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REVIEW

Peritoneal dialysis access: open versus laparoscopic surgical techniques

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ABSTRACT

Aim: **To outline pros and cons with the open and laparoscopic techniques when placing peritoneal dialysis (PD) catheters.**

Background: **Controversy exists regarding which technique, the open and laparoscopic, if any, is superior to the other. In addition, there is the question of which approach is best in rescuing malfunctioning PD catheters.**

Results: **Rather than promoting one doctrine fits all, philosophically, doing the right thing for the patient by specific criteria is ethically the better model. These specific selection criteria include patient characteristics, the team's skills and knowledge and institutional resources and commitment. Also, the sophistication of a PD unit for training and monitoring of patients is crucial for successful outcomes. Open paramedian and two laparoscopic approaches are described in detail, outlining advantages and disadvantages of each, with suggestions when one method is preferred.**

Conclusions: **In general, the laparoscopic technique is associated with longer operative times, higher costs and the need to utilize general anesthesia. It is, however, the preferred method when rescuing malfunctioning catheters and may increase the PD patient population in patients with previous abdominal surgeries. The dialysis access surgeon should be familiar with both open and laparoscopic techniques and appropriately choose the ideal method based upon the individual patient and institutional resources.**

Key words: Access, Catheter, Dialysis, Laparoscopy, Peritoneal, Surgery

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INTRODUCTION

There are three forms of renal replacement therapy (RRT) available to patients with end-stage renal disease (ESRD). They include hemodialysis (HD), peritoneal dialysis (PD) and kidney transplantation. Although kidney transplantation is the treatment of choice for patients with ESRD, many patients may either not be able to receive a kidney transplant preemptively or even be a candidate for kidney transplantation at all: only 2.7% of the US dialysis population receives a transplant each year. Thus, the two modes of RRT for ESRD patients who have not yet been transplanted are HD and PD. PD has many advantages over HD, including a more flexible schedule for the patient, greater patient survival when compared to HD in the first years of dialysis (1-8) and better preservation of residual renal function (6-11). Despite these advantages of PD over HD, only 8.8% of the US population with ESRD is on PD (12), and there has actually been a decline in the number of patients in the United States who are on PD (13). Even in Europe, data are not satisfactory. In Italy, 14.3% of the dialysis population is treated by PD (14).

PD was first introduced in the 1950s, and in 1968 Tenckhoff described his open surgical approach when placing an indwelling PD catheter (15).

Laparoscopic surgery, also known as minimally invasive surgery, has gained popularity, with many surgeries previously performed open being done laparoscopically. With small incisions made in the abdomen, the peritoneal cavity is insufflated with carbon dioxide and a camera called a laparoscope is introduced. Small working ports are then introduced into the abdomen, allowing surgery to be performed. By the 1990s, there were several reports of placing PD catheters using the laparoscopic approach (16, 17), with some studies discussing the benefits of laparoscopic PD catheter placement in patients who had

previously undergone other abdominal surgeries (18). The benefits of laparoscopic surgery have been said to include smaller incisions, shorter recovery time and/or length of stay after surgery and less pain.

With two different surgical approaches now available for PD catheter placement, the question that needs to be answered is which method should be preferred. Several small studies have indicated that there is no difference in outcomes between the two approaches (19-21). There are no published large multicenter randomized controlled trials comparing which method has better outcomes, although there is one trial that is being developed (22).

A nonsurgical method of placing a PD catheter is the percutaneous approach, which can be done with fluoroscopic assistance or with peritoneoscopic visualization (23). It is beyond the scope of this paper to describe these methods in detail. Both approaches are performed by nephrologists under local anesthesia and conscious sedation and are generally performed in patients who have not had previous abdominal surgeries. Some cited benefits of this approach include placement of the catheter using minimal sedation and the potential that the PD catheter may be placed more expeditiously than if a surgeon were to place it. As will be later discussed, surgically placed PD catheters can also be placed with minimal sedation, and depending upon an institution's resources, surgeons may also place PD catheters expeditiously. This method is mentioned for the sake of completeness and will not be discussed further in this review, as the authors discourage this method due to the risk of inadvertent visceral injury.

This review summarizes the surgical evaluation of the patient, starting from the preoperative visit; the surgical technique, including the advantages and disadvantages associated with the surgical approaches (laparoscopic vs. open) of PD catheter placement; and postoperative management of the patient with a PD catheter.

PREOPERATIVE EVALUATION

The preoperative evaluation is the first step in assessing if a patient is an appropriate candidate for PD. All patients are evaluated by the nephrologist and surgeon, who assess several relevant issues, including visual acuity, manual dexterity, the level of social support and the patient's willingness to perform PD. A lack in any of these can preclude PD, although some limitations can be overcome if the patient has adequate family and/or social support to assist them.

