Kidney
Diseases

Research Article

Kidney Dis
DOI: 10.1159/000543824

Received: July 4, 2024
Accepted: January 12, 2025
Published online: February 25, 2025

A Novel Approach to Repositioning Peritoneal Dialysis Catheters

Xiuling Chen[a] Nan Wang[b] Yurong Zou[a] Jin Chen[a] Hui Gao[a] Guisen Li[a] Junru Wang[a]

[a]Department of Nephrology and Institute of Nephrology, Sichuan Provincial People's Hospital, School of Medicine, University of Electronic Science and Technology of China, Sichuan Clinical Research Centre for Kidney Diseases, Chengdu, China; [b]Department of Nephrology, Chengdu Second People's Hospital, Chengdu, China

Keywords

Peritoneal dialysis · Peritoneal dialysis catheter malfunction · Novel approach

Abstract

Introduction: Peritoneal dialysis (PD) is a crucial kidney replacement therapy for patients with end-stage kidney disease. Despite its advantages over hemodialysis (HD), long-term success can be hindered by catheter dysfunction, which often necessitates revision. Currently, surgical treatment methods for PD catheter malfunction include fluoroscopy-guided procedures and laparoscopic or open surgery to salvage or replace the catheter. Here, we introduce the first novel, minimally invasive surgery for repositioning PD catheters. ***Methods:*** From November 2021 to May 2024, 8 patients with PD catheter dysfunction underwent this innovative procedure at the Department of Nephrology, Sichuan Provincial People's Hospital. Surgical Procedure: On the side of the original abdominal incision, blunt separation was used to find the PD catheter tunnel segment. The anterior rectus abdominal muscle sheath was incised, followed by separation of the deep polyester sleeve. The original catheter was exposed in the abdominal port or purse-string suture, and the intra-abdominal segment of the dialysis catheter was pulled out. Blunt cleaning around the periphery was performed to ensure that the PD catheter was smooth, and a rigid guidewire was placed through the intra-abdominal segment of the proximal end of the catheter of the first lateral hole. The intra-abdominal segment of the PD catheter was placed into the pelvis via the original catheter in the abdominal port. Clinical data were retrospectively collected, and patients were followed up for safety and efficacy assessment. ***Results:*** In a study involving 8 patients, no significant complications were observed, with an immediate imaging success rate of 100% and a clinical PD catheter reset success rate of 75%. The catheter remained patent until the end of the study, with a mean follow-up time of 17.25 ± 9.25 months. ***Conclusion:*** This new method for resetting dysfunctional PD catheters demonstrates technical feasibility, simplicity, cost-effectiveness, and safety. It has the potential to emerge as an alternative, particularly suitable for resource-limited settings.

Introduction

Peritoneal dialysis (PD) is a widespread mode of renal replacement therapy for patients with end-stage kidney disease. The prevalence of PD varies by country and

Xiuling Chen and Nan Wang contributed equally to this work.

karger@karger.com
www.karger.com/kdd

Karger
OPEN ACCESS

Correspondence to:
Guisen Li, guisenli@163.com

region, with approximately 11% of dialysis patients receive PD globally [1, 2]. In China, data up to 2022 from the Chinese National Renal Data System (CNRDS) revealed that Chinese PD patients comprise approximately 25% of the global PD population and approximately 15% of the country's dialysis population [3]. Compared with hemodialysis (HD), PD offers advantages such as preserved residual renal function, enhanced quality of life, similar survival rates, and cost-effectiveness [4–8]. Nevertheless, the efficacy of PD relies heavily on a well-functioning PD catheter, which is pivotal for its success [9–11]. Catheter dysfunction, a common occurrence, often necessitates revision and can lead to technical failure, directly impacting catheter longevity and prompting a switch to HD in up to 20% of cases [12]. Current treatments for PD catheter dysfunction include fluoroscopic manipulation, open or laparoscopic salvage, or replacement. While many radiologists can manipulate ectopic PD catheters under fluoroscopy, outcomes vary widely, with an initial success rate ranging from 55% to 80% and less reliable long-term results of 33% [13–19]. Traditional surgical or laparoscopic approaches can also address ectopic PD catheters, offering direct visualization of the peritoneal cavity [20]. However, these methods necessitate general anesthesia, entail lengthy operation times, and incur significant expenses. By embracing the trend toward "minimally invasive surgery," we introduce a novel PD catheter repositioning method characterized by reduced trauma, diminished postoperative discomfort, expedited recovery, and lower costs while ensuring ongoing safety and efficacy assessments.

