The peritoneal dialysis catheter

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ABSTRACT

The results obtained from the positioning and management of the catheter for peritoneal dialysis depend on the techniques used, but also and above all, on the experience of the practitioners. A comparison between practitioners may help to change their convictions, as well as to further improve results, in the interests of patient welfare. This is the aim of these Best Practice Guidelines.

Key words: Peritoneal catheter, Implantation, Complication, Prophylaxis, Exit-site, Infection, Anesthesia

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1. **Patient Assessment**

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**Introduction**

The patient assessment process should be performed by the patient’s regular nephrologist and, if his/her knowledge of the positioning technique is inadequate, by a surgeon. The aim of patient assessment prior to peritoneal catheter positioning is to exclude contraindications and reduce complications, and it should be performed during the briefing on the choice of dialysis method.

**Literature Review**

The most recent guidelines published by the International Society for Peritoneal Dialysis (ISPD), recommend a physical exam to identify the presence of any hernias and screening for methicillin-resistant *Staphylococcus aureus* and for the presence of endonasal *S. aureus* (1). The guidelines also suggest using a dermographic marker to indicate the catheter exit site on the abdomen in both seated and standing positions. The medical history should focus on allergic reactions to medicinal products and devices such as patches and on any prior abdominal surgeries and related complications. During the physical exam, the clinician notes the presence and position of any abdominal scarring; umbilical, inguinal or incisional hernia; areas of relaxation in the abdominal muscular wall and cutaneous infections. Hernias may increase in size with an increase in intra-abdominal pressure due to the presence of dialysis liquid, and related complications may jeopardize the performance of peritoneal dialysis. Hernias must be surgically corrected, either prior to, or at the same time as, catheter placement, to prevent potential complications. General clinical evidence suggests that only small umbilical hernias, with a diameter of less than 5-6 mm, do not require surgical repair. The presence of abdominal scarring and a history of intraoperative and postoperative complications are not contraindications to peritoneal dialysis. In these cases, the patient should be managed using a video-guided laparoscopic placement technique, on the scar-free side of the abdomen. The presence of adhesions cannot be predictable, and it goes without saying that the prevalence of adhesions increases with the number of prior surgeries (2-5). To prevent discomfort due to rubbing and compression of the tunnel, the position of the exit site must not coincide with clothing waistbands and belts. The exit site should also be easily accessible to the patient when seated, to perform medication. If night-time automated peritoneal dialysis is to be used, the patient’s usual sleeping position should be considered, specifying the side he/she usually lies on. Where possible, the catheter should be positioned on the side the patient prefers to lie on, to reduce the likelihood of inadequate or incomplete emptying. No controlled studies have been performed to ascertain which side – left or right – should be favored for the placement of peritoneal catheters. Positioning the end of the peritoneal catheter on the left side means avoiding the ileocecal area, which is particularly risky during unguided percutaneous placement, and makes it possible for the catheter to follow the same direction as peristalsis through the descending and sigmoid colon, theoretically reducing the risk of displacement; however, this has not been backed up by scientific evidence. Crabtree developed a technique for identifying the position of the inner and outer cuffs of coiled peritoneal catheters (6, 7). The coiled part is positioned at the pubic symphysis, and the length of the straight segment up to the inner cuff coincides with the area at which it enters the abdominal cavity, whereas the exit site is located along the arc between the inner cuff and 2 cm distal to the outer cuff (6, 7). In patients with colostomies, urinary incontinence or severe obesity, the tunnel should be prolonged as far as the upper abdomen or chest (7-9).

**Discussion**

The recent ISPD guidelines only consider the abdominal physical exam, assays for pathogens such as *Staphylococcus aureus* and the position of the exit site (1). The specific problems of obese or colostomized patients is not discussed. The most recent guidelines are:

- a thorough medical history and physical exam are fundamental for the correct programming of peritoneal catheter placement and for avoiding complications;
- the exit site must be easily accessible to the patient for medication purposes and must not coincide with belts or waistbands;
- hernia repair should be performed prior to, or at the same time as, catheter placement to avoid complications that can prejudice the performance of dialysis;
- in severely obese or colostomized patients, the exit site...
should be located in the upper abdomen or thorax, by elongating the catheter;
• the presence of abdominal scarring due to prior surgeries is not a contraindication for peritoneal dialysis.

REFERENCES


2. CHOOSING A CATHETER

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INTRODUCTION AND LITERATURE REVIEW

It is universally accepted that an “ideal” peritoneal catheter should guarantee rapid 2-way flow without leakage or infections, characteristics that have been satisfied in a more than satisfactory manner by the original Tenckhoff catheter and the variants thereof proposed subsequently to minimize potential complications (1). However, the few experiences reported in the literature do not identify a variety of catheter that is superior to others, and it would appear that rather than the type of catheter used, the determinants for a favorable outcome are the positioning technique and exit site medication (2). In any case, the nephrologist must be familiar with the characteristics of the catheters available on the market to choose that best suited to the positioning technique used and the patient’s characteristics.

When describing the main characteristics of the catheter, reference is made to the original Tenckhoff model that, despite having been invented back in 1968, is still the most commonly used, albeit in a number of different embodiments (3). The material used is silicone, which has a less irritant action than polyvinyl or other materials used previously, is nontraumatic for the surrounding tissues and soft, flexible and free from clinically harmful plasticizing agents that may be released. The adult version has an overall length of approximately 40 cm and is composed of a straight intraperitoneal segment with a number of holes, a transpapertial or intramural segment, a subcutaneous segment and an external or extraabdominal segment. The inner diameter is 2.6 mm; 2 polyester cuffs (Dacron) – 1 deep intramural and 1 superficial subcutaneous – attach it firmly to the tissues; and lastly, a radiopaque strip allows easy radiological identification in the event of displacement or accidental breakage (Fig. 1).

As mentioned previously, a number of variants of the original model have been proposed over the years, and today’s market offers a number of diverse combinations in terms of the number of cuffs (1 or 2); the shape of the intraperitoneal tip, which can be straight or coiled; the shape of the subcutaneous segment of the catheter, which can be either straight or have a swan neck; and, lastly, the presence of devices to prevent the displacement of the intraperitoneal segment (Figs. 2 and 3).

Of these, one of the most commonly used variants is the swan neck catheter, a classic Tenckhoff catheter with a curved subcutaneous stretch between 2 cuffs with an offset of 170°-180°, reminiscent of the shape of a swan’s neck (Fig. 4): this makes it possible to direct the catheter's exit downwards, to favor the drainage of any secretions and therefore reduce exit site infectious complications. This solution also overcomes the catheter’s elastic memory and reduces the displacement of the intraperitoneal tip and superficial cuff extrusion (4). Both the original Tenckhoff catheter and the swan neck variant are available with either a straight or coiled intraperitoneal tip. The latter has several advantages: It restricts displacement and omental entrapment and, above all, relieves abdominal pain during filling, in patients with a peritoneum that is “sensitive” to particularly
brisk infusion flows and it is less traumatic for the visceral organs than straight-tipped models.

The other variants, developed primarily to minimize the dislocation of the intraperitoneal tip, include:

- the Toronto Western Hospital (TWH) catheter (Fig. 5): a Tenckhoff catheter characterized by the presence of 2 silicone disks positioned perpendicular to one another at the end of the catheter's intraperitoneal segment with the dual purpose of keeping the omentum and the loops of the intestine away from the outlet holes and minimizing tip migration. The disadvantages include greater difficulties when implanting and removing the catheter (5);

- the Ask & Janle T-fluted catheter: in this model, the intraperitoneal portion that comes into contact with the parietal peritoneum has 8 large fluted grooves instead of side holes; its grooves and its T-shape are designed to guarantee better flow and minimize displacement problems (6);

- Di Paolo’s self-locating catheter (Fig. 6): a straight Tenckhoff catheter with a small tungsten cylinder measuring 12 g built into the catheter's intraperitoneal tip, with enough weight as to prevent displacement outside the pelvis (7).

Alternatives made of materials other than silicone include:
• Cruz catheter: a few years ago, this author suggested a catheter made of polyurethane, which is more biocompatible than silicone, characterized by a larger lumen (3.1 mm) but with the same outer diameter as the conventional Tenckhoff catheter, and which also features a double contouring of the intraperitoneal and subcutaneous segments, intended to reduce displacement. After an initial successful phase, this catheter was seen to be prone to damage when it comes into contact with alcoholic disinfectant solutions, which led to a gradual reduction in its use (8).

Alternatives to the anchoring system: in addition to the classic Dacron cuffs, which are usually 5 cm apart (a greater distance is recommended for obese patients), a number of alternative or additional solutions have been suggested: In the TWH and Swan-Neck Missouri catheters, in addition to the 2 Dacron cuffs, a spherical support and a flange located in the catheter's intramural segment are fastened, respectively, just below the peritoneum and between the peritoneal membrane and the posterior fascia of the rectus abdominis muscle; while reducing the likelihood of leakage, however, this solution is more difficult to implant (Fig. 4).

Another aspect to be considered is the length of the catheter, which must be individualized to suit the patient’s physical characteristics. Crabtree et al make a very important contribution in this sense by describing a method for determining the correct length and type of catheter to match the location of the intraperitoneal segment in the pelvis with an adequate tunnel for the patient’s anatomy and size (9).

This last concept is supported by the following 2 known variants:
• the swan neck presternal catheter: a variation on the Swan-Neck Missouri with a coiled tip, composed of 2 silicone catheters connected to one another end-to-end by a titanium connector: the bottom part constitutes the intra-abdominal segment and part of the intramural segment, the upper or thoracic segment constitutes the rest of the intramural segment and the entire subcutaneous tunnel fitted with 2 Dacron cuffs; this type of catheter is indicated for use in severely obese and colostomized patients (10).
• Vicenza catheter (Fig. 7): the Vicenza short peritoneal catheter is a straight, 2-cuff Tenckhoff catheter with a shorter intraperitoneal segment (8 cm vs. 15 cm) than the original model. It was designed by the Vicenza group and is indicated for suprapubic implantation, to limit the risk of omental entrapment and displacement (11).

An overview of the catheters for peritoneal dialysis cannot exclude those designed for continuous flow peritoneal dialysis. In this sector, Ronco et al recently devised a double-lumen catheter with built-in silicone diffuser (Fig. 8).

To reduce recirculation, the diffuser’s design means that the liquid, which is infused at a high flow rate, is dispersed around 360° which reduces the damage to the parietal peritoneum and allows the dialysate to blend in the peritoneal cavity. The liquid is then drained by the second branch of the catheter, the tip of which is positioned in the rectouterine pouch (12).
This development of catheter variants has been accompanied by several studies, in small case series, conducted to identify the best type of catheter in terms of survival and a reduced incidence of complications. Assuming that acceptable catheter survival at 1 year should be at least 80% (1), the guidelines published recently by the UK Renal Association, in agreement with the international guidelines indicated above, indicate that no catheter has yet been proven to be superior to the others (13).

**SYNOPSIS AND CONCLUSIONS**

A review of the randomized controlled trials that form the basis of the Italian Society of Nephrology (SIN) guidelines (14) can be summarized as follows:

- there is no evidence that a coiled intraperitoneal segment presents advantages over straight-tip catheters in terms of either the prevention of infectious complications or catheter survival;
- similarly, there are no significant differences between 1-cuff (intramural) catheters and 2-cuff models in terms of number of peritonitis episodes, exit site/tunnel infections or difficulties during the removal or replacement of the peritoneal catheter;
- the 2-cuff catheters implanted with downward-facing exit sites can involve a lower risk of exit site infection.

To conclude, there are no clear characteristics in favor of a certain type of catheter, the success of which depends to a great extent both on the experience of the practitioner and his/her mastery of the implantation technique and on meticulous exit site care. However, although they do not provide sturdy statistically significant evidence, routine practice and the results reported in the literature suggest a 2-cuff silicone catheter with a downward-facing exit site may give better results.

To facilitate this kind of tunnel direction and manage the not infrequent cases of migration of the intraperitoneal segment, the swan neck and self-locating variants present 2 valid alternatives to the classic Tenckhoff catheter.

**REFERENCES**

Patient preparation in the days leading up to the surgical implantation of the peritoneal catheter is essential for a successful outcome. Many patients with chronic kidney disease are on antiplatelet and anticoagulant medication for concomitant cardiovascular disorders. To avoid significant bleeding during the procedure and in the immediate postoperative period, the possibility of suspending these medications and replacing them with low-molecular-weight heparin for the necessary period must be considered on a case-by-case basis. This decision is to be taken together with the anesthetist and, on occasions, also the cardiologist (e.g., double antiplatelet medication for coronary stenting), making it appropriate to have a number of protocols (see the section “Anesthesia Assessment of the Patient” Tab. IV).

In addition to the risk of intraoperative and postoperative bleeding, antiplatelet and anticoagulant medications must be suspended and, if necessary, replaced, in the case of spinal anesthesia (e.g., when catheter implantation is performed at the same time as hernia repair surgery).

A close relationship between endonasal Staphylococcus aureus and incidence of peritonitis in peritoneal dialysis (PD) patients has been known for about 20 years (1). Of the most important papers published, that authored by the Mupirocin Study Group showed that regular treatment with nasal mupirocin in patients on PD affected by the microorganism, significantly reduces the incidence of exit site infections (2). However, the family members and medical staff who have contact with the patient may also be carriers (3). After the publication of these and many other papers, it was suggested that prophylaxis for S. aureus infections be administered using mupirocin both before and after catheter implantation, in patients and in endonasal carriers; this approach has just 1 drawback, however: the cost (4). The guidelines published by the International Society for Peritoneal Dialysis (ISPD) in 2005 (5) suggest an operative protocol in which intranasal mupirocin is administered twice a day for 5-7 days. To reduce the risk of a recurrence of carrier status, which one study reported as being 62% at 1 year (6), the treatment should subsequently be cyclically repeated (7). The importance of nasal screening to identify S. aureus carriers was also highlighted in the guidelines recently published by Figueiredo et al (8).

### Suggested operative approach

One protocol proposed by the Italian Society of Nephrology's Peritoneal Dialysis Study Group is as follows: to treat all patients with mupirocin (twice a day, in both nostrils for the 3 days before and the 3 days after the procedure), without performing nasal culture tests, which will, on the other hand, be performed subsequently to test for recurrence. Nasal culture tests should, however, be performed for family members and medical professionals, and only carriers should be treated and subsequently have regular culture tests.

Before surgery, it is appropriate to run some blood tests (including blood group, hepatic markers and HIV tests) and perform an electrocardiogram (ECG). With the exception of hepatic markets and HIV tests, which should be recent (2-3 months) and the blood group, which should have been already determined, the other lab tests and the ECG should be performed on the afternoon before the procedure, or the same morning if it is scheduled for the afternoon (Tab. I). The afternoon prior to the procedure, an enema should be administered, abdominal hair removed and the waist marked to make sure that the exit site does not coincide with clothing waistbands or belts. Patients must not have nail varnish on their hands or feet, as this would interfere with oxygen saturation measurements.

