Research Square

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Modified laparoscopic peritoneal dialysis catheter placement using abdominal wall suspension fixation for peritoneal dialysis patients: a case series

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Abstract

Laparoscopic technology has some advantages over open techniques for peritoneal dialysis catheterization (PDC) insertion, particularly in terms of minimal trauma, improved visualization and others. We aimed to present a retrospective case series of an improved, minimally invasive laparoscopic PDC external fixation method with a relatively simple surgical procedure. This case series included 127 patients who underwent a modified laparoscopic peritoneal dialysis catheterization method (AMLPDCM) at The First Affiliated Hospital of Zhejiang Chinese Medical University, with clinical data extracted from medical records. Preoperative data including sex, age, body mass index (BMI), and primary disease were collected. Surgical parameters such as operative time and surgical outcome were analyzed. Peritoneal function status and complications (e.g., catheter migration, peritonitis) were also evaluated. This study included 127 patients with a mean age of 55.94 ± 12.50 years. Among them, 114 (89.76%) had hypertension, 47 (37.01%) had diabetes, and the mean preoperative serum creatinine level was 743.65 ± 254.49 μmol/L. This modified technique was relatively safe with fewer complications. Our study introduces a new external fixation method for laparoscopic PDC placement, which reduces the risk of catheter displacement, significantly improves tip positioning accuracy, and promotes wound healing.

Introduction

Chronic kidney disease (CKD) is a major global health issue and is an independent risk factor for cardiovascular disease and all-cause mortality[1–3]. As CKD progresses to end-stage renal disease (ESRD), the risk of death for patients increases significantly[4], and these patients require renal replacement therapy (RRT), with hemodialysis or peritoneal dialysis (PD) being the most common form of RRT[5].

PD has advantages such as effective protection of residual kidney function, low cost, and ease of operation[6]. It is widely acknowledged as a more flexible, safe, and effective treatment for ESRD compared with hemodialysis, and has been used as a renal replacement therapy for nearly a century[7]. However, PD also causes some issues, including peritonitis, catheter displacement, dialysate leakage, and outflow obstruction [8].

Moreover, dialysis technology is constantly improving, the main methods for PDC insertion include bedside percutaneous implantation, open surgical insertion, peritoneoscopic insertion, and laparoscopic insertion[9]. Laparoscopic technology has replaced the open surgery, as it reduces the incidence of catheter malfunction, shortens operation time, and lowers the rate of short-term complications compared with open surgery[10]. Notably, catheter migration and outflow obstruction remain non-negligible issues even with laparoscopic placement[11], and available external fixation techniques often require additional instruments or prolonged operative time. To address these limitations, we aimed to introduce an improved, minimally invasive laparoscopic PDC external fixation method that involves a relatively simple surgical procedure, and to report a retrospective case series.

Materials and methods

Patients

This retrospective analysis included 127 patients with ESRD who underwent modified laparoscopic peritoneal dialysis catheterization at the nephrology department of The First Affiliated Hospital of Zhejiang Chinese Medical University from December 2019 to May 2025. The mean follow-up period after catheter insertion was approximately 1 year, and clinical data were collected and retrospectively analyzed. The inclusion criteria were: (1) diagnosis of ESRD requiring peritoneal dialysis (PD); (2) age > 18 years at the time of catheterization. For patients with a history of abdominal surgery, laparoscopy was recommended for peritoneal dialysis catheter (PDC) placement.. The characteristics of laparoscopic PDC placement using a suture passer and those of open surgical PDC insertion were explained to the patients. The choice of PDC placement method was based on patient preference, physical condition, ability to tolerate general anesthesia, obesity, and history of abdominal surgery. Written informed consent for publication of these details was obtained from all individual participants.

Statement of ethical approval

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of The First Affiliated Hospital of Zhejiang Chinese Medical University (approval No. 2025-KLS-755-02). The data were anonymous, and the requirement for informed consent was therefore waived.

