Journal of Mind and Medical Sciences

https://scholar.valpo.edu/jmms/

https://proscholar.org/jmms/

Evaluation of short-term complications in laparoscopic peritoneal dialysis catheter placement - a single tertiary center experience

Cristina Raluca Iorga[1,2], Iuliana Andreiana[1,3], Simona Hildegard Stancu[1,3], Traian Constantin[1,4], Victor Strambu[1,2*], Cristian Iorga[1,2]

[1] *Carol Davila University of Medicine and Pharmacy, Bucharest, Romania*

[2] *Dr. Carol Davila Clinical Nephrology Hospital, Department of General Surgery, Bucharest, Romania*

[3] *Dr. Carol Davila Clinical Nephrology Hospital, Department of Nephrology, Bucharest, Romania*

[4] *Prof. Dr. Th. Burghele Hospital, Department of Urology, Bucharest, Romania*

ABSTRACT

Background. Peritoneal dialysis is a form of kidney function replacement that is not as widespread as hemodialysis. However, it has recognized advantages, such as preservation of residual renal function, lack of vascular access, and the ability to be performed at home. On the other hand, it requires the correct insertion of a peritoneal dialysis (PD) catheter and maintaining its patency. *Methods*. We conducted a retrospective study of 126 patients with end-stage renal disease who underwent laparoscopic Tenckhoff catheter placement for peritoneal dialysis between January 2016 and December 2022. The study analyzed the frequency and type of complications registered within three months, in order to validate laparoscopy as a safe method of catheter insertion (with reduced periprocedural complications), as well as the importance of the multidisciplinary team in the care of patients with peritoneal dialysis. *Results*. In about 14% of patients, we encountered a total of 23 complications: 61% in the first month, 34.7% in the second month, and 4.3% in the third month. The most frequent complication was infection (peritonitis 35%, catheter exit site infection 30.4%), followed by peri-catheter leak (21.7% of total complications). Catheter migration, hernia, and significant bleeding were rare events (4.3% of total complications each). All complications were managed by medical treatment, except two cases which required replacement of the catheter. *Conclusions*. Laparoscopic catheter insertion is a safe procedure with low post-procedural complications in patients who are dependent on peritoneal dialysis.

Category: Original Research Paper

Received: April 16, 2024
Accepted: June 24, 2024
Published: October 30, 2024

Keywords:

peritoneal dialysis, laparoscopy, peritoneal catheter, complications

***Corresponding author:**

Victor Strambu,

Carol Davila University of Medicine and Pharmacy, Dr. Carol Davila Clinical Nephrology Hospital, Department of General Surgery, Bucharest, Romania

E-mail: drstrambu@gmail.com

Introduction

The concept of peritoneal dialysis was first presented in London in 1743 by Christopher Warrick at the Royal Society of Medicine. Experiments were initially carried out on animals. In 1895, Orlow performed the first attempts of peritoneal dialysis on dogs; then, in 1923, Putnam published similar experiments on cats, confirming the attempts made by Orlow.

In 1946, Seligman and Fine published the first peritoneal dialysis treatment in humans for a patient with acute renal failure [1]. Later, peritoneal dialysis was also introduced for patients with end-stage renal disease (ESRD) which nowadays represents the main indication for peritoneal catheter placement and peritoneal dialysis. Other indications are represented by acute kidney injury and chronic cardiorenal syndrome. Also, peritoneal dialysis is the method of choice for pediatric patients under 5 years of age [2,3]. Sporadically, peritoneal dialysis is used for the treatment of refractory heart failure and, historical, it was used for hypothermia, hyperthermia, and acute poisoning treatment [4-6].

In the 1960s and 1970s, Tenckhoff developed the peritoneal dialysis catheter and the methods of inserting it in the peritoneal cavity. Later, there were continuous attempts to improve peritoneal dialysis catheters and their insertion techniques. In Romania, the first insertion of a PD catheter for patients with ESRD was carried out in 1995.

The catheters in use currently are single or double cuff silicone catheters, with a straight or coiled tip [7].

