REVIEW ARTICLE

Renal Disease and Transplantation Forum
2021, vol. 14, no. 1, 7–13

ISSN 2720–2771

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VIA MEDICA

Creating and maintaining optimal peritoneal dialysis access — ISPD 2019 recommendations

Abstract

Following the 2016 and 2017 update of the ISPD guidelines on infectious complications of peritoneal dialysis, new guidelines were published in 2019 on how to create and maintain optimal peritoneal access. This document highlights the benefits of laparoscopic catheter implantation and the possibility of additional interventions such as omentopexy or adhesion release. It also discusses the most common complications regarding catheter function and how to manage them. Each peritoneal dialysis center should monitor and analyze the functioning of the peritoneal access, which contributes to improving the care of the peritoneal dialysis patient.

Renal Disease and Transplantation Forum 2021, vol 14, no 1, 7–13

Key words: peritoneal dialysis, peritoneal access

INTRODUCTION

The success of peritoneal dialysis as a method of renal replacement therapy is undoubtedly influenced by the creation and then the maintenance of the most optimal access for its conduct. Mechanical or infectious complications of the catheter may lead to its loss and increase the failure rate of the dialysis technique. Following the update of the guidelines on the prevention, diagnosis and treatment of peritoneal dialysis related peritonitis in 2016 [1] and the guidelines on catheter-associated infections in 2017 [2], an update of the International Society for Peritoneal Dialysis (ISPD) recommendations on peritoneal dialysis access was released in 2019 after approximately 10 years of previous recommendations [3]. According to the GRADE (Grades of Recommendation Assessment, Development and Evaluation) classification system, the guidelines were differentiated according to the strength and quality of supporting evidence. These should also be adapted to local conditions and clinical situations.

CHOOSING A CATHETER FOR CHRONIC DIALYSIS THERAPY

ISPD guidelines recommend the use of peritoneal catheters made of silicone (1B) [3]. Polyurethane catheters, which were in wider use earlier, are characterized by greater stiffness and a greater risk of mechanical damage to surrounding tissues. It has also been shown that the application of mupirocin ointment to the area of the exit site may contribute to damage to polyurethane catheters [4]. In addition to catheters with a straight intraperitoneal end, there are modifications with a twisted spiral end, just as the catheter section within the subcutaneous canal can be straight or modeled in a "swan neck" form. The functionality of any of the catheter modifications was not shown to be superior to the others. However, ISPD recommendations indicate that catheters with two cuffs constructed of dacron should be used. This recommendation assumes particular importance in the Polish patient population in which, in the absence of antibiotic prophylaxis to the area of the exit site, the double-cuff catheter may reduce the risk of *Staphylococcus aureus* infection, especially in diabetic patients or those on immunosuppression [5]. The extended catheter allows an exit site to be created in the epigastrium or chest. Indications for this modification include, but are not limited to, obesity, the presence of intestinal stomas or gastrostomies, and the presence of a suprapubic catheter; it is also a possible option for

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Table 1. Practical recommendations during peritoneal catheter implantation

Peritoneal catheter implantation — practical recommendations
1. Selection of the most appropriate: catheter type, implantation technique, peritoneal entry site and exit site based on clinical data
2. Prevention of constipation in the perioperative period
3. On the day of surgery, wash the surgical area thoroughly with chlorhexidine soap
4. Depilation of the surgical area on the day of surgery with surgical clippers
5. Bladder emptying before surgery (or placement of a Foley catheter)
6. Administration of a single dose of antibiotic before surgery
7. Transrectal incision access, placement of deep cuff in the rectus muscle or below the muscle
8. Placing the tip of the catheter in the pelvis minor
9. Placement of a slipper suture around the peritoneal incision, tight suturing of the fascia
10. Use of a tunnelizer with a diameter smaller than the diameter of the catheter
11. Perform a catheter function test
12. Exit site at ≥ 2 cm from superficial cuff
13. Exit site directed lateral/downward
14. Smallest possible exit site diameter to allow passage of the catheter
15. No sutures in the area of the exit site
16. Securing the titanium adapter and transfer set drain during the procedure
17. Securing the exit site and immobilizing the catheter using a non-occlusive dressing

those patients who do not wish to stop taking long baths [6].

