Chapter 2

Techniques for Peritoneal Dialysis Catheter Placement

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Additional information is available at the end of the chapter

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Abstract

This chapter describes the peritoneal dialysis (PD) catheter implantation techniques. It will also discuss the merits and demerits of each technique, catheter types as well as the PD catheter-related complications. Several techniques and modifications have been described for the insertion of the catheter into the abdominal cavity. We will describe the currently available catheter designs which come in a variety of shapes (straight, pigtail-curled, swan-neck), length and number of Dacron cuffs for optimal ingrowth and fixation and insertion techniques with its early and late complications. These techniques include open surgical, laparoscopic and percutaneous techniques. The strategy for an optimal catheter implantation together with the preventive and therapeutic means for complicated treatment will be discussed.

Keywords: technique, peritoneal dialysis, catheter placement

1. Introduction

A well-placed and functioning peritoneal dialysis (PD) catheter is central to the success of peritoneal dialysis (PD) as a renal replacement therapy, therefore, knowledge of best practices in catheter insertion can minimise the risk of catheter complications that leads to peritoneal dialysis failure [1]. The first successful PD was done in 1959 by Richard Ruben, his patient survived for 6 months, by 1964, Fred Boen from the Netherlands used a machine he developed a year earlier to treat two patients with end-stage renal disease for 2 years [2, 3]. These initial successes with the PD were soon followed by descriptions of several techniques and modifications for catheter placement ranging from open surgical techniques, through percutaneous placement to later laparoscopic placement [2, 4–8].

Several advantages of PD over haemodialysis (HD) have been described, including the quality of life due to superior patient mobility and independence, its simplicity in use, along with the clinical advantages like the maintenance of residual renal function and lower mortality in the first years after the beginning of PD. A significant disadvantage is the poor blood pressure control due to fluid overload [9].

The aim of this chapter is to describe the currently available catheter types and insertion techniques.

2. Technique for peritoneal dialysis catheter insertion

2.1. Types of peritoneal dialysis catheters

Peritoneal dialysis catheters come in various shapes (straight, pigtail-curled, swan-neck), lengths and numbers of Dacron cuffs (**Figure 1**). The peritoneal dialysis catheter is composed of a flexible silicone tube with an open-end port and several side holes to provide optimal drainage and absorption of the dialysate [2, 10].

The extraperitoneal component of the catheter has either one or two Dacron cuffs. The Dacron cuffs are for optimal growth and fixation. In adults, a double-cuff catheter is typically used. With the double-cuff peritoneal dialysis catheter, the proximal cuff is positioned in the preperitoneal space and the distal cuff in the subcutaneous tissue [2, 10]. The pubic symphysis

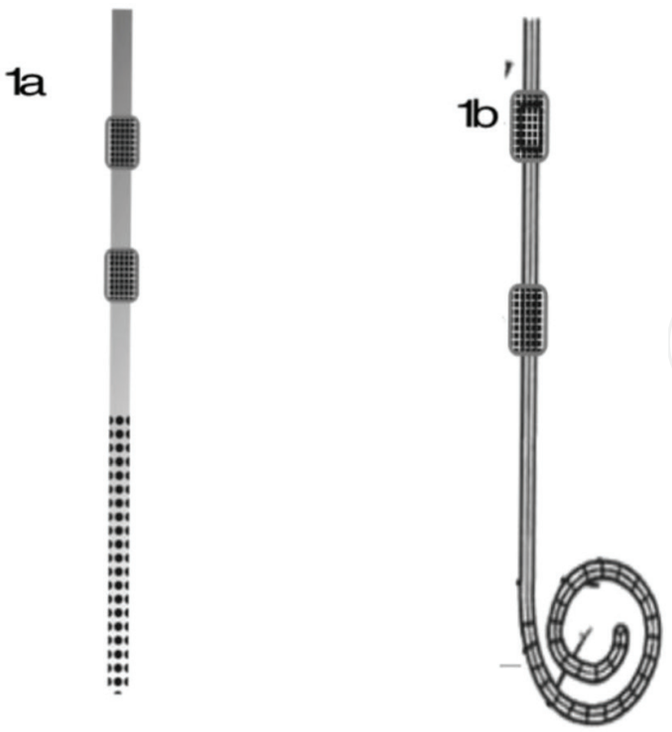

Figure 1. (a) Straight and (b) coiled PD catheters.

has been recommended as a reliable marker for the ideal location of the catheter tip in the true pelvis [2] (**Figure 2**).

