Original Article

Continuous ambulatory peritoneal dialysis catheter insertion by open technique: 20-year experience from a single center

Mrinal Pahwa, Mahendra Singh[1]*, Vipin Tyagi, Manu Gupta, Saurabh Jain, Sudhir Chaddha, Harsha Jauhari

Department of Urology, Sir Ganga Ram Hospital, Delhi, [1]Department of Urology, AIIMS, Jodhpur, India
*E-mail: dr.mahi1118@gmail.com

ABSTRACT

Introduction: Continuous ambulatory peritoneal dialysis (CAPD) catheter placement is a part of renal replacement therapy. We describe our 20-year experience in using the open technique and assess its safety, efficacy, and outcome in the treatment of end-stage renal disease patients.

Methods: In a retrospective study, we analyzed data of all patients who had a CAPD catheter placed using our open dissection technique using local anesthesia over the previous 20 years, with minimum 1 year of follow-up. Intraoperative data, postoperative data, and complications were noted.

Results: A total of 1410 cases were included in the study. The mean duration of follow-up was 72 ± 18 months (range 12–120 months). The mean operative time was 19 ± 7.5 min and mean hospital stay was 3 ± 1 days. No major intraoperative complications were noted. We observed a peritonitis rate of 0.49 episodes/patient/year. The most common reason for permanent catheter removal was refractory peritonitis in 21%, followed by flow failure in 7%, and ultrafiltration failure in 6.5%. The death-censored technical survival rate was 94.3%, 83.2%, 75.9%, 69.2%, and 60.6% patients at 1 year, 2 years, 3 years, 4 years, and 5 years, respectively.

Conclusions: The open dissection method of peritoneal dialysis catheter insertion using local anesthesia at well-experienced center is a simple, painless, and uncomplicated procedure with excellent outcomes. Optimal exposure, judicious use of energy source, and using appropriate technique provide good technical success rate with lesser complications.

INTRODUCTION

End-stage renal disease (ESRD) is a major health problem encountered worldwide and there is a dramatic increase in the number of the patients requiring renal replacement therapy. Management options for patients with ESRD are hemodialysis (HD), peritoneal dialysis (PD), and kidney transplantation.[1] The benefits of PD over HD include its simplicity, better quality of life and clinical advantages of maintaining residual renal function.[1,2] The methods of PD include intermittent PD (IPD), continuous ambulatory PD (CAPD), and automated PD (APD).[2]

Access this article online	
Quick Response Code:	Website: www.indianjurol.com
	DOI: 10.4103/iju.iju_156_22

The use of CAPD for ESRD has increased gradually, and around 15% of the total dialysis population currently uses PD.[2-4] A successful PD program is dependent on the proper placement of the permanent PD catheters with in-depth knowledge of various implantation techniques and complications.[4] The techniques to insert PD catheter include open dissection technique, laparoscopic technique, and percutaneous insertion. The advantage of the open dissection technique are simplicity and long-term reliability.[3,4] Our center has a dedicated system for the management of ESRD patients. We describe our experience in CAPD placement

Received: 14.05.2022, **Revised:** 22.10.2022,

Accepted: 14.12.2022, **Published:** 29.12.2022

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

and assess its safety, efficacy, and outcome in the treatment of ESRD patients.

MATERIALS AND METHODS

This study was approved by the institutional ethics committee. In this retrospective study, we analyzed data of all patients who had a Tenckhoff catheter placed for CAPD, using the open dissection technique at our institute in the past 20 years. Patients who underwent first-time CAPD catheter insertion with minimum 1 year of follow-up were included. We excluded the cases where catheters other than Tenckhoff was used. We also excluded cases where the catheter was inserted by laparoscopic or percutaneous technique. Cases where catheter insertion failed were included. Intraoperative data, such as operative time, blood loss, and complications were analyzed. Postoperative data, such as wound soakage and the need for re-exploration, were noted. Immediate and long-term complications such as wound site infection, catheter malfunction, postinsertion peritonitis, and any other complication were noted. The mean follow-up of patients was 72 ± 18 months.