Methods

Between November 2021 and May 2024, a total of 8 patients underwent a novel procedure at the Department of Nephrology, Sichuan Provincial People's Hospital. Clinical data from surgery inception until the study's conclusion in May 2024 were retrospectively collected. Patients had previously undergone percutaneous placement of a PD catheter, utilizing either an open or modified Seldinger technique, with either a Tenckhoff straight catheter (Kirchhoff, LLC) or a Medcomp PD straight catheter and accessories (MDP-242-C model, Baxter Medical Supplies Trading (Shanghai) Co.). All initial placements of peritoneal catheters in patients were via a lateral route (2 cm lateral to the outer 8–10 cm above the symphysis pubis), with the deep cuff placed within the rectus sheath. All patients were in stable condition and presented with either unidirectional or bidirectional

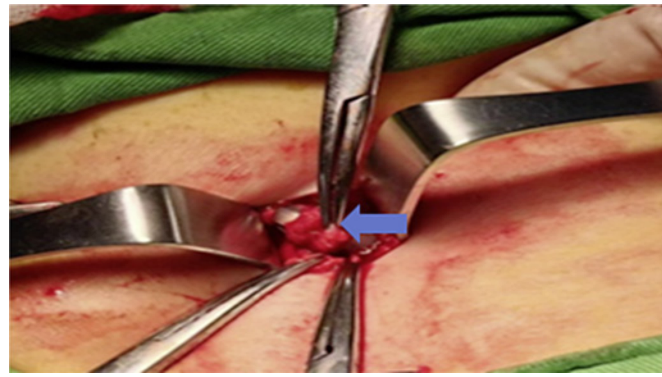

Fig. 1. Separation of the deep polyester sleeve of the PD catheter.

obstruction of peritoneal dialysate drainage, confirmed by abdominal plain films indicating catheter migration out of the true pelvis or omental wrapping. Informed consent was obtained from all patients. Initial conservative measures, including increased activity, catheter flushing, laxatives, enemas, and urokinase sealing, were attempted to restore patency. Preoperative cefazolin was administered for infection prevention. Low-volume PD was resumed within 1–8 days post-procedure, unless catheter malfunction occurred.

Surgical Methods

In the operating room under sterile conditions and with 1% lidocaine for local anesthesia, a parallel longitudinal incision of 1–2 cm was made alongside the original abdominal incision. Subcutaneous fat was bluntly separated to access the tunneled segment. Tissues were carefully separated along the catheter, and the anterior sheath of the rectus abdominis was incised. Deep polyester sheaths were then separated to expose the original catheter entry site or purse-string sutures. The intra-abdominal segment of the PD catheter was meticulously and slowly withdrawn, with simultaneous blunt cleaning of the peritubular tissue and encapsulated greater omental tissue. Clots, fibrin, or adipose tissue from the PD catheter were removed manually by squeezing, saline flushing, and passing of a rigid guidewire to ensure catheter patency. A rigid guidewire was used through the intra-abdominal segment of the PD catheter proximal to the end of the first lateral hole to access the catheter. The proximal end of the intra-abdominal segment of the PD catheter was reinserted into the pelvis through the original catheter entry site by the rigid guidewire. This was achieved by carefully advancing the catheter along the anterior abdominal wall with the aid of the guidewire to avoid the greater omentum until the catheter end reached the Douglas

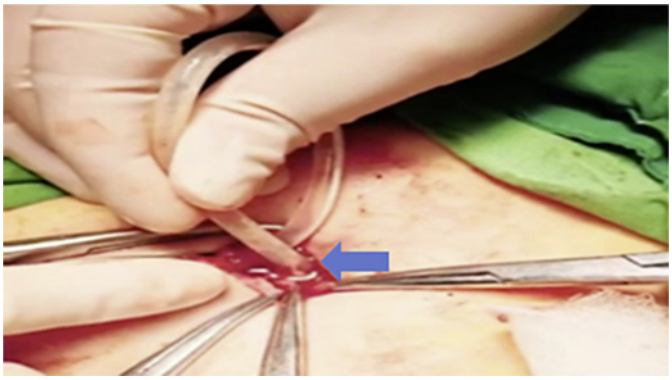

Fig. 2. Exposure of the original catheter entry site or purse-string suture, with careful extraction of the intra-abdominal segment of the PD catheter. Omental wrapping around the lateral holes causing luminal obstruction is visible.