Previous abdominal surgeries and a history of intra-abdominal infections predispose a patient to developing adhesions within the peritoneal cavity. Neither is an absolute contraindication to proceeding with PD catheter placement. With an increasing number of surgeries and/or intra-abdominal infections, a patient is more likely to have extensive adhesions and potentially a higher risk of PD failure. In such scenarios, the authors recommend a laparoscopic approach for placement of a PD catheter as this will allow the surgeon to assess the degree of intra-abdominal adhesions present and the likelihood of PD catheter success or failure.

Timing of catheter placement is also determined at the clinic visit. Ideally, the catheter should be placed 3-4 weeks prior to first use to allow the catheter tract to heal and prevent dialysate fluid leakage. Sometimes a PD catheter needs to be used within the first 24 to 48 hours after placement. In this scenario, the authors advocate an open placement of a PD catheter as this approach minimizes the risk of dialysate fluid leakage. In the open approach, a purse-string suture is placed in the posterior rectus sheath to obtain a watertight seal, which should minimize the rate of fluid leakage.

Obesity does not preclude PD catheter placement. The US population is increasingly becoming overweight, and obese patients can be candidates for PD catheters as well. Caveats to keep in mind include a larger incision if done in the open approach, and modification of the exit site taking into account the patient's pannus and skin folds.

The patient should be examined to assess the ideal location of the PD catheter. This is important as technical problems are strongly associated with catheter failure (12), with one in five technical failures in the first year of PD catheter placement being related to mechanical problems (24). Areas of importance with the catheter include the catheter tip, the subcutaneous tunnel and the exit site. The tip must lie in the true pelvis to allow for proper dialysate exchanges. The exit site of the PD catheter must be placed so that it is easily visible to the patient. It must be away from skin folds or creases and away from the belt line. In the obese patient, the catheter exit site may have to be slightly modified based upon body habitus, possibly being higher than usual when compared to other patients. The subcutaneous tunnel of the PD catheter must be created so that this portion of the catheter has no stresses or kinks that could cause mechanical malfunction.

After this assessment, the patient's skin is marked for catheter placement (Fig. 1). The authors prefer a paramedian approach for placement of the PD catheter. The patient is examined and landmarks, including the umbilicus, the anterior superior iliac spines and pubic symphysis, are noted. It is also important to examine the obese patient in both the supine and upright positions, as landmarks may shift with movement. The authors' preference is to place a PD catheter in the left side of the abdomen for several reasons. Most patients who proceed to kidney transplantation will have the kidney placed in the right iliac fossa as the external iliac vessels are more superficial on the right side. By placing the PD catheter on the left side of the abdomen, transplantation of the kidney into the right iliac fossa is easier as the PD catheter is

Fig. 1 - *Abdomen marked for open PD catheter placement. The patient's head is to the right in this image. The planned incision is 3 cm lateral to the umbilicus. The left side is preferred for a first time PD catheter as a future kidney transplant ideally is placed on the right side for anatomical reasons. Figures 1-12 were copied and reproduced with permission from the publisher (DIVADI LLC, Dallas, TX) (Ref. 30,31,37).*

not in the surgical field. In addition, when the catheter is placed on the left side, peristalsis of the descending colon is thought to help to maintain the catheter in its proper orientation.

Among alternative options, the PD catheter may be placed in the midline below the umbilicus. There are fewer early postoperative complications, longer function of the PD catheter and better overall patient survival with the paramedian approach compared to the midline approach (25). Also in the authors' opinion, with the paramedian approach there are fewer occurrences of postoperative hernias and a lower likelihood of dialysate leak as it is easier to place a purse-string suture around the posterior rectus fascia than in the midline.

PD CATHETER TYPES

There are many different configurations of PD catheters (Tab. I). Most commonly, dual-cuff catheters are preferred (26). The internal cuff is secured at the posterior rectus sheath with the open surgery or in the rectus muscle itself with the laparoscopic technique, while the second cuff is placed in the subcutaneous tissue 1.5-2.0 cm from the skin exit site (27). The intraperitoneal portion of the PD catheter may be straight, curled or weighted, as is the case for the self-locating catheter (28). Compared to the straight models, due to their configuration, coiled catheters are less susceptible to migration and displacement compared to the traditional Tenckhoff catheter (12, 29). Dislocation is a common reason for surgical or laparoscopic catheter repositioning, removal or substitution. Too acute of an angle as the catheter enters the abdomen may contribute to this complication (30, 31). The self-locating heavy tip catheter was designed to avoid dislocation, with fewer

TABLE I - COMMONLY USED PERITONEAL CATHETERS

Tenckhoff and Tenckhoff-modified
Straight
• Classic Tenckhoff
• Short (Vicenza)
• Self-locating, with tungsten weight (Di Paolo)
Coiled
• Tenckhoff
Permanent bend
Swan-neck, with permanent 150° arc, straight and coiled (Different models are available, see (26))

episodes of catheter displacement reported (28). Importantly, the use of the self-locating catheter avoids catheter malposition during traditional open surgery method for catheter placement under local anesthesia, restricting the indication of laparoscopic placement to selected patients with suspect of peritoneal adhesion or other specific problems requiring additional surgery. Occasional difficulties in catheter removal because of omental wrapping around the catheter tip have been reported, but they are easily avoided by a slightly larger incision of the peritoneal wall at the catheter entrance.