Technique

The procedure was carried out in the supine position with cephalosporin antibiotic prophylaxis. After giving local anesthesia (lignocaine 2%), we made an oblique, 5–8 cm incision starting infraumbilically from midline and reaching the right paramedian area to the level of the umbilicus [Figure 1]. Subcutaneous fat was dissected to expose the anterior rectus sheath which was incised after infiltration of a local anesthetic agent. The rectus muscle fibers were separated bluntly using two mastoid self-retaining retractors, one to retract the subcutaneous fat and another one to retract rectus muscle [Figure 2]. After infiltrating local anesthetic agent again, the posterior sheath and the peritoneum were incised after lifting peritoneum with an artery forceps, to create a small opening [Figure 2]. A long Kelly clamp was passed into the pelvis to check any hindrance to free passage of the catheter to the opposite iliac fossa [Figure 3]. A double-cuffed Tenckhoff catheter was flushed with heparinized saline (5000 unit Heparin in 500 ml Normal saline) before insertion. Another long Kelly clamp was used to position the intraperitoneal segment of the Tenckhoff catheter in the pelvic cavity [Figure 4]. After insertion, heparinized saline was introduced through the catheter into the abdominal cavity to test free flow, and same time the peritoneum was gently lifted and approximate with artery forceps to prevent leakage as we did not use a preplaced purse string suture. If dissatisfied with the flow, the catheter was re-inserted. Once satisfied with the outflow, we sutured the peritoneum and the posterior rectus sheath using absorbable suture (Vicryl 2-0) in a water-tight manner and again the outflow was checked before final suture placement. If satisfied with outflow, we took a superficial suture from the inner cuff, which helped in keeping the catheter in position. The anterior rectus sheath was approximated using continuous Vicryl 2-0 suture. The exit site was selected about 5–6 cm above the incision site, usually located in the right upper abdomen for easy

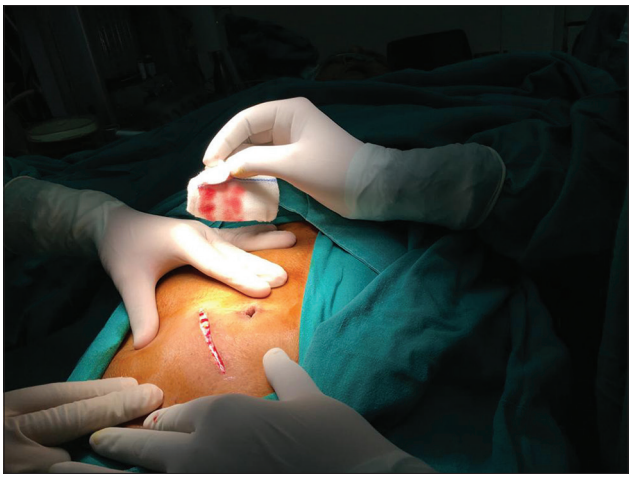

Figure 1: Incision site

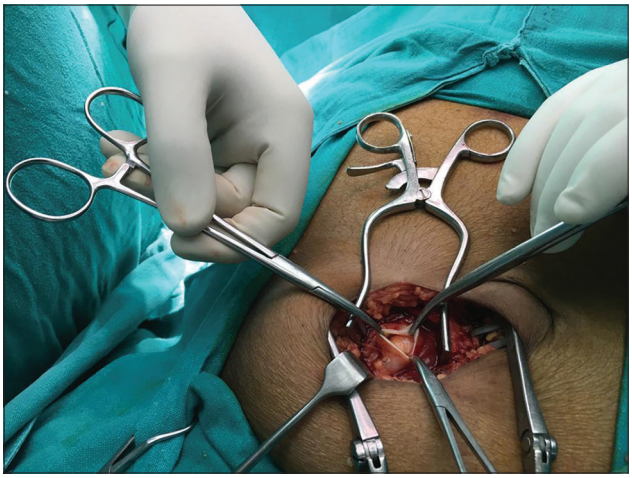

Figure 2: Application of self-retaining retractors and opening of peritoneum after lifting