The proximal cuff holds the catheter in place while the distal cuff acts as a barrier to infection. The type of catheter selected is usually based on the surgeon's preference.

2.1.1. Characteristic of an ideal peritoneal dialysis catheter

An ideal PD catheter should allow for optimal inflow and outflow and should be kink resistant; it should have no effect on physiology of abdominal tissues, should be resistant to infection with good surgical handling and should be affordable [10].

2.2. Techniques for insertion

There are several techniques used for the introduction of the PD catheter into the abdominal cavity. Open surgical and laparoscopic techniques are preferred because of their safety and good initial results [2]. The laparoscopic technique is becoming more popular because of its advantage in performing partial omentectomy, omentopexy or adhesionlysis during

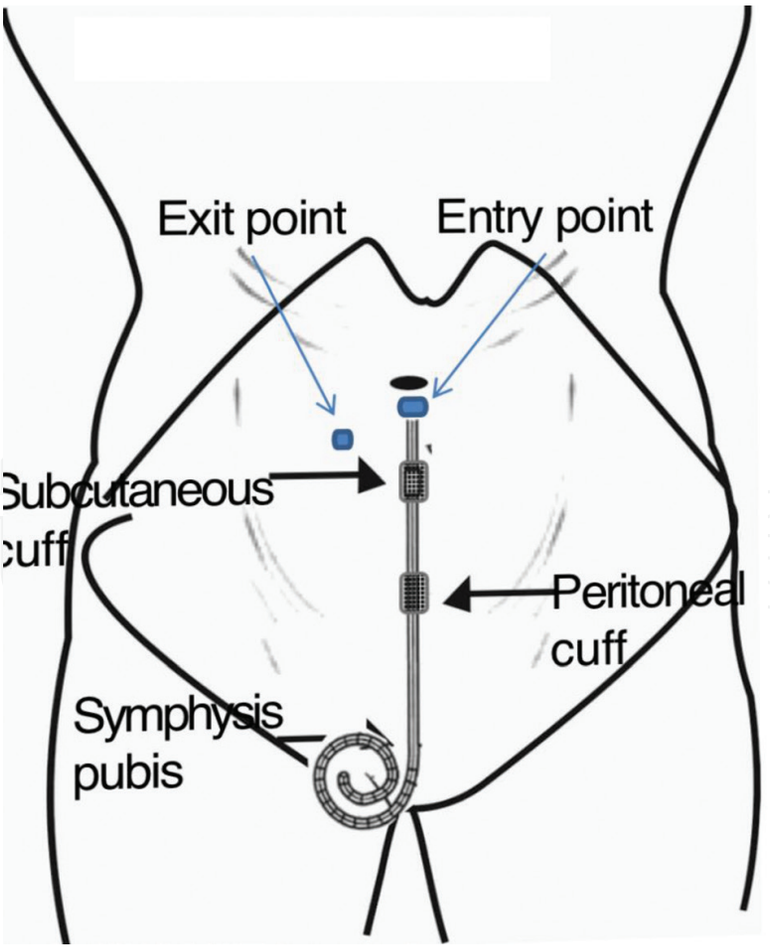

Figure 2. Exit and entry point of PD catheter with final position of the catheter tip.

the initial catheter placement [2, 11–14]. Percutaneous (radiological) catheter insertion may be less invasive but bears the risk of unsatisfactory catheter placement and danger of bowel perforation [2, 8].

2.2.1. Open surgical technique

With the patient placed in supine position under general anaesthesia, we routinely use an infraumbilical (two finger breaths) curvilinear incision on skin and subcutaneous tissue and a midline incision is then made on the fascia to gain access to the peritoneal cavity. However, Peppelenbosch et al. [2] described a technique in which a vertical incision of ~5 cm is made in the midline, 2–3 cm below the umbilicus. The subcutaneous layer is then dissected, till the sheath of the rectal abdominal muscle is reached. The anterior rectus sheath is opened and the muscle fibres are bluntly dissected. Subsequently, the posterior sheath is cut to 3–4 cm and the abdominal cavity is opened after dissecting the peritoneum. The abdominal wall is inspected for adhesions. After this, a retractor is used to lift the anterior abdominal wall. If the adhesions are present close to the abdominal wall, they are dissected. The patient is placed in a Trendelenburg position and the catheter is placed over a stylet and advanced into the peritoneal cavity. The intraperitoneal segment is slid off the stylet and the cuff is advanced to the preperitoneal space. The peritoneum and rectus sheaths (posterior and anterior) are closed carefully with absorbable sutures, ensuring not to obstruct the catheter and to prevent dialysate leakage. A tunnel is created to the preferred exit site using a needle and care should be taken to ensure that the exit site is facing downwards. The distal cuff is placed subcutaneously, 2 cm from the exit site. The exit site is usually lateral and caudal to the entrance site (**Figure 2**). Haemostasis is secured, and the incision is closed and the catheter itself is not fixated with a suture. The functioning of the catheter is tested by filling the abdomen with 100 ml of saline and the entrance site is checked for leakage. The saline is allowed to drain and is inspected for evidence of haemoperitoneum and faecal contamination.