To cite this article: Iorga CR, Andreiana I, Stancu SH, Constantin T, Strambu V, Iorga C. Evaluation of short-term complications in laparoscopic peritoneal dialysis catheter placement - a single tertiary center experience. *J Mind Med Sci*. 2024;11(2):452-458. doi:10.22543/2392-7674.1547

The placement of the PD catheter is performed by nephrologists, interventional radiologists, or surgeons and the current unanimously accepted placement techniques for PD catheters are percutaneous insertion, peritoneoscopic insertion, and open surgical or laparoscopic insertion [8]. Bleeding and organ perforation can complicate the PD catheter insertion. Bleeding from trauma of the blood vessels located in the abdominal wall is frequent, it is favorized by anticoagulants, antiaggregant, thrombocytopenia in patients with already increased bleeding risk due to uremia and presents as hemoperitoneum or pericatheter bleeding. In majority of cases is minor, auto limited and it is treated conservatively [9,10]. Major bleeding complicates around 2% of interventions due to direct blood vessel injury or rectus sheath hematoma [11,12]. In these cases, treatment consists in exploratory surgery or angiographic embolization, in addition to transfusion support [12].

Intestinal or urinary bladder perforation are rare events but are life-threatening and they necessitate a high index of suspicion for rapid diagnosis and treatment [13,14].

The long-term success of PD begins with the correct choice of catheter type and the correctness of its placement. Over the years, there have been numerous attempts at improving PD placement methods, with the aim of decreasing as much as possible the number of early complications of peritoneal dialysis and increasing the compliance and well-being of patients undergoing this dialysis type and avoiding PD failure [15].

The main early complications that occur after the insertion of the PD catheter include catheter dysfunction, leaks and infections. These are mostly related to the way in which the insertion is carried out (regardless of the chosen method) and the experience of the medical team involved, and less so the type of catheter used [16,17]. Half of them appear before the start of the peritoneal dialysis and in six percents of the patients, peritoneal dialysis never starts because of them [18].

Infections are the major complication of PD on short and long term because they represent the leading cause of permanent technique failure (20% in the first year) [19]. Data from literature shows that peritonitis soon after catheter implantation (pre-training peritonitis) compared with post-training peritonitis have the worse prognosis (more frequent transfer in hemodialysis, death, shorter PD technique survival) [20].

The catheter dysfunction by migration, intraluminal obstruction by fibrin or clot, extraluminal obstruction usually due to constipation, kinking or entrapment represent the second cause of permanent technique failure in the first year of the treatment (15%) [19]. The flow impairment can be during inflow, outflow, or during both phases and, in most of the cases, is obvious during days-weeks after the catheter implantation. Except extraluminal obstruction which can be resolved with laxative and intraluminal obstruction, with heparin and increased inflow pressure, the other causes imply surgical repositioning or replacement.

The incidence of leakage is around 5% and most frequent at the exit site due to increased intra-abdominal pressure, mostly in patients which start dialysis in less than two weeks after catheter placement. They are managed by temporarily decreasing dwell volume, ensuring supine position during exchanges, avoiding activities that increase intra-abdominal pressure or by temporary (days – weeks) resting of the peritoneum [18].

In the USA, most PD catheters are inserted by surgeons (80%), and in their residency training program, there is a specific internship for learning proper placement techniques [16].

In Romania, catheters for PD are installed exclusively by surgeons and there is no training opportunity in residency for learning placement techniques. The first technique used in Romania was insertion by open laparotomy. Later, due to an increase in the numbers of patients who required PD, as well as due to the continuous endowments in urban medical centers, laparoscopic placement was increasingly used.

An important obstacle that delayed the use of the laparoscopic technique was a lack of confidence and the limitations of general anesthesia. Nevertheless, laparoscopy has several advantages: less trauma to the abdominal wall, preserving the peritoneal surface, the possibility of adhesiolysis, and the correct placement of the catheter in the pouch of Douglas [17].

In this article, we present our 7 years of experience in the laparoscopic placement of PD catheters, the patient outcomes, the early complications encountered within 3 months post-procedure, and the solutions used to address the complications.

Materials and Methods

We conducted a retrospective study on 126 patients hospitalized for PD catheter insertion at the "Dr Carol Davila" Clinical Hospital of Nephrology (Bucharest, Romania), a tertiary surgery center dedicated to the treatment of patients with ESRD, from January 2016 to December 2022

Objectives

- Analysis of the frequency and type of complications recorded within three months.
- To emphasize that laparoscopy is a safe method of catheter insertion with reduced periprocedural complications
- To underline the importance of multidisciplinary team strategy for enhancing care to advance the safe use of peritoneal dialysis

Ethical aspects

The study was performed in accordance with the Declaration of Helsinki and was approved by the local Ethics Committee (number 69, March 2024, Local Ethics Committee, "Dr Carol Davila" Clinical Nephrology Hospital, Bucharest).