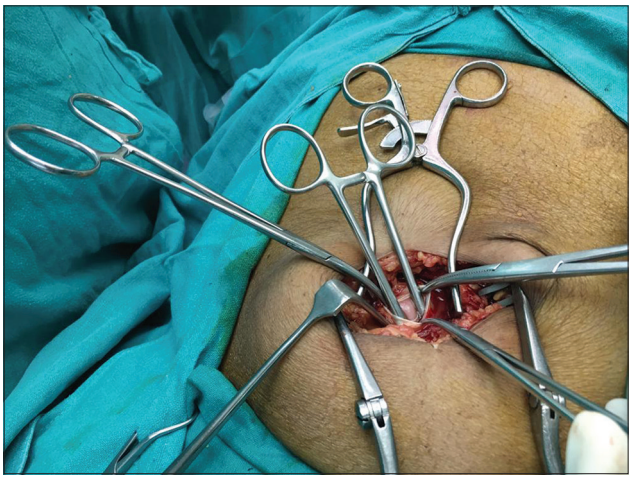

Figure 3: Passing of long Kelly clamp in pelvis to check free passage

handling. For choosing the exit site, we placed the catheter along the course of the tunnel and the exit site to ensure that the lie of the catheter was unobstructed without any acute angle and the outer cuff buried approximately 2 cm from the designated exit. A tunnel was created below the subcutaneous fat, up to the chosen exit site by gently opening a small artery forceps. A small incision was made between the tips of the artery forceps, at the exit site. After making the incision, another small artery forceps were guided from outside of the exit site, through the created tunnel, along the previously placed artery forceps. The catheter was held gently using the artery forceps passed from outside and the catheter was brought outside through the exit site. After passing the catheter, we ensured that the lie of the catheter in the tunnel was proper, without any kink, and the outflow was again checked at this stage. No suture was placed at the site of skin exit. The wound was closed using staples after approximating the subcutaneous fat using Vicryl 2-0. The wound and catheter were separately covered using absorbent sterile dressings, which remained intact for 1 week. Care of the Tenckhoff catheter was undertaken by trained nurses, according to standard protocols of the institute.

Statistics

Continuous variables are presented as mean ± standard deviation, categorical variables are being expressed as frequencies and percentages. Statistical analysis was perfomed used the Student's *t*-test and Chi-square test for continuous variables and categorical variables, respectively. For all statistical tests, a $P < 0.05$ was considered to indicate a significant difference. The latest SPSS statistics package was being used for statistical analysis.

RESULTS

A total of 1576 patients underwent CAPD insertion at our institute from January 1997 to December 2017. Sixty patients underwent CAPD insertion by laparoscopic technique and 44 patients were lost to follow-up and were excluded. We also excluded 62 patients with less than 1-year follow-up. After excluding these patients, the remaining 1410 cases were included in the study. Male patients (928/1410) outnumbered female patients (482/1410). The mean age and mean BMI of patients were 52.8 ± 10.5 years (range 22–91 years) and 23.6 ± 7.4 (range 17–40), respectively. The mean duration of follow-up was 72 ± 18 months (range 12–120 months). We were able to insert catheter under local anesthesia in 99.1% (1398/1410), 112 patients needed additional sedation, and only 12 (0.9%) patients needed general anesthesia due to pain during local anesthesia or due to personal preference. The mean operative time was 19 ± 7.5 min (range 11–65 min). The mean hospital stay was 3 ± 1 days (range 1–7 days). The high mean hospital stay was due to nephrological reasons in most cases.

Figure 4: Introduction of CAPD catheter. CAPD: Continuous ambulatory peritoneal dialysis

Patient comorbidities are provided in Table 1 and complications in Table 2. No major intraoperative complications were noted. 3.76% patients had bleeding and 0.78% had omental injury. None of them had bowel injury. Pericatheter fluid leak after surgery was noted in 2% and all of them were managed with a compression dressing. Wound site hematoma was noted in 1.63%, all were managed with a compression dressing barring one patient who needed re-exploration and control of bleeding points. Two patients developed infection in the hematoma and were managed with opening of one or two dependent stitches, daily dressing and prolonged antibiotics. Protrusion of the cuff at the exit site was noted in 2.6% of patients and needed repositioning. Incisional hernia noted in 1% of patients and needed catheter removal and hernia repair.