2.2.2. Percutaneous

Placement of PD catheters with a guide wire and peel-away sheath is performed using a Seldinger technique. The procedure can be performed under local or general anaesthesia with prophylactic antibiotics. A small incision is created above the entrance site, usually in the midline with blunt dissection of the abdominal rectus sheath. The peritoneal cavity is cannulated with an 18-gauge needle and filled with either air or 500 ml of saline. With proper needle placement, the patient should not experience pain or resistance to fill the cavity with fluid. A 0.035-inch guide wire is advanced into the abdomen and the introduction needle is removed. A dilator and the peel-away sheath are advanced over the wire into the abdominal cavity. The wire and the dilator are removed and the catheter is placed on the stylet, advanced through the sheath. The intraperitoneal segment is advanced until the proximal cuff is located in the preperitoneal space. The peel-away sheath and stylet are removed and the catheter position is checked. A tunnel is created to the selected exit site with the placement of the distal cuff subcutaneously, 2 cm from the exit site. The entrance site is closed. The abdomen is filled with 500 ml of saline and drained [2].

2.2.3. Laparoscopic technique

The patient is placed in the supine position. General anaesthesia is inducted and intravenous antibiotics are administered. It is preferable to create a pneumoperitoneum with an open procedure. A small subumbilical incision is made (2–3 cm) and the umbilical cord is grasped with forceps and lifted. Subsequently, the subcutaneous layer is transected. The anterior rectus sheath is opened and a suture is placed to lift the anterior sheath. The posterior sheath and subsequently the peritoneum are digitally opened. If adhesions are present close to the abdominal wall, they are transected. A 5 mm trocar or a screw trocar is inserted into the abdomen and insufflated with CO_2 gas to create a pneumoperitoneum of 12–14 mmHg. A Veress needle technique can also be adopted. Several methods have been described. One is to place the needle in the upper-left quadrant of the abdomen. Another way is to open the anterior sheath as explained in the open procedure, but the Veress needle is used for the last one or two steps (the posterior sheath or the peritoneum). After the needle is in place, its correct position is tested by the water drop test, which should disappear into the abdomen through the needle and by insufflating and aspirating the 10 ml saline. After creating a pneumoperitoneum, a 5 mm trocar is inserted in the subumbilical position. After the 5 mm trocar is in place, the patient is placed in a Trendelenburg position and a diagnostic laparoscopy is performed with a 5 mm 0° scoop. In case the Veress needle is placed in the left-upper quadrant of the abdomen, its position is checked and the needle is removed. An extra 5 mm trocar is inserted under direct vision at the site of the planned exit-site position of the PD catheter (paraumbilical left or right 2–3 cm below the umbilicus). This trocar is introduced through the anterior and posterior rectus sheaths but not through the peritoneum. Under direct vision, the trocar is directed in the preperitoneal space, 2–4 cm downwards and to the midline of the abdomen. If adhesions are present, the trocar is introduced into the peritoneal cavity. Adhesions close to the abdominal wall are ligated with electrocoagulation or with the ligature device (US Surgical). A double-cuffed curled-tip PD catheter is then introduced through the paraumbilical port, ensuring no torsion has occurred, and is placed with the curled tip into the cavum douglasi. If no adhesions are present, then the second trocar is not introduced into the peritoneal cavity but is left in the preperitoneal space. Now, the stiff stylet is used to introduce the catheter into the peritoneal cavity. If the placement is troublesome, an extra 5 mm trocar is used, which can be inserted under the direct vision to grasp the catheter for proper positioning. The distal cuff of the PD catheter should be outside the peritoneum (in the preperitoneal space or between both the rectus sheaths). The paraumbilical trocar is removed and the catheter is now directed to its exit-site position. A needle is used to create the subcutaneous tunnel to the left or the right abdomen. The proximal cuff should be in this tunnel. The catheter is tested and then the abdomen is desufflated, with the camera still in position to check on the location of the catheter. The trocar is removed and the rectus sheaths are closed carefully with resorbable sutures. The wounds are closed with a resorbable monofilament suture, intracutaneously [2].