Intravenous antibiotic should be administered to prevent early-onset peritonitis (i.e., in the first 2 weeks after the procedure). The efficacy of this approach was confirmed in a trial conducted some time ago, which showed that the administration of a single dose of vancomycin (1,000 mg) administered 12 hours before the procedure reduced the risk of peritonitis to a greater degree than placebo, and that it was superior to treatment with the albeit efficacious cefazolin (1,000 mg) administered 3 hours earlier (9). A subsequent analysis of 4 more studies confirmed the efficacy of this approach in terms of early-onset peritonitis, but not on exit site and tunnel infections (10).
The guidelines published by the International Society for Peritoneal Dialysis in 2005 stressed the importance of prophylaxis with vancomycin, but also warned of the greater risk of developing resistant microorganisms with the use of this antibiotic than with cefazolin (5). The conclusions in both of these guidelines and in the more recent ones authored by Figuereido et al (8) and mentioned above are that the antibiotic should be chosen according to “local” guidelines. Our protocol involves the administration of vancomycin 12 hours before surgery (Vancocin 1 g in 250 mL of sterile saline or 5% glucose solution with an infusion time of at least 60 minutes).

On the day of the procedure the patient must remain in a fasting condition to avoid aspiration pneumonia which may occur during intubation maneuvers (that may be necessary in the presence of severe complications, even if the procedure is performed under local anesthesia) and be taken to the operating theater without dentures and jewelry (watches, bracelets, rings, necklaces etc.). It is also important for the patient to urinate before being positioned on the operating table, so that the bladder is empty during the procedure.

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### REFERENCES

4. ANESTHESIA ASSESSMENT OF THE PATIENT

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INTRODUCTION

Most of the surgical procedures performed for implantation, removal and handling of minor complications (e.g., cuff shaving) of peritoneal dialysis catheters, can be performed by the nephrologist under local anesthesia, autonomously and under his/her own responsibility, placing special attention on the anesthetics used particularly in terms of the speed of the induction and duration of the analgesic effect and the maximum permitted dose (Tab. I).

If deeper sedation is required, due to either the type of patient or the procedure to be performed, or spinal anesthesia (e.g., for implantation plus hernia repair surgery) or general anesthetic (e.g., in video-guided laparoscopy for malfunction) are needed, responsibility for anesthesia lies exclusively with the anesthesiology and intensive care specialist.

Purpose of anesthesia assessment

The term anesthesia assessment refers to a medical act, performed by specialists, that precedes the administration of anesthetics for diagnostic and/or therapeutic procedures (1-5). These procedures and the administration of anesthetics can cause organ function alterations. For anesthesia assessment, it is consequently important:

- to define the patient’s baseline status (baseline clinical assessment), by means of laboratory tests and/or instrumental procedures;
- to plan any therapeutic measures;
- to define the anesthetic approach to be adopted;
- to provide analgesia if required;
- to program perioperative management;
- to evaluate risk (balance between the patient’s baseline status and the nature of the procedure planned and the type of anesthesia required);
- to provide the patient with adequate information and acquire his/her informed consent.

Baseline clinical assessment

The choice and management of anesthesia are the exclusive competence of the anesthetist (in Italy, Law no. 653 of August 9, 1954), who decides on the anesthetic technique and prepares the patient for the procedure, according to his/her assessment and the scheduled procedure, taking into account the preferences of the patient (or the patient’s parents in the case of a minor, or the legally appointed guardian if the patient is subject to a guardianship order) and the indications provided by the requesting physician.

On the basis of the clinical data collected, the anesthetist may decide that anesthesia is contraindicated or to postpone the diagnostic/therapeutic procedure. In this case, he/she must notify the requesting physician and the patient and must record the reasons for the decision on the patient's medical chart. A collegial evaluation of the risks and benefits can make it possible to identify the best time to perform the procedure: in the case of a difference in opinions between the requesting physician and the anesthetist, the patient should be informed.

During this evaluation, which is based on the consultation of clinical documentation and the investigations performed, as well as collection of a medical history, and on the physical exam, it is necessary to consider the various potential options with regard to premedication, anesthetic technique...
and any analgesia to be used; the need for clinical and instrumen-
tational monitoring, particularly during the procedure; and the appropriateness of specialist care at the end of the procedure. The medical history and physical exam must specifically aim to identify prior or current conditions and medications that may interfere with the anesthesia – in particular, the response of the patient and his/her family to anesthetics and any confirmed or suspected allergies. The physical exam should aim to identify any anatomical abnormalities that could hinder anesthesia.

The request for an anesthesia assessment for an elective procedure must be made by the requesting physician with time frames that allow the anesthetist to perform an in-depth examination and further diagnostic investigations, organize specialist appointments or conduct special patient preparation procedures. The requesting physician should provide the anesthetist with all of the information needed for correct assessment, in particular with regard to the type of procedure planned and any surgical techniques to be used, anticipated duration, the required or preferred position to be adopted by the patient, anticipated blood loss and confirmed or suspected infections. The decision to perform additional laboratory tests, instrumental procedures or specialist consultations must be taken by the anesthetist on a case-by-case basis, following the indications that, in addition to those that the patient’s medical history, age and risk factors present, also include the type of procedure. However, the scientific evidence concerning the impact of laboratory tests and other risk assessment investigations on the patient’s anesthesia outcome is unclear: although a number of studies have explored this relationship, they do not appear to reach any univocal scientific consensus (3, 4).

Special care should be taken when assessing a patient with cardiopathy not undergoing heart surgery. The cardiac complications related to non-heart surgery depend both on specific clinical risk factors (Tab. II), and the nature of the surgical procedure and circumstances in which it is conducted (5). The surgical factors that condition cardiovascular risk are related to the urgency, entity, nature and duration of the procedure, as well as changes in body temperature, blood loss and displacement of liquids (6).

Surgery may also alter the equilibrium between pro-thrombotic and fibrinolytic factors, such as to favor a state of hypercoagulability and possible coronary thrombosis (elevation of fibrinogen and other clotting factors,

### TABLE I
LOCAL ANESTHETICS

<table>
<thead>
<tr>
<th>Agent</th>
<th>Trade name</th>
<th>Strength</th>
<th>Speed of action</th>
<th>Duration of action</th>
<th>Toxicity</th>
<th>Maximum dose for adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine 1%, 2%</td>
<td>Xilocaina</td>
<td>Medium</td>
<td>Rapid 4-7 minutes</td>
<td>Intermediate 80-120 minutes</td>
<td>Low</td>
<td>200 mg (approx. 3 mg/kg) infiltration &lt;20 mL of 1%</td>
</tr>
<tr>
<td>Mepivacaine 1%, 2%</td>
<td>Carbocaina</td>
<td>Medium</td>
<td>Rapid 4-7 minutes</td>
<td>Intermediate 80-120 minutes</td>
<td>Low</td>
<td>550 mg (7 mg/kg, &lt;90 minutes) infiltration &lt;40 mL of 1%</td>
</tr>
<tr>
<td>Bupivacaine 0.25%, 0.5%</td>
<td>Marciana</td>
<td>High</td>
<td>Moderate 8-20 minutes</td>
<td>Long 180-360 minutes</td>
<td>High</td>
<td>150 mg (2 mg/kg) infiltration &lt;60 mL of 0.25%</td>
</tr>
<tr>
<td>Levobupivacaine 0.25%, 0.5%</td>
<td>Chirocaina</td>
<td>High</td>
<td>Moderate 15-20 minutes</td>
<td>Long 180-200 minutes</td>
<td>Medium</td>
<td>150 mg (approx. 2-2.5 mg/kg) infiltration &lt;60 mL of 0.25%</td>
</tr>
<tr>
<td>Ropivacaine 0.2%</td>
<td>Naropina</td>
<td>Medium-high</td>
<td>Rapid-moderate 2-15 minutes</td>
<td>Long 120-360 minutes</td>
<td>Medium</td>
<td>200 mg (approx. 2.5-3 mg/kg) infiltration &lt;100 mL of 0.2%</td>
</tr>
</tbody>
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increased platelet activation and aggregation, and reduction in fibrinolysis). The magnitude of these variations is directly proportionate to the nature and duration of the procedure. These factors must be carefully considered in high-risk patients, as each could cause myocardial ischemia or decompensated heart failure, and the surgical approach should be redefined accordingly.

It is also essential to consider the type of non-heart surgery the patient will be undergoing. With regard to cardiovascular risk, surgical procedures can be grouped into 3 categories – low, medium and high – corresponding to an incidence of cardiac events at 30 days of <1%, between 1% and 5% and >5% (Tab. III), respectively (7).

Unlike conventional open surgery, laparoscopic procedures present a number of advantages, such as less tissue trauma, less incision site pain, faster recovery of intestinal function and reduced fluid displacement, associated with postoperative intestinal paralysis. On the other hand, the induction of pneumoperitoneum, which precedes this kind of procedure, involves an increase in intra-abdominal pressure and a reduction in venous return to the heart, with a consequent reduction in cardiac output and increase in systemic vascular resistance. Therefore, laparoscopic procedures do not reduce the cardiovascular risk for patients with decompen-

### TABLE II
CLINICAL AND MEDICAL HISTORY FACTORS PREDICTIVE OF AN INCREASED RISK OF PREOPERATIVE CARDIO-VASCULAR RISK (ACC/AHA 2002 GUIDELINES)

<table>
<thead>
<tr>
<th>Category</th>
<th>Clinical Factors</th>
</tr>
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<tbody>
<tr>
<td><strong>Major</strong></td>
<td></td>
</tr>
<tr>
<td>Unstable coronary syndromes:</td>
<td></td>
</tr>
<tr>
<td>• Current or recent (&lt;1 month) AMI with high risk of ischemia as suggested by symptoms or non-invasive investigations</td>
<td></td>
</tr>
<tr>
<td>• Unstable or severe angina (Canadian class III or IV)</td>
<td></td>
</tr>
<tr>
<td>• Acute decompensated heart failure</td>
<td></td>
</tr>
<tr>
<td>Significant arrhythmias:</td>
<td></td>
</tr>
<tr>
<td>• High-grade A-V block</td>
<td></td>
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<tr>
<td>• Symptomatic ventricular arrhythmias in patient with cardiopathy</td>
<td></td>
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<tr>
<td>• Supraventricular arrhythmias with uncontrolled ventricular response</td>
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<tr>
<td>Severe valve disease</td>
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<tr>
<td><strong>Intermediate</strong></td>
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<tr>
<td>Mild angina (Canadian class I or II)</td>
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<tr>
<td>History of prior AMI or ECG finding of pathological Q-waves</td>
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<tr>
<td>History of decompensated or compensated heart failure</td>
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<tr>
<td>Diabetes mellitus (particularly if insulin-dependent)</td>
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<tr>
<td>Renal insufficiency (creatinine &gt; 2 mg/dl)</td>
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<tr>
<td><strong>Minor</strong></td>
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<tr>
<td>Old age</td>
<td></td>
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<tr>
<td>ECG alterations (ventricular hypertrophy, LBBB, ST-T abnormalities)</td>
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<tr>
<td>Non-sinus rhythm (e.g. atrial fibrillation)</td>
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<tr>
<td>Low productive capacity (unable to climb stairs carrying a load)</td>
<td></td>
</tr>
<tr>
<td>History of stroke</td>
<td></td>
</tr>
<tr>
<td>Uncontrolled hypertension</td>
<td></td>
</tr>
</tbody>
</table>

ACC/AHA = American College of Cardiology–American Heart Association; AMI = acute myocardial infarction; ECG = electrocardiogram; LBBB = left bundle branch block.
sated heart failure compared with conventional surgery and should be considered to be on the same level. During the anesthesia consultation, the patient will also be briefed on preoperative fasting. The indications for the fasting period to be observed before sedation must be given to the patient, parents or legally appointed guardian for children or incapacitated patients (Tab. IV) (8). The anesthetist must also provide precise instructions regarding the medication the patient is to take. More specifically, on the morning of the procedure, it is appropriate for all oral medication to be taken with a glass of water 2 hours before the patient is taken to the operating theater (with the exception of anticoagulants, psychiatric medications and antidiabetics, for which the specialist must be contacted for a joint assessment with the anesthetist).

### Patient information and consent

The anesthesia informed consent form must provide the patient with the information needed to participate in the decision-making process, as part of the doctor–patient relationship (9). A correct informed consent process must guarantee:

- good doctor–patient communication;
- acknowledgement of the patient’s right to accept or refuse the diagnostic and therapeutic options suggested;
- the doctor’s right to obtain legally valid confirmation that the patient understands the potential risks and benefits associated with the procedure and the anesthetist’s role.

Once the assessment is complete, the patient should be informed of his/her general condition, the chosen anesthetic technique (general, local, locoregional or sedation) and corresponding known risks, of potential complementary maneuvers (invasive monitoring, placement of additional catheters and probes), the potential related risks and complications, the possibility that the anesthetic technique may have to be adjusted during the procedure. The patient should also be informed of the possibility that he/she will receive a blood transfusion, undergo postoperative analgesic treatment and may require intensive care.

The aim of patient information is to answer his/her ques-

---

**TABLE III**

<table>
<thead>
<tr>
<th>Risk stratification</th>
<th>Examples of procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Aortic surgery</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>Other major vascular surgery</td>
</tr>
<tr>
<td>(risk &gt;5%)</td>
<td>Peripheral vascular surgery</td>
</tr>
<tr>
<td></td>
<td>Intraperitoneal and intrathoracic surgery</td>
</tr>
<tr>
<td></td>
<td>Carotid endarterectomy</td>
</tr>
<tr>
<td></td>
<td>Head and neck surgery</td>
</tr>
<tr>
<td></td>
<td>Orthopedic surgery</td>
</tr>
<tr>
<td></td>
<td>Prostate surgery</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Endoscopic procedures</td>
</tr>
<tr>
<td>(risk between 1% and 5%)</td>
<td>Superficial procedures</td>
</tr>
<tr>
<td></td>
<td>Cataract</td>
</tr>
<tr>
<td></td>
<td>Breast surgery</td>
</tr>
<tr>
<td></td>
<td>Day surgery procedures</td>
</tr>
<tr>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>(risk &lt;1%)</td>
<td></td>
</tr>
</tbody>
</table>

ACC/AHA = American College of Cardiology–American Heart Association.
tions, dispel any doubts and obtain valid consent. The au-
thorization, which must be dated and signed by the patient
(or parents or guardian) and signed by the doctor conduct-
ing the informed consent talk, must be filed in the medical
chart. The anesthetist may not subject a minor or incapaci-
tated person to anesthesia without the authorization of his/
her parents or guardian.