The choice of the catheter should take into account the possibility of placing its intra-abdominal tip at the level of the pubic symphysis, with the exit site in a location where it is easily accessible and visible to the patient, and where catheter stress and risk of infection are minimal. Therefore, the location of skin folds, the presence of scars, emerged stomas, physical restrictions, bathing habits, or the place where a belt is worn should be considered. The exit site should be below the navel in patients wearing the belt in a line above the navel. Inversely, in those patients where the belt line is below the umbilicus, it would be most beneficial to produce the exit site in the higher parts of the abdominal cavity. The location of the exit site also depends on the distance between the cuffs, so the subcutaneous channel should be made so that the exit to the skin is no closer than 2–4 cm from the superficial cuff lying in the channel. Both the inner end and the outer end of the channel should point obliquely downwards and sideways. The catheter exit to the skin should be modeled and tight so that sutures do not have to be placed on it, reducing the risk of mechanical damage to the catheter or infectious complications of the exit site. Correct planning of the skin incision sites, peritoneal cavity entrance and shape of the canal is essential for the success of the procedure, so this should take place before the procedure and be carried out with the patient in a sitting position.

PERITONEAL CATHETER IMPLANTATION METHODS

Appropriate procedures and recommendations are helpful in creating long-lasting optimal peritoneal access. These are presented in Table 1.

The method of catheter implantation should take into account patient factors, center resources and operator experience. The most commonly used methods are laparotomy (called open surgery in the English-language literature) or advanced laparoscopy. Alternative and much less frequently used techniques include the peritoneoscopic technique and the percutaneous Seldinger technique, which allows catheter implantation to be performed outside the operating room under local anesthesia when rapid initiation of dialysis is required.

The most recommended implantation technique in terms of optimal and long-lasting catheter function is the advanced laparoscopic method, which — in contrast to the primary laparoscopic method, which only shows the location of the intra-abdominal end of the catheter — uses additional capabilities, thus reducing the risk of mechanical complications (1B). One such option is to *tunnelize the sheath of the rectus muscle* so that the catheter passes through the muscle obliquely, which lengthens its path and improves its fixation. Additional procedures also include *selective omentopexy*, which allows excess larger netting to be moved from around the catheter tip and attached to the wall peritoneum, reducing the risk of netting around the

catheter, and *adhesiolysis*, or adhesion release, which prevents compartmentalization of the peritoneal cavity. Other procedures used may be *salpingectomy*, *appendectomy* or *colopexy* [7]. In addition, abdominal hernia repair procedures can be performed simultaneously during catheter implantation. A recent meta-analysis of studies comparing laparotomy and basic and advanced laparoscopic techniques showed significantly better rates of peritoneal access maintenance for advanced laparoscopy [8]. These data indicate that the use of laparoscopy only to image the location of the end of the peritoneal catheter does not exploit the full potential of this technique.

A particular type of catheter implantation is the use of the Moncrief and Popovich technique [9]. Catheter implantation, in this case, occurs well in advance of its use. Therefore, after the catheter channel has been created, the catheter is not brought out onto the skin but left sewn into the subcutaneous tissue. When residual kidney function has declined to a level where renal replacement therapy becomes necessary, the catheter is emerged externally through a small incision. The patient can immediately start dialysis with the full volumes required, while the absence of biofilm may be associated with a reduced incidence of catheter-related infections. The fact that the patient is more likely to accept renal replacement therapy with anticipatory catheter implantation should also not be overlooked. Disadvantages of this technique include the need for two procedures and the possibility that catheter implantation may prove unnecessary if, for example, anticipatory transplantation occurs before its use. This technique should also not be used in patients whose anticipated time of dialysis initiation is less than 4 weeks. Once the catheter has been externalized, its normal function is found in 85–93% of patients. Catheter function abnormalities are mainly due to adhesions or the presence of fiber in the catheter.

SPECIFIC CLINICAL SITUATIONS ACCOMPANYING CATHETER IMPLANTATION

SIMULTANEOUS ABDOMINAL SURGERY

Repair of abdominal hernias can be performed simultaneously with peritoneal catheter implantation. For more complex procedures requiring a longer recovery period, catheter implantation using the Moncrief and Popovich method should be considered. The use of mesh prostheses in the treatment of hernias is essential to reduce hernia recurrence and is widely practiced, but the safety of their use in peritoneal dialysis patients has not been thoroughly evaluated. An important consideration is whether an intraperitoneal mesh prosthesis can become infected during peritoneal dialysis related peritonitis. This requires further research.

Cholecystectomy can be performed simultaneously with peritoneal catheter implantation in patients without signs of active biliary infection. Catheter implantation should precede cholecystectomy.