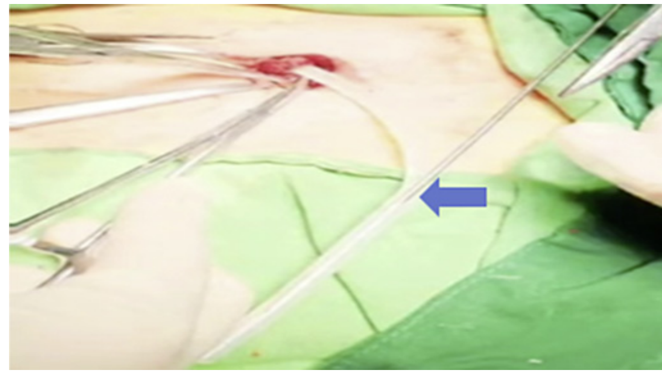

Fig. 3. Gentle cleaning of intra- and extra-catheter tissues to ensure smoothness of the PD catheter, followed by insertion of a rigid guidewire into the intraperitoneal segment of the catheter for placement into the pelvis.

fossa. The guidewire was then removed. Following confirmation of smooth injection and drainage of the PD solution, thorough hemostasis was ensured before the abdomen was closed. Aseptic dressings were then applied (Fig. 1–4).

Data Collection

Information regarding the initial PD catheter placement and treatment was accessed. Details included the initial insertion of the PD catheter, PD treatment regimen, duration until catheter failure, and any associated symptoms, as well as the current location of the catheter. Surgical parameters for revision surgery included the duration of the surgical procedure, intraoperative bleeding, and any catheter-related issues identified during the surgery that contributed to dysfunction. Information on postoperative outcomes included commencement of PD treatment post-surgery, occurrence of complications such as peritonitis and exit site and tunnel infections, catheter displacement, inadequate drainage, presence of bloody PD solution, leakage, herniation, and subsequent survival of both the catheter and the patient.

Intraoperative Reset Criteria

Smooth flow of PD solution was observed from the PD catheter without any interruptions or blockages.

Safety Evaluation

Occurrence during and after Surgery

(1) Symptoms such as abdominal pain, abdominal distension, the presence of bloody PD solution, or leakage.
(2) Evaluation of damage to abdominal organs.

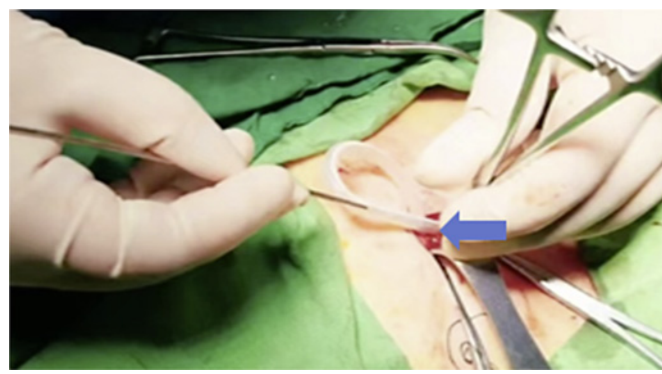

Fig. 4. Advancement of the catheter through the original catheter entry port under the guidance of the guidewire.

(3) Monitoring for symptoms indicative of peritonitis, such as turbidity of the PD solution.

Postoperative Evaluation

Successful Reset Criteria

(1) Smooth inflow and outflow of PD solution.
(2) Confirmation of catheter placement in the pelvic cavity via abdominal frontal and lateral X-rays.

Safety Assessment Criteria

(1) Absence of evident postoperative bleeding.
(2) No observed damage to abdominal organs.
(3) No occurrence of peritonitis.