Suspension of anticoagulants and antiplatelet
medications

Surgery involving patients on anticoagulant and antiplatelet
medications is an important issue in clinical practice, due to
the growing number of patients on oral anticoagulant ther-
apy and/or antiplatelet medication, who are often elderly and
with multiple comorbidities. For surgical procedures or in-
vasive maneuvers, suspending treatment may increase the
risk of thromboembolism (TE), whereas continuing it may
increase the risk of bleeding.

The aim is to bring the patient to the surgical procedure or
other invasive maneuver with adequate hemostasis while
exposing him/her to the risk of TE for the shortest possible
time, and to do so, it is important that indications are ap-
propriate.

The choice of the most suitable treatment depends on:

- the risk of TE concerning the various clinical situations,
  for which the oral anticoagulant or antiplatelet therapy
  were prescribed, and the patient’s specific risk;
- the risk of bleeding associated with perioperative oral
  anticoagulant and/or antiplatelet use, the type and site
  of the procedure, associated clinical conditions (liver
disease and/or kidney disease), use of medications that
  interfere with hemostasis and the possibility of adopting
  appropriate local hemostatic measures (10-13).

The conditions relevant to the level of risk are:

**Conditions at high risk of TE:**
- atrial fibrillation associated with mitral valve disease;
- artificial mitral valves;
- first-generation artificial aortic valves;
- recent deep vein thrombosis (in the previous 3 months).

**Conditions with a medium to low risk of TE:**
- last generation artificial aortic valves;
- atrial fibrillation not associated with valve disease;

<table>
<thead>
<tr>
<th>Material swallowed</th>
<th>Minimum hours of fasting required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear liquids</td>
<td>2</td>
</tr>
<tr>
<td>Breast milk</td>
<td>4</td>
</tr>
<tr>
<td>Formula/nonhuman milk</td>
<td>6</td>
</tr>
<tr>
<td>Light meal</td>
<td>6</td>
</tr>
</tbody>
</table>

**TABLE IV**

**LIQUID ADMINISTRATION AND PREOPERATIVE FASTING**

<table>
<thead>
<tr>
<th></th>
<th>Solid food and nonclear liquids</th>
<th>Clear liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>6-8 hours or nothing after midnight</td>
<td>2-3 hours</td>
</tr>
<tr>
<td>Children &lt;3 years</td>
<td>6-8 hours</td>
<td>2-3 hours</td>
</tr>
<tr>
<td>Children 3-6 years</td>
<td>6 hours</td>
<td>2-3 hours</td>
</tr>
<tr>
<td>Children &gt;6 years</td>
<td>4 hours</td>
<td>2 hours</td>
</tr>
</tbody>
</table>
### TABLE V
PROTOCOLS FOR SUSPENSION OF ANTICOAGULANT AND ANTIPLATELET MEDICATION

#### Oral anticoagulants

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dicumarol:</td>
<td>Suspend 5 days before the procedure. On days 5-4-3-2 replace with low-molecular weight heparin; e.g.: Enoxaparin s.c. 100 IU/kg body weight twice a day.</td>
</tr>
<tr>
<td>Warfarin sodium</td>
<td>Day before the procedure:</td>
</tr>
<tr>
<td>Acenocoumarol</td>
<td>Clexane s.c. 100 IU/kg body weight, single dose at 8 AM. (Reduce the dose of Enoxaparin by 50% if creatinine clearance is &lt;30 ml/min.) Day of the procedure: full clotting parameter profile. The PT value must be between 80 and 100% if INR &lt;1.5.</td>
</tr>
</tbody>
</table>

#### Parenteral anticoagulants

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-molecular-weight heparin:</td>
<td>Suspend 24 hours before the procedure. Last administration no later than 8 AM on the day before the procedure.</td>
</tr>
<tr>
<td>Dalteparin</td>
<td></td>
</tr>
<tr>
<td>Enoxaparin</td>
<td></td>
</tr>
<tr>
<td>Parnaparin</td>
<td></td>
</tr>
<tr>
<td>Nadroparin</td>
<td></td>
</tr>
</tbody>
</table>

#### Oral antiplatelet medication

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylsalicylic acid or its salts</td>
<td>Suspend 4 days before the procedure. From the day after suspension: Enoxaparin 4,000 IU s.c. 8 AM. The day before the procedure, last administration of Clexane at 8 AM.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clopidogrel</td>
<td>Suspend 7 days before the procedure. From the day after suspension: Enoxaparin 4,000 IU s.c. 8 AM. The day before the procedure, last administration of Clexane at 8 AM.</td>
</tr>
<tr>
<td>Indobufen</td>
<td>Suspend 4 days before the procedure. From the day after suspension: Enoxaparin 4,000 IU s.c. 8 AM. The day before the procedure, last administration of Clexane at 8 AM.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticlopidine</td>
<td>Suspend 7 days before the procedure. From the day after suspension: Enoxaparin 4,000 IU sc. 8 AM. The day before the procedure, last administration of Clexane at 8 AM.</td>
</tr>
<tr>
<td>Picotamide</td>
<td>Suspend 14 days before the procedure. From the day after suspension: Enoxaparin 4,000 IU sc. 8 AM. The day before the procedure, last administration of Clexane at 8 AM.</td>
</tr>
</tbody>
</table>

**“Double antiplatelet therapy” and nondeferrable surgery**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clopidogrel +</td>
<td>Consult the cardiologist who treats the patient. Suspend Clopidogrel 7 days before the procedure. From the day after suspension: Enoxaparin 100 IU/kg of body weight s.c. twice a day. (Reduce the dose of Enoxaparin by 50% if creatinine clearance &lt;30 ml/min.) Suspend Acetylsalicylic acid 3 days before the procedure. The day before the procedure, last administration of Enoxaparin at 8 AM.</td>
</tr>
<tr>
<td>Acetylsalicylic acid</td>
<td></td>
</tr>
</tbody>
</table>

Based on guidelines issued by the American Society of Regional Anesthesia (ASRA) (14), European Society of Regional Anesthesia (ESRA) (15) and the Società Italiana di Anestesia Analgesia Rianimazione e Terapia Intensiva (SIAARTI; Italian Society for Anesthesia, Analgesia and Intensive Care) (16).

INR = international normalized ratio; PT = prothrombin time; s.c. = subcutaneously.
• not-recent deep vein thrombosis (more than 3 months earlier).

Generic risk factors:
• age over 75 years;
• arterial hypertension;
• left ventricular insufficiency.

Whereas major surgery is associated with a 100-fold increase in the risk of venous TE, no association has been proven with an increased risk of arterial TE.

The criteria used to define the risk of bleeding are the procedure type and site and the possibility of adopting local hemostatic measures. A high risk of bleeding is related to both the site of the procedure (e.g., neurosurgery, major cancer surgery and vascular surgery) and the technical difficulties of surgical hemostasis (e.g., transurethral prostatectomy, gastrointestinal or bladder polypectomy, hepatic or renal biopsy).

It should also be noted that there is no standard definition of major surgery: according to the American Society of Anesthesiology (ASA), the definition should be based on the degree of invasiveness and of perioperative blood loss. The risk of heavy postoperative bleeding in patients on heparin therapy has been estimated to be between 1% and 3%. There is no consensus with regard to perioperative treatment. But the treatment options are:
• continuation of anticoagulant and/or antiplatelet therapy;
• temporary suspension of the anticoagulant therapy and replacement with therapeutic dose heparin if appropriate (bridging therapy), when the international normalized ratio (INR) is below the therapeutic range.

The American College of Cardiology (ACC), American Heart Association (AHA) and American College of Chest Physicians (ACPP) suggest bridging therapy in most patients, whereas other authors only advocate the use of hepatic therapy in patients with a very high risk of TE.

The suggested protocols (Tab. V) refer to the guidelines issued by the American Society of Regional Anesthesia (ASRA) (14), European Society of Regional Anesthesia (ESRA) (15) and the Società Italiana di Anestesia Analgesia Rianimazione e Terapia Intensiva (SIAARTI; Italian Society for Anesthesia, Analgesia and Intensive Care) (16).

REFERENCES


5. STANDARD OPEN SURGICAL IMPLANTATION

Stefano Santarelli

Nephrology and Dialysis Unit, Carlo Urbani Hospital, Jesi - Italy

INTRODUCTION AND LITERATURE REVIEW

The standard open surgical implantation technique is the most commonly used worldwide. It is utilized both by nephrologists and surgeons, in most, but not all cases, working in dedicated teams. Despite being a technique that can be conducted by nephrologists, most prefer to use percutaneous techniques, and open surgery is mainly performed by surgeons, albeit with significant differences between the United States, Asia and Europe (1).

In one study published recently in the United Kingdom involving 43 peritoneal dialysis (PD) units, the peritoneal catheter was positioned by specialist surgeons in 71.7% of cases, nephrology specialists in 19.3% of cases and by other professional figures (registrars and specialized nurses) in the remaining 9% of cases. More than 50% of centers use the open surgical technique only, and the remainder use both it and percutaneous techniques (2).

In one study published recently in the United Kingdom involving 43 peritoneal dialysis (PD) units, the peritoneal catheter was positioned by specialist surgeons in 71.7% of cases, nephrology specialists in 19.3% of cases and by other professional figures (registrars and specialized nurses) in the remaining 9% of cases. More than 50% of centers use the open surgical technique only, and the remainder use both it and percutaneous techniques (2).

In Italy, the most recent data was recorded in 2010 as part of the census conducted by the SIN Peritoneal Dialysis Study Group: they show that the catheter is implanted by surgeons in 36% of cases, by nephrologists in 28% and by teams including both in 32% (data was missing for 4% of centers). The open surgical technique is the most commonly used approach (87%), followed by percutaneous (2%) and laparoscopic approaches (5%) and other methods (6%) (3).

The results obtained for the open technique are good, regardless of whether the operator is a nephrologist or surgeon. There are many positive experiences of positioning with this technique performed by nephrologists, and one interesting study was recently published by the Li and Chow group in Hong Kong (4). However, the same authors also published a literature review showing that nephrologists prefer percutaneous techniques (1).

The main factor conditioning catheter survival and, therefore, the possibility for a patient to continue being dialyzed with PD, is malfunction due to mechanical complications such as displacement and occlusion. With the open method, the main study of a series published over the past decade (at least 50 catheters implanted, with a follow-up of more than 3 months) (5) reported an incidence for this kind of complication of between 10% and 17%. Percutaneous methods are associated with a lower incidence of occlusion, between 2% and 13%, but also with a very high incidence of leakage, between 2% and 18%. No leakage occurs with open and video-guided laparoscopic techniques, which involve the opening of the peritoneum by minilaparotomy and purse-string suturing, as reported in a recent paper by Yang et al, who did not experience any complications in 228 catheter implantations using the open technique and 9 video-guided laparoscopic procedures (6).

The advanced video-guided laparoscopic technique (7, 8) alone is able to bring advantages in terms of the incidence of occlusion and displacement, which, with the aforementioned method is 0-0.5%, however, greater diffusion of this technique is hampered by its considerable drawbacks.

TECHNIQUE

After preoperative preparation (Tab. I), access to the abdominal cavity is gained using a minilaparotomy, which allows direct visual control over abdominal wall structures to reduce the risk of vascular and intestinal lesions. The mini-laparotomy should be performed at the point at which the catheter's inner cuff is to be positioned, usually a subumbilical paramedian location (2-3 cm below the transverse umbilical line, 2-3 cm to the side of the alba line), either to the left or right.

The procedure is usually performed under local anesthesia (Fig. 1). When other procedures are to be carried out, such
as hernia repair or laparoplastic procedures, such as to require an excessive amount of local anesthetic, general or spinal anesthesia should be used.

Having performed an incision in the skin and subcutaneous tissue (Fig. 2), access the anterior fascia of the rectus abdominis muscle (Fig. 3) and make another incision (Fig. 4). Separate the muscle fibers, paying careful attention not to damage the inferior epigastric artery, which can sometimes run between them, and uncover the posterior fascia of the rectus abdominis muscle and the peritoneum (Fig. 5).

When operating under local anesthesia, infiltrate the anesthetic onto the 2 structures (Fig. 6). Grasp the 2 structures, or the peritoneum alone if the fascia has already been opened, with 2 clamps, and lift to distance them from any adjacent intestinal loops; before using surgical scissors to make a small cut (approximately 5 mm) in the peritoneum (Fig. 7). Prepare the purse-string with absorbable suture, attempting to include also the posterior fascia of the rectus abdominis muscle (Figs. 8 and 9). At the end of the procedure, this will allow a closure that will almost completely eliminate the risk of leakage, even when an immediate postoperative start to PD is required. Insert the Tenckhoff catheter fitted with a lubricated Guyton introducer through the opening in the peritoneum (Figs. 10 and 11), and leave it in place (in the pelvis) as the introducer is retracted. Position the catheter’s inner cuff above the peritoneum and tighten (without tying)
the purse-string, to perform a trial using a liter of dialysis solution. If it works well, the purse-string can be tied with a number of knots (Fig. 12), some of which also including the upper margin of the inner cuff, having surrounded the catheter with suture thread (Fig. 13); this will keep the anchorage stable for about a month, during which time the thread will be reabsorbed and the catheter will be held in place by the scar tissue that will form around it. Suture the anterior fascia of the rectus abdominis muscle from bottom to top (Fig. 14) allowing the catheter to protrude from the top corner of the stitches (Fig. 15). By allowing the catheter to maintain its elastic memory and therefore a downward inclination, this maneuver should minimize the risk of displacement. One variant that again has the purpose of maintaining the catheter’s elastic memory is to make a transverse incision into the superficial fascia (during the abdominal wall opening phase) and allow the external part of the catheter and the superficial cuff to protrude through a hole, made using the scalpel, laterally and cranially to the incision in the superficial fascia (9). Infiltrate the anesthetic (if using local anesthesia) into the subcutaneous tissues and the area of skin from which the catheter is to protrude (Fig. 16).
Using a curved tunneler (Fig. 17), trace the catheter's subcutaneous course proceeding in a sideways and downward direction (Fig. 18) and position the outer cuff approximately 2 cm from the exit site (Fig. 19). Suture the subcutaneous tissue with button stitches (Fig. 20) and the skin with subcuticular sutures (Fig. 21) or, alternatively, button stitches.

**Discussion**

In addition to being the most commonly used worldwide, the open surgical technique performed under local anesthesia continues to be the gold standard for PD catheter implantation. Wherever possible, it is preferable to the unguided percutaneous and fluoroscopic techniques. Ideal candidates for this technique should preferably never have had abdominal surgery.

The fundamental aspects for good open implantation are:

- the nephrologist should always be present in the team on the operating field, preferably as the first operator or, alternatively, as the assistant surgeon;
- the presence of the PD nurse in the theater is recommended;
always prepare the purse-string as carefully as possible, attempting to include the posterior fascia of the rectus peritoneum;

• sink the inner cuff between the fibers of the rectus abdominis muscle parallel to it, and suture the fascia from the bottom up.