Operative technique

Following anesthesia, routine disinfection and draping were performed. The patient was placed in the head-high foot-low position. A transverse incision was made approximately 5 mm above the center of the umbilicus. An insufflation needle was inserted, and carbon dioxide was injected to achieve an intra-abdominal pressure of approximately 12 mmHg. A 10 mm trocar was inserted, a light source was introduced, and laparoscopic visualization was established. A three-port Trocar puncture was performed using the three-hole method. The other two operation ports were designated as Port B(approximately 4 cm below the umbilicus on the left side) and port C(near the McBurney point on the right side). Two 5 mm Trocars were inserted into each port. For the left entrance, a 5 mm trocar was used to create a 2–3 cm transitional tunnel beneath the fat and muscle layers. The peritoneal dialysis catheter was pulled into the abdominal cavity using a laparoscopic grasper. The cuff was fixed to the rectus abdominis muscle and confirmed to be located at the base of the pelvis. The catheter was fixed above the pouch of Douglas using a Pediatric Hernia Hook with Prolene 3/0 suture, and the knot was made and buried under the skin. A tunnel was created using a tunnel needle, and the catheter was led out through the skin. A titanium connector and short tube were then connected. There was no active bleeding, and the positions of internal and external cuffs were confirmed. The insufflation needle was removed, the laparoscopic

equipment was withdrawn, and the abdominal rectus abdominis external sheath was sutured layer by layer. The internal sheath of the umbilical upper port was sutured with the posterior sheath and the peritoneum. The internal cuff was fixed, the remaining fascial layers of the incision were sutured, the skin was then sutured, disinfected, and a dressing was applied. Specific surgical procedures are shown in Figs. 1 and 2. A cartoon schematic diagram shows the site of three-port trocar puncture(Fig. 3).

Postoperative catheter use and follow-up

Abdominal flushing was performed on the first postoperative day. Unless there are any special circumstances, patients are required to attend regular monthly outpatient visits. Medication adjustments are made based on the results. Peritoneal dialysis evaluation is conducted six months postoperatively. Abdominal X-rays are performed every six months to monitor catheter displacement. In cases of poor catheter drainage, X-rays should also be obtained.

Data collection

Baseline patient information, including sex, age, body mass index (BMI), and primary disease, was collected preoperatively. Surgical conditions, including operative duration and surgical outcome, were subsequently analyzed. Peritoneal function status and complications (e.g., catheter migration and peritonitis) were evaluated at 12 months postoperatively.

Statistical analyses

Statistical analyses were performed using SPSS Statistics (version 25.0). Continuous variables following a normal distribution are presented as mean ± standard deviation, and categorical variables are presented as counts (percentages).

Results

This study comprised 127 patients who underwent modified laparoscopic peritoneal dialysis catheterization (AMLPDCM). There were 77 men and 50 women, with a mean age of 55.94 ± 12.50 years and a mean BMI of 23.99 ± 3.66. Before surgery, the mean serum creatinine was 743.65 ± 254.49μmol/L. A history of abdominal surgery and hemodialysis was present in 25 patients(19.69%) and 24 patients(18.90%), respectively (Table 1).

The mean operative time was 1.16 ± 0.41 hours. In the AMLPDCM group, four patients underwent extubation without dialysis, six switched from peritoneal dialysis to hemodialysis for reasons other than catheter malfunction or infection, and one patient died due to cerebral hemorrhage. During the 1-year follow-up, the rate of catheter migration was relatively low (4.76%), while the rates of exit-site infection, dialysate leakage from the wound, wound hemorrhage, and peritonitis were 6.30%, 13.39%, 27.56%, and 11.11%, respectively (Table 2).

