of a new PDC. The operative time was 12-40 minutes (mean 33.6 ±5.4). The hospitalization time was 1-3 days. Postsurgical follow-up had a range of 16 - 48 months and an average of 30 ± 8.8.

Table 2:Operative data as reported in the study cases.

Operative data	Frequency (%) (n=31)
Double port laparoscopy	25 (80.6%)
More ports are needed	6 (19.6%)
Selective adhesiolysis, n (%)	9 (29%)
Omentopexy for redundancy, n (%)	7 (22.6%)
Resection of epiploic appendices, n (%)	4 (12.9%)
Recurrent catheter replacement, n (%)	5 (16.1%)
Operative time (12-40 minute) (mean ± SD)	33.6 ± 5.4
Postsurgical follow-up (16-48 mo) (mean ± SD)	21.6 ± 18.8

The outcome and complications were presented in table-III

The first step of clinical achievement was accomplished in twenty-three (74.2%) with obstacles in eight (25.8%) patients. After the management of the complicated cases, twenty-nine (93.5%) of the 31 patients of the series were continued on

follow-up about16 to 48 months after the PD. However, two patients who did not sustained peritonitis were put back to the hemodialysis.

four (12.9%) patients out of 31, has found with the complexity regarding the catheter such as blockage, malposition, migration, and omental adhesions and the process was performed again in these patients. Hence, thirty-one patients had 35 PDC procedures using LA insertion.

The catheter-related complications in four PDCs occurred at a variable time after the primary procedure. It was due to blockage in one (3.2%), mal-position in one (3.2%) and catheter migration in another (3.2%) patient as an early complication (within 2 weeks of the primary procedure), and omental adhesions in one (3.2%) patient as a late complication (after 8 months) (Table III). Among the complications three (9.6%) were early stage, two cases (6.4%) were fixed by laparoscopic handling and one case (3.2%) of a patient where the catheter was replaced. There were no cases of hemorrhage, gut perforation, or leakage. There was no intraoperative mortality.

Four patients were found with post complication of infections. Off them two (6.4%) were involved infections at port site (Staphylococcus aureus bacterial were found in both cases). Both cases were effectively treated systemic and local antibiotics. Similarly, the other two (6.4%) cases were presented at third- and eighth-months post operation and infected by the bacteria Pseudomonas aeruginosa. Ther complexity was severed due to the existence of type II diabetes mellitus. These patients' catheters were removed managed them with the intravenous antibiotics for two weeks and moved them to hemodialysis section. There were no cases of port site hernia in the studies patients.

Table 3: Complications reported in the study cases.

Complication	Frequency (%) (n=31)	Early/Late	Second procedure	Result	Fate
Catheter-related					
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	Laparoscopic re-implantation + Omentopexy	Success	Still on PD

Complication	Frequency (%) (n=31)	Early/Late	Second procedure	Result	Fate
Non-catheter-related					
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%)				

Discussion

PDC insertion could be ultimately beneficial in management of ESRD cases without waiting for prolonged periods, during which potential patients may lose interest or die. There are several different techniques for PDC insertion. Most of the published studies were observational prospective or retrospective trials [19–21]. In the early days of PD, catheter insertion was done either by mini-laparotomy or percutaneously. Both techniques were "blind," as the peritoneal anatomy, presence of adhesions, length of the omentum, and exact catheter position could not be precisely assessed. However, the percutaneous approach accomplished a better continuity of care and reduced waiting times for peritoneal catheter placement [22].

In this study the LA insertion of PDC was evaluated for its effectiveness and complications in 31 high-risk patients having ESRD. It was a prospective single-arm clinical study. This research would like to answer three questions; 1) why the laparoscopic approach was used? 2) what are the operative findings? and 3) what are the outcomes and complications?

1)Why the laparoscopic approach was used?

Away from the surgical expertise of the author and the availability of laparoscopic resources, the included ESRD cases in this study were high-risk cases. Obesity and overweight (55%) as well as surgical risk factors (74%) were detailed in table I. For these factors, laparoscopy was selected. In the current research, the anesthetic risk (ASA) ranged from 1-3 with an average of 2.4 which means a good anesthetic risk.

Many publications supported this approach in high-risk cases. One study in Saudi Arabia compared the laparoscopic (21 cases) and percutaneous (22 cases) approaches. The incidence of complications in PD catheters was not largely different between the two groups. He concluded that the percutaneous approach was non-inferior to the surgical approach, provided that the high-risk patients were avoided[8]. However, in the current article, high-risk cases were selected, hence only laparoscopic PDC insertion was used.

Regardless of the selection and publication

bias in some systematic reviews which were published to compare the percutaneous provided by nephrologists versus the surgical approaches of PDC placement., one review concluded that the percutaneous technique is safe, effective, and offers equivalent and satisfactory outcomes in the selected patients (such as no previous abdominal surgery, BMI < 28 kg/m2). This was contrary to the inclusion criteria in the current article (BMI was > 29 kg/m2) [9]. Another two systematic reviews concluded that the percutaneous can be initially attempted for all low-risk patients, while, the surgical method can be reserved for cases of failed percutaneous placement or high-risk patients. This conclusion was partially in line with the current study [10, 11].