The selection of laparoscopic versus open technique is guided by several influences. First, and perhaps most importantly, the surgeon's training will have a decisive impact. It is the authors' opinion that surgeons performing access for dialysis must be trained in all dialysis techniques in order to choose the right mode of dialysis (HD vs. PD) and the optimal access site and technique for each patient at all times. This includes choosing techniques for placing PD catheters. Second, the availability of a trained and dedicated nephrology support team for patient training and monitoring is a basic dialysis requirement regardless of operative method used and will greatly affect the outcome (12). Third, patient factors will impact the choice of technique. For example, individuals with severe cardiopulmonary impairment will not tolerate abdominal insufflation and therefore may be selected for the open approach with general anesthesia and endotracheal intubation or local anesthesia with carefully titrated IV sedation.

OPERATIVE TECHNIQUES

The two surgical approaches in placing a PD catheter that will be discussed are the open (paramedian) and the laparoscopic approaches. There have been only a few studies examining if one surgical approach has better outcomes than the other (19-21). All studies have concluded that neither approach is superior when examining outcome, but there are longer operative times associated with

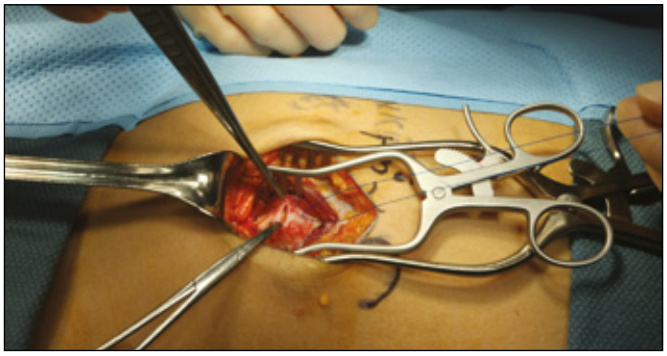

Fig. 2 - *A purse-string suture (polypropylene 2-0 on an SH needle) is placed around the small incision in the posterior rectus sheath in such a way that the knot will be tied in the cephalad aspect of the catheter and behind the Dacron cuff. The same stitch is placed through the posterior aspect of the Dacron cuff keeping the catheter orientation firmly in place on top of the posterior rectus muscle fascia and behind the rectus muscle.*

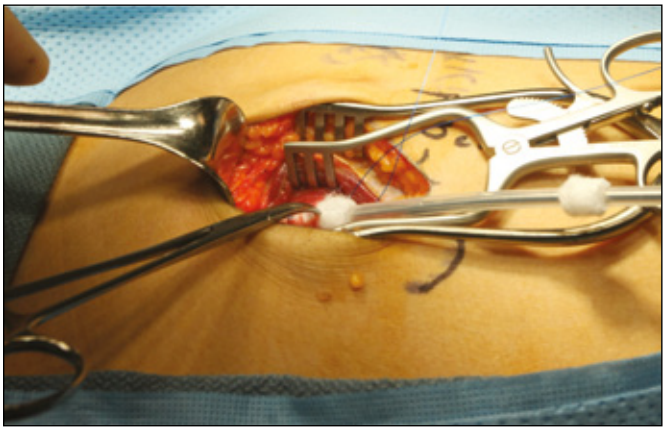

Fig. 3 - *PD catheter inserted into the abdomen with the stiffening guide wire partially in the catheter. The guide wire is pulled back to allow the curled portion to re-coil. This also prevents visceral injuries from the guide wire's sharp end as the catheter is allowed to slide into the pelvis.*

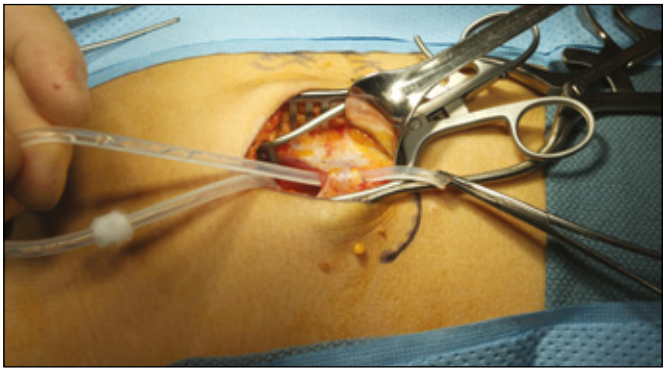

Fig. 4 - *Tunneling of catheter through the rectus muscle and the anterior rectus sheath will ensure the direction of the catheter in the up-down direction as it enters the abdomen toward the pelvis.*

the laparoscopic approach. With regard to cost, the open approach has been noted to be more cost-effective (19) as the instruments used in the open approach are from a basic set and less operative time is utilized. In addition, patient factors, surgeon training and institutional resources may also dictate which approach will be used.