PRESENCE OF VASCULAR PROSTHESES IN THE ABDOMINAL CAVITY

The main concern with peritoneal dialysis in patients with abdominal vascular prostheses is the possibility, in the case of peritoneal dialysis related peritonitis, of the infection passing into the retroperitoneal space or, due to concomitant bacteremia, of the prosthesis becoming infected via the bloodstream. Such cases appear to be very rare. Although Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines recommend waiting at least 4 months from abdominal graft placement to the start of peritoneal dialysis [10], a 2-week period would presumably be sufficient, and it is reasonable to believe that with increasing numbers of endovascular procedures, peritoneal dialysis patients may continue therapy without interruption. Moreover, since the incidence of bacteremia is much lower among peritoneal dialysis patients compared to hemodialysis patients, this method seems to be a more logical choice in patients with the presence of vascular grafts.

PRESENCE OF GASTROSTOMY

The use of PEG (percutaneous endoscopic gastrostomy) in peritoneal dialysis patients can be associated with frequent infectious complications. Dialysate leak around the percutaneous endoscopic gastrostomy leads to severe peritonitis, including those of fungal etiology. If a patient requires percutaneous endoscopic gastrostomy implantation, it is therefore recommended that the peritoneal catheter be removed and not implanted again until the gastrostomy has healed. In contrast, peritoneal catheter implantation in a patient already receiving percutaneous endoscopic gastrostomy feeding is considered relatively safe. However, an exit site should be created far from the gastrostomy, on the opposite side of the abdominal cavity or in the pre-sternal region.

ADPKD (AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE)

Providing peritoneal dialysis in patients with autosomal dominant polycystic kidney disease usually raises concerns about decreased intra-abdominal space, peritonitis, or hernias. However, recent studies indicate that there are no differences in rates of dialysis adequacy, technique survival, or peritonitis in this group compared to other patients [11, 12]. The presence of hernias may not be directly related to increased intra-abdominal pressure but to collagen defects. During catheter implantation, it is important to be alert for significantly enlarged kidneys, so it is recommended to begin the procedure using the open method.

DIVERTICULOSIS

The results of studies on the relationship between diverticulosis and the incidence of peritoneal dialysis related peritonitis are inconclusive. This may be due to different patient characteristics in different countries, e.g., in the Asian population, colonic diverticula are found mainly in the ascending colon, whereas in Western countries, they are found in the sigmoid colon. The risk of peritonitis appears to be most influenced by the number of diverticula, their size and extent in the colon. One study found that the presence of 10 or more diverticula or at least one with a dimension greater than 10 mm was associated with an increased risk of risk of peritoneal dialysis related peritonitis [13].

BARIATRIC SURGERIES

Laparoscopic bariatric surgery may be the only option in some cases of obesity to get a patient on the waiting list for a kidney transplant. During the bariatric procedure, the operator must pay special attention to the location of the laparoscopic ports to avoid catheter damage. After the procedure and careful closure of the ports, peritoneal dialysis can be continued immediately with the patient in a supine position and small volumes of fluids for 2 weeks after the procedure.

PERIOPERATIVE CATHETERIZATION PROCEDURES

Catheter function should be checked immediately after implantation during the procedure. For this purpose, 500–1000 mL of saline or dialysis fluid can be used, leaving approximately 100–200 mL of residual volume in the peritoneal cavity. The catheter should then be "flushed" at weekly intervals with a volume of fluid of approximately 500–1000 mL until renal replacement therapy is initiated. If the peritoneal catheter is not used for one month after implantation, this interval can be extended to 2–4 weeks. "Catheter flushing" is designed to prevent fibrin or blood clots from forming, which could lead to catheter obstruction. If bloody dialysate is already present during the procedure, especially if the patient has undergone additional laparoscopic procedures, another wash should be performed within 24 hours and repeated until clear dialysate is obtained. Heparin at 1000 IU/L may be added to the fluid used for the wash.

During the procedure, because of the sterile environment, it is advantageous to place a titanium connector on the catheter after implantation and attach a *transfer set drain*. A nonexclusive surgical dressing applied to the wound is intended to immobilize the catheter and prevent wound damage and contamination. It should not be renewed for 5–10 days, except in the case of overt bleeding or infection. Specific recommendations for catheter exit site care are described in earlier ISPD guidelines [1, 2].

A 2-week catheter healing period before starting peritoneal dialysis is recommended (1B). If early initiation of therapy is required, it is recommended to conduct exchanges with low volumes of fluids with the patient in the supine position. Initiating treatment less than 2 weeks after catheter implantation may be associated with a small increase in the risk of mechanical complications, but does not affect patient survival or techniques or the rate of peritoneal dialysis related peritonitis.