Table 1
Demographic and clinical characteristics of ESRD patients

Age	**AMLPDCM(n = 127)**
	55.94488189 ± 12.49908383
Sex(Male)	77(60.63%)
BMI	23.98889947 ± 3.66171915
sCr(μmol/L)	743.6488189 ± 254.4920462
Hypertension	114(89.76%)
Diabetes	47(37.01%)
history of abdominal operation	25(19.69%)
Midline laparotomy	8(6.3%)
History of hemodialysis	24(18.90%)
Previous history of peritoneal dialysis tube insertion	5(3.94%)

Table 2
Operative process and postoperative complications

time of operation	**AMLPDCM(n = 127)**
	1.159894737 ± 0.40802194
hernia repair	7(5.6%)
The recurrence rate of hernia	1(0.81%)
Outcome normal use	116(91.34%)
Extubation(transplantation or not on dialysis)	4(3.15%)
Hemodialysis	6(4.72%)
Death	1(0.79%)
wound infection	0(0%)
Infection at the exit location	8(6.30%)
Leakage of dialysis fluid from the wound	17(13.39%)
wound hemorrhage	35(27.56%)
catheter migration	6(4.76%)
peritonitis	14(11.11%)

Discussion

Laparoscopic surgery has largely replaced traditional open surgery, which is associated with greater trauma and often requires the expertise of highly experienced surgeons. In contrast, laparoscopic techniques offer advantages such as reduced surgical trauma and faster postoperative recovery[12]. A meta-analysis of pediatric peritoneal dialysis catheterization demonstrated that, compared with open surgery, laparoscopic catheterization was associated with a lower risk of reoperation and peritonitis[13]. A meta-analysis of RCTs revealed that the laparoscopic approach had a lower incidence of catheter displacement and catheter removal than the traditional approach, although the incidence of bleeding was relatively higher in the laparoscopic group[14]. In the present study, the rate of wound hemorrhage in the AMLPDCM group was 27.56%. Therefore, further large-sample, multicenter, high-quality RCTs are needed to address this question.

Currently, catheter dysfunction remains the primary cause of peritoneal dialysis catheter failure. In response, many researchers have proposed modifications to the conventional laparoscopic technique. The 2023 guidelines for peritoneal dialysis catheter placement also recommend the use of advanced modified laparoscopic insertion techniques when appropriate[15]. To date, there have been few reports on the use of a three-port approach (including the use of a 5 mm Trocar for two of the ports) combined with abdominal wall suspension fixation for PD catheter placement. This technique not only reduces surgical trauma but also helps prevent catheter displacement.

In this study, we adopted a three-port method (including two 5 mm Trocars) combined with abdominal wall suspension and fixation of the PDC. This approach enabled direct visualization of adjunctive surgeries, such as adhesion release and catheter fixation. Compared with conventional laparoscopic surgery, the use of two 5 mm Trocars resulted in less abdominal wall trauma, which significantly promoted wound healing. Multiple studies have demonstrated that trocar size ≥ 10 mm is associated with an increased rate of hernia development, whereas the use of 5 mm trocars results in smaller fascial defects and reduced tissue trauma[16, 17]. Moreover, the three-port method is simple in steps and easy for junior physicians to learn and master. The key points of laparoscopic PD catheter placement are the insertion and fixation of the catheter. Currently, common insertion techniques include using a 10 mm Tocar to pass the catheter under direct vision, or using a guidewire to introduce the PD tube into the abdominal cavity. However, these methods are associated with several disadvantages, including excessively large trocar incisions, greater tissue damage, and delayed wound healing, which can easily lead to peritoneal dialysis fluid leakage and an increased risk of incisional hernia, among other adverse outcomes. So we recommend using a 5 mm Trocar with double holes for peritoneal dialysis catheter introduction. Regardless of whether a straight or curved catheter is used, it can be precisely delivered from hole B to the pouch of Douglas using an "operating lever"(Fig. 1), thereby avoiding excessive bleeding or tissue damage. The smaller trocar diameter facilitates wound healing and prevents leakage of peritoneal dialysis fluid.