Although there is no difference in outcome shown when comparing the open and laparoscopic techniques, it has been shown that laparoscopy is the better approach when rescuing malfunctioning PD catheters (20, 32, 33).

Open paramedian approach

The open approach can be performed under either local or general anesthesia, depending on the specific patient characteristics (30). This is in contrast to the laparoscopic approach, where general anesthesia is indicated (31). Prophylactic antibiotics are administered, and usually a first generation cephalosporin will suffice. If the patient has penicillin allergy, vancomycin or clindamycin may be used (30, 31).

The patient's skin should be marked prior to coming to the operating room. The incision is usually 2-3 cm lateral to the umbilicus, with the left side being preferred (Fig. 1).

Dissection is carried through the subcutaneous tissues and the anterior rectus sheath is divided. The rectus muscle fibers are split and the posterior rectus sheath is identified and grasped. A small opening about 3 mm in size is sharply made through the posterior sheath and the peritoneum, taking care not to injure any bowel lying underneath. A non-absorbable purse-string suture is placed around the opening such that the tie will be on the cephalad side (Fig. 2).

The PD catheter is then placed over a stiffening stylet which makes placement in the peritoneal cavity easier. The tip of the stylet should not protrude out from the end of the catheter to prevent inadvertent injury to the viscera. The catheter is guided down into the pelvis along the anterior abdominal wall and pulled back once the tip is in the pelvis (Fig. 3). The purse-string suture is then secured to create a watertight seal and small suture bites of the Dacron cuff is taken on the cephalad side of the cuff and tied down with the suture. The catheter is then tunneled through the rectus muscle and anterior sheath (Fig. 4).

The subcutaneous tunnel is then created. A Faller tunneler (Covidien, Mansfield, MA) or a #15 Blake drain trocar, both of which have the same diameter as the PD catheter tubing, is used to create this tunnel tract. The catheter tip is attached to the tunneler, and a subcutaneous tract is created (Fig. 5). Several factors are important in creation of this tunnel. First, the skin exit site should be 1.5-2 cm away from the subcutaneous Dacron cuff. Second, the tract should have a gentle curve and be free of any kinks or stresses to prevent any mechanical obstruction of the catheter. Finally, the tunneler should exit the skin at a 30°-45° angle which will optimize patient comfort and

Fig. 5 - *Creation of the subcutaneous tunnel using a curved Faller tunneler. A pre-curved #15 Blake drain trocar used in this image is preferred by the authors as its sharp ridges will firmly hold the catheter as it is pulled through the skin. The Faller tunneler requires a tie to keep the catheter in place, which causes unnecessary trauma to the skin.*

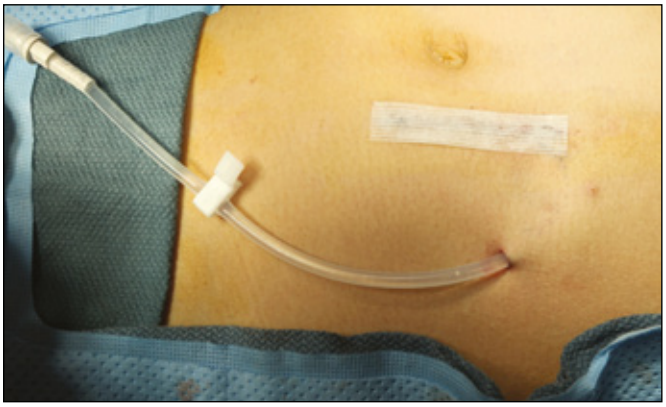

Fig. 6 - *Abdominal view at the completion of the open technique (patient's head is to the right). The direction of the catheter should be downward as it exits the skin at a 30°-45° angle.*

Fig. 7 - *Insertion of Veress needle may be at the umbilical level or as in this image in the mid-costal line about 5 cm below the costal margin.*

catheter position. By creating the tract in this fashion, a snug clean exit site is created. If desired, a 3 mm skin punch may be applied at the intended exit site which aids with creating a clean exit site. About 60-80 mL of saline is then injected to the abdominal cavity and allowed to drain to gravity to assure free passage. Finally, the catheter is "locked" with 3 mL of Heparin (1000 Units/mL) to prevent fibrin and blood clots from forming in the catheter.