Observational Indexes and Follow-Up

The following variables were assessed: patency of PD solution intraoperatively and postoperatively, initial imaging success rate, pre- and post-surgery PD solution

DOI: 10.1159/000543824

Table 1. General information of patients and follow-up

Case	Gender	Age	BMI	Primary disease	History of abdominal surgery	PD catheter insertion	X-ray catheter position	Causes of catheter dysfunction	Follow-up, months
1	M	34	30.1	DM	None	Modified Seldinger (MS)	Pelvis	Extraperitoneal space	27
2	F	51	17.5	UK	Nephrolithotomy	MS	Pelvis	Retina wrap	24
3	F	34	21.0	UK	None	Open	Right upper abdomen	The purse stitches are brought into the retina	24
4	M	61	24.3	HBP	None	MS	Right upper abdomen	Displacement	23
5	M	41	26.2	DM	None	MS	Right upper abdomen	Retina wrap	19
6	F	34	18.0	SLE	None	MS	Right upper abdomen	Retina wrap	12
7	F	41	17.7	HBP	None	MS	Pelvis	Retina wrap	8
8	F	35	23.3	UK	Caesarean section	MS	Left upper abdomen	Retina wrap	1

inflow and outflow times, and preoperative day 1 and postoperative 24-h ultrafiltration volume on initiation of PD treatment. Patients were monitored for PD solution drainage status, recurrence of catheter dysfunction, and resolution at 1 month and at study completion.

Statistical Methods

IBM SPSS Statistics 20.0 software was used for data analysis. The measurement data are presented as the means ± standard deviations, whereas the count data are expressed as the number of cases (percentages).

Results

General Information of the Enrolled Patients

Table 1 summarizes the patient characteristics and clinical outcomes of a cohort of 8 patients. The duration from PD catheter placement to catheter dysfunction was 22.38 ± 29.67 days, with a follow-up period of 17.25 ± 9.25 months.

Causes of Catheter Dysfunction

Based on abdominal X-ray findings and intraoperative observations, omental wrapping was identified as the primary cause of catheter dysfunction (6 out of 8 cases, with 1 patient requiring surgical intervention due to excessive omental tissue, which was secured using a purse-string ligature), 1 patient experienced catheter displacement, and another patient (with a BMI of 30.1) had the catheter mistakenly placed into the extraperitoneal space during percutaneous surgery.

Imaging Evaluation on the First Postoperative Day

Among the 8 patients, 8 successful catheter reset operations were performed on the first postoperative day, resulting in a 100% success rate. The duration of the operation ranged from 30 to 135 min.

Complications

No patients experienced significant complications, such as abdominal pain, abdominal distension, abdominal organ injury, hemorrhage, exit site infection, tunnel infection, or peritonitis.

Postoperative Follow-Up and Regression

Two patients experienced catheter dysfunction during the follow-up period (patients 3 and 6). In patient 3, PD solution drainage was obstructed on the second postoperative day. Abdominal plain film confirmed catheter placement on the first postoperative day, prompting laparoscopic exploration, which revealed intestinal adhesions. The catheter was in place, adhesions were loosened, and catheter fixation was performed. In patient 6, initial postoperative imaging indicated proper catheter placement and smooth flow. However, 26 days later, drainage obstruction recurred, and subsequent imaging revealed catheter displacement in the right upper abdomen. Laparoscopic intervention revealed intestinal tubes and greater omentum wrapping around the catheter. Adhesions were released, and the greater omentum was resected. Two patients underwent successful laparoscopic surgical restoration, resulting in smooth drainage of the PD solution within 1 month post-restoration. At the conclusion of the study, all 8 patients exhibited normal catheter function, and PD continued without complications.

Discussion

PD treatments are frequently delayed or interrupted due to outlet leakage or flow restriction, with the latter being the primary procedural concern [21]. Outflow and inflow obstructions are commonly observed early within 2 weeks of catheter placement [22], affecting 4–20% of PD patients [9, 23]. Different PD placement procedures yield varying rates of postoperative flow restriction, with catheter outflow failure ranging from 4% to 34.5% for open surgical placements and combined flow dysfunction occurring in 4.5%–13% of laparoscopic placements [2–4]. Catheter dysfunction, characterized by mechanical failure of dialysate injection or drainage, constitutes 55% of catheter mechanical complications [24]. Significant variation in catheter outcomes between centers was observed, which correlated more closely with operator and center characteristics than with catheter design. Common causes of catheter failure include catheter tip displacement (10–30%), omental wrapping or adhesion (15%), intraluminal and extraluminal catheter obstructions, and catheter kinking [25–27]. The incidence of catheter tip displacement associated with opening is as high as approximately 15–20% [9, 28]. Management of catheter dysfunction typically begins with conservative measures such as increased physical activity, laxatives, enemas, or pressure flushing of the PD catheter, along with heparin or fibrinolytic agent instillation. While some cases respond to conservative management, many necessitate salvage maneuvers such as subinterventional techniques, catheter revision, or replacement [22]. The 2019 ISPD guidelines recommend the selection of interventions for catheter flow obstruction based on patient factors, facility resources, and operator expertise, including imaging manipulation, laparoscopic surgery, or simultaneous catheter replacement [11]. Treatment approaches have evolved from open or replacement surgeries to include laparoscopic techniques, as well as nonsurgical options such as TPA perfusion and guidewire manipulation in interventional radiology [29].