Catheter fixation in laparoscopic surgery commonly involves three methods: subcutaneous tunnel burial, internal fixation, and external fixation. The subcutaneous tunnel burial method employs an extraperitoneal puncture to create a tunnel, after which the dialysis catheter is advanced into the pelvic cavity through a peel-away sheath. However, a drawback of this method is that if the tunnel is too short, the catheter tip may still drift; if it is too long, it causes greater tissue damage. When the internal fixation method is used, removal of the PD catheter requires a repeat laparoscopic procedure to cut the fixation suture between the catheter and the abdominal wall. This endoscopic operation is technically demanding and difficult to master.

Alternatively, the external fixation method can be utilized, and this technique is our preferred approach. In prior studies, external fixation has been achieved through techniques such as percutaneous puncture 3 cm below the umbilicus or by using a syringe needle to create a silk thread loop through which the catheter is passed and secured. In contrast, we performed percutaneous puncture and endoscopic external fixation above the pubic symphysis, an area that avoids rich blood vessels and subcutaneous fat, making the procedure intuitive, safe, and easy to operate. Furthermore, we introduced an innovative external fixation method involving a U-shaped suture configuration at the puncture site, which can effectively prevent future catheter migration caused by suture knot slippage over time. Owing to the adoption of this technique, the rate of catheter displacement at our center is notably lower(4.76%) than previously reported incidences (range 5%–35%)[18].

Our center adopt a 5 mm double-hole Trocar to introduce a peritoneal dialysis catheter through abdominal wall suspension fixation, with the features of simple operation, easy learning, minimal surgical trauma, faciliteted wound healing, and reduced postoperative dialysate leakage.

In summary, our study introduced a new external fixation method for laparoscopic placement of peritoneal dialysis catheters. This technique reduces the risk of catheter displacement, substantially improves the accuracy of catheter tip positioning, and promotes wound healing. Furthermore, laparoscopic surgery offers the advantage of reduced patient trauma compared with conventional open surgery.. However, given the novelty of this technique, extended follow-up is needed to fully evaluate its complications.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of The First Affiliated Hospital of Zhejiang Chinese Medical University (approval No. 2025-KLS-755-02). The data were anonymous, and the requirement for informed consent was therefore waived.

Consent for publication

Written informed consent was obtained from participants for publication ofthe details of their medical case and any accompanying images.

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Author Contribution

Liqing Ye and Zhejun Chen: Investigation, Data Curation, Writing - Original Draft. Zan Shen:Investigation, Formal Analysis. Jianjian Shi: Investigation, Resources, DataCuration. Fangyan Lu: Investigation, Resource. Shouci Hu: Investigation,Resources. Xi Lin: Investigation,Resources. Hongbo Chen: Conceptualization, Supervision,Writing - Review & Editing, Project Administration.

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Not applicable.

Data Availability

The data that support the findings of this study are available from thecorresponding author upon reasonable request. The data are not publiclyavailable due to their containing information that could compromise theprivacy of the research participant.