CATHETER-RELATED COMPLICATIONS

INFECTIOUS COMPLICATIONS

Prevention and antibiotic therapy of infectious complications are discussed in detail in the 2016 and 2017 ISPD guidelines [1, 2]. In some cases, additional interventions may be helpful to maintain peritoneal access. Removal is recommended if the superficial cuff is protruding beyond the exit site as a result of stress and distortion in the catheter. Leaving the cuff promotes its colonization by bacteria and predisposes the patient to infection of the exit site.

In cases of chronic exit site inflammation or acute orifice inflammation with poor response to treatment, especially infections with *Sta-*

phylococcus aureus and *Pseudomonas aeruginosa* etiologies, ultrasonographic evaluation of the tunnel and the catheter fragment located between the two cuffs is recommended (1B). If ultrasound (US) examination shows no fluid in the superficial cuff area and the existing location of the exit site is contributing to chronic infection, it is recommended that a new section of the catheter be attached to the cuff part and a new exit site be brought out. When ultrasound shows fluid in the superficial cuff area, but without deep cuff involvement and peritonitis, it is possible to incise the exit site, bring the cuff outside, remove it, and allow the wound to heal. However, when the location of the exit site and catheter function are not optimal, it is possible to simultaneously implant a new peritoneal catheter on the opposite side of the abdomen and then remove the "old" catheter. If the deep cuff is also infected or peritonitis coexists, a new catheter is implanted later (1B). Simultaneous implantation of a new peritoneal catheter and removal of the old one is possible in selected cases of recurrent peritonitis of *Staphylococcus aureus* etiology (1A). For such a procedure, earlier resolution of clinical symptoms of peritonitis under the influence of antibiotic therapy and a dialysate cytosis lower than 100/μL are required.

NON-INFECTIOUS COMPLICATIONS

Dialysis fluid leak

Early (< 30 days after catheter implantation) dialysis fluid leakage is usually related to catheter implantation technique, the time elapsed between implantation and initiation of dialysis therapy, exchange volume, or abdominal wall weakness. Temporary interruption of dialysis therapy for 1–3 weeks usually results in resolution of the leakage. Increased dialysate leaking may indicate a complication of the implantation or healing procedure and requires immediate evaluation.

Late leakage of dialysis fluid (> 30 days after catheter implantation) is favored by periurethral hernias, pseudohernias or hidden tunnel infections separating the cuffs from surrounding tissues. Treatment of peritoneal hernias and pseudohernias includes repair with simultaneous implantation of a new peritoneal catheter. It is important to note that catheter tunnel infections can be asymptomatic and without accompanying symptoms of an exit site infection or peritonitis. Dialysate leak resulting from tunnel infection requires removal of the catheter and transient use of hemodialysis therapy.

Physical overload can cause both early and late leaking. The risk is further increased by abdominal wall weakness, obesity, steroid intake, increased intra-abdominal pressure, or the use of large exchange volumes. It is recommended that lifting weights greater than 7–10 kg be limited, but both the weight and activity level are primarily dependent on the individual patient's physical condition. To minimize the risk of infiltrating, it is suggested to play sports with an "empty stomach."

The infiltrates may manifest as scrotal or abdominal wall edema, weight gain, or a marked decrease in ultrafiltration, among other things. Contrast-enhanced computed tomography peritoneography or peritoneal scintigraphy with technetium-99 (1A) are useful in the diagnosis of infiltration.

Infiltration into the pleural cavity causes dyspnea, sometimes pleuritic pain. The diagnosis is confirmed by high glucose levels in fluid collected during thoracocentesis. Performing pleurodesis with talc gives a high treatment success rate of 85–100%. After repair procedures, dialysis therapy in the supine position with small volumes of fluid is recommended for 2 weeks. In more severe cases, bridging hemodialysis is used, which usually does not last longer than 1–3 weeks.

PERITONEAL CATHETER DYSFUNCTION

Peritoneal catheter dysfunction usually manifests as impaired drainage. It is recommended that diagnostic testing and treatment management be conducted in an orderly fashion, starting with the least invasive approach to the most invasive.

The most common cause of peritoneal catheter dysfunction is constipation. Widening of the rectum and sigmoid colon may block drainage from the catheter tip or move it to a position where drainage is impaired. Use osmotically active agents such as lactulose or sorbitol for treatment. Agents such as bisacodyl should only be used in resistant cases; irritation of the intestinal mucosa can cause bacterial migration and peritonitis.

Urinary retention with bladder dilation and catheter compression is much less common. For symptoms of urinary retention, bladder catheterization should be performed; obtaining a urine volume > 50–100 mL after urination is already considered abnormal.