Study design and patient selection

The study included all patients who underwent laparoscopic implantation of a peritoneal catheter. The exclusion criteria included age <18 years, open surgery, follow-up period <3 months, acute kidney injury, and missing data. The demographic and clinical parameters of interest were retrieved from the electronic files of the patients, from the register of surgical interventions, and from the PD treatment monitoring files.

The protocol for patients opting for PD included a surgical clinical evaluation for detection of ventral or inguinal hernia, in which case these were surgically corrected prior to inserting the PD catheter. Based on this protocol, nine patients were identified to have hernias: six presented with inguinal hernia, and three with umbilical hernia. These nine patients underwent open surgery using the Lichtenstein alloplastic technique/omphalectomy and reinforcement mesh insertion a minimum of 3 months prior to the placement of the PD catheter.

All patients stopped antiagregants seven days before admission. If indicated, oral anticoagulation was replaced with low weight molecular heparin once daily. Pre-procedure preparation included a dose of sodium picosulfate for preparation and emptying of the digestive tract. Before the intervention, an indwelling urethral catheter was placed, which was removed at the end of the procedure. Prophylactic antibiotic therapy single dose was then given (cefuroxime 1,5 g).

Surgical intervention

The laparoscopic placement of the PD catheter was performed by a single surgical team composed of two surgeons. We used the conventional straight Tenckhoff catheter.

We used a minimal open incision above the umbilicus (Hasson technique) for the insertion of the 10 mm optical trocar. After the introduction of the laparoscopic camera, we meticulously inspected the peritoneal cavity for possible intraperitoneal adhesions, parietal defects, or other intraperitoneal pathologies. After this, a 5 mm working trocar was placed in the right flank. If adhesions were detected during the inspection of the peritoneal cavity, adhesiolysis was performed (Figure 1). At the first insertion, the catheter was placed in the left flank.

The trocar for the insertion of the catheter, 10 mm, was placed into the left flank by tunneling the left rectus abdominis muscle in an oblique direction towards the bottom of the Douglas pouch.

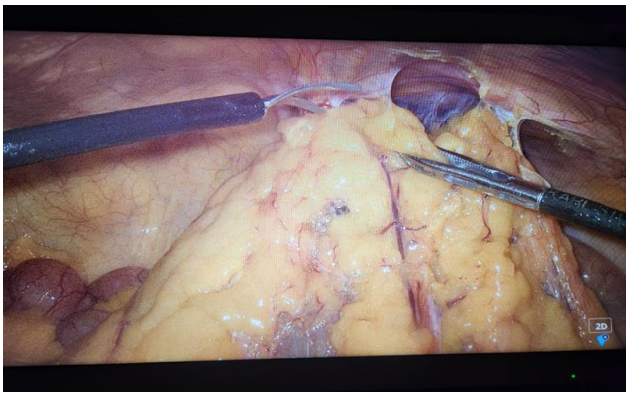

Figure 1. Laparoscopic adhesiolysis

After the correct positioning of the catheter at the bottom of the Douglas sac, it was tightened with polypropylene thread 3/0 at the point of externalization in the peritoneum with a fascial closure needle. The deep cuff was positioned strictly preperitoneal, and the superficial cuff was placed at the level of the cutaneous incision made for trocar insertion. The functionality of the catheter was checked by instillation and aspiration of 0.9% saline solution (Figure 2).

Figure 2. Final laparoscopic position of the catheter

We did not suture the omentum to the anterior abdominal wall. The exterior lumen of the catheter was placed 2 cm from the superficial cuff through a minimum incision corresponding to the diameter of the catheter.

The suturing of the supraumbilical wound aponeurosis was carried out with polypropylene thread no. 1. All skin incisions were sutured with thread polypropylene 3/0, including the minimum incision for the insertion of the fascial closure needle.

For patients who required laparoscopic catheter reinsertion after its extraction, we used a technical artifice: the opening that remained after the deep cuff dissection during extraction was used for placing the optic trocar. We used this tactic to decrease the number of incisions and possible postoperative parietal complications. Otherwise, the laparoscopic procedure continued as described above.

Follow up

On the first postoperative day, we radiographically monitored the correct positioning of the catheter with the tip in the pelvis on the median line and the absence of folds.

Lavage of the peritoneal cavity was initiated once/day, on average for 3 days (until clear), then 2 times/week. The frequency was increased to 3 times/week if the inflow or outflow of the solution was difficult due to obstruction by fibrin deposits. The incision wounds and exterior opening around the catheter were protected with non-occlusive dressings. Monitoring for complications was performed every 2–3 days or as needed. Disinfection was carried out with betadine followed by washing with 0.9% saline solution and application of mupirocin cream.