REFERENCES


6. IMPLANTATION OF THE VICENZA SHORT CATHETER

Roberto Dell’Aquila
Nephrology and Dialysis Unit, San Bassiano Hospital, Bassano del Grappa - Italy

INTRODUCTION

In a peritoneal dialysis (PD) program, access to the cavity remains one of the most important aspects for the survival of the technique it is known that catheter displacement and infection are the main causes of the failure of the reported here refers to approximately 1,100 placements of the Vicenza short catheter (VSC) using an open surgical technique.

LITERATURE REVIEW

The VSC is a modified version of the classic Tenckhoff: a straight, 2-cuff silicone catheter with a short intraperitoneal segment (8 cm vs. the 15 cm of the classic Tenckhoff catheter) (Fig. 1) (4, 5). The Dacron cuffs are 5 cm apart, and they have a length of 1 cm.

In 2006, a retrospective analysis was performed on the survival and operation of the VSC (6), which has been used since 1982. A 20-year period was considered, from 1985 to 2005, during which 726 Short catheters (manufactured by Braun Carex, Mirandola, Italy) were implanted. The catheters were implanted mainly by nephrologists and, in just a handful of cases, also by surgeons, under general anesthesia, for clinical reasons.

Although not based on comparison data or guidelines, some authors believe good catheter survival to be around 90%-95% at 2 years (7, 8), whereas others claim that it is good if it is not under 80% at 1 year (9, 10). In our analysis, the VSC showed superior survival (94.3% at 2 years and 91.5% at 5 years). This high survival rate is most likely due to the attention dedicated to exit site care, use of exit site and tunnel ultrasound and early infection treatment to prevent major complications.

The trend for exit site infection and catheter removal underwent a clear drop over the 20-year evaluation period, demonstrating that the acquisition of good surgical experience and increasingly scrupulous care of the exit site are the
most important factors in reducing the incidence of infectious complications and catheter removal. Catheter displacement is another cause for removal (3), and it was precisely to try to prevent this complication that Dr. Stefano Chiaramonte of Vicenza developed the VSC. Due to its shorter peritoneal segment, this catheter has a lesser relative elasticity and flexion capacity and, consequently, is less likely to migrate. In the case series described above, the displacement rate was 4% (6).

Lastly, in one survey, patients declared good acceptance of the catheter (body image) (98%) and excellent compatibility with clothing (100%) (6).

**TECHNIQUE**

The evening before the procedure, the patient has a shower, the procedure area is shaved, prophylactic antibiotic therapy is administered and an enema is performed. On the morning of the procedure, for patients with preserved diuresis, fit a bladder catheter with a urine meter to be removed at the end of the procedure: this step is dictated by the fact that the point of access to the peritoneum is lower, and it is therefore best to keep the bladder empty (lower volume) to avoid accidental incision during the procedure. Since the intraperitoneal segment is shorter than that of a classic Tenckhoff catheter, the implantation site is 5 cm above the pubic symphysis to either side of the alba line (Fig. 2).

Having identified the point of insertion, anesthetize the area involved and, subsequently, make a 1.5-2 cm craniocaudal incision in the skin using a scalpel. With an electric scalpel and/or round-ended surgical scissors, make an incision/opening in the subcutaneous tissues as far as the anterior fascia of the rectus abdominis muscle. Grasp the fascia using 2 Klemmer clamps and use the scalpel to gently cut into and open it.

Having completed this operation, detach the muscle fascia with a round-ended surgical scissors in a craniocaudal direction. Cut the fascia taking care not to damage the muscle fibers; delicately introduce a hemostat into the muscle fasciae and separate them in a laterolateral manner until you reach the preperitoneal fat and, finally, the peritoneum. The latter will appear as a whitish membrane with a consistency that varies from a thin, almost transparent membrane to a thicker translucent white membrane (taking care not to confuse it with the posterior muscle fascia). The clamping of the peritoneum is painful for the patient and should therefore be infiltrated with approximately 1 mL of anesthetic. Having grasped the peritoneum with 2 hemostats and ascertained that there are no other structures underneath it, make an incision with round-ended scissors (Fig. 3): a hole opens giving access to the abdominal cavity (Fig. 4).

Evaluate cavity patency by inserting a long forceps with the tips closed (Fig. 5); clamp the peritoneum with 4 hemostats so that the edge can be lifted; with an absorbable Polysorb® 3-0 suture (Tyco) prepare the purse-string, which consists in running stitches in and out of the peritoneal wall so that eventually both ends of the suture thread are outside the wall (Fig. 6).

Prepare the catheter by wetting and squeezing the cuffs
in a heparin-saline solution (Fig. 7), inject the heparin solution into the catheter lumen and fit the steel introducer (Fig. 8), leaving the last 5 cm free to avoid damaging any organs during introduction into the cavity. Introduce the catheter gently following the easiest route – i.e., that where there is least resistance. Point the tip toward the rectouterine pouch, guiding it slightly to the patient’s left so that, in the event of migration, the clockwise direction of intestinal peristalsis, stimulated by laxatives, can guide the tip back to an optimum position. With the first cuff remaining outside the peritoneum, tie a double knot in the ends of the suture used to make the purse-string and tighten the peritoneum around the catheter (Fig. 9). For safety, tie 4 more single knots and secure the catheter in place with 4 knots on top of the cuff. Infuse 50-100 mL of dialysis solution using a syringe to test the function of the catheter and check the urine meter to make sure that the peritoneal catheter has not been inadvertently inserted into the bladder. Suture the muscle fascia in a caudocranial direction with button stitches using absorbable Polysorb® 0 (Tyco) suture. Make the last and highest stitch starting from the
catheter side (Figs. 10 and 11) to push the catheter downward, so that the tip stays in position.

Assemble the tunneling stylet, make the subcutaneous tunnel following a gentle curve and position the second (subcutaneous) cuff about 1.5-2 cm from the exit site. Once the skin has been perforated with the stylet, extract with an alternating left–right rotation movement to slightly widen the outlet hole and facilitate the external drainage of the necrotic material formed during tunneling (Figs. 12 and 13).

A few years ago (11), we evaluated a total of 27 direct X-ray studies of the abdomen for peritoneal catheter malfunction, and we observed that catheters with exit sites on the left side of the abdomen (18/27) had a higher irreversible migration rate than those with exit sites on the right (9/27), which could be better repositioned following peristalsis enhancement, thanks to the clockwise direction of peristalsis, which made it possible to move the tip of the catheter downward.

Therefore, in our experience, with this type of catheter, it is preferable for the exit site to be located on the right. Once the tunneling is complete, close the surgical wound with layered sutures. In the absence of complications, average operating time is about 20 minutes.
DISCUSSION

The VSC is a valid alternative to other types of PD catheter. Its main advantages that justify its use over other types of catheter in PD programs or individual patients are:

• a probable reduced incidence of displacement;
• better dialysis fluid drainage;
• better compatibility with clothing and acceptance by the patient due to the fact that, because of its position, both the exit site and the dressing are easier to conceal.

REFERENCES

Best Practice on: The peritoneal dialysis catheter

7. One-Port Video-Guided Laparoscopic Implantation

Stefano Santarelli¹, Emilo Ceraudo²

¹Nephrology and Dialysis Unit, Carlo Urbani Hospital, Jesi - Italy
²General Surgery Unit, Carlo Urbani Hospital, Jesi - Italy

INTRODUCTION AND LITERATURE REVIEW

Although it is still uncommon both in Italy and internationally, the video-guided laparoscopic (VLS) positioning of catheters for peritoneal dialysis (PD) is attracting increasing interest, due to the advantages it offers. A distinction can be made between basic and advanced VLS (1). The former involves catheter placement under visual control and allows the performance of other diagnostic procedures (liver or peritoneal biopsies) and therapeutic procedures (cholecystectomy, appendectomy, hysteradnexectomy, etc.), whereas during the latter, it is also possible to take measures to prevent catheter malfunction (due to occlusion caused by omental wrapping or displacement), such as omentopexy and rectal tunneling.

The basic technique is discussed in many scientific publications, of which only a few are randomized controlled trials, due partly to the impossibility of recruiting large case series. Some of these publications highlight the advantages (1, 2) of this method over the standard surgical technique in terms of catheter survival; others merely describe it as being not inferior (3, 4).

What can be said for sure is that the VLS technique makes it possible to position the catheter securely even in patients who have had previous abdominal surgery, and when necessary, it makes it possible to perform the lysis of adhesions to prepare the abdominal cavity and make it suitable for PD treatment.

The basic method therefore makes it possible to increase the number of patients who can be treated by peritoneal dialysis, allowing them the same long-term results as patients with catheters implanted using the standard surgical technique, who have never had surgery or who have only had minor surgical procedures (appendectomy) (5).

The main indication for the basic VLS technique is the implantation of catheters in patients who have already undergone several procedures or with a history of major abdominal surgery, as reported in the 2010 UK guidelines (6). Implantation using the VLS method involves the use of 2 or 3 ports for access to the peritoneal cavity. Just 2 papers describe 1-port placement, but they generally envisage an additional access for the peritoneal catheter or report a lack of control and the need for subsequent correction (7, 8).

The original technique described here involves the use of a single port to be used for all of the steps involved: exploration, operation, video-guided laparoscopic control and catheter insertion (5).

The VLS procedure can be performed under local anesthesia when abdominal cavity exploration alone is to be carried out with a duration not exceeding 5-10 minutes; however, it is necessary to reconvert to general anesthesia if adhesion lysis is required. In all other cases, the procedure should be conducted under general anesthesia from the outset. In countries in which nitric oxide is considered a medical device gas (not so in Italy), it can be used for the induction of pneumoperitoneum, and the entire surgical procedure can be performed under local anesthesia (9).

TECHNIQUE

Access to the abdominal cavity is gained using a minilaparotomy, allowing direct visual control over abdominal wall structures to reduce the risk of vascular and intestinal lesions. The minilaparotomy should be performed at the point in which the catheter’s inner cuff is to be positioned, usually a subumbilical paramedian location (2-3 cm below the transverse umbilical line, 2-3 cm to the side of the alba line), either to the left or right.

Induce general or local anesthesia (as above).

Having performed an incision in the skin and subcutaneous tissue (Fig. 1), access the anterior fascia of the rectus abdominis muscle (Fig. 2) and make another incision (Fig. 3). Separate the muscle fibers, paying careful attention not to damage the inferior epigastric artery, which can sometimes run between them, and uncover the posterior fascia of the rectus abdominis muscle and the peritoneum (Fig. 4). When operating under local anesthesia, infiltrate the anesthetic onto the 2 structures (Fig. 5). Grasp both structures, or the peritoneum alone if the fascia has already been opened, with 2 clamps and lift away from any ad-
jacent intestinal loops; before using surgical scissors to 
smake a small cut (approximately 5 mm) to create an 
opening (Fig. 6). Prepare the purse-string with absorbable 
suture, attempting to include also the posterior fascia of the 
rectus abdominis muscle (Figs. 7 and 8).

At the end of the procedure, this will allow a closure that 
will almost completely eliminate the risk of leakage, even 
when an immediate postoperative start to PD is required.

The minilaparotomy is used to insert a 10-mm port, 
through which it is possible to induce pneumoperitoneum 
with carbon dioxide at an intra-abdominal pressure of 12 
mm Hg (Fig. 9). This allows adequate abdominal cavity 
distension to allow video-guided laparoscopic exploration 
(Fig. 10). The instrument used has a working channel (0 
degree videolaparoscope with a 5-mm-diameter working 
channel; Karl Storz, Tuttingen, Germany) (Fig. 11), which 
makes it possible, in the presence of adhesions, to per-
form lysis of the same, using the appropriate instruments 
(dissector and surgical scissors) with simultaneous cut-
ting and coagulation.

The Tenckhoff catheter fitted with a Guyton introducer 
(Fig. 12) is inserted through the port and left in position 
(pelvic cavity) when first the introducer and then the port 
are retracted (Fig. 13). The port is then reintroduced next 
to the catheter (Fig. 14), and pneumoperitoneum is rein-
stated to confirm correct positioning using the videolapa-
roscope, or for any necessary correction.

Once the port has been removed, the catheter's inner 
cuff is positioned above the peritoneum, and the purse-
string is closed with a number of knots (Fig. 15), some of 
which also involve the top edge of the inner cuff, having 
wound the suture round the catheter (Fig. 16); this allows 
an anchorage that becomes stable after about 1 month, 
during which time the suture will be reabsorbed, and the 
catheter will be held in place by the scar tissue that will 
form around it.
Suture the anterior fascia of the rectus abdominis muscle from the bottom up (Fig. 17) allowing the catheter to protrude from the top of the stitches (Fig. 18).

By allowing the catheter to maintain its elastic memory and therefore a downward inclination, this maneuver should minimize the risk of displacement. Infiltrate the an-
esthetic (if using local anesthesia) into the subcutaneous tissues and the area of skin from which the catheter is to protrude (Fig. 19).

Using a curved tunneler (Fig. 20), trace the catheter’s subcutaneous course proceeding in a sideways and downward direction (Fig. 21) and position the outer cuff approximately 2 cm from the exit site (Fig. 22). The subcutaneous tissues are sutured using button stitches (Fig. 23), and the skin is sutured using subcuticular sutures (Fig. 24) or, alternatively, button stitches.

Discussion

There is no agreement in the literature as to the actual advantages of using the basic video-guided laparoscopic technique over the open surgical method, and the only randomized trials available report similar results in terms of long-term catheter survival (2-4). However, it has been proven that advanced VLS practically eliminates the mechanical complications of catheter operation (1, 10, 11), although it is unlikely that the technique will become a gold standard, for the following reasons:

- the technique is more complex;
- the procedure can be performed by surgeons only;
- it cannot always be performed under local anesthesia (nitric oxide is only available as a medical device in very few countries).

Basic VLS has 2 very important indications, namely: peritoneal catheter implantation in pluri-operated patients; simultaneous performance of other surgical procedures with catheter implantation (cholecystectomy, appendectomy, hysterectomy etc.).
The first indication makes it possible to recover a large percentage of patients for PD, as was recently demonstrated (5). Basic VLS using the one-port technique:

• can be performed in the nephrology/dialysis centers of hospitals with a surgery division that performs VLS procedures;
• can be performed autonomously, after adequate briefing and training, even by nephrologists who perform surgical catheter implantation, although the presence of a surgeon in the team, while not essential, is preferable.