The International Society for Peritoneal Dialysis (ISPD) guidelines were published. In cases having previous major surgery or peritonitis, the recommended procedures are advanced laparoscopy, then open surgical dissection. If the cases had no such risks, the order of recommended procedures are advanced laparoscopic, Image-guided percutaneous, open surgical dissection, Peritoneoscopy, and lastly percutaneous without image-guidance [23].

2)what are the operative findings in the studied cases?

Upon doing the recommended double-port laparoscopy (25 patients) and after visualization of the peritoneal cavity, there were some factors in 6 patients which might lead to difficult exposure and were dealt with by adding some extra ports. The mean operative time was 33.6 min. Follow-up had an average of 30 months. As described in table II, the adjuvant needed procedures were: selective adhesiolysis in nine patients (29%), omental plication for redundant omentum in 7 patients (22.6%), epiploectomy in 4 cases (12.9%) and recurrent catheter replacement in 5 cases (16.1%). So, nearly 64% of cases need some adjuvant procedure.

A plethora of publications discussed the adjuvant value of laparoscopic PDC insertion. The findings coincide with and supported the current laparoscopic approach for these benefits. Krezalek M. et al (2016) reported that laparoscopy provides a complete visualization and ensures the accurate place¬ment of PD catheter. One advantage is the adjunctive procedures that significantly improve cath¬eter outcomes. If adhesions exist, adhesiolysis can be used to prevent mechanical catheter compli¬cations [24]. Keramati M. et al. reported that laparoscopically guided rectus sheath tunneling places the catheter in a long musculo-fascial tunnel directed toward the pelvis and effectively prevents catheter-tip migration, eliminates pericatheter hernias, and reduces the risk of pericatheter leaks[25].

Cao et al. mentioned that recognizing the capacity of the omentum to obliterate the catheter orifices, some authors recommended routine omentopexy to improve the prospect of long-term catheter patency[26].Some authors reported that laparoscopy advanced PDC implantation. Other techniques like omentopexy, adhesiolysis, and pelvic fixation can also be performed simultaneously by adding other ports, if necessary [27]. Laparoscopy is the best way to find the suitability of the abdominal cavity for PD in patients with adhesions and peritonitis [28].

3)What are the different outcomes and complications in the studied cases?

The primary success in the current study was accomplished in twenty-three (74.2%) patients. There were four (12.9%) patients who developed catheter-related complications like blockage, malposition, migration, and omental adhesions. port site infections were observed in two (6.4%) patients. After the management of these complications, a final twenty-nine of the 31 patients (93.5%) are still maintained on PD. Two (6.4%) cases had developed late peritonitis; where the catheters were removed and they were shifted to hemodialysis. There was no hernia. There were no intraoperative complications.

Contrary to the current findings, one of the studies reported peri/post-operative hemorrhage in 5% of patients; re surgical intervention was done 50% of them. Another study documented the 2nd most frequent complication was malfunction of the catheter. Therefore, it was withdrawn from 20% of the patients. The causes occurred due to the adhesions or clot, bowel, omentum, and relocation of the catheter tip outside the pelvis [29].

Some reports from Saudi Arabia discussed the outcome of laparoscopic PDC placement. In a series of nine cases of ESRF, they reported that the mean operating time was 41 minutes. Two patients (22.2%) developed leakage of dialysate from the 5 mm-port and one patient (11.1%) had migration of the PDC and required re insertion of a new catheter [30].

In a retrospective review for laparoscopic PDC placement, 222 case files from 2008-2018 were found. Supra umbilical open technique was used to establish a pneumoperitoneum and 2nd trocar was used in the right side to guide the catheter with dissection forceps. The encountered compli¬cations include: catheter dysfunction in 13 patients (6%), adhesions in 2 patients (1%), bacterial peritonitis in 25 patients (11%), leakage in 15 patients (7%), and 16 patients (7%) developed an umbilical hernia [31]. However, no details were reported about the adhesiolysis nor omentopexy in this study. Moreover, the larger diameter of

the trocars and the different surgical procedure may be a reason for different rates of complications especially umbilical hernia. Jha et al. published an important report on the barriers preventing PD utilization. They concluded that a collaborative ex¬pertise coupled with a referral mechanism with expert centers that can undertake catheter insertion are needed to face the challenge. After shared decision-making, in the low-risk cases, nephrolo¬gists could perform the insertion, whereas, the surgeons should take care of high-risk cases that might require advanced la¬paroscopy [32].

This study had some limitations. With different reports justifying laparoscopic procedures in high-risk and complicated cases, it was unethical for the author to justify a double randomized controlled study. The small number of cases may also affect the power of the study. The heterogeneity in the included cases did not allow for a more systematic clustered analysis of the complication in each category of the high-risk groups.

Conclusions

Laparoscopic-assisted PDC insertion in high-risk cases with ESRD minimized surgical trauma, allowed accurate catheter positioning, and visualized rectus sheath tunneling, omentopexy, and adhesiolysis. It was linked with a few catheter-related complications that were easily treated. Long-term compliance with the PDC was high (93.5%). Although the fact that the laparoscopic approach could be a primary method to prevent mechanical problems, it could be selectively reserved for high-risk patients or complicated cases after blind insertion, for better patient time management and resource keeping.

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Ethics approval and consent to participate

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Competing interests

The author declare that no competing inetersts.

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