Catheter kinking almost exclusively affects the part of the catheter remaining in the tunnel and is most often the result of errors

occurring during catheter implantation. The location of the kink determines whether the required repair procedure will be revision or catheter reimplantation.

Blockage of the catheter lumen with fibrous deposits or blood clots can be another cause of catheter dysfunction. After ruling out the previously discussed causes, fibrinolytic treatment with tissue plasminogen activator (tPA) may be considered. If the blockage of the catheter lumen is due to the presence of deposits, this management can lead to curing almost 100% of cases.

Other, less common causes of catheter dysfunction include catheter tip displacement or blockage by surrounding tissues. Repair procedures include guidewire radiologic interventions, laparoscopic procedures, or catheter replacement. Because of the frequent need for repeated radiological interventions and the relatively low final cure rate (46–75%), laparoscopic procedures appear to be the treatment of choice, characterized by excellent long-term cure rates (63–100%) and the ability to identify the cause of catheter impairment.

Damage to the outside of the catheter can result from improper instrumentation, but chemical damage can also occur when antibiotic ointments are applied. A repair procedure involving the attachment of a new catheter section is possible if, counting from the exit site, a 2 cm section of the catheter is available without damage. Catheter failure with leakage is considered a potential source of infection; in this situation, diagnosis for peritoneal dialysis related peritonitis as well as administration of prophylactic antibiotic therapy are required. Procedures to attach the catheter to the intercuff part or to replace the catheter are also possible.

CATHETER REMOVAL

CATHETER REMOVAL CAN BE DONE BY LAPAROTOMY OR "PULL TECHNIQUE"

The laparotomy method is recommended when the reason for catheter removal is catheter tunnel infection or peritonitis associated with catheter infection, especially for extended catheters. If drainage of a tunnel abscess or removal of granulation tissue in the exit site occurs during catheter removal, the wound should be left open for further healing.

"Pull technique" should be reserved for non-infectious cases in which leaving dacron cuffs in the tissue poses minimal risk to the patient. The incidence of infection of cuffs left in tissues, requiring subsequent excision, is 2.5–3.2%. No complications of catheter damage were noted during gentle pulling for catheter removal.

In some cases, removal of the peritoneal catheter is followed by recovery of the patient's own kidney function sufficient to discontinue dialysis therapy, although this improvement is not expected to be long-lasting. In these situations, an alternative to removing the catheter is to attach an additional portion of the catheter to the intercuff part and encapsulate it in subcutaneous tissue. The existing outer portion of the catheter is removed. If renal function declines again, the catheter is emerged.

PERITONEAL ACCESS AUDIT

It is recommended that peritoneal access function be evaluated at least annually. Regular audit contributes to improved patient care. Peritoneal dialysis centers should strive to maintain the following clinical indicators for peritoneal access:

1. Retention of catheter function 12 months after implantation: > 95% for catheters implanted by advanced laparoscopy and > 80% for other implantation techniques,
2. Incidence of exit site/tunnel infections within 30 days of catheter implantation: < 5%,
3. Incidence of peritonitis within 30 days of catheter implantation: < 5%,
4. Incidence of internal organ damage (bowel, bladder, other organs) during catheter implantation: < 1%,
5. Incidence of bleeding requiring blood transfusion or surgical intervention: < 1%.

In addition, it is recommended that the frequency of dialysis fluid leaks within 30 days of peritoneal catheter implantation be recorded, broken down into leak rates for dialysis started before day 14 of catheter implantation and later than day 14 of catheter implantation. Reasons for catheter loss should be monitored, such as patient death, kidney transplantation, conversion of treatment to hemodialysis due to inadequacy of peritoneal dialysis, infection, leakage, or psychosocial reasons.

SUMMARY

New ISPD guidelines emphasize the importance of creating and maintaining optimal peritoneal access in the delivery of effective

and safe renal replacement therapy. Following the 2016 and 2017 updates of the guidelines on infectious complications, issues regarding the impact of mechanical complications and catheter infection consequences on the success of the technique became more apparent. The new recommendations highlight the benefits of laparoscopic catheter implantation and the potential for additional interventions such as omentopexy and adhesion release. In addition, they present special clinical situations during peritoneal dialysis, such as the presence of vascular prostheses, gastrostomies or intestinal diverticula. They also discuss the most common complications found regarding catheter function and how to manage them. Each peritoneal dialysis center should monitor and analyze the functioning of the peritoneal access, which contributes to improving the care of the peritoneal dialysis patient.

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