The fascial defect in the anterior rectus sheath is closed using a running non-absorbable suture. The skin is closed. A drain sponge is placed at the exit site of the PD catheter and the entire catheter is covered with 4×4 cm gauze, followed by transparent adhesive dressings (Fig. 6).

When to perform the open technique

Consider performing the open approach in patients who cannot tolerate general anesthesia, those who would be unsuitable for laparoscopic surgery (i.e., patients with severe chronic obstructive pulmonary disease or cardiac disease) and patients who need to have anesthetic time minimized (as the open approach is associated with shorter operative times). In addition, patients who need to undergo PD fluid exchanges immediately after surgery and cases with no previous abdominal surgeries are candidates for the open approach.

Laparoscopic approach

The laparoscopic approach should be done under general anesthesia (31), as insufflating the peritoneal cavity is uncomfortable to the patient. As with the open approach, prophylactic antibiotics are administered prior to the start of the case. The patient's skin is marked prior to surgery. Depending upon surgeon preference, a Veress needle may be inserted into the abdomen at either the level of the umbilicus or 5-6 cm below the costal margin in the mid-axillary line (Fig. 7).

Benefits of placing the Veress needle at the umbilicus include better cosmesis, as it is easier to hide a scar in the umbilicus. The umbilicus is also the thinnest portion of

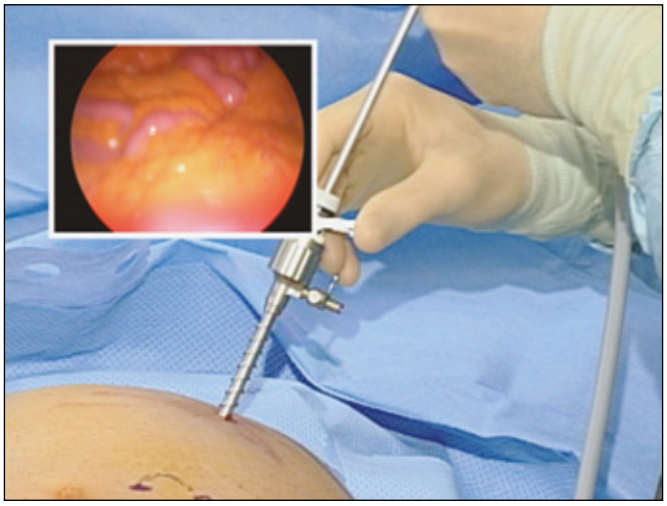

Fig. 8 - *Insertion of the laparoscope at the site of the Veress needle after carbon dioxide insufflation to a pressure of 15 mm Hg (31, 37).*

Fig. 9 - *Insertion of the 0.035″ J guide wire through the spinal needle is shown entering the abdomen on the insert screen (31, 37).*

the abdominal wall, making entrance into the peritoneal cavity easy even in the obese individual. In patients with previous abdominal surgeries, the Hasson Port (Genicon, Winter Park, FL) may be used to gain access to the peritoneal cavity at the level of the umbilicus. If additional procedures are needed, one or two additional 5 mm ports can be placed to perform a hernia repair.

Once the Veress needle has been introduced, placement of the needle is verified with the "hanging drop test" (visualized when saline is seen to flow easily down the Veress needle into the peritoneal cavity). After verification of proper needle placement, pneumoperitoneum is obtained to a pressure of 15 mm Hg using carbon dioxide. The Veress needle is then exchanged for a 5 mm port and the laparoscope is introduced into the peritoneal cavity (Fig. 8). The peritoneal cavity is examined for pathology and to ensure there is no iatrogenic injury.

A 5 mm transverse incision is made at the superior portion of the catheter insertion site. An 18G spinal needle is introduced and a 3-4 cm tract is created between the incision and the entrance site into the peritoneal cavity, taking care to enter the abdomen at a 30°-45° angle. Local anesthetic is infiltrated along the course of this tract. Prior to entering the peritoneum, a local anesthetic is infiltrated just above the peritoneum to create a flare to aid with postoperative analgesia. A 0.035″ J wire is passed through the needle and the needle is removed (Fig. 9). The catheter tract is then dilated with the 22 Fr peel-away sheath. The dilator is first passed over the wire to help create the tract and then the dilator with the peel-away sheath is passed over the wire as a unit (Fig. 10). The wire and dilator are then removed. The PD catheter is placed over a stiffening stylet and this unit is placed into the peel-away sheath into the peritoneal cavity under direct visualization. The catheter is advanced until the internal cuff

Fig. 10 - *Placement of a peel-away sheath, shown with external and inside abdominal views. The guide wire (seen on the outside view) and the dilator is next removed (31, 37).*

is visualized within the peritoneal cavity. The stylet is then pulled back allowing the curl to reform at the end of the PD catheter (Fig. 11). Our preference is for the curl to face the anterior abdominal wall. The end of the catheter is then positioned in the pelvis under direct visualization. The peel-away sheath is removed and the internal cuff is gently pulled back so the first Dacron cuff rests outside the peritoneum or within the fibers of the rectus muscle. The subcutaneous tract is then created in a manner identical to the creation of the tract in the open procedure (Fig. 5).