Patient training began in the second week, during the procedures described above, and was concluded once the patient understood the techniques and could recognize complications.

Statistical analysis

The statistical analysis was performed using the Analyse-it™ Standard Edition (Analyse-it 4.80 Software, Ltd., Leeds, UK) package. Categorical variables are presented as percentages, comparisons of which were performed using Pearson's $\chi 2$ test. Continuous variables are displayed as the mean with the 95% confidence interval (95% CI) or median and quartiles [1,3], according to their distribution. The normality testing was done with Shapiro-Wilk test. Comparisons were carried out using ANOVA, Mann–Whitney, and Kruskal–Wallis tests, as appropriate. $p \leq 0.05$ was considered statistically significant. Microsoft Excel 2013 was used for graphics and tables.

Results

A total of 126 patients met the inclusion and exclusion criteria, equally distributed by gender, with a mean age in the seventh decade (Table 1). Except two, all had a per primam catheter insertion.

Table 1. Patients' general characteristics

Variable	
Age (years)	62,6 ± 14,1
Gender (% female)	44
Primary insertion (%)	98.4
History of surgery (%)	9
Body mass index > 24 kg/m^2 (%)	19

The continuous variable with a normal distribution is presented as mean with standard deviation (SD). Categorical variables are presented as percentages.

During the laparoscopic exploration of the peritoneal cavity, no hernias or parietal defects were detected. Laparoscopic adhesiolysis was performed in 17% of patients due to visceroparietal intraperitoneal adhesions.

Out of these patients, 54% had a history of previous surgical interventions (appendectomy, cholecystectomy, cesarean section, tubal abscess). All patients underwent laparoscopic adhesiolysis without intraoperative incidents using various electro-surgery instruments or a blunt instrumental dissection if intestinal loops were present near the adhesions.

The duration of the laparoscopic procedure was on average 32 minutes, with a time range from 20 to 55 minutes. Adhesiolysis increased the operative time by 30 minutes. At three months, 14% of patients (18/126) experienced a total of 23 complications: 61% in the first month, 34.7% in the second month, and 4.3% in the third month (Figure 3).

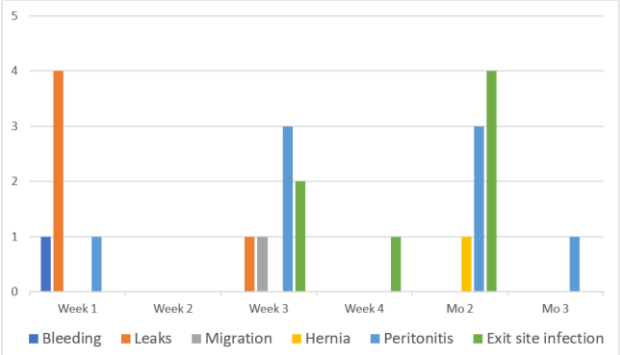

Figure 3. Peritoneal dialysis-associated complications during the first three months after laparoscopic implantation of the catheter

The most frequent complication was infection (peritonitis 35%, catheter exit site infection 30.4%), followed by leaks (21.7%), bleeding (4.3%), hernia (4.3%), and catheter migration (4.3%).

Eight patients (6.5%) each had one episode of peritonitis. All cases were a single pre-training peritonitis episode (12.5% of all peritonitis); 37.5% were diagnosed during the patient training period and 50% were in the post-training period (in the first month of home treatment) (Figure 3). All episodes were diagnosed in women and there was a tendency towards a higher frequency in patients who experienced a peri-catheter leak (Table 2). One episode was refractory to antibiotics and the patient was ultimately transferred on hemodialysis, as he refused to return to PD after healing of the peritonitis episode.

Table 2. Factors associated with peritonitis (univariable analysis)

Variable	Without peritonitis N=118	With peritonitis N=8	P value
Age (years)	62,7	61,7	0,86
Gender (% female)	43,5	100	0,005
Body mass index > 24 kg/m^2 (%)	17,4	28,6	0,48
Exit site infection (%)	13	14,3	0,92
Leaks (%)	6,5	28,6	0,06

Continuous variables with a normal distribution are presented as the mean with the 95% confidence interval (95% CI). Categorical variables are presented as percentages.

Seven patients (5.5%) were diagnosed with a PD catheter exit site infection, none in the pre-training period. Almost half (43%) were diagnosed during the training and the other half were post-training episodes (57%) (Figure 3).