Regarding infective complications, an overall peritonitis rate of 0.45 episodes/patient/year was noted. Culture-positive peritonitis was observed in 54% instances, majority of organisms leading to culture-positive peritonitis were Gram-positive in 54.6%, followed by Gram-negative in 33.8%, fungi in 8.4%, and tuberculous in 3.2%. Technical success with good outflow from catheter was noted in all patients after surgery except five patients. These five patients had a poor outflow after insertion despite all the efforts and they were labeled as primarily nonfunctional. Outflow failure in the 1st month was noted in 66 patients. The reason for outflow failure was catheter-tip migration in 34 patients, occluding clots in 14 patients, development of omental wrap-around catheter in 6 patients, and a kink

Table 1: Associated comorbidities

Comorbidities	*n* (%)
Diabetes	760 (53.9)
Hypertension	1301 (92.27)
Hepatitis C	66 (4.68)
Hepatitis B	50 (3.54)
HIV	35 (2.48)
Severe obesity	121 (8.58)

in the subcutaneous tunnel in 4 patients. Eight patients needed catheter removal permanently as they developed refractory peritonitis within 1 month of surgery and were labeled as early catheter failures. The reasons for permanent catheter removal are shown in Table 3. The most common reason was refractory peritonitis in 21%, followed by flow failure in 7%, and ultrafiltration failure in 6.5%.

3.5% functioning catheters were removed as the patients underwent successful renal transplant and 1.4% opted for catheter removal due to personal reason as they wished to discontinue PD. The death-censored technical survival rate was 94.3%, 83.2%, 75.9%, 69.2%, and 60.6% patients at 1 year, 2 years, 3 years, 4 years, and 5 years. Totally 32.4% of patients expired during the study. The 1-year, 2-year, 3-year, 4-year, and 5-year patients survival rate was 89%, 79.1%, 68.2%, 60%, and 52.6%, respectively.

Table 2: Mechanical and infectious complications

Complications	Types	*n* (%)	Management
Mechanical complications	Bleeding	53 (3.76)	Intraoperative control of diffuse bleed with energy sources and focal point bleed with suture ligation
	Omental injury	11 (0.8)	Managed with suture ligation
	Bowel injury	0	-
	Pericatheter fluid leak	28 (2)	Compression dressing
	Hematoma	23 (1.63)	Compressive dressing except one, who needed exploration and control of bleeding points
	Scrotal swelling	25 (1.78)	1.20% - Surgical repair 0.60% - Conservative management
	Incisional hernia	14 (1)	Catheter removal, hernia repair, and reinsertion on the opposite site
	Protrusion of cuff at exit site	37 (2.6)	Shaving of extruded cuff and re-positioning
Infectious complications	Exit site infection	28 (2)	Oral/Intravenous antibiotics, topical antibiotics, and adequate wound care
	Tunnel site infection	21 (1.5)	Managed conservatively except one needing change of catheter
	Peritonitis	339 (24)	62.5% was managed by intravenous and/or intraperitoneal antibiotics and 37.5% needed catheter removal

Table 3: Reason for catheter removal

Reason for catheter removal	*n* (%)
Refractory peritonitis	296 (21)
Flow failure	99 (7)
Ultrafiltration failure	92 (6.5)
Renal transplantation	49 (3.5)
Personal reason	20 (1.4)

DISCUSSION

PD catheter placement is a straightforward procedure but the challenge lies in getting good technical success. This procedure is performed by nephrologists, urologists, transplant surgeons, and even by general surgeons.[5-7] The techniques to insert PD catheters vary between different centers and also vary according to geographical location.[8] The PD catheter can be placed using an open dissection technique, or with the use of a laparoscope approach, or can be inserted percutaneously. The ultimate goal should be safe placement of technical successful catheter irrespective of the technique.[5,7,8] A meta-analysis by Xie *et al*. revealed that laparoscopic and open approaches were comparable in terms of complications rate and catheter success rate.[9]