Several studies have highlighted the effectiveness of subinterventional catheter manipulation [14, 15, 30, 31]. The success rate of wire manipulation under fluoroscopy ranges from 27% to 75% [18, 32–39]. This procedure is minimally invasive, does not necessitate anesthesia, is cost-effective except for possible conscious sedation, and, if technically successful, permits immediate resumption of PD. However, long-term clinical success often requires multiple operations due to the challenge of definitively addressing the underlying cause of flow disorders, leading to initial catheter dysfunction and recurrent issues.

Wei et al. [40] identified three types of intraperitoneal PD catheter dysfunction (catheter tip wrapped by intestinal collaterals, greater omentum wrapping, and abdominal adhesions) under laparoscopy, all of which were effectively repaired through laparoscopic intervention. Laparoscopy offers the advantage of pinpointing the underlying cause of catheter flow obstruction, enabling tailored management. Several studies have reported success rates exceeding 80% for laparoscopic repair of PD catheter malfunction [12, 24]. Consequently, it is often considered the next step in managing catheter flow obstruction once alternative diagnoses such as constipation, bladder filling, and fibrin blockage have been excluded. While laparoscopy allows for the immediate resumption of PD and is minimally invasive, it requires general anesthesia, specialized laparoscopic equipment, and expertise and incurs high surgical costs. Moreover, the adverse physiological effects of pneumoperitoneum and the presence of multiple working ports increase the risk of dialysate leakage.

Catheter replacement is considered the least preferred option for managing complications of catheter flow. This approach involves removing the catheter in situ and then recatheterizing, which can subject the patient to additional surgical trauma and expose them to potential complications associated with a new catheter insertion.

An incision adjacent to the original surgical opening can be used, followed by abdominal exploration to locate the PD catheter and then resetting and securing the catheter, effectively treating catheter malfunction and reducing the risk of recurrence [41, 42]. Our modified technique involves a smaller incision next to the original one, simplifying catheter location (the original catheter can be located by separating subcutaneous tissues), minimizing peritoneal irritation, and reducing patient discomfort. This approach resembles the method described by Sarafidis et al. [43] although their series primarily addressed catheter migration or bending rather than omental attachment or catheter occlusion. Additionally, they employed a flexible guidewire and dilatation of the catheter tear-off sheath, positioning the patient's deep cuff in the subcutaneous tissue rather than anchoring it to the rectus abdominis muscle.

Our innovative approach and advantages are as follows: (1) utilization of a smaller incision adjacent to the original surgical port facilitates easier location of the PD catheter without the need for extensive abdominal exploration. (2) The catheter can be carefully separated from its original position or slowly withdrawn to identify the cause of catheter failure. (3) Reintroduction of the catheter through the original abdominal entrance eliminates the need for additional incisions or purse-string sutures, minimizing peritoneal irritation. (4) Insertion of a guidewire through the lateral hole of the intra-abdominal section of the catheter ensures a short operation path, precise positioning, and a high success rate with minimal risk. (5) Preservation of the short tube and the extra-abdominal section of the catheter maintain the integrity of the tunnel, reducing the risk of contamination and infection. (6) The procedure is straightforward, resulting in less trauma, and reduced pain for the patient, who typically tolerates it well. (7) Preservation of the original catheter obviates the need for special consumables and equipment, leading to lower costs. (8) The reset effect is evident, with a high success rate, achieving immediate success in 100% of cases, and the clinical PD catheter reset success rate is 75%. (9) Since the outlet, shallow cuff, and tunnel remain intact, PD can be resumed more quickly than new catheter placement. PD can be resumed immediately after reset, with a low risk of leakage, avoiding the discomfort and infection risk associated with temporary deep venous catheterization for HD. (10) Avoidance of X-ray exposure during the procedure enhances patient safety. (11) Long-term PD catheter use yields reliable results with our approach.