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Figures

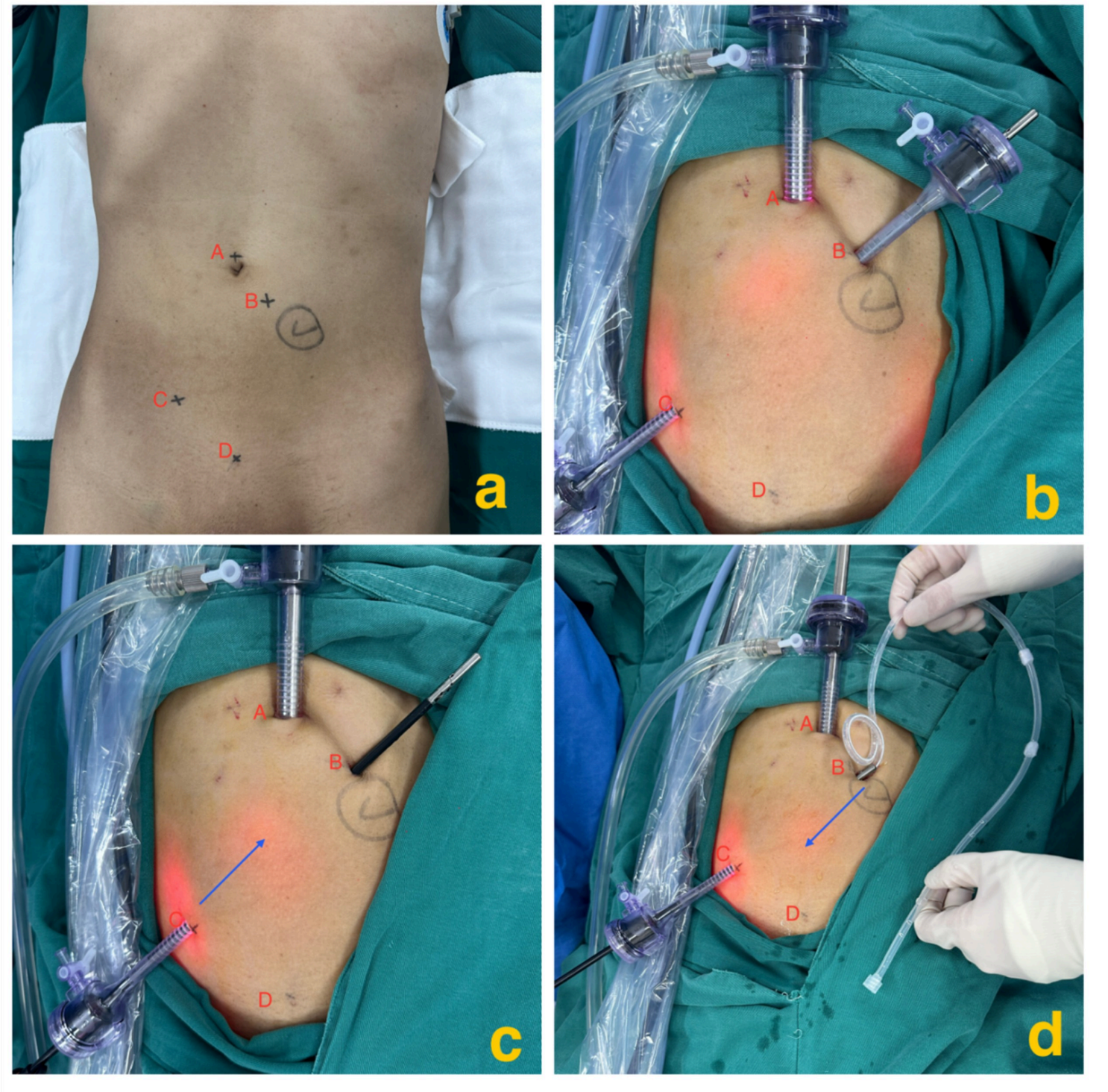


Figure 1

The specific surgical procedures are as follows. The yellow letters represent the sequence of the laparoscopic peritoneal dialysis catheterization. The red letters indicate the locations of the three-port

trocar punctures. Port A trocar puncture is used for laparoscopic visualization. The other two operating ports are Port B (approximately 4 cm below the umbilicus on the left side) and Port C (near the McBurney point on the right side). The dialysis catheter is introduced through Port B and pulled into the abdominal cavity by a laparoscopic grasper inserted through Port C. The blue arrow indicates the direction of movement of the laparoscopic grasper.