REFERENCES

8. Implantation with marsupialization using the technique proposed by Moncrief and Popovich

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Introduction and literature review

To obtain good exit site tissue ingrowth, which can be complicated by accidental pulling on the catheter and/or bacterial colonization, and to prevent bacterial colonization, which is thought to lead to a greater risk of episodes of peritonitis, in 1993, Moncrief and Popovich (MP technique) described a technique for surgical peritoneal catheter implantation (1) involving the marsupialization in the subcutaneous tissues of the external segment of the catheter and subsequent exteriorization 3-5 weeks after complete ingrowth (Fig. 1). However, the expected advantages of this modification have been debated in the literature and remain controversial. A number of publications (2-6) confirm the results anticipated by the authors: a reduction in the incidence of exit site infections, with fewer episodes of peritonitis and, ultimately, an increase in the survival of the peritoneal dialysis technique.

Conversely, other studies (7-11) do not confirm these advantages, reporting that there are no statistically significant differences in the incidence of peritonitis between the MP technique and the classic peritoneal catheter implantation technique.

However, all of the studies agree in reporting the obvious disadvantage of the MP technique – i.e., the need for 2 procedures rather than a single surgery. Esson et al (12) conclude that the positive results can be attributed to the time elapsing between the first and second procedure and recommend an ideal marsupialization time of 6 weeks to 5 months. However, Elhassan et al (13), in a recent personal case series review challenged these results.

The disadvantage of performing 2 procedures is even more obvious in the case of patients with a very thick layer of subcutaneous fat: in these patients the exteriorization procedure could prove complicated and require a larger incision. For this and other reasons, we modified the technique proposed by MP in order to make the exteriorization of the catheter more straightforward.

We introduced this surgical technique at our center, after conducting a predialysis program with a dedicated outpatient clinic. At the end of the training course, we considered peritoneal catheter implantation on a par with the creation of an arteriovenous fistula and believed that compared with other techniques, this solution makes it possible to schedule the procedure as elective surgery and allow adequate maturation times for correct use, in the conviction that the organizational aspect is more important than technical and material-related issues (14).

Technique

The peritoneal catheter implantation technique chosen by our group is that of standard surgery (11) with the only variant, as described by MP, of burying the distal portion of the catheter (1). Having been informed about the procedure and given consent for the surgery, the patient must be adequately prepared: it is very important that the patient empties his/her bladder before entering the theater.

Having identified the catheter implantation site (a transrectal location is most common) (Fig. 2), local anesthesia is induced using lidocaine (2% 10mL) in the subcutaneous tissues and mepivacaine (2% 10mL) at deeper levels (Fig. 3).

Perform a 3-4 cm incision in the skin (2 cm beneath the transverse umbilical line and 2 cm to the side of the midline) and dissect the subcutaneous tissues to reach the anterior fascia of the rectus abdominis muscle (Fig. 4).

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Perform a 3-4 cm incision in the skin (2 cm beneath the transverse umbilical line and 2 cm to the side of the midline) and dissect the subcutaneous tissues to reach the anterior fascia of the rectus abdominis muscle (Fig. 4).

Make an incision in the anterior muscle fascia (Fig. 5) and isolate the muscle, observing the direction of the fibers (Fig. 6), then locate the posterior fascia of the rectus abdominis muscle and the peritoneum below (Fig. 7). Simultaneously lift the fascia and peritoneum using a delicate forceps (Fig. 8).
Prepare the purse-string (Fig. 9), including the muscle fascia with the peritoneum to make the suture sturdier and airtight (Fig. 10). Insert the catheter, trying to locate its tip in the rectouterine pouch (Fig. 11) and secure the first Dacron cuff inside the muscle fascia, taking care not to damage the inferior epigastric artery.

Create the subcutaneous portion by forming a half-moon with a downward-facing concave aspect and secure the second Dacron cuff 2-3 cm from the exit site, keeping the point at which the catheter enters the peritoneum and the exit site at the same height (Fig. 12). With the surgical technique described by MP, instead of
protruding from the skin, the catheter is entirely tunneled into the subcutaneous tissue, using a Redon needle, which results in an open catheter (peritoneal cavity to subcutaneous tissue connection) without landmarks for the subsequent creation of the exit site. This can prove even more difficult to perform, through a small incision in the skin, in patients with a very thick layer of subcutaneous fat.

We therefore decided to modify the technique to avoid a number of disadvantages of the MP technique, such as:

- not having a landmark to be used as a reference point for cuff positioning;
• excessive catheter depth at exactly the point at which the exit site is to be created;
• the impossibility of closing the catheter.

When positioning the catheter, it is important to evaluate the best option for the creation of the exit site (Fig. 13), so that it is not necessary to have to guess where it is during the exteriorization procedure.

Once the best position has been identified, the catheter is retracted and buried for a few centimeters in the subcutaneous tissue and, once it has been capped (Fig. 14), it is rolled (Fig. 15) exactly underneath the incision of the skin, at the end covered by bandages (Fig. 16). Our modification to the technique proposed by MP makes the exteriorization procedure much more straightforward (Figs. 17
and 18) as, after a modest subcutaneous infiltration of 2% lidocaine (Fig. 19), a small incision is made in the skin (Fig. 20), at the correct distance from the second Dacron cuff (Fig. 21) located deep in the subcutaneous tissue (Figs. 22 and 23).

**Discussion**

As reported above, the advantages of this technique in terms of a reduced incidence of exit site infections and episodes of peritonitis secondary to the same have not been shown with certainty. However, the implantation technique described can be a valid option, on a center-dependent basis, for purely organizational reasons.

**References**


9. IMPLANTATION OF THE SELF-LOCATING CATHETER USING THE PARAMEDIAN MINI-LAPAROTOMY TECHNIQUE

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INTRODUCTION AND LITERATURE REVIEW

On the basis of the concept that a peritoneal catheter should be difficult to displace and should be implanted with a straightforward procedure, in 1992, Nicola Di Paolo devised a peritoneal catheter obtained by modifying the classic straight, 2-cuff Tenckhoff catheter (1). The modification consists in the presence, in the distal part (last 2 cm) of the catheter, of a 12-g tungsten cylinder, entirely coated in silastic (Fig. 1), together with a 0.5-mm increase in the diameter of the catheter. The decision to use tungsten was dictated by the fact that this material is chemically inert and biocompatible.

By increasing the weight of the end of the catheter, the presence of the tungsten weight allows 2 important physical functions: the distal end is kept in the lower part of the abdominal cavity (which significantly reduces displacement) and a moderate pull is exerted inside the abdominal cavity that counterbalances the forces of traction toward the exterior (preventing the extrusion of the superficial cuff).

The self-locating catheter was designed to solve the problem of catheter displacement. To work effectively, the catheter should be located in the rectouterine pouch, where there is no omentum (2). Contact between the omentum and the catheter’s end hole, in the drainage phase, can cause catheter malfunction if the omentum is sucked into the opening.

In 2004, Di Paolo published a multicenter study (3) comparing the data for 2 cohorts of patients implanted with 2 types of catheter: the Tenckhoff catheter (216 patients) and the self-locating catheter (746 patients). At the end of a 2-year follow-up period, displacement had occurred in 12% of subjects in the Tenckhoff group and in 0.8% of the self-locating group.

Statistically significant improvements were observed in the self-locating group also in terms of the incidence of peritonitis, subcutaneous tunnel infections, cuff extrusion, and early leakage (3). In a Spanish study conducted in 2001, Miguéla et al (4) obtained the same results, which were confirmed by Lanuza et al in 2006 (5) after a 9-year observation period.

As reported also in a presentation by Roberto Russo of the Bari group (8), in some cases, adhesions (viscero-omental and viscero-visceral) that complicated removal were observed when the catheter was removed. This complication is most likely due to the sudden increase in diameter between the silastic and the tungsten cylinder. Another possibility is the presence of a foreign body in the peritoneal cavity causing a peritoneal reaction leading to the formation of inflammatory scar tissue. Another recent alteration made the difference in diameter less drastic, with the addition of more silastic in the area between the 2 different diameters.

Most authors implant the self-locating catheter using a
percutaneous technique, whereas for about 15 years, our center has preferred a minilaparotomy approach, which allows a direct view of abdominal wall tissues, more efficacious hemostasis and a more careful plastic repair of the abdominal wall, with full control over leakage.

**Technique**

Access to the abdominal cavity is obtained by means of a paramedian minilaparotomy through the rectus abdominis muscle, usually on the right, under local anesthesia. Figure 2 shows the skin area before incision. The decision to use this area of the abdomen is dictated by the fact that the presence of the rectus abdominis muscle provides protection from early and late leakage and herniation through the abdominal wall around the catheter. After induction of local anesthesia (Fig. 3) and having performed an incision in the skin and subcutaneous tissues (Fig. 4), isolate the anterior fascia of the rectus abdominis muscle and make a 1-1.5 cm craniocaudal incision in the same. Once the rectus abdominis muscle is exposed, separate its fibers (Fig. 5), taking care not to damage the epigastric artery. At each stage of the procedure, the tissue accessed should be infiltrated with additional anesthetic. Separate the fibers of the rectus abdominis muscle using Farabeuf retractors (Fig. 6), expose the muscle’s posterior fascia and the peritoneum; lift the latter with forceps (having excluded the presence of intestinal loops) and cut (Fig. 7).

Once the metal guide wire has been inserted into the catheter, introduce it into the abdominal cavity, directing it toward the rectouterine pouch. The patient will feel a dull pain in the anal region if the catheter fitted to the guide wire is pressed gently downward (Fig. 8). This confirms
that the end of the catheter is in the correct position. The guide wire can now be retracted, leaving the catheter in the abdominal cavity. Prepare a purse-string on the peritoneum, preferably including the posterior fascia of the rectus abdominis muscle to guarantee an antileakage mechanism, leaving the deep cuff on top of the peritoneum (Fig. 9).

Once the purse-string is complete, suture the anterior fascia of the rectus abdominis muscle with running stitches from the bottom up, allowing the catheter to protrude from the top corner (Figs. 10 and 11).

Perform a functional check using 50 mL of sterile saline solution (Fig. 12), prepare the subcutaneous tunnel using a tunneler or, more simply, with a curved Klemmer forceps (Figs. 13-15). When creating the tunnel, follow a downward and sideward course, leaving the superficial cuff about 2 cm from the exit site.

Lastly, suture the subcutaneous tissues with button stitches (Fig. 16) and the skin with metal staples (Fig. 17).

**Discussion**

The self-locating catheter can be a valid alternative to the other types of peritoneal dialysis catheter. Whereas there is clear consensus on the reduction in the incidence of displacement achieved when this catheter is used, doubts persist as to the incidence of omental wrapping, which does not appear to be any lower and which always requires open or video-guided laparoscopic surgery for resolution. In addition to the lower incidence of displacement, the following important aspects should also be noted:

- better X-ray and echotomographic visualization;
- likely lower incidence of cuff extrusion;
- the use of minilaparotomy, instead of the percutaneous technique, adds further known advantages to the use of this surgical approach, such as implantation even in patients who have had prior abdominal surgery, better, safer hemostasis and, above all, an absence of leakage;
- like all other catheter types, in patients who have had multiple surgeries or who have already had major abdominal surgery, the self-locating catheter can be positioned using the video-guided laparoscopic technique (recommended).

**References**


10. Percutaneous Implantation

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**Introduction**

Despite being an uncommon practice in Italy, percutaneous peritoneal catheter implantation is used internation-
ally because of its advantages in terms of simplicity and affordability, particularly in developing countries and in poorly equipped medical facilities.

The technique can be performed by either doctors or appropriately trained nursing staff, it does not require an operating theater and it is a rapid technique that can be performed at the patient’s bedside, in both elective and emergency settings.

As an unguided technique, it entails a higher risk of mal-positioning and damage to the abdominal structures than the standard surgical technique. It is consequently not recommended in patients who are obese or who have had major abdominal surgery, due to the possible presence of adhesions.

**Literature review**

The first publications refer to percutaneous or "non-surgical" positioning by nephrologists, using a metal trocar to obtain direct access to the peritoneal cavity (1). After blunt dissection, the technique described involved the insertion of the trocar on the alba line, due to its being an avascular structure that minimizes bleeding risks, subject to preparation of a purse-string. The metal cannula was then used to introduce the peritoneal catheter fitted with a blunt mandrel. Some authors also describe use of this procedure in more recent times (2).

The positioning of permanent catheters for peritoneal dialysis using the modified percutaneous technique devised by Seldinger was subsequently described in a number of publications (3-7). All of these publications share a common basic technique involving the piercing of the peritoneal cavity, introduction of a metal guide and positioning of the catheter following the same guide. Other studies describe procedural variants: different introducers and retractors used to position the catheter and use of fluoroscopy, contrast enhancement and ultrasound to verify correct peritoneal access (7-9).

All considerations concerning complications and catheter survival must be carefully weighed up, since the elective indication for percutaneous positioning excludes cases complicated by obesity, previous surgery or abdominal hernia. All of the studies published on the subject refer to retrospective descriptions, and there are no randomized controlled clinical trials available. Even the classification of early and delayed complications is subjective, and the operator’s experience is paramount to the success of the technique. Overall, percutaneous implantation experiences describe the following early complications: malfunction between 8% and 28%, bleeding 4%, leakage 21% and perforation of hollow abdominal organs 2% (4-9).

**Basic technique**

The percutaneous implantation of peritoneal dialysis catheters uses the modified Seldinger technique, with a guide and a peel-away introducer-sheath kit. It goes without saying that the procedure must be carried out in a suitable facility. It can be performed under local anesthesia or mild sedation, and antibiotic prophylaxis must always be performed. Before the procedure, the patient’s bladder should be emptied and the intestine purged, preferably by administering an enema the evening before the procedure.

A small incision is made at the catheter entry site, usually along the midline or to the side of the rectus abdominis muscle and 2-5 cm below the transverse umbilical line. Isolate the fascia structures using a blunt technique. Insert an 18G needle into the peritoneal cavity.

Check that the needle is positioned correctly by filling the peritoneal cavity with 500 mL of sterile saline solution. The absence of pain or resistance confirms correct positioning.

Introduce a 0.98-mm flexible metal guide into the needle lumen (Fig. 1); then extract the needle leaving the guide in place. Introduce a 16F dilator and introducer into the abdominal cavity following the guide wire (Fig. 2), after making a small incision with the scalpel, then remove the dilator and guide wire (Fig. 3) leaving the sheath introducer in place (Fig. 4). Then position the peritoneal catheter, fitted with a metal mandrel, inside the abdomen using the introducer (Fig. 5).

Special care must be taken to ensure the catheter is correctly positioned to the left and underneath the pouch of Douglas, as with any other type of implantation. Remove the mandrel and peel-away introducer by separating the 2 parts along the tear line (Figs. 6 and 7), and position the preperitoneal cuff beneath the fascia but suitably outside the peritoneal cavity.

Check the catheter works properly by infusing and draining sterile saline solution (Fig. 8). A circular purse-string using absorbable suture can be performed before or after the catheter is introduced, but in any case it must be tightened at the end of the procedure, so that the fascia fits the catheter better and to minimize the risk of leakage, even if an immediate start to peritoneal dialysis is required.