In summary, our novel method offers a simple and cost-effective salvage procedure featuring small incisions, leading to rapid patient recovery and enabling immediate resumption of PD therapy; thus, it is particularly suitable for resource-limited settings. Further studies and long-term follow-up are essential to validate its safety and effectiveness in a larger cohort.

Acknowledgments

The authors gratefully acknowledge the contributions of all nurses from the PD unit, at Sichuan Academy of Medical Science and Sichuan Provincial People's Hospital.

Statement of Ethics

This study protocol was reviewed and approved by the Medical Ethics Committee of Sichuan Academy of Medical Science and Sichuan Provincial People's Hospital, Approval No. 2024-258-1. Written informed consent was obtained from patients to participate in this study.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Funding Sources

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions

X.C., N.W., Y.Z., J.C., H.G., G.L., and J.W. contributed to the concept of the study and conducted the study. X.C. and J.W. performed analyses and drafted the article. N.W. and G.L. revised the manuscript. All authors reviewed and approved the version to be published.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

References

1 Himmelfarb J, Vanholder R, Mehrotra R, Tonelli M. The current and future landscape of dialysis. Nat Rev Nephrol. 2020;16(10):573–85. https://doi.org/10.1038/s41581-020-0315-4
2 Cho Y, Bello AK, Levin A, Lunney M, Osman MA, Ye F, et al. Peritoneal dialysis use and practice patterns: an international survey study. Am J Kidney Dis. 2021;77(3):315–25. https://doi.org/10.1053/j.ajkd.2020.05.032
3 National Health Commission of P.R. China. Chinese national renal data System [online]. Available from: http://www.cnrds.net
4 Lang SM, Bergner A, Töpfer M, Schiffl H. Preservation of residual renal function in dialysis patients: effects of dialysis technique related factors. Perit Dial Int. 2001;21(1):1–7. https://doi.org/10.1177/089686080102100108