All the leaks were peri-catheter, with the majority (4/5) being diagnosed in the first week, during lavage. In one patient, the peri-catheter leakage started in week 3 with the initiation of treatment (Figure 3). With the exception of one patient who required catheter discontinuation and contralateral insertion, all the episodes were relieved by a total, temporary (7–14 days) rest of the peritoneal cavity. Catheter migration, hernia, and significant bleeding were rare events (0.8%, one patient each). Migration of the catheter occurred in week three with the initiation of exchanges. The catheter was repositioned and secured to the abdominal wall laparoscopically. After this, the catheter functioned optimally.

One patient from the group with early leakage developed a pericatheter hernia in the second month after the initiation of treatment. The catheter was extracted and, using our adapted surgical technique (described above), a new catheter was placed in the contralateral flank. The parietal defect was reinforced with supra-aponeurotic mesh. After a break of four weeks the patient was able to resume dialysis shifts successfully.

One patient (0.8%) presented with bleeding from the catheter tunnel, a complication that was resolved successfully on the spot by securing the anchor wire of the catheter.

Discussions

Although the International Society of Peritoneal Dialysis (ISPD) guidelines describe each insertion method for the PD catheter in detail, researchers are continually improving the techniques to decrease the number of early complications and, subsequently, the number of patients with PD failure [17,21-23].

To our knowledge, no study has compared all catheter placement techniques. Most studies have been comparisons of only two methods, either laparoscopic/ open surgery (most studies) or open/ percutaneous placement [24-27].

From the meta-analyses published by Sun et al., Agarwal et al., and van Laanen et al., laparoscopic PD catheter placement has important advantages because of the reduced percentage of early mechanical complications, such as migration, obstructions, peri-catheter leaks, bleeding, and perforation of the cavitary intraperitoneal organs [28-31]. Similarly, our study demonstrated good results for the laparoscopic PD catheter insertion technique, with early complications being few in number and the great majority being able to be treated by specific oral therapy or through laparoscopic surgical treatment, thus ensuring the continuation of PD.

Moreover, our study identified the advantages of laparoscopic insertion for patients with intraperitoneal adhesions (postoperative or in situ). From our experience, the learning curve for laparoscopic PD catheter insertion is a short one, involving assisting in three interventions and performing five interventions as the first operator. The subsequent training of a surgeon specialist with good laparoscopic skills in centers that wish to insert PD catheters is considered sufficient [32-34].

Performing adhesiolysis laparoscopically allows patients who have had prior surgical interventions to benefit from the laparoscopic insertion of the PD catheter, as placement by the open technique is much more susceptible to problems [35,36].

Another advantage of laparoscopic placement is the visible fixation of the catheter at the exit site of the peritoneum, which also prevents catheter migration [37,38]. Some researchers prefer fixing the catheter at the pelvic level [31]. We do not prefer securing the catheter at the pelvic level because, at the time of extraction, the maneuver can become much more laborious, requiring either a laparoscopic approach or open surgery.

We did not carry out suturing of the omentum to the abdominal wall, because the adhesions that appear after this procedure can complicate subsequent surgical interventions. If omentum wrapping occurs, the omentum can be resected laparoscopically to de-obstruct the catheter. Although data from the literature shows a percentage of 3.2% for omentum wrapping, in our study this complication did not occur in any patient [39].

Two thirds of the complications were peritoneal dialysis-associated infections, which have major implications as they represent the first cause of permanent technique drop out [19]. Contamination during surgery can be a cause; however, this risk factor has not been evaluated yet and the incubation period would have been too long [40,41].

The incidence of pre-training infection was lower (0.8% of the patients) compared to incidents reported in studies that followed the epidemiology and prognosis of pre-training peritonitis (4–17.7%) [40,41]. Wu et al. considered the frequency and risk factors associated with peritonitis in the first three months of peritoneal dialysis in a large cohort of 1690 PD patients. The frequency they found was similar to ours (7% versus 6.5%), but, unlike in our study, exit site infections and obesity, along with hypoalbuminemia, were the main determinants [42]. The close association between infections and the training period made us consider that insufficient training was the most probable explanation for our results. However, in our center, training is standardized at 2 hours daily for eight days, with a nurse-to-patient ratio of 1:1; these are conditions associated with a decreased risk of PD-associated infections [43,44]. The gender-associated peritonitis risk and the onset of infections related to the

training period also made us consider that anxiety, which is more frequent in women and associated with impaired cognitive performance, could explain our findings [45,46]. Our hypothesis was supported by data which showed a higher peritonitis incidence in PD patients with anxiety, as evaluated using the Patient Rated Anxiety Scale (PRAS) or using the Hospital Anxiety Depression Scale [47,48]. Moreover, peri-catheter leaks, equally distributed between the two genders in our study, could have contributed to peritonitis risk through the nutritive environment this creates for germs and the continuity between the skin and the peritoneal cavity [49].