Using a tunneling instrument, trace the catheter’s subcutaneous course proceeding sideways and downward, and position the outer cuff approximately 2 cm from the exit site (Fig. 9). At the end of the procedure, the subcutaneous tissue and skin are sutured with button stitches or subcuticular suture.
Ultrasound-guided technique

The use of standard ultrasound, with suitable sterile protection of the probe, makes it possible to identify the area of greatest separation between the wall and intestinal loops, starting 2 cm from the navel; due to their gaseous content, the loops appear as hyperechoic rings with shadow cones. The color Doppler technique can be used to identify the course of the epigastric artery; to avoid accidentally puncturing it, introduce the needle at least 1 cm away and direct it to 45° caudally (Fig. 10). The ultrasound appearance of the abdominal wall around the paramedian subumbilical area presents a subcutaneous hypoechoic area, a hyperechoic line coinciding with the fascia, a hypoechoic area of muscle and, lastly, a hyperechoic line that coincides with the peritoneum. Once the needle has been positioned, introduce 500 mL of sterile saline solution to facilitate the subsequent maneuvers and then proceed with the basic technique described previously. The ultrasound-guided technique makes it possible to reduce the risk of puncturing an artery or perforating the intestine associated with the unguided maneuver.

Discussion

Percutaneous implantation can have an alternative value in situations in which a shortage of resources means that the other safer, more effective methods are not readily available.
The choice of this kind of technique, at least in Italy, can be justified in emergency situations and in centers in which it is not possible to position the peritoneal dialysis catheter using open or video-guided laparoscopic techniques.

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**Additional references**

**Historical background of percutaneous implantation**


**Different percutaneous implantation techniques**

- Borazan A, Comert M, Ucan BH, et al. The comparison in


**Fluoroscopic and ultrasound-guided techniques**


**11. Prophylaxis of exit site and tunnel infections**

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**Introduction**

Clinical catheter supervision must be provided by staff with experience in the peritoneal dialysis (PD) sector. Training of patients and medical and nursing staff that are motivated and dedicated to PD are crucial factors for the maintenance of good peritoneal access (1). The training technique adopted can influence the risk of infections in PD, and a well-structured training method can be associated with improved results (2).

**Management of the exit site**

The exit site (ES) should be protected with sterile gauze, although research published in the literature does not provide strong evidence either for or against covering the ES. The ES does not need to be covered in cases with a perfect ES and poor tolerance of dressings. On the other hand, it is recommended in cases where the ES is not perfect or in the presence of infection. One randomized study including patients with both a perfect ES and with disepithelization or other factors favoring infection, conducted by Luzar et al (3) demonstrated a higher incidence of infections in patients who did not use dressings.

The catheter must be immobilized, with a securing plaster, to avoid traction injuries that may constitute factors favoring the onset of concomitant inflammatory processes (3). As the ES must be kept dry, transparent occlusive dressings should be avoided (4). Dressings should be changed following strict rules (sterile gauze, thorough handwashing and use of a face mask).

Routine ES care by the patient commences once the ES is fully healed. This care must be part of the patient’s training. Washing with soap and water is recommended at some centers. Use of antiseptic substances is preferred in many care programs. The position statement issued by the ISPD in 2011 (like the ISPD guidelines mentioned above) specifies that disinfectants should not be cytotoxic and that their concentration should be carefully considered, taking into account the fact that certain substances are cytotoxic in vitro even at very weak concentrations, such as iodopovidone (>0.001%), hydrogen peroxide (>0.003%), sodium hypochlorite (>0.24%) and chlorhexidine (>0.005%) (1).

The European Best Practice Guidelines issued in 2005 (4) point out that iodopovidone and hydrogen peroxide, in particular, are cytotoxic, especially during the ES formation phase and that they may delay healing: in this phase, simple cleansing with sterile saline solution should be used, whereas once the ES is consolidated, a nonionic detergent (such as 20% poloxamer 188, Shur-Clens) and simple soap are possible alternatives for everyday ES management, although research published in the literature does not provide strong evidence either for or against covering the ES. The ES does not need to be covered in cases with a perfect ES and poor tolerance of dressings. On the other hand, it is recommended in cases where the ES is not perfect or in the presence of infection. One randomized study including patients with both a perfect ES and with disepithelization or other factors favoring infection, conducted by Luzar et al (3) demonstrated a higher incidence of infections in patients who did not use dressings.

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The choice of agent is also linked to any patient allergies. Ultimately, taking into account also the recent updates, the guidance issued by the ISPD in 1998 (6) can still be considered to a large extent to be applicable:

- the catheter exit site should be cleansed at least every other day with antibacterial soap or a disinfectant, in order to keep it clean and reduce the resident bacterial load;
- the choice between soap or disinfectant must be made considering any patient sensitivities or skin allergies;
- it is important not to force the removal of scabs when cleansing the exit site, since this may traumatize the exit site, producing breaks in the skin and increasing the risk of infection;
- the exit site must be kept dry after cleansing;
- liquid soap and disinfectants should not be transferred into containers other than their original ones, due to the risk of contamination.

Given the possibility of contamination by nasal carriers of Staphylococcus or the dispersion of droplets of saliva, it is advisable to use a disposable face mask, which must cover the nose and mouth when dressings are being changed (5). The patient must be trained to perform careful handwashing before ES care. It is very important to have excellent hand hygiene before the patient or caregiver starts their examination of the ES. The ISPD position statement published in 2011 (1) adopts the guidelines issued by the US Centers for Disease Control and Prevention which identify 70% solutions of alcohol as the most efficacious agent for hand cleansing. Once the cleanser has been applied to the hands, they must be rubbed together, without wetting, for at least 15 seconds. Washing the hands for 15 seconds with antimicrobial soap (with chlorhexidine 4%) is the next most efficacious way to clean the hands. Varnished and artificial nails greatly increase the risk of bacterial contamination. If it is likely that the water available to the patient is characterized by a high bacterial load, hand cleansing using alcohol should be preferred over the use of tap water. Patients should be trained to recognize the signs of ES and catheter tunnel infection and to report them swiftly to their dialysis center.

Showers should be preferred over baths for personal hygiene (5).

Patients may bathe in swimming pools or sea water, providing they are careful; however, they must then shower and change their dressing afterwards (5); they should consider using colostomy bags attached to the skin by adhesive rings, in order to protect the ES from contact with water whose bacterial load is unknown and/or from sea water and/or air.

Any breaks in the skin and granular lesions around the ES sinus tract must be carefully monitored and cauterized using silver nitrate, on dry skin (7). This type of lesion may be caused by inadequate care when immobilizing the catheter or by traumas or subclinical infections.

The antibiotic protocols for the treatment of Staphylococcus aureus are effective for reducing the risk of catheter infection by S. aureus (1). Carriers of endonasal S. aureus must be treated. Eradication treatment of carriers of endonasal S. aureus using topical mupirocin effectively reduces ES and tunnel infection, but not peritonitis (level of evidence 1) (8). If exit site medication is not performed directly by patients, it is also useful for caregivers to have a nasal smear test. The recommended frequency for nasal smears is about every 3 months.

The gentamycin applied to the ES reduces the total risk of peritonitis by significantly reducing gram-negative bacteria (level of evidence 2) (8). The use of antibiotics for the perioperative prophylaxis for PD catheter implantation effectively reduces the risk of early peritonitis only, but not ES and tunnel infections (8).

There are various efficacious protocols (from systemic rifampicin to nasal mupirocin) for the prophylaxis of ES infections and peritonitis. One simple way to prevent ES infections in nasal carriers of S. aureus is a daily application of mupirocin on the ES, after medication (1), starting with the first dressing of the ES following peritoneal catheter implantation. Various studies have shown the efficacy of mupirocin in the prevention of peritonitis and S. aureus infection of the ES. One recent British audit reports that (9) topical mupirocin reduces the overall ES infection rate, and mupirocin and topical gentamycin reduce the rate of ES S. aureus, but not the overall incidence of peritonitis. By reducing S. aureus infections, the use of mupirocin caused a higher relative frequency of Pseudomonas aeruginosa in ES infections, this is a continuation of the results by Davenpoort (9). The use of topical gentamycin has proven effective in reducing ES infections caused by this organism, although the use of topical gentamycin would appear to be associated with an increased rate of fungal exit site infections (1).

In the ISPD’s 2005 update and 2011 position statement (1, 10) containing guidelines on PD-related infections (in addition to recommending against using antibiotic ointments containing polyethylene glycol in patients with polyurethane peritoneal catheters, following reports of structural damage to the catheter), it describes the mupirocin resistance reported by a number of authors, particularly when the medicinal product is applied intermittently. Mupirocin resistance can be classified as low if the minimum inhibitory concentration (MIC) is ≥8 mg/mL and high if ≥512 mg/
mL. A high level of resistance is associated with treatment failure or a high recurrence rate. Indeed, some authors question the indiscriminate a priori use of topical antibiotic therapy.

The ISPD (10) proposes a series of protocols (to be considered alternatives to one another) to prevent ES infections:

1. Mupirocin at the exit site:
   a. daily after ES cleansing in all patients;
   b. daily after ES cleansing in carriers only;
   c. in response to a positive Staphylococcus aureus culture test, indicating carrier status.

2. Intranasal mupirocin twice a day for 5–7 days:
   a. each month, once a patient has been identified as an endonasal carrier;
   b. only in response to a positive nasal smear.

3. Gentamycin cream daily at the ES after cleansing in all patients.

Other substances can be used for ES infection and peritonitis prophylaxis. On this subject, the conclusions of the randomized controlled study Mupirocin Versus Polysporin Triple Study (MP3) (11) (enrolling 201 patients) were recently published (12), showing that Polysporin Triple (P3) is not superior to mupirocin for the prophylaxis of PD-related infections. Furthermore, the finding of a greater risk of ES colonization by fungal organisms and fungal peritonitis does not make it possible to recommend the use of P3 in the prophylaxis of PD-related infections.

**REFERENCES**


**ADDITIONAL REFERENCES**


12. Break-in Period for Dialysis with a Peritoneal Catheter

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Introduction

There is no consensus in the literature as to the most appropriate time to start dialysis after implantation of a peritoneal catheter. In the same way as positioning methods can vary greatly, the same applies to break-in behavior: it is not known how long it should last or, indeed, whether it is really necessary. There are no publications that give indications based on scientific evidence, due in particular to the difficulty, for catheter-related topics, of putting together large case series and performing randomized controlled trials. The reasons given to justify the importance of a break-in period are that, in its absence, there could be a greater incidence of catheter malfunction, infection and, above all, leakage.

Literature Review

Once of the first studies performed on the subject of break-in procedures dates back more than 20 years and provided a retrospective analysis of episodes of early and delayed leakage (use before or after 30 days from implantation) obtained in 386 patients, in 11 years of dialysis activity in the Albuquerque Medical Center (New Mexico, USA). The data refer to the period between 1980 and 1990: both early and late leakages were frequent (18 patients developed 21 early leakages, and 18 patients developed 28 delayed leakages). The cause was identified as technical deficit, as in most cases the complication was associated with median surgical positioning across the alba line (1). A report of 86 catheters positioned using a surgical technique was published in 1996, in which 40% were used after a break-in period during which the patient was treated by hemodialysis (group A), and the remaining 60% were used immediately (group B). After a 6-month follow-up period, the incidence of leakage was significantly higher in group B (0% vs. 13%, p<0.05), especially in the subgroup of diabetic patients (71% vs. 22%, p<0.05); and, in addition, patients who experienced leakage also presented a higher incidence of outer cuff exteriorization (57% vs. 7%, p<0.005) (2). In children requiring renal replacement treatment, extracorporeal dialysis may be problematic or not available, and for these reasons, particularly in younger patients, they are often treated by peritoneal dialysis. Two studies on pediatric case series showed that the use of the catheter with very short or no break-in period did not give significant disadvantages over a more delayed utilisation (3, 4). One retrospective Danish study, published in 2006 (5), reported the results obtained on 52 patients in whom dialysis was commenced immediately after implantation, compared with 88 patients who started treatment with a break-in of at least 12 days. The open surgical technique was used for implantation. The no break-in group was not characterized by a higher incidence of leakage or infectious complications; however, there was a significant increase in mechanical complications (28.9% vs. 7.7%, p<0.01) and consequently, in surgical repositioning (19.2% vs. 3.9%, p<0.02). The authors concluded that these results, although apparently slightly negative for immediate use of the catheter, should have encouraged the practice, particularly when compared with the potential risks of bacteremia, stenosis and venous thrombosis obtained with the use of central venous catheters for extracorporeal treatment in the break-in period (5).

The argument put forward by the Danish authors is almost always misrepresented; however, it should be taken into serious consideration.

In this sense, the most important experience was published in 2004 by a group of Australian authors who compared all-cause mortality in patients on hemodialysis with the use of central venous catheters or arteriovenous fistulae. The authors used data from the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA), and considered the deaths (n=612) of all incident patients (n=3,749) in the 3-year period between April 1, 1999, and March 31, 2002. The results showed, for the entire population, a significant increase in all-cause mortality (p<0.001) with the use of venous catheters compared with native arteriovenous fistulae in the first 6 months of treatment. The higher mortality rate persisted even when the data were analyzed using a multivariate analysis model (propensity score analysis) to eliminate the confounding factors (age at first treatment, late referral, coronary disease, peripheral vascular disease and cerebrovascular disease). The study also showed a higher mortality for infections associated with the use of the venous catheter than with the fistula (6).

In 2007, a Korean group reported the results of a prospective observational study on 51 consecutive patients, in whom the catheter was implanted using a modified percutaneous technique, and it was used without a break-in period. The access described was surgical up to the anterior fascia of the rectus abdominis muscle, then dilators were...
used to reach the peritoneal cavity through the muscle; the inner cuff was anchored using a purse-string to the muscle aspect of the external fascia of the rectus abdominis. A low incidence of complications (2% for leakage and 6% for displacement) was reported. Despite the limited size of the case series and the short observation period, in their appraisal of the results, the authors did not deny the need for randomized controlled studies to validate their method (7).

The most recent case series on the subject (published in 2011) is that presented by a Taiwanese group, in which the authors retrospectively examined mechanical complications (including leakage) and infectious complications in 310 patients undergoing open surgery for catheter implantation. They were divided into 2 groups: In the first group, the catheter was used after at least 14 days and, in the other, sooner (in some cases, immediately). No statistically significant differences were noted. The authors believe that it is fundamental, for an early start to dialysis, to use a purse-string closure of the peritoneum (8).

**Discussion**

The experiences reported in the literature suggest that, in the absence of scientific data for evidence-based medicine, approaches taken by different centers vary and opinions are extremely diverse. However, it is increasingly acknowledged that the break-in period is not necessary, primarily because of the progress made in terms of implantation techniques.