A few studies have reported the experience of PD catheters in India, but our study has a larger number.[5,6,8] We have been using the open dissection technique at our institute for the past 20 years and modified it with time to get good results. Despite training in advanced laparoscopy, we used the laparoscopic approach in only 60 patients out of a total of 1576 catheter placement, particularly in patients with the previous laparotomy and major abdominal surgery (30 patients) in anticipation of dense adhesion leading to difficult placement by the open technique. None of our patients, chosen for the open technique, had a previous laparotomy for major abdominal surgery. Twenty-four patients planned for open technique had a history of open cholecystectomy. We also opted for the laparoscopic approach in patients with previously failed CAPD catheter insertion (20 patients). Laparoscopy in these cases helped in performing adhesiolysis and in placing the catheter tip at the desired location.[9,10] The mean age in our study was comparable to other Indian studies.[6,8] The male outnumbered the female candidates, which was also shown in other Indian studies.[11,12] The mean duration of follow-up was 72 ± 18 months with minimum follow-up of at least 12 months and maximum of 120 months. Only a few studies have reported follow-up of 5 years.[13,14]

PD catheters are available in a variety of shapes such as straight, coiled, and swan neck. The length and number of Dacron cuffs may also vary for optimal in-growth and fixation.[15,16] A systemic review and meta-analysis by Hagen *et al*. revealed no significant difference between swan-neck and straight tip catheter and also between single and double cuff catheter, but they found that the success rate was more favorable in straight tip in comparison to coiled-tip catheters.[16] We also used a straight Tenckhoff catheter with double cuff in our cases.

Laparoscopic insertion is usually performed under general anesthesia, whereas insertion by open technique can be performed under general or regional or local anesthesia.[9,10]

ESRD patients usually have associated comorbidities, placing them at higher-risk for general anesthesia. The aim of any technique should be a painless uncomplicated procedure with excellent outcomes.[17,18] We were able to place the catheter under local anesthesia and only 12 patients needed general anesthesia, as 7 patients were apprehensive for local anesthesia and 5 patients were converted to general anesthesia due to severe pain. We use two mastoid self-retaining retractors, a larger one at subcutaneous level and another small retractor at rectus muscle level. Vigiola *et al*. also used a single self-retaining Weitlaner retractor and two Allis clamps pulled by the assistants for retraction. Using two self-retaining retractors provides optimal exposure and decreases the need of assistance in our technique.[19]

We did not observe any major intraoperative complications. As ESRD patients are prone to bleeding complications, energy source should be used judiciously for good hemostasis.[20] Wani *et al*. reported wound site hematoma in 2.6% of cases operated by open technique.[21] In our study, only 1.63% of cases developed wound site hematoma and all were managed with compressive dressing barring one, who needed exploration and control of bleeding points. Chow *et al*. reported incidence of injury to internal organ in 1.0%–1.4% of cases and bowel injury in 0.8% cases in open technique.[22] We did not observe any case of bowel injury probably owing to the simple technique of lifting peritoneum with artery forceps and giving small cut in peritoneum using a knife before opening it adequately. We usually avoid open technique in patients with previous major abdominal surgery in anticipation of adhesions. In cases with bowel adhesions at the incision site, we extended the incision to get better exposure and perform gentle dissection to release bowel loops.

The incidence of peri-catheter leakage is reported to be approximately 5% and the reasons include technical factors, immediate PD initiation, and weakness of abdominal wall tissue.[23] We tried to perform watertight closure of peritoneum and posterior rectus sheath and initiated PD after giving enough time to mature leading to leakage in only 2%.