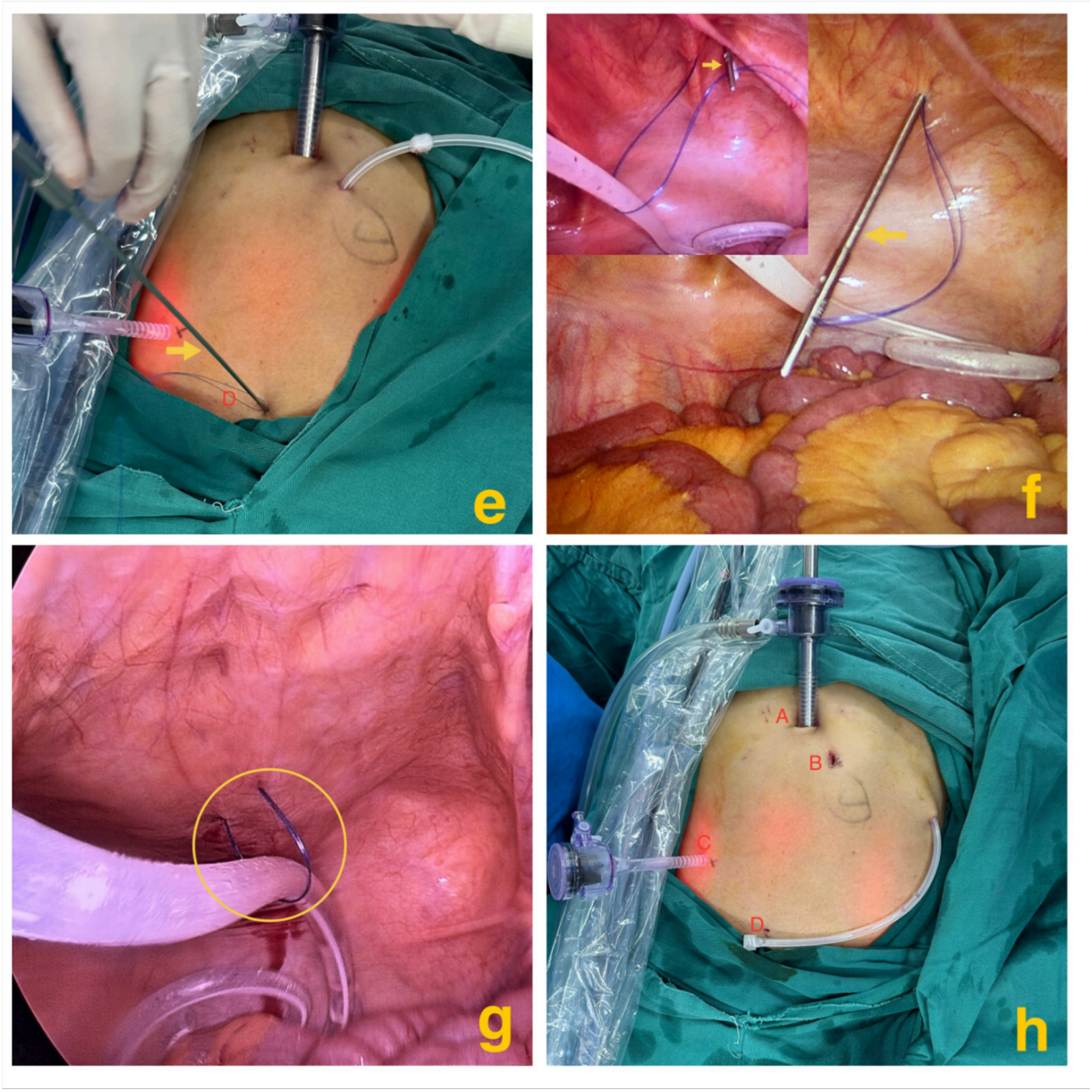


Figure 2

In the specific surgical procedures, the yellow letters represent the sequence of fixing the peritoneal dialysis tube with a Pediatric Hernia Hook. The yellow arrow indicates the Pediatric Hernia Hook, and the yellow circle represents the U-type suture for abdominal wall suspension fixation during peritoneal dialysis catheterization.