Of these, those that make patients less likely to experience leakage (the most feared early complication and for which a break-in period is always recommended) are open surgery and the video-guided laparoscopic technique; this was shown in a recent literature review by Crabtree, demonstrating that when implantation is performed using surgical and video-guided laparoscopic techniques, the incidence of leakage is much lower (0-7.4%), than when percutaneous or fluoroscopic techniques are used (2%-18.3%) (9).

If the surgical and video-guided laparoscopic techniques involve access to the peritoneal cavity by minilaparotomy and closure around the catheter using a purse-string, the leakage complication is practically nonexistent (8, 10, 11).

Back in 1998, in an update, a group of experts claimed that “although immediate dialysis without fluid leakage is possible, it is preferable to postpone dialysis by 1-3 days, to allow good tissue healing. If dialysis is required immediately, it can be started in a supine or semi-seated position with small exchanges (500-1500 mL)” (12).

Guideline C of the European Best Practices published in 2005 claims that following the implantation of a catheter for peritoneal dialysis, it is preferable to observe a break-in period of at least two weeks to prevent early leakage. Immediate dialysis may be performed, particularly if the catheter was positioned using a laparoscopic technique.

In this case, intermittent automated dialysis with small volumes (1 liter for adult patients) should be used (13). This recommendation is also echoed in the guidelines for peritoneal access prepared by an international group of experts led by Wilkie in 2010 (14).

The above suggests that the conviction (based on consensus opinions) that a break-in period is advisable but not essential, is an outdated concept.

More up-to-date guidelines would be:

- favor surgical and video-guided laparoscopic implantation techniques, when possible, over peritoneoscopic and fluoroscopic methods;
- use a minilaparotomy to access the peritoneum and a purse-string (mandatory) to close the peritoneum around the catheter;
- early use of the catheter is possible and safe; it does not result in a greater incidence of complications than use after a break-in period and should be performed particularly if the patient requires dialysis, to avoid a period of hemodialysis;
- observe a 2- to 4-week break-in period when hernia repair or laparoplastic procedures are performed at the same time as catheter implantation;
- it is advisable to use the automated peritoneal dialysis and loads not exceeding 1 L for the first 2 weeks; however, continuous ambulatory peritoneal dialysis with the same volumes may also be used.

**References**


13. Malfunction of Peritoneal Dialysis Catheters

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Introduction

Peritoneal catheter malfunction precludes the possibility of being able to perform peritoneal dialysis (PD) adequately and conditions the technical survival of the catheter and often, also, the continuation of the dialysis method. The risk of peritoneal catheter malfunction is approximately 15% per year (1, 2). Implantation techniques involving procedures such as omentectomy, omentopexy, rectal tunneling or intra-abdominal fixation would appear to present a lower malfunction rate (3, 4). The patient’s history is central to identifying causes of malfunction such as the presence of constipation, fibrin fragments and peritoneal fluid containing blood during emptying. The position the patient has to adopt to avoid drainage problems may indicate the position of the catheter inside the abdominal cavity. An X-ray of the abdomen in anteroposterior and laterolateral projections and, if necessary, also in a supine position, is necessary to ascertain the position of the catheter, to confirm a suspicion of displacement or kinking and to observe any fecal impaction in the colon (5, 6). The techniques used to salvage a malfunctioning peritoneal catheter can be divided into noninvasive or conservative techniques and techniques requiring surgery.

Literature review

Noninvasive techniques for the treatment of malfunction

The most commonly used noninvasive techniques purge the intestine: enemas and laxatives. In cases of malfunction secondary to catheter displacement outside the pelvic cavity, effective results can very often be obtained by using drastic laxatives such as polyethylene glycol, which are used to prepare the intestine for colonoscopy procedures. The rationale behind this approach is to stimulate intestinal peristalsis and favor natural repositioning.

To clear a catheter with filling and emptying problems due to confirmed or suspected obstruction of the lumen, successful results can be obtained with intraluminal manipulations such as introduction of dialysis fluid under positive (bag squeezing) or negative (aspiration using a syringe) pressure, or the introduction of heparin or urokinase (7), endoscopic brushes (8), ureteral catheters (diameter: 5-6 Fr) or Fogarty catheter (9). Manipulations under fluoroscopic control with Fogarty catheters (10), using a flexible guide wire (single and double) (10, 11) or stiff guide wire (alpha-replacer) (12-14) are described as being effective in 60%-80% of cases. Again for cases of displacement, one Chinese group suggested a manual repositioning technique that they claimed was successful, after multiple attempts, in over 80% of all cases treated (15).

Invasive techniques for the treatment of malfunction

Invasive techniques such as laparotomy and video-guided laparoscopy are indicated in the event of persistent malfunction following the failure of noninvasive approaches. They directly identify the causes of peritoneal catheter malfunction so that they can be treated. Video-guided laparoscopy has superseded laparotomy on account of its minimal invasiveness, which allows very rapid patient recovery and immediate recommencement of dialysis (16-27). As an alternative to video-guided laparoscopy, other authors have suggested performing a minilaparotomy with manual externalization of the catheter’s intraperitoneal segment, sub-
sequent removal of the occluding tissue and repositioning of the catheter within the abdominal cavity (28). We believe that this technique should only be considered when video-guided laparoscopy is not available (24).

Video-guided laparoscopy procedures are performed under general anesthesia. The choice of the abdominal cavity entry site depends on the position of the catheter and the location of previous abdominal cavity accesses. The first point of entry, by minilaparotomy, should be prepared on the opposite side of the abdomen to tip of the catheter, located by X-ray, to ascertain and treat the causes of malfunction with a single access. This may be achieved using an instrument with a working channel (0° laparoscope with a 5-mm working channel; Karl Storz, Tuttingen, Germany). A trocar (with a diameter of 10 mm) can be used to induce pneumoperitoneum with carbon dioxide at an intra-abdominal pressure of 12 mm Hg. On rare occasions, additional accesses may be required (Figs. 1 and 2), and can be prepared using the same minilaparotomy technique. The instruments usually used for abdominal video-guided laparoscopic surgery are also utilized for peritoneal catheter salvage. In 80% of cases the cause of the malfunction is displacement and/or omental wrapping (in which omental tissue wraps around the catheter) (16-27) (Fig. 3). Other causes include: adhesions (Figs. 4 and 5), endoluminal thromboses, catheter kinking, occlusion by adnexal tissue (Fig. 6) or epiploic appendices, and incorrect pre-peritoneal positioning of the catheter. This technique makes it possible to treat the above complications with repositioning in the pelvic cavity, unwrapping, endoluminal (Fig. 7) and extraluminal (Fig. 8) mechanical dis-obstruction and anchorage (Fig. 9). Specific procedures are also proposed to prevent recurrence of catheter malfunction, such as omen-
tectomy, omentopexy, omental folding (29), resection of the epiploic appendices, adhesion lysis and fixing of the catheter to the anterior abdominal wall (24) (Fig. 10) or inside of the pelvic cavity. These preventative procedures would appear to be efficacious in obtaining a reduction in long-term recurrence of catheter malfunction (26, 29, 30).

The main complications of this method are transient dynamic ileus, peritonitis and tunnel infection, bleeding, umbilical and incisional hernia, subcutaneous leakage, scrotal edema (Fig. 11) or edema of the vulvar labia and, on rare occasions, intestinal perforation.

The incidence rate of complications has been reported to be between 0.04% (24) and 17.3% (23). Prophylactic antibiotic therapy is recommended to reduce infectious complications.

Video-guided laparoscopic treatment of malfunction is successful in over 90% of cases treated in the short term. Technical survival of the catheter is prolonged by an average of 6-9 months (19, 24).

**Discussion**

The management of peritoneal catheter malfunction should follow the sequence of procedures indicated in the algorithm in Figure 12. The patient should be treated with video-guided laparoscopy if noninvasive procedures are unsuccessful.

Almost all malfunctioning catheters can be recovered with the pathway from noninvasive procedures followed by video-guided laparoscopy.

More recent guidelines are:
- patient history and abdominal X-ray must guide the choice...
of the noninvasive technique to be used;
• intestinal purging and intraluminal catheter manipulations make it possible to recover more than half of all cases of malfunction;
• recovery of the catheter in video-guided laparoscopy is indicated for cases in which noninvasive techniques are unsuccessful;
• video-guided laparoscopic maneuvers not only usually allow the recovery of the peritoneal catheter in the short-term, but also prevent complications that cause recurrence of the malfunction.

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14. Exit site and tunnel infections: diagnosis and conservative treatment

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Introduction

Infections of peritoneal dialysis (PD) catheter exit sites (ES) and tunnels are complications that have a significant impact on the performance of PD and must be managed accordingly. In addition to causing a local inflammatory process, these infections can spread and lead to the onset of relapsing, recurrent peritonitis. The risk of peritonitis would appear to depend on the microorganism involved. ES infection by Staphylococcus aureus or Pseudomonas aeruginosa, which frequently lead to loss of the catheter (1).
Best Practice on: The peritoneal dialysis catheter

ES infection

A healthy ES is dry, it does not present any blood or pus and is defined by an absence of redness, inflammation and scabs (2). There is no universally-accepted definition of ES infection. Clear and simple diagnostic criteria, however, exist for peritonitis: the same cannot be said for ES infection. This fact, coupled with the typical chronic course of the condition make it difficult to perform an epidemiological assessment or any comparisons between the various preventative approaches. The guidelines published by the SIN in 2003 (3), the most exhaustive publication defining diagnostic criteria, proposed a classification based on a careful assessment of the appearance of the ES, combined with use of a magnifying glass and macrophotography (4, 5); however, the method presented is complicated, and the results are not confirmed by significant experiences by other groups. According to SIN guidelines, it is advisable when monitoring ES infection to use a nursing assessment sheet that examines the signs of inflammation: redness, secretion, granulation tissue and pain. These signs can be used to classify ES alterations by adopting the most agile and pragmatic system available, which was proposed in 1993 by the PD Research Cooperation Group in Italy (6) (Tab. I).

Alternatively, the 2005 ISPD review (7), without altering the fact that purulent secretion at the ES indicates the presence of an infection, whereas erythema alone is not always suggestive of the presence of an infection, proposes a rating system that classifies the ES as certainly infected if it scores at least 4 points (Tab. II); however, a score of less than 4 points does not exclude the presence of an infection.

Tunnel infection

Tunnel infections usually start with the presence of a palpable inflammation and/or pain in the subcutaneous segment of the catheter, accompanied, on some occasions, by an intermittent appearance of secretion from the exit site (3). As secretions can be hidden, they may only be visible on an ultrasound examination of the subcutaneous course (8). Tunnel infections usually present together with an ES infection and rarely occur alone (9).

Role of ultrasound in diagnosis and monitoring of peritoneal catheter tunnel infections

Ultrasound examinations of the PD catheter tunnel are useful for diagnosing and managing these infections. That make it possible to identify areas of hypoechoogenicity around the catheter’s Dacron cuffs and along its subcutaneous course. The definition of significance depends on the maximum diameter of the hypoechoic area that, according to some authors, must not be less than 2 mm (10) along any segment of the catheter’s course. In other experiences, the persistence of an area of hypoechoogenicity with a thickness of >1 mm, especially at the end of the cycle of antibiotic therapy is associated with unfavorable clinical results, as in cases of involvement of the deep cuff (11).

The ultrasound probe most suitable for obtaining the best images is a linear 7.5 MHz probe (10, 12). The importance of ultrasound in the early diagnosis of tunnel infections and their follow-up is well documented, whereas other indications are controversial. One attempt to rationalize the indications was published in 1999 by Vychytil (13) who decided, on the basis of a large case series of 738 examinations in 114 patients, that tunnel ultrasound examination can be indicated as follows:

Ultrasound examination of the tunnel is indicated in cases of:

- ES infections (especially if the culture test is positive for S. aureus);
- tunnel infection follow-up (especially 2 weeks from the start of antibiotic treatment);
- peritonitis in patients with clinical signs of ES infection;
- persistent/recurrent peritonitis (regardless of the appearance of the ES).

| TABLE I |
| CLASSIFICATION OF EXIT SITE (ES) ALTERATIONS |

| Healthy exit site | Normal ES color, no scabs, redness or purulent or serous secretions. |
| Exit site requiring observation | Presence of scabs or redness but no purulent secretion, presence of cheloidal tissue without serous or purulent secretion, presence of serous secretion during ES maturation (first 2-3 months) |
| Exit site to be treated | Purulent and/or serous secretion associated with redness of the surrounding skin and a positive culture test |
Ultrasound examination of the tunnel is not indicated in cases of:
- routine screening;
- searching for focal inflammation in the absence of clinical signs of ES or tunnel infection;
- peritonitis in the absence of clinical signs of ES or tunnel infection;
- pain along the tunnel in the absence of clinical signs of ES or tunnel infection.

In addition to visualizing the hypoechoic areas along the catheter’s subcutaneous course and for measuring the degree of tissue involvement by inflammatory processes, tunnel ultrasound would therefore appear to be useful for monitoring clinical response to the therapy adopted, by monitoring the gradual regression of the hypoechoic areas over time. It also makes it possible to establish, both when the process does not regress and in the case of incomplete resolution with even a very small area of persisting inflammation (particularly with *S. aureus* and *P. aeruginosa* infections), the timing of any cuff shaving required. According to the SIN’s 2003 guidelines, ultrasound examination of the subcutaneous tunnel is useful for evaluating the extent of its involvement in the infection, for judging response to therapy and for deciding whether to perform review surgery, remove/replace the catheter, or continue antibiotic therapy (3). The clinical results in *P. Aeruginosa* infections of the ES are usually consistently poor and have a weak correlation with the findings of the ultrasound examination (9).

### Culture smear

The ISPD guidelines (9) confirm the importance of culture tests for the complete diagnostic definition of PD-catheter ES and tunnel infections, also in terms of guiding therapy. The culture test must be performed on a smear of ES secretion or any secretion caused by the fistulization of a tunnel abscess (when there is no secretion from the ES). The microbiological assay should include aerobic and anaerobic microorganism growth, combined with an optical microscopic assay. Treatment must be guided by the result of gram staining where available and, above all, culture test results and antibiogram. On the other hand, a positive culture test, in the absence of signs of inflammation, indicates colonization alone and does not require therapy, but merely close monitoring. In these conditions, it is advisable to intensify ES cleansing with antiseptic agents (9). The culture test should be performed when the ES presents clear or suspect signs of inflammation, and it is important that it is performed before starting topical and/or systemic treatment (3).