The present study has some limitations, including the single-center, retrospective design and the focus on a single surgical method (laparoscopic placement). The significant number of enrolled patients, the low number of complications, and the personalized technique used for catheter reimplantation were strengths of the study.

Conclusions

Laparoscopic catheter insertion for PD is a safe method, with reduced early postprocedural complications even in countries with no extensive PD programs.

Compliance with ethical standards

Any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. Informed consent was obtained from all subjects involved in the study.

Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

References

1. Pyper RA. Peritoneal Dialysis. *Ulster Med J*. 1948;17(2):179-187.
2. Cullis B, Al-Hwiesh A, Kilonzo K, et al. ISPD guidelines for peritoneal dialysis in acute kidney injury: 2020 update (adults). *Perit Dial Int*. 2021;41(1):15-31. doi:10.1177/0896860820970834
3. François K, Ronco C, Bargman JM. Peritoneal Dialysis for Chronic Congestive Heart Failure. *Blood Purif*. 2015;40(1):45-52. doi: 10.1159/000430084
4. Timóteo AT, Mano TB. Efficacy of peritoneal dialysis in patients with refractory congestive heart failure: a systematic review and meta-analysis. *Heart Fail Rev*. 2023;28(5):1053-1063. doi:10.1007/s10741-023-10297-3
5. Vella J, Farrell J, Leavey S, Magee C, Carmody M, Walshe J. The rapid reversal of profound hypothermia using peritoneal dialysis. *Ir J Med Sci*. 1996;165(2):113-114. doi:10.1007/BF02943796
6. Bunchman TE, Ferris ME. Management of toxic ingestions with the use of renal replacement therapy. *Pediatr Nephrol*. 2011;26(4):535-541. doi:10.1007/s00467-010-1654-3
7. Khan SF, Rosner MH. Optimizing peritoneal dialysis catheter placement. *Front Nephrol*. 2023;3:1056574. Published 2023 Apr 11. doi:10.3389/fneph.2023.1056574
8. Gao X, Peng Z, Li E, Tian J. Modified minimally invasive laparoscopic peritoneal dialysis catheter insertion with internal fixation. *Ren Fail*. 2023;45(1):2162416. doi:10.1080/0886022X.2022.2162416
9. Li JR, Chen CH, Chiu KY, et al. Management of pericannular bleeding after peritoneal dialysis catheter placement. *Perit Dial Int*. 2012;32(3):361-362. doi:10.3747/pdi.2011.00064
10. Sohal AS, Gangji AS, Crowther MA, Treleaven D. Uremic bleeding: pathophysiology and clinical risk factors. *Thromb Res*. 2006; 118(3):417-422. doi:10.1016/j.thromres.2005.03.032
11. Mital S, Fried LF, Piraino B. Bleeding complications associated with peritoneal dialysis catheter insertion. *Perit Dial Int*. 2004;24(5):478-480.
12. Crabtree JH, Chow KM. Peritoneal Dialysis Catheter Insertion. *Semin Nephrol*. 2017;37(1):17-29. doi:10.1016/j.semnephrol.2016.10.004
13. Asif A, Byers P, Vieira CF, et al. Peritoneoscopic placement of peritoneal dialysis catheter and bowel perforation: experience of an interventional nephrology program. *Am J Kidney Dis*. 2003;42(6): 1270-1274. doi:10.1053/j.ajkd.2003.08.029
14. Elgaali M, Abiola O, Collinson H, Bhandari S. Urine producing peritoneal dialysis catheter. *BMJ Case Rep*. 2017;2017: bcr2017219844. Published 2017 Aug 9. doi:10.1136/bcr-2017-219844
15. Santarelli S, Amici G, Bernacconi T, Bonforte G, Ceraudo E, et al. The peritoneal dialysis catheter. *J Nephrol*. 2013;26 Suppl 21:4-75. doi:10.5301/JN.2013.11633
16. Wong LP, Liebman SE, Wakefield KA, Messing S. Training of surgeons in peritoneal dialysis catheter placement in the United States: a national survey. *Clin J Am Soc Nephrol*. 2010;5(8):1439-1446. doi:10.2215/CJN.08751209
17. Crabtree JH, Shrestha BM, Chow K-M, et al. Creating and Maintaining Optimal Peritoneal Dialysis Access in the Adult Patient: 2019 Update. *Peritoneal Dialysis International*. 2019;39(5):414-436. doi:10.3747/pdi.2018.00232
18. Oliver MJ, Perl J, McQuillan R, et al. Quantifying the risk of insertion-related peritoneal dialysis catheter complications following laparoscopic placement: Results from the North American PD Catheter Registry. *Perit Dial Int*. 2020;40(2):185-192. doi: 10.1177/0896860819893813
19. Bonenkamp AA, van Eck van der Sluijs A, Dekker FW, et al. Technique failure in peritoneal dialysis: Modifiable causes and patient-specific risk factors. *Perit Dial Int.* 2023;43(1):73-83. doi: 10.1177/08968608221077461
20. Hayat A, Johnson DW, Hawley CM, et al. Associations, microbiology and outcomes of pre-training peritoneal dialysis-related peritonitis. *Perit Dial Int*. 2023;43(2):173-181. doi:10.1177/08968608221079183
21. Li Z, Ding H, Liu X, Zhang J. Ultrasound-guided percutaneous peritoneal dialysis catheter insertion using multifunctional bladder paracentesis trocar: A modified percutaneous PD catheter placement technique. *Semin Dial*. 2020;33(2):133-139. doi:10.1111/sdi.12862
22. Lee YK, Yang PS, Park KS, Choi KH, Kim BS. Modified Peritoneal Dialysis Catheter Insertion: Comparison with a Conventional Method. *Yonsei Med J*. 2015;56(4):981-986. doi:10.3349/ymj.2015.56.4.981
23. Blitzkow ACB, Biagini G, Sabbag CA, Buffara-Junior VA. Laparoscopic Peritoneal Dialysis Catheter Placement With Rectus Sheath Tunneling: A One-Port Simplified Technique. *Arq Bras Cir Dig*. 2022;35:e1690. doi:10.1590/0102-672020220002e1690