Among late complications, protrusion of cuff at exit site was noted in 2.6% and was managed with shaving of extruded cuff and re-positioning. The incidence of cuff extrusion has been reported to be around 3.6%–17% and the reasons mentioned are short tunnel and/or recurrent ESIs.[24] We mark the exit site of cuff at an adequate distance from the main incision site to preventing extrusion. No case of preperitoneal migration of CAPD catheter was noted in our study. Incisional hernia noted in 1% needing catheter removal, hernia repair, and re-insertion on the opposite site at a later date. The reasons for incisional hernia can be attributed to poor wound healing and/or poor musculature in CKD patients.[25] Among long-term complications, scrotal swelling was found in 1.78%. Scrotal edema is an uncommon complication in patients undergoing CAPD, reported in 2%–4% of patients. The causes mentioned are usually inguinal hernia, patent processus vaginalis, peritoneal tears, and leakage around the dialysis catheter.[26] In our study, 1.20% was having obvious inguinal hernia or PPV managed with surgical repair. Rest was having peritoneal tear and managed conservatively by providing optimal healing time.

The infection rate in various studies has been observed between 0.24 and 1.66 episodes per patient years.[27,28] We observed a peritonitis rate of 0.49 episodes/patient/year in our study. Another Indian study reported a culture positivity in 32.7% in first half of the study and increased to 45.8% in the second half of the study period. In their study, Gram-positive microorganisms were isolated in 60.5%, followed by Gram-negative in 31.6% and Candida in 7.7%.[29]

The primary nonfunctional rate has been reported around 1.1%–18.6% in literature.[30,31] The reasons have been attributed to catheter tip mal-position or dense adhesion or omental wrapping around the catheter.[30,31] The utmost importance given to correct placement and checking flow at various steps may decrease primary nonfunctionality. The outflow failure in early period may be due to multiple reasons, including occlusion of the catheter by a clot, kinking in the subcutaneous tunnel, omental wrap-around catheter, or catheter-tip migration.[18]

Early peritonitis has been reported in the range of 1.1%–12.5% in literature.[13,32] Early infection can be related to the procedure, breaches in sterility, or inappropriate use of prophylactic antibiotics.[13,32] We used prophylactic antibiotic in every case and used no-touch technique while inserting catheter. We even used two Kelly clamp; one for checking hindrance in passage and another one to insert the catheter. We avoided touching the proximal part of the catheter to be placed intraperitoneal. We catch the tip of the catheter with Kelly clamp and handled only distal most part of the catheter for insertion.

The most common reason for catheter removal in our study was infection followed by flow failure and ultra-filtration failure. The catheter survival rates at 5 years mentioned in literature are variable, ranging from 27% to 70.0%.[33,34] The factor contributing to wide variability of catheter survival between different centers is associated with the experience of centers in PD and number of patients undergoing PD per day. The centers with less than 20 patients on PD had lower technical survival rates in comparison to large centers.[16,33,34] Our center with 20 years of experience in PD has good numbers of PD patients, which may explain our favorable catheter survival rates. The survival of patients on PD at 5 years mentioned in literature is variable, ranging from 11% to 78%. Young age, absence of diabetes, nonsmokers, good nutritional status, and city dwellers are some of the factors

associated with good survival.[5,6,8,35] In our study, majority were city dwellers with a mean age of 52.8 years, which may explain comparatively better survival.

The major limitation of our study is that it is a single-center retrospective study. The strength lies in the inclusion of a large number of cases, using single-center uniform surgical technique and long duration of follow-up.

CONCLUSIONS

PD catheter placement is a straightforward procedure but the challenges lie in getting good technical success rate. The open dissection method of PD catheter insertion using local anesthesia at well-experienced center is a simple, painless, and uncomplicated procedure with excellent outcomes. Optimal exposure, judicious use of energy source, and using appropriate technique provide good technical success rate with lesser complications.