2.2.4. Alternative techniques

The Moncrief-Popovich catheter and technique involves subcutaneous burial of the external segment of the peritoneal dialysis catheter to prevent colonisation of the catheter by skin

bacteria and to promote attachment of the cuff to the tissue prior to exteriorization. A reduction in the rate of peritonitis and colonisation of bacterial biofilms in the catheter segments between the two cuffs was noted with the Moncrief-Popovich catheter [15]; however, a controlled randomised study failed to confirm these results [16].

2.2.5. Extended dialysis catheters

Longer dialysis catheters have been developed to allow placement of the exit site in remote places such as the presternal area [17]. Such extended catheters may be useful in obese patients and in those with an abdominal stoma [18].

2.3. Complications

Complications after PD catheter placement are defined as those occurring early (<30 days) or late (>30 days), after surgery [2].

2.3.1. Early complications

2.3.1.1. Bowel perforation

The risk of bowel perforation is less than 1%, and it usually occurs during entry into the abdominal cavity or when the catheter and stylet are advanced into the abdomen. Surgical exploration is necessary with repair of the perforation and removal of the catheter [2].

2.3.1.2. Bleeding

Bleeding is rarely a significant problem after peritoneal dialysis catheter placement. When bleeding occurs, it is usually at the exit site.

2.3.1.3. Wound infection

Wound infection is uncommon and often can be treated with antibiotics when it is superficial. If the wound is deeper, then it may need to be drained.

Outflow failure may be due to

1. Clots or fibrin in the catheter: an attempt to irrigate the catheter forcefully with saline or urokinase can be tried or a stiff wire can be inserted into the catheter under fluoroscopy.
2. A kink in the subcutaneous tunnel: an incision is made directly over the kink and the catheter is repositioned.
3. Placement of the catheter in the omentum.
4. Occlusion from omentum or adhesions.
5. Malpositioning of the catheter into the upper abdomen.

Laparoscopy is useful for identification and treatment of obstruction due to omentum or adhesions as well as for repositioning and fixation in the case of a malpositioned catheter [19]. The position of the catheter may also be identified on plain film or under fluoroscopy with the injection of contrast into the catheter and may be repositioned with a stiff guide wire or forceps [20].

Leakage of the dialysate may be identified by the presence of drainage at the exit site or the appearance of a bulge underneath the entrance site. Leaks may occur due to

1. hernia at the entrance site
2. positioning of the proximal cuff on the rectus muscle
3. trauma

Withholding use of the peritoneal dialysis catheter for several weeks may solve the problem [21]. The use of a modified technique of peritoneal dialysis catheter insertion with fibrin glue has been shown to prevent pericatheter leakage [18, 22].

Peritonitis may occur early and manifests as abdominal pain associated with cloudy peritoneal fluid. The fluid should be cultured, and appropriate antibiotics should be administered [18].

2.3.2. Late complications

Late complications include exit-site infection, tunnel infection, cuff protrusion, outflow failure and dialysate leaks or hernias [2, 18].

2.3.2.1. Cuff extrusion or infection

Cuff extrusion or infection can occur when the exit site is placed directly beneath the belt line. Superficial cuffs placed close to the skin may extrude or become infected. In such situations, the catheter should be exchanged and a new exit site selected [2, 18].

2.3.2.2. Outflow failure

Outflow failure beyond 30 days may occur due to constipation and can be treated with laxatives.

2.3.2.3. Peritonitis

Peritonitis is often the result of contamination with skin bacteria, but it may also be due to gram-negative bacteria associated with diarrhoea or diverticulitis. Systemic or intraperitoneal antibiotics are administered, and the exchange volumes decrease. Usually, a peritoneal dialysis catheter-related peritonitis will resolve with proper antibiotic therapy. If the infection persists, catheter removal and use of haemodialysis for 4–6 weeks is sufficient for

resolution of the peritonitis [18, 22]. There is a strong association between exit-site infections and subsequent peritonitis, with an increased risk up to 60 days after initial diagnosis [18, 23].

3. Conclusion

The success of PD as a renal replacement therapy is dependent on the proper placement of the permanent PD catheters. A good knowledge of the implantation techniques and complications is very essential for a good outcome.

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