A final examination is done at this time. The position of the tip of the catheter is again verified as being in the pelvis. The catheter is flushed with saline under visualization. The laparoscope is removed, followed by

Fig. 11 - *The curled portion of the catheter placed into the pelvis under direct vision before the peel-away sheath is removed (31, 37).*

release of the pneumoperitoneum. The catheter is allowed to drain by gravity as with the open procedure. This ensures no mechanical obstruction is present. By leaving the port in the peritoneal cavity, the pneumoperitoneum can quickly be re-established if a mechanical obstruction is suspected. Finally, 60-80 mL of saline is left within the peritoneal cavity followed by 3000 units of heparin (3 mL of 1000 units/mL) as a "lock" solution to prevent fibrin or clot formation in the catheter. The 5 mm port is then removed and the incisions are closed with inverted sutures.

When to consider the laparoscopic approach

The laparoscopic approach is preferred in patients who have had previous abdominal surgeries, in the obese, and in individuals who may need other simple procedures performed concomitantly. This set of indications increases the number of patients who can receive PD catheters (12). The laparoscopic approach is associated with longer operative times but allows for visualization of the precise catheter location in the pelvis.

Laparoscopy for assessing the malfunctioning PD catheter

As previously noted, laparoscopy is the best method to assess and potentially address the cause of catheter malfunction. As with other laparoscopic procedures, general anesthesia is preferred followed by the administration of prophylactic antibiotics. After pneumoperitoneum is established, a 5 mm port followed by a laparoscope is introduced into the peritoneal cavity. Oftentimes, the etiology of catheter malfunction can be identified and addressed; for example, omentum causing catheter obstruction can be resolved with an omentopexy or omentectomy, and a malpositioned catheter can be easily repositioned into the patient's pelvis. Another common problem causing catheter dislocation is when the catheter is entering the peritoneal cavity at too acute an angle. This problem is best addressed by suturing the catheter with a non-absorbable suture to the anterior abdominal wall to change the angle of entry (Fig. 12). Adhesiolysis is also done as indicated.

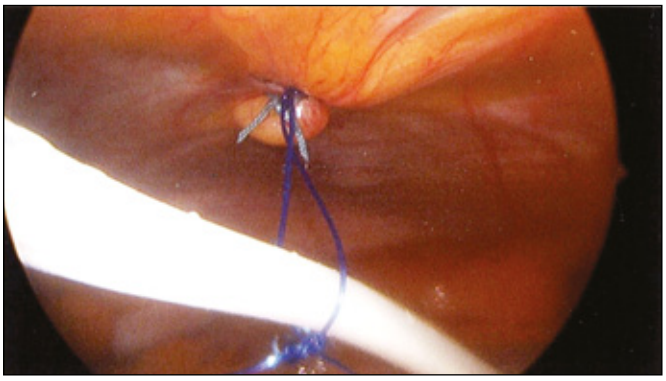

Fig. 12 - *Tacking of the PD catheter to the anterior abdominal wall. A "slack" or "air knot" is intentionally left to allow the catheter to slide as well as to facilitate future removal.*

Postoperative management

The patient is asked to return to the clinic 5-7 days after catheter placement for the first dressing change and referred to the PD clinic to flush the catheter and have the transfer set placed. It is recommended that the catheter not be used for 3-4 weeks after placement. To avoid central line HD catheter placement, if immediate dialysis is indicated, the authors may start low-volume PD exchanges as soon as 24-48 hours after placement.

A MODIFIED 10 MM LAPAROSCOPIC ASSISTED APPROACH

This technique utilizes the open paramedian transrectus muscle approach exposing the posterior rectus fascia and peritoneum similar to what is described above (Figs 1-6) (17, 34).

According to the 2010 survey of the Peritoneal Dialysis Study Group (GSPD) of the Italian Society of Nephrology (SIN), PD catheter placement surgery in Italy is undertaken by surgeons in 36% of cases, by nephrologists in 28% of cases and by a nephrologist assisting the surgeon in 32% of cases (unpublished data). This is in contrast to other countries such as the United States, where PD catheters are almost exclusively placed by surgeons. The most common placement method in Italy is open approach (87%), followed by laparoscopic (5%) and percutaneous (2%) approaches. In the Italian Best Practice model, "open" surgery is considered to be the most

effective technique to place PD catheters. The 10 mm laparoscopic placement has potential advantages. It combines the open and the laparoscopic methods and is indicated when additional more complex procedures are required as a larger 10 mm port is used. Examples of such procedures include hernia repairs, omentopexy and partial omentectomy (17, 34). The longer operating time and associated increased cost are two significant drawbacks.