REFERENCES

1. Li PK, Chow KM. Peritoneal dialysis patient selection: Characteristics for success. Adv Chronic Kidney Dis 2009;16:160-8.
2. Davies SJ. Comparing outcomes on peritoneal and hemodialysis: A case study in the interpretation of observational studies. Saudi J Kidney Dis Transpl 2007;18:24-30.
3. Jaar BG, Coresh J, Plantinga LC, Fink NE, Klag MJ, Levey AS, *et al.* Comparing the risk for death with peritoneal dialysis and hemodialysis in a national cohort of patients with chronic kidney disease. Ann Intern Med 2005;143:174-83.
4. Figueiredo A, Goh BL, Jenkins S, Johnson DW, Mactier R, Ramalakshmi S, *et al.* Clinical practice guidelines for peritoneal access. Perit Dial Int 2010;30:424-9.
5. Vikrant S. Long-term clinical outcomes of peritoneal dialysis patients: 9-year experience of a single center from north India. Perit Dial Int 2014;34:426-33.
6. Prasad N, Gupta A, Sinha A, Singh A, Sharma RK, Kumar A, *et al*. A comparison of outcomes between diabetic and nondiabetic CAPD patients in India. Perit Dial Int 2008;28:468-76.
7. Abraham G, Pratap B, Sankarasubbaiyan S, Govindan P, Nayak KS, Sheriff R, *et al.* Chronic peritoneal dialysis in South Asia – challenges and future. Perit Dial Int 2008;28:13-9.
8. Abraham G, Kumar V, Nayak KS, Ravichandran R, Srinivasan G, Krishnamurthy M, *et al.* Predictors of long-term survival on peritoneal dialysis in South India: A multicenter study. Perit Dial Int 2010;30:29-34.
9. Xie H, Zhang W, Cheng J, He Q. Laparoscopic versus open catheter placement in peritoneal dialysis patients: A systematic review and meta-analysis. BMC Nephrol 2012;13:69.
10. Oğünç G, Tuncer M, Oğünç D, Yardimsever M, Ersoy F. Laparoscopic omental fixation technique versus open surgical placement of peritoneal dialysis catheters. Surg Endosc 2003;17:1749-55.
11. Karthikeyan B, Sharma RK, Kaul A, Gupta A, Prasad N, Bhadauria DS. Clinical characteristics, patient and technique survival in elderly patients on peritoneal dialysis. Indian J Nephrol 2019;29:334-9.
12. Makkar V, Kumar M, Mahajan R, Khaira NS. Comparison of outcomes and quality of life between hemodialysis and peritoneal dialysis patients in Indian ESRD Population. J Clin Diagn Res 2015;9:C28-31.
13. Vaux EC, Torrie PH, Barker LC, Naik RB, Gibson MR. Percutaneous fluoroscopically guided placement of peritoneal dialysis catheters – A 10-year experience. Semin Dial 2008;21:459-65.
14. Moon JY, Song S, Jung KH, Park M, Lee SH, Ihm CG, *et al.* Fluoroscopically guided peritoneal dialysis catheter placement: Long-term results from a single center. Perit Dial Int 2008;28:163-9.
15. Johnson DW, Wong J, Wiggins KJ, Kirwan R, Griffin A, Preston J, *et al*. A randomized controlled trial of coiled versus straight swan-neck Tenckhoff catheters in peritoneal dialysis patients. Am J Kidney Dis 2006;48:812-21.
16. Hagen SM, Lafranca JA, IJzermans JN, Dor FJ. A systematic review and meta-analysis of the influence of peritoneal dialysis catheter type on complication rate and catheter survival. Kidney Int 2014;85:920-32.
17. Javid MJ, Rahimi M, Keshvari A. Dissociative conscious sedation, an alternative to general anesthesia for laparoscopic peritoneal dialysis catheter implantation: A randomized trial comparing intravenous and subcutaneous ketamine. Perit Dial Int 2011;31:308-14.
18. Peppelenbosch A, van Kuijk WH, Bouvy ND, van der Sande FM, Tordoir JH. Peritoneal dialysis catheter placement technique and complications. NDT Plus 2008;1:v23-8.