5 Chuasuwan A, Pooripussarakul S, Thakkinstian A, Ingsathit A, Pattanaprateep O. Comparisons of quality of life between patients underwent peritoneal dialysis and hemodialysis: a systematic review and meta analysis. Health Qual Life Outcomes. 2020;18(1):191. https://doi.org/10.1186/s12955-020-01449-2
6 Mehrotra R, Chiu Y-W, Kalantar-Zadeh K, Bargman J, Vonesh E. Similar outcomes with hemodialysis and peritoneal dialysis in patients with end-stage renal disease. Arch Intern Med. 2011;171(2):110–8. https://doi.org/10.1001/archinternmed.2010.352
7 Saran R, Robinson B, Abbott KC, Agodoa LYC, Bragg-Gresham J, Balkrishnan R, et al. US renal data System 2018 annual data report: epidemiology of kidney disease in the United States. Am J Kidney Dis. 2019;73(3 Suppl 1):A7–8. https://doi.org/10.1053/j.ajkd.2019.01.001
8 Liu J, Hutton DW, Gu Y, Hu Y, Li Y, Ma L, et al. Financial implications of dialysis modalities in the developing world:a Chinese perspective. Perit Dial Int. 2020;40(2):193–201. https://doi.org/10.1177/0896860819893812
9 Liu WJ, Hooi LS. Complications after tenckhoff catheter insertion: a single-centre experience using multiple operators over four years. Perit Dial Int. 2010;30(5):509–12. https://doi.org/10.3747/pdi.2009.00083
10 Ma TK, Chow KM, Kwan BC, Ng JKC, Choy ASM, Kwong VWK, et al. Peritoneal dialysis catheter revision and replacement by nephrologist for peritoneal dialysis catheter malfunction. Nephron. 2018;138(3):214–9. https://doi.org/10.1159/000485643
11 Crabtree JH, Shrestha BM, Chow KM, Figueiredo AE, Povlsen JV, Wilkie M, et al. Creating and maintaining optimal peritoneal dialysis access in the adult patient: 2019 Update. Perit Dial Int. 2019;39(5):414–36. https://doi.org/10.3747/pdi.2018.00232
12 Maio R, Figueiredo N, Costa P. Laparoscopic placement of Tenckhoff catheters for peritoneal dialysis: a safe, effective, and reproducible procedure. Perit Dial Int. 2008;28(2):170–3. https://doi.org/10.1177/089686080802800213
13 Jaques P, Richey W, Mandel S. Tenckhoff peritoneal dialysis catheter: cannulography and manipulation. Am J Roentgenol. 1980;135(1):83–6. https://doi.org/10.2214/ajr.135.1.83
14 Moss JS, Minda SA, Newman GE, Dunnick NR, Vernon WB, Schwab SJ. Malpositioned peritoneal dialysis catheters: a critical reappraisal of correction by stiff-wire manipulation. Am J Kidney Dis. 1990;15(4):305–8. https://doi.org/10.1016/s0272-6386(12)80075-8
15 Dobrashian RD, Conway B, Hutchison A, Gokal R, Taylor PM. The repositioning of migrated Tenckhoff continuous ambulatory peritoneal dialysis catheters under fluoroscopic control. Br J Radiol. 1999;72(857):452–6. https://doi.org/10.1259/bjr.72.857.10505008
16 Simons ME, Pron G, Voros M, Vanderburgh LC, Rao PS, Oreopoulos DG. Fluoroscopically-guided manipulation of malfunctioning peritoneal dialysis catheters. Perit Dial Int. 1999;19(6):544–9. https://doi.org/10.1177/089686089901900609
17 McLaughlin K, Jardine AG. Closed stiff-wire manipulation of malpositioned Tenckhoff catheters offers a safe and effective way of prolonging peritoneal dialysis. Int J Artif Organs. 2000;23(4):219–20. https://doi.org/10.1177/039139880002300402
18 Miller M, McCormick B, Lavoie S, Biyani M, Zimmerman D. Fluoroscopic manipulation of peritoneal dialysis catheters: outcomes and factors associated with successful manipulation. Clin J Am Soc Nephrol. 2012;7(5):795–800. https://doi.org/10.2215/CJN.09850911
19 Li P, Choo D, Deved V, Shah N, Shurraw S, Zuidema S, et al. Salvage of malfunctioning peritoneal dialysis catheters: an algorithm for recanalization and repositioning. J Vasc Interv Radiol. 2021;32(6):902–6. https://doi.org/10.1016/j.jvir.2021.03.522
20 Yilmazlar T, Kirdak T, Bilgin S, Yavuz M, Yurtkuran M. Laparoscopic findings of peritoneal dialysis catheter malfunction and management outcomes. Perit Dial Int. 2006;26(3):374–9. https://doi.org/10.1177/089686080602600316
21 Oliver MJ, Perl J, McQuillan R, Blake PG, Jain AK, McCormick B, 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):185–92. https://doi.org/10.1177/0896860819893813
22 Gokal R, Alexander S, Ash S, Chen TW, Danielson A, Holmes C, et al. Peritoneal catheters and exit-site practices toward optimum peritoneal access: 1998 update. (Official report from the International Society for Peritoneal Dialysis). Perit Dial Int. 1998;18(1):11–33. https://doi.org/10.1177/089686089801800102