The various techniques used for placing PD catheters likely reflect differences in surgical training programs, medical socioeconomic traditions and personal biases (20, 22, 35). As the individual and team experience increases, the outcome is also likely to improve regardless of surgical technique. In fact, the rigorous continuing monitoring of the PD patient by the PD nephrology team may be the most deciding factor for long-term success (12).

The modified laparoscopic approach allows safe placement of the PD catheter in patients with previous abdominal surgical operations. It is indicated for placing PD catheters in patients with previous abdominal surgeries, especially in the upper abdomen, as suggested in the UK's 2010 guidelines (36) and may increase the number of patients who can have a successful placement of a PD catheter (33).

The 10 mm method was developed by one of the authors (SS) in the Nephrology and Dialysis unit at Carlo Urbani Hospital (Jesi, Italy) and advocates the use of the 10 mm port access to perform all the necessary procedures associated with PD catheter placement (33). This technique can be performed under local anesthesia to explore the abdominal cavity. Should adhesiolysis be indicated, general anesthesia is induced.

Technique

A minilaparotomy, similar to that described earlier (Figs 1-6), is used to access the abdominal cavity, which allows for a direct visual examination of the abdominal wall and organs. The incision is made where the internal cuff of the catheter will be placed, in the sub-umbilical paramedian region (2-3 cm below the transverse umbilical line, 2-3 cm lateral to the midline).

After local or general anesthesia has been established, the skin and subcutaneous tissues are dissected. The anterior rectus sheath is opened and the rectus fibers are separated avoiding damage to the epigastric artery. After identifying the posterior fascia of the rectus muscle and the peritoneum, a 5 mm incision is made with fine scissors. A purse-string suture is placed in the posterior rectus sheath.

Through the minilaparotomy a 10 mm port is inserted, through which a pneumoperitoneum is created with carbon dioxide to a pressure of 12-15 mm Hg. This produces sufficient distension of the abdominal cavity to perform the exploration with the laparoscope (Fig. 13). The instrument used is equipped with an operator channel (laparoscope 0°, working channel diameter of 5 mm, Karl Storz, Tuttlingen, Germany) (Fig. 14), allowing the necessary additional procedures to be performed. At this point, the Tenckhoff catheter is introduced via the port, over a stiffening guide wire (Figs 3 and 15). The catheter is left in the pelvis by removing the introducer followed by the port (Fig. 16). The port is reinserted next to the catheter (Fig. 17) and pneumoperitoneum is restored. This step confirms via the laparoscope that the catheter position is correct; if this is not the case, it is possible to make necessary adjustments. After removal of the port, the internal cuff of the catheter is placed above the peritoneum and the purse-string suture is securely tied. The superficial fascia of the rectus muscle is then closed starting at the lower end. The catheter exits at the upper corner of the anterior rectus fascia incision. Creation of a smooth curved subcutaneous catheter tunnel completes the procedure (Fig. 5).

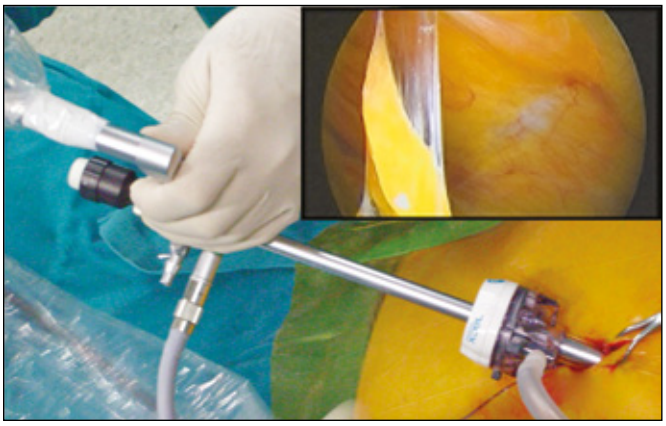

Fig. 13 - *Exploration of the abdominal cavity after the pneumoperitoneum is created. The 10 mm laparoscopic surgery technique uses a 10 mm port to examine the abdomen and perform indicated additional procedures such as partial omentectomy, omentopexy and adhesiolysis.*

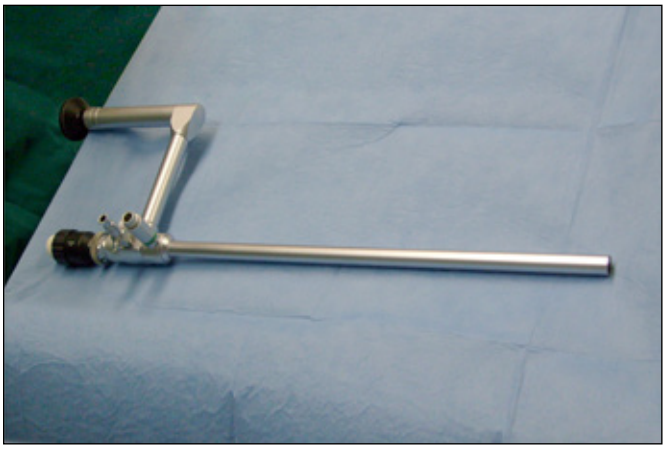

Fig. 14 - *The 10 mm laparoscopic camera used in "one port" technique, shown in detail (Karl Storz, Tuttlingen, Germany).*