19. Vigiola Cruz M, Bellorin O, Srivatana V, Afaneh C. Safety and efficacy of bedside peritoneal dialysis catheter placement in the COVID-19 era: Initial experience at a New York city hospital. World J Surg 2020;44:2464-70.
20. Acedillo RR, Shah M, Devereaux PJ, Li L, Iansavichus AV, Walsh M, *et al.* The risk of perioperative bleeding in patients with chronic kidney disease: A systematic review and meta-analysis. Ann Surg 2013;258:901-13.
21. Wani IA, Sheikh RY, Wani MM, Hamid A, Bhat GM, Bhat NA. Comparison of percutaneous versus open surgical techniques for placement of peritoneal dialysis catheters. JMS SKIMS 2019;22:54-7.
22. Chow KM, Szeto CC, Leung CB, Kwan BC, Pang WF, Li PK. Tenckhoff catheter insertion by nephrologists: Open dissection technique. Perit Dial Int 2010;30:524-7.
23. Sakurada T, Ueda A, Komukai D, Uchiyama K, Tsujimoto Y, Yuasa H, *et al.* Outcomes after peritoneal dialysis catheter placement by laparoscopic surgery versus open surgery: Systematic review and meta-analysis. Ren Replace Ther 2019;5:37.
24. Debowski JA, Wærp C, Kjellevold SA, Abedini S. Cuff extrusion in peritoneal dialysis: Single-centre experience with the cuff-shaving procedure in five patients over a 4-year period. Clin Kidney J 2017;10:131-4.
25. Sandhu S, Dickerman R, Smith B, Shetty A. Incisional hernia after peritoneal dialysis catheter placement in a patient on sirolimus. Adv Perit Dial 2017;33:35-9.
26. Haggerty SP, Jorge JM. Laparoscopy to evaluate scrotal edema during peritoneal dialysis. JSLS 2013;17:429-32.
27. Shigidi MM, Fituri OM, Chandy SK, Asim M, Al Malki HA, Rashed AH. Microbial spectrum and outcome of peritoneal dialysis related peritonitis in Qatar. Saudi J Kidney Dis Transpl 2010;21:168-73.
28. Akoh JA. Peritoneal dialysis associated infections: An update on diagnosis and management. World J Nephrol 2012;1:106-22.
29. Sood V, Kumar V, Ramachandran R, Gupta S, Gautam V, *et al*. Incidence, microbiological spectrum and outcomes of infective peritonitis in chronic peritoneal dialysis patients. J Clin Nephrol Ren Care 2020;6:049.
30. Sivaramakrishnan R, Gupta S, Agarwal SK, Bhowmik D, Mahajan S. Comparison of outcomes between surgically placed and percutaneously placed peritoneal dialysis catheters: A retrospective study. Indian J Nephrol 2016;26:268-74.
31. Dogra PM, Hooda AK, Shanmugraj G, Pramanik SK. Continuous ambulatory peritoneal dialysis catheter insertion technique: A comparative study of percutaneous versus surgical insertion. Indian J Nephrol 2018;28:291-7.
32. Gadallah MF, Pervez A, el-Shahawy MA, Sorrells D, Zibari G, McDonald J, *et al.* Peritoneoscopic versus surgical placement of peritoneal dialysis catheters: A prospective randomized study on outcome. Am J Kidney Dis 1999;33:118-22.

33. Singh N, Davidson I, Minhajuddin A, Gieser S, Nurenberg M, Saxena R. Risk factors associated with peritoneal dialysis catheter survival: A 9-year single-center study in 315 patients. J Vasc Access 2010;11:316-22.
34. Ko YK, Kim YB, Shin WJ, Lim CH, Cheon W, Park JH, *et al*. Effects of early detection of peritoneal catheter migration on clinical outcomes: 15-years experiences from a single centre. Nephrology (Carlton) 2020;25:413-20.
35. Litwin M, Grenda R, Prokurat S, Abuauba M, Latoszyñska J, Jobs K, *et al*. Patient survival and causes of death on hemodialysis and peritoneal dialysis – Single-center study. Pediatr Nephrol 2001;16:996-1001.

How to cite this article: Pahwa M, Singh M, Tyagi V, Gupta M, Jain S, Chaddha S, *et al*. Continuous ambulatory peritoneal dialysis catheter insertion by open technique: 20-year experience from a single center. Indian J Urol 2023;39:46-52.