23 Yang PJ, Lee CY, Yeh CC, Nien HC, Tsai TJ, Tsai MK. Mini-laparotomy implantation of peritoneal dialysis catheters: outcome and rescue. Perit Dial Int. 2010;30(5):513–8. https://doi.org/10.3747/pdi.2009.00033
24 Elbokl M, Momciu B, Kishibe T, Oliver MJ, Perl J. Peritoneal dialysis access outcomes reported in randomized controlled trials: a systematic review. Perit Dial Int. 2021;41(6):552–63. https://doi.org/10.1177/0896860820966898
25 McCormick BB, Bargman JM. Noninfectious complications of peritoneal dialysis: implications for patient and technique survival. J Am Soc Nephrol. 2007;18(12):3023–5. https://doi.org/10.1681/ASN.2007070796
26 Farooq MM, Freischlag JA. Peritoneal dialysis: an increasingly popular option. Semin Vasc Surg. 1997;10(3):144–50.
27 Soontrapornchai P, Simapatanapong T. Comparison of open and laparoscopic secure placement of peritoneal dialysis catheters. Surg Endosc. 2005;19(1):137–9. https://doi.org/10.1007/s00464-004-8156-y
28 Bergamin B, Senn O, Corsenca A, Dutkowski P, Weber M, Wüthrich RP, et al. Finding the right position: a three-year,single-center experience with the "self-locating" catheter. Perit Dial Int. 2010;30(5):519–23. https://doi.org/10.3747/pdi.2009.00106
29 Haggerty SP, Kumar SS, Collings AT, Alli VV, Miraflor E, Hanna NM, et al. SAGES peritoneal dialysis access guideline update 2023. Surg Endosc. 2024;38(1):1–23. https://doi.org/10.1007/s00464-023-10550-8
30 Kim HJ, Lee TW, Ihm CG, Kim MJ. Use of fluoroscopy guided wire manipulation and/or laparoscopic surgery in the repair of malfunctioning peritoneal dialysis catheters. Am J Nephrol. 2002;22(5–6):532–8. https://doi.org/10.1159/000065292
31 Diaz-Buxo JA, Turner MW, Nelms M. Fluoroscopic manipulation of Tenckhoff catheters: outcome analysis. Clin Nephrol. 1997;47(6):384–8.
32 Davis R, Young J, Diamond D, Bourke E. Management of chronic peritoneal catheter malfunction. Am J Nephrol. 1982;2:85–90. https://doi.org/10.1159/000166589
33 Kappel JE, Ferguson GM, Kudel RM, Kudel TA, Lawlor BJ, Pylypchuk GB. Stiff wire manipulation of peritoneal dialysis catheters. Adv Perit Dial. 1995;11:202–7.
34 Siegel RL, Nosher JL, Gesner LR. Peritoneal dialysis catheters: repositioning with new fluoroscopic technique. Radiology. 1994;190(3):899–901. https://doi.org/10.1148/radiology.190.3.8115648
35 Savader SJ, Lund G, Scheel PJ, Prescott C, Feeley N, Singh H, et al. Guide wire directed manipulation of malfunctioning peritoneal dialysis catheters: a critical analysis. J Vasc Interv Radiol. 1997;8(6):957–63. https://doi.org/10.1016/s1051-0443(97)70693-6
36 Simons ME, Pron G, Voros M, Vanderburgh LC, Rao PS, Oreopoulos DG. Fluoroscopically guided manipulation of malfunctioning peritoneal dialysis catheters. Perit Dial Int. 1999;19(6):544–9. https://doi.org/10.1177/089686089901900609
37 Kim HJ, Lee TW, Ihm CG, Kim MJ. Use of fluoroscopy-guided wire manipulation and/or laparoscopic surgery in the repair of malfunctioning peritoneal dialysis catheters. Am J Nephrol. 2002;22(5–6):532–8. https://doi.org/10.1159/000065292
38 Ozyer U, Harman A, Aytekin C, Boyvat F, Ozdemir N. Correction of displaced peritoneal dialysis catheters with an angular stiff rod. Acta Radiol. 2009;50(2):139–43. https://doi.org/10.1080/02841850802631983
39 Kwon YH, Kwon SH, Oh JH, Jeong KH, Lee TW. Fluoroscopic guide wire manipulation of malfunctioning peritoneal dialysis catheters initially placed by interventional radiologists. J Vasc Interv Radiol. 2014;25(6):904–10. https://doi.org/10.1016/j.jvir.2014.02.012

40 Wei W, Fanous M. Laparoscopic salvage of the dysfunctional peritoneal dialysis catheter. Am Surg. 2022;88(9):2238–40. https://doi.org/10.1177/00031348221093801
41 Li JR, Cheng CH, Chiu KY, Cheng CL, Yang CR, Ho HC, et al. Minilaparotomy salvage of malfunctioning catheters in peritoneal dialysis. Perit Dial Int. 2013; 33(1):46–50. https://doi.org/10.3747/pdi.2011.00237
42 Xiang SL, Zhang XH, Wang YM. The clinical application of modified peritoneal dialysis catheter revision of malfunctioning catheter. Chin J Blood Purif. 2022;21(6):393–7.
43 Sarafidis P, Bowes E, Rumjon A, Ansari B, Cairns H. A novel technique for repositioning, under local anesthetic, malfunctioning and migrated peritoneal dialysis catheters. Perit Dial Int. 2013;33(6): 700–4. https://doi.org/10.3747/pdi.2012.00051