24. Shahbazi N, McCormick BB. Peritoneal dialysis catheter insertion strategies and maintenance of catheter function. *Semin Nephrol*. 2011; 31(2):138-151. doi:10.1016/j.semnephrol.2011.01.003
25. Zhang X, Xiang S, Wang Y, et al. Laparoscopic vs open surgical insertion of peritoneal dialysis catheters: A propensity score-matched cohort study. *Curr Probl Surg*. 2024;61(1):101425. doi: 10.1016/j.cpsurg.2023.101425
26. Sun TY, Voss D, Beechey D, Lam-Po-Tang M. Comparison of peritoneal dialysis catheter insertion techniques: Peritoneoscopic, radiological and laparoscopic: A single-centre study. *Nephrology (Carlton).* 2016;21(5):416-422. doi:10.1111/nep.12621
27. Jwo SC, Chen KS, Lee CC, Chen HY. Prospective randomized study for comparison of open surgery with laparoscopic-assisted placement of Tenckhoff peritoneal dialysis catheter--a single center experience and literature review. *J Surg Res*. 2010;159(1):489-496. doi: 10.1016/j.jss.2008.09.008
28. Hagen SM, van Alphen AM, Ijzermans JN, Dor FJ. Laparoscopic versus open peritoneal dialysis catheter insertion, the LOCI-trial: a study protocol. *BMC Surg*. 2011;11:35. Published 2011 Dec 20. doi:10.1186/1471-2482-11-35
29. Sun ML, Zhang Y, Wang B, et al. Randomized controlled trials for comparison of laparoscopic versus conventional open catheter placement in peritoneal dialysis patients: a meta-analysis. *BMC Nephrol*. 2020;21(1):60. Published 2020 Feb 24. doi:10.1186/s12882-020-01724-w
30. Agarwal A, Whitlock RH, Bamforth RJ, et al. Percutaneous Versus Surgical Insertion of Peritoneal Dialysis Catheters: A Systematic Review and Meta-Analysis. *Can J Kidney Health Dis*. 2021;8: 20543581211052731. doi:10.1177/20543581211052731
31. van Laanen JHH, Litjens EJ, Snoeijs M, ET AL. Introduction of advanced laparoscopy for peritoneal dialysis catheter placement and the outcome in a University Hospital. *Int Urol Nephrol*. 2022;54(6):1391-1398. doi:10.1007/s11255-021-03020-4
32. Crabtree JH, Penner T, Armstrong SW, Burkart J. Peritoneal Dialysis University for Surgeons: A Peritoneal Access Training Program. *Perit Dial Int*. 2016;36(2):177-181. doi:10.3747/pdi.2015.00013
33. Crabtree JH. Who should place peritoneal dialysis catheters?. *Perit Dial Int*. 2010;30(2):142-150. doi:10.3747/pdi.2009.00066
34. Mehrotra R, Blake P, Berman N, Nolph KD. An analysis of dialysis training in the United States and Canada. *Am J Kidney Dis*. 2002;40(1):152-160. doi:10.1053/ajkd.2002.33924
35. Kou HW, Yeh CN, Tsai CY, et al. Clinical Benefits of Laparoscopic Adhesiolysis during Peritoneal Dialysis Catheter Insertion: A Single-Center Experience. *Medicina (Kaunas).* 2023;59(6):1014. Published 2023 May 24. doi:10.3390/medicina59061014
36. Crabtree JH. Previous abdominal surgery is not necessarily a contraindication for peritoneal dialysis. *Nat Clin Pract Nephrol*. 2008;4(1):16-17. doi:10.1038/ncpneph0669