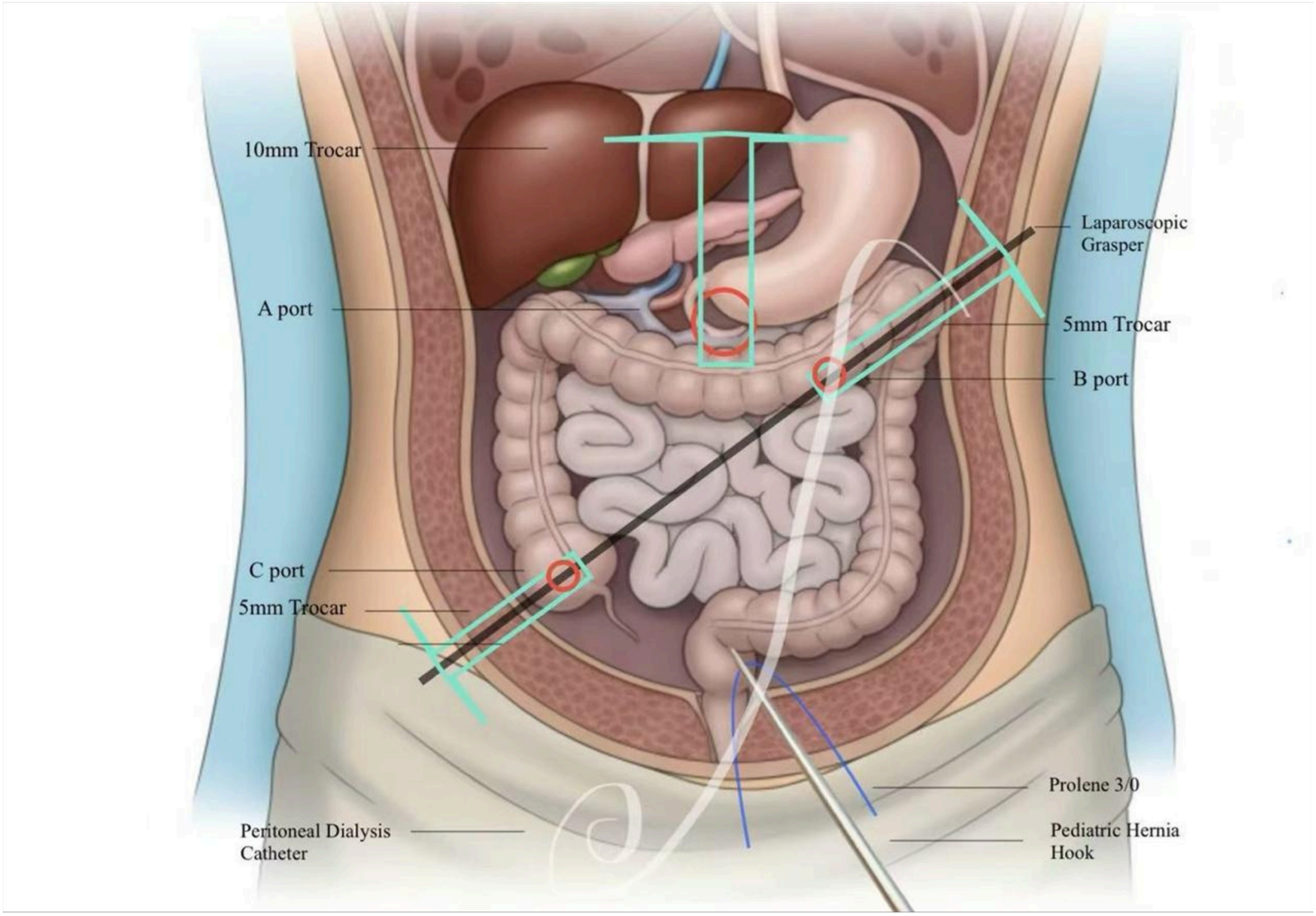


Figure 3

The cartoon schematic diagram shows in detail the sites of the three-port trocar puncture and the fixation the peritoneal dialysis tube using a Pediatric Hernia Hook.