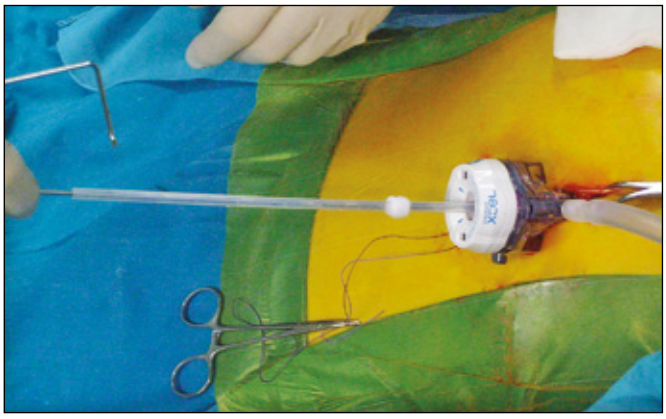

Fig. 15 - *Introduction of Tenckhoff catheter via the port, after abdominal inspection for the need of potential additional procedures. The stiff guide wire is used to insert the PD catheter through the 10 mm camera port. (This is similar to that described in Fig. 11 using the 22 Fr peel-away sheath).*

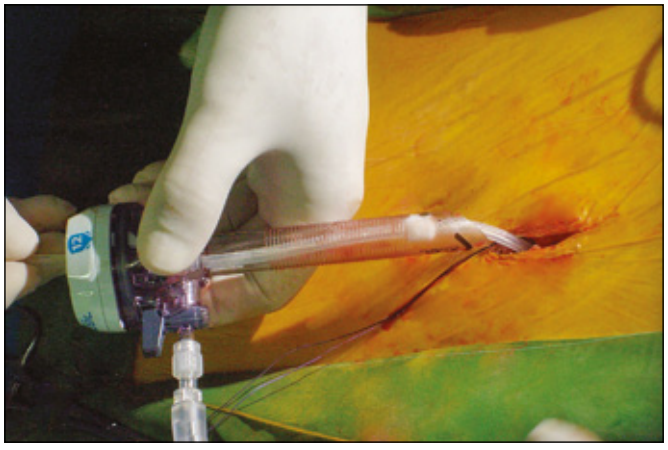

Fig. 16 - *The 10 mm trocar is now removed leaving the PD catheter in place.*

CONCLUSIONS

The choice between the open and laparoscopic technique for PD catheter placement is guided by the surgeon training, the team skill set, institutional/hospital resources and the patient's comorbid conditions and preference.

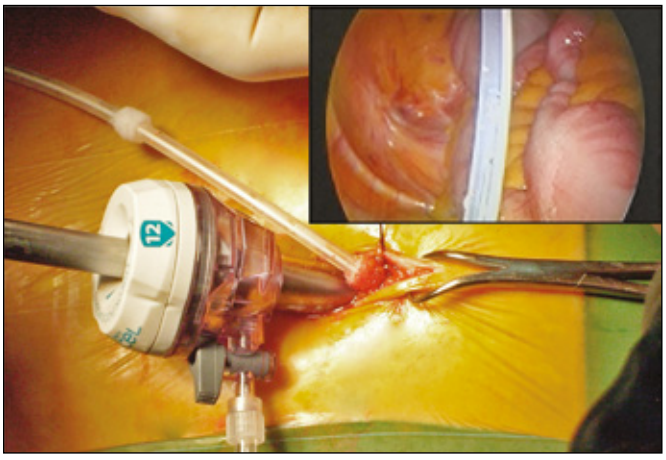

Fig. 17 - *Reintroduction of the port into the abdominal cavity to check the correct position of the catheter. The 10 mm trocar with the video camera has been reinserted parallel with and through the same defect as the PD catheter to visually assure the correct location of the PD catheter. After removal of the camera and the 10 mm port, the purse string is securely tied around the catheter. The closing of the fascia must also be exact to avoid leaks should PD exchanges be needed soon after surgery (32, 33).*

Each has relative pros and cons. In general, the laparoscopic technique is associated with longer operative times and the need to utilize general anesthesia, but is the preferred method when rescuing malfunctioning catheters and will increase the PD patient population in patients with previous abdominal surgeries. The dialysis access surgeon should be familiar with both techniques and appropriately choose the method based upon patient variables, team skills and available resources.

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