37. van Laanen JHH, Cornelis T, Mees BM, et al. Randomized Controlled Trial Comparing Open Versus Laparoscopic Placement of a Peritoneal Dialysis Catheter and Outcomes: The CAPD I Trial. *Perit Dial Int*. 2018;38(2):104-112. doi:10.3747/pdi.2017.00023
38. Chen Y, Shao Y, Xu J. The Survival and Complication Rates of Laparoscopic Versus Open Catheter Placement in Peritoneal Dialysis Patients: A Meta-Analysis. *Surg Laparosc Endosc Percutan Tech*. 2015;25(5):440-443. doi:10.1097/SLE.0000000000000188
39. Oviedo Flores K, Kaltenegger L, Eibensteiner F, et al. Assessing mechanical catheter dysfunction in automated tidal peritoneal dialysis using cycler software: a case control, proof-of-concept study. Sci Rep. 2022;12(1):5657. Published 2022 Apr 5. doi:10.1038/s41598-022-09462-9
40. Kerschbaum J, König P, Rudnicki M. Risk factors associated with peritoneal-dialysis-related peritonitis. *Int J Nephrol*. 2012;2012: 483250. doi:10.1155/2012/483250
41. Ma TK, Chow KM, Kwan BC, et al. Peritonitis before Peritoneal Dialysis Training: Analysis of Causative Organisms, Clinical Outcomes, Risk Factors, and Long-Term Consequences. *Clin J Am Soc Nephrol*. 2016;11(7):1219-1226. doi:10.2215/CJN.00830116
42. Wu H, Huang R, Yi C, et al. Risk Factors for Early-Onset Peritonitis in Southern Chinese Peritoneal Dialysis Patients. *Perit Dial Int*. 2016;36(6):640-646. doi:10.3747/pdi.2015.00203
43. Jaelani TR, Ibrahim K, Jonny J, et al. Peritoneal Dialysis Patient Training Program to Enhance independence and Prevent Complications: A Scoping Review. *Int J Nephrol Renovasc Dis*. 2023;16:207-222. doi:10.2147/IJNRD.S414447
44. Hu J, Liu Z, Liu J, Zhang H. Reducing the occurrence rate of catheter dysfunction in peritoneal dialysis: a single-center experience about CQI. *Ren Fail*. 2018;40(1):628-633. doi:10.1080/0886022X.2018.1515084
45. McLean CP, Asnaani A, Litz BT, Hofmann SG. Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. *J Psychiatr Res*. 2011;45(8):1027-1035. doi: 10.1016/j.jpsychires.2011.03.006
46. Robinson OJ, Vytal K, Cornwell BR, Grillon C. The impact of anxiety upon cognition: perspectives from human threat of shock studies. *Front Hum Neurosci*. 2013;7:203. doi:10.3389/fnhum.2013.00203
47. Juergensen PH, Juergensen DM, Wuerth DB, et al. Psychosocial factors and incidence of peritonitis. *Adv Perit Dial*. 1996;12:196-198.
48. Chan KM, Cheung CY, Chan YH, Chan HW, Chak WL, Chau KF. Prevalence and impact of anxiety and depression in Chinese peritoneal dialysis patients: A single centre study. *Nephrology (Carlton).* 2018; 23(2):155-161. doi:10.1111/nep.12970
49. Ueki K, Tsuchimoto A, Torisu K, et al. A case of peritoneal dialysis-related peritonitis caused by dialysate leakage with successful treatment by intravenous and intraperitoneal antibiotic therapy. *CEN Case Rep*. 2022;11(2):161-165. doi:10.1007/s13730-021-00644-4