### Bacterial strains

ES and tunnel infections can be caused by any of many microorganisms. Although *S. aureus* and *P. aeruginosa* are responsible for the majority of infections, other bacteria can also cause ES and tunnel infections, and assays should therefore be performed for diphtheroids, anaerobic organisms, nonfermenting bacteria, *Streptococci*, nontuberculous mycobacteria, *Legionella*, yeasts and fungi. Microorganisms present in the skin’s normal bacterial flora, such as *Corynebacterium*, may also cause catheter ES and tunnel infections (9). ES infection caused by *S. aureus* and *P. aeruginosa* are often associated with concomitant tunnel infections and frequently evolve into peritonitis. Aggressive management is always indicated when these kinds of bacteria are present (9).
Treatment

In cases of confirmed or suspected infection, ES medication should be intensified to daily administration, even when the protocols followed at the center require less frequent medication (3). Any excess granulation tissue that is not secreting can be cauterized using a silver nitrate stick, making sure that application is localized and brief, to avoid the risk of sores or damage to the surrounding healthy tissues (3).

Empirical antibiotic therapy should be initiated immediately and must always cover \textit{S. aureus}. If the patient has a history of ES infection by \textit{P. aeruginosa}, empirical treatment must include an antibiotic that is active against this microorganism (9). Alternatively, when the clinical and ultrasound findings are compatible, it can be decided whether to postpone the start of antibiotic therapy until the results of the microbiology tests are available and able to guide the choice of antibiotic (9). Until such time as the culture results are available, in cases of unconfirmed and mild infection and in the absence of purulent secretion, cutaneous fragility and edema (9), isolated topical treatment (mupirocin, gentamycin etc.) may be useful (3). In all other cases, topical treatment must be immediately combined with oral antibiotic therapy (3) (Tab. III).

According to ISPD guidelines (2010 update) (9), gram-positive strains should be treated with first-generation cephalosporins (either penicillinase-resistant penicillins or broad-spectrum). The use of vancomycin should generally be avoided in routine infection management, due to the risk of generating resistance; however, it must always be considered in methicillin-resistant \textit{S. aureus} and in patients who

<table>
<thead>
<tr>
<th>TABLE III</th>
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<tbody>
<tr>
<td><strong>ORAL ANTIBIOTICS USED TO TREAT EXIT SITE (ES) AND TUNNEL INFECTIONS (9)</strong></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dosage</th>
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</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>250-500 mg b.i.d.</td>
</tr>
<tr>
<td>Cephalexin</td>
<td>500 mg b.i.d. or t.i.d.</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>250 mg b.i.d.</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>500-mg loading dose followed by 250 mg b.i.d. or q.d.</td>
</tr>
<tr>
<td>Dicloxacillin</td>
<td>500 mg q.i.d.</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>500 mg q.i.d.</td>
</tr>
<tr>
<td>Flucloxacillin (or cloxacillin)</td>
<td>500 mg q.i.d.</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>200 mg q.d. for 2 days, followed by 100 mg q.d.</td>
</tr>
<tr>
<td>Flucytosine</td>
<td>0.5-1 g/day according to response and serum levels (25-50 mg/mL)</td>
</tr>
<tr>
<td>Isoniazid</td>
<td>200-300 mg q.d.</td>
</tr>
<tr>
<td>Linezolid</td>
<td>400-600 mg b.i.d.</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>400 mg t.i.d.</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>400 mg daily</td>
</tr>
<tr>
<td>Ofloxacin</td>
<td>400 mg on the first day, followed by 200 mg q.d.</td>
</tr>
<tr>
<td>Pyrazinamide</td>
<td>25-35 mg/kg 3 times/week</td>
</tr>
<tr>
<td>Rifampicin</td>
<td>450 mg q.d. &lt;50 kg; 600 mg q.d. &gt;50 kg body weight</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>80/400 mg q.d.</td>
</tr>
</tbody>
</table>

Daily or q.d. = every day; b.i.d. = twice a day; t.i.d. = 3 times a day; q.i.d. = 4 times a day.
are allergic to other antibiotics.

Following a culture finding of *S. aureus*, it may be useful to add rifampicin, in particular with slow-resolving or extensive ES infections. Rifampicin must not be administered as monotherapy, and its effect of reducing the efficacy of warfarin, statins and anticonvulsants must always be taken into consideration.

*P. aeruginosa* infections are always particularly difficult to treat and often require prolonged dual antibiotic therapy. Fluoroquinolones are recommended as a first choice, but preferably not as monotherapy as this favors the development of resistance. Taking quinolones at the same time as sevelamer, calcium, oral iron, sucralfate, antacids containing magnesium and aluminum or with milk may result in reduced absorption of the antibiotic, and it must therefore be taken at least 2 hours before these medicinal products. If the infection is slow to resolve, or in the event of a recurrent *P. aeruginosa* ES infection, a second antibiotic must be added (e.g., amino glycoside, ceftazidime, cefepime, imipenem-cilastatin or meropenem).

Antibiotic therapy must be continued until full ES normalization on the physical exam (9). Treatment must last at least 2 weeks, and 3 weeks’ treatment is needed for *P. aeruginosa* infections of the ES.

If prolonged treatment exceeding 3 weeks is unable to resolve the infection, cuff shaving or catheter removal should be considered; in *P. aeruginosa* infections, these procedures should be performed sooner.

Catheter removal is required in patients with ES infection evolving to peritonitis or that is concomitant with peritonitis in which the same strain of bacterium as that present on the ES is isolated.

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15. Exit Site and Tunnel Infections: Surgical Treatment to Remove the Outer Cuff

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Introduction

Peritoneal catheter exit site and tunnel infection puts the patient at risk of peritonitis. Local and systemic antibiotic therapy often fails to eradicate the infection. The rationale behind surgical treatment of the exit site and subcutaneous tunnel is fundamentally to remove the infected foreign body and surrounding inflammation-altered tissue and, in combination with specific antibiotic therapy, to favor healing. The 2010 ISPD guidelines currently classify cuff shaving as the only alternative to removal of the peritoneal catheter in certain cases (1).

Literature Review

Since the early 1980s, various surgical techniques have been described for the treatment of peritoneal catheter exit site or tunnel infections (2-4). In most cases, the technique described involves the simple excision of the distal segment of the tunnel and removal of the outer cuff and inflamed tissues (cuff shaving, deroofing, unroofing) (5-11). One alternative to this technique is to replace the segment between the inner cuff and the catheter connector with the creation of a new subcutaneous tunnel (splicing, partial replantation, translocation) (12-17). The former does not require surgical experience and can be managed in outpatient settings.

Table I compares studies on the removal of the outer cuff for chronic or relapsing infections with case series of at least 10 procedures (5-11). The exit site and tunnel were clinically assessed in all studies. None of the studies involved an ultrasound examination of the tunnel and inner cuff to exclude deep-seated infection. The duration of antibiotic therapy prior to the procedure varied from a minimum of 10 days to a maximum of 4-8 weeks. The most frequently isolated pathogens were (from most to least frequent): Staphylococcus aureus, Pseudomonas aeruginosa, Staphylococcus epidermidis and Serratia marcescens. The duration of treatment after the procedure does not appear to be standardized, with some patients not receiving any antibiotic therapy at all (7), while others were treated for up to 4 weeks (6, 10). The study conducted by Piraino et al (5) did not confirm the efficacy of the procedure, which led to recovery in a minority of cases, with an increase in catheter survival of just 1.5 months and with catheter leakage or extrusion in more than half of all cases. However, the cuff shaving technique was characterized by the application of greater traction on the catheter during the procedure, and by the fact that the area of the previously removed outer cuff was incorporated into the new subcutaneous tunnel.

In more recent studies, the success of the cuff shaving procedure, regardless of the pathogen involved, is between 27% (5) and 100% of all cases, and catheter survival is undoubtedly improved by more than 6-12 months (10, 11, 18). Infections caused by S. aureus and P. aeruginosa are the most difficult to eradicate (5-8).

Suh et al (8) compared 2 patient cohorts, the first consisting of patients who gave their consent to have the cuff removed, and the second of patients who denied consent. The cuff shaving group showed a reduction in peritonitis, particularly that caused by S. aureus during follow-up. In a pediatric case series, Yoshino et al (9) analyzed the effect of cuff shaving compared with catheter replacement. No difference was observed in the incidence of recurrent tunnel infections, with a similar incidence of infections between gram-positive and gram-negative pathogens, and the authors described a slight, nonstatistically significant increase in the onset of peritonitis in the cuff shaving group.

There are currently no studies comparing the outcome of cuff shaving with partial replantation of the peritoneal catheter.

Method

Prepare a sterile field and organize a surgical set including forceps, surgical scissors, scalpel, gauze and disinfectants. Once the surgical field has been disinfected, apply local anesthetic to the area around the cuff and parallel to the catheter’s subcutaneous course, taking care not to pierce the catheter with the needle (Fig. 1). Perform an incision in the first segment of the tunnel as far as the catheter’s outer cuff (Fig. 2). Extend the incision beyond the outer cuff in a direction that is medial or lateral to the catheter’s course. Remove the whole outer cuff together with the surrounding tissue, taking care to subsequently remove the entire Dacron component (Fig. 3). Irrigate the inflamed granulation tissue. Perform local hemostasis by means of local compression or electrocauterization. Wrap gauze soaked in disinfectant for bro-
### TABLE I

**PUBLICATIONS DESCRIBING OUTER CUFF SHAVING PROCEDURES (WITH CASELOADS OF >10 PROCEDURES)**

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Case series</th>
<th>Ultrasound (before)</th>
<th>Therapy Pathogen</th>
<th>Therapy (after)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helfrich (1982)</td>
<td>12</td>
<td>No</td>
<td>Not specified</td>
<td>Not specified</td>
<td>8 out of 12 healed (66.7%); function increased by 7 months</td>
</tr>
<tr>
<td>Piraino (1987)</td>
<td>22</td>
<td>No</td>
<td>&gt;10 days</td>
<td>8 <em>Staphylococcus aureus</em> 3 <em>S. aureus</em> + other 2 <em>Staphylococcus. epitrdemidis</em> ± others 4 <em>Pseudomonas aeruginosa</em> 3 <em>P. aeruginosa</em> + others 2 <em>Serratia / Proteus</em> + others</td>
<td>About 1 week</td>
</tr>
<tr>
<td>Scalamogna (1995)</td>
<td>41</td>
<td>No</td>
<td>3-4 weeks</td>
<td>34 <em>S. aureus</em> 2 <em>S. epidermidis</em> 4 <em>P. aeruginosa</em> 1 <em>Serratia marcescens</em></td>
<td>3-4 weeks</td>
</tr>
<tr>
<td>Ahmed (1997)</td>
<td>12</td>
<td>No</td>
<td>2 weeks</td>
<td>6 <em>S. aureus</em> 1 <em>S. epidermidis</em> 2 <em>P. aeruginosa</em> 2 <em>S. marcescens</em> 1 <em>Enterococcus</em></td>
<td>5 with antibiotics; 7 without antibiotics</td>
</tr>
<tr>
<td>Suh (1997)</td>
<td>16</td>
<td>No</td>
<td>4-8 weeks</td>
<td>10 <em>S. aureus</em> 6 <em>P. aeruginosa</em></td>
<td>1-2 weeks</td>
</tr>
<tr>
<td>Yoshino (2004)</td>
<td>32</td>
<td>No</td>
<td>4 weeks</td>
<td>19 <em>S. aureus</em> 4 <em>S. epidermidis</em> 8 <em>P. aeruginosa</em> 1 <em>Neisseria</em></td>
<td>6-8 days</td>
</tr>
<tr>
<td>Crabtree (2005)</td>
<td>13</td>
<td>No</td>
<td>2-4 weeks</td>
<td>4 <em>S. aureus</em> 1 <em>S. epidermidis</em> 5 <em>P. aeruginosa</em> ± <em>S. marcescens</em> 2 <em>S. marcescens</em> 1 <em>Klebsiella + Enterobacter</em></td>
<td>2-4 weeks</td>
</tr>
<tr>
<td>Macchini (2009)</td>
<td>13</td>
<td>No</td>
<td>2-4 weeks</td>
<td>12 <em>S. aureus</em> 1 <em>P. aeruginosa</em></td>
<td>2-3 weeks</td>
</tr>
</tbody>
</table>
Ken skin (iodopovidone 10%) around the catheter along the segment between the inner and outer cuffs to protect the tunnel near the inner cuff (Fig. 4). Remove the outer cuff, together with the adjacent tissue, by making incisions parallel to the catheter. Use gauze soaked in acetone as solvent for the glue used to cement the Dacron cuff to the silicone catheter to facilitate complete removal (Figs. 5 and 6). Other authors even suggest using a sterile razor to shave the catheter off the cuff (19). For the subsequent preparation of the new exit site, use a new set of surgical instruments and sterile gloves. The area around the outer cuff, that has now been removed from the catheter, must not coincide with the new tunnel segment or with the new exit site. When necessary, the skin incision can be extended medially or laterally to the catheter. Using nonabsorbable sutures, stitch the tissue flaps together, so that the catheter protrudes cranially in an area free of inflamed skin (Fig. 7). Place an iodoform gauze pad in the previous exit site area to guarantee drainage and healing by second intention. Specific systemic antibiotic therapy should be performed for at least 2-3 weeks, starting from before the procedure. Dressings should be changed every 1-3 days. Remove sutures after 5-7 days. To avoid further traumatization of the new exit site, fasten the peritoneal catheter using adhesive material.

**Discussion**

The absence of signs of infection such as redness, secretion, hardness and local pain on clinical examination is most likely not enough to exclude concomitant inner cuff...
infection. The preoperative workup should include an ultrasound examination of the catheter tunnel and inner cuff (using a linear probe with a wavelength of at least 7 MHz). The presence of a hypoechoic/anechoic area with a thickness of at least 1 mm around the catheter or inner cuff indicates an infection in this area (20-25). Manipulation of the peritoneal catheter during local surgery can increase the risk of peritonitis due to both the propagation of the infection toward the inner cuff and the peritoneum, and the indirect mobilization of the infected inner cuff that cannot be diagnosed clinically (9). In the short term, the risk of peritonitis can be limited by concomitant intraperitoneal antibiotic therapy. The success of local surgical therapy, which must always be combined with systemic antibiotic therapy, depends not only on the technique chosen and the operator's surgical experience, but also on the type of pathogen (5-8). The success rate appears to be high (>70%) for *S. epidermidis*, lower (50%-70%) for *S. aureus*, and more unfavorable still (≤50%) in the presence of *P. aeruginosa* or other gram-negative pathogens.

The removal of the outer cuff is indicated in patients who have already had at least 2 weeks of local and systemic antibiotic treatment without signs of recovery, when an infection of the tunnel segment between the cuffs and of the inner cuff has been excluded by ultrasound examination.

Fundamental aspects for the surgical review of the exit site:

- assessment prior to any cuff shaving procedure must include an ultrasound examination of the tunnel and inner cuff using a linear probe with a wavelength of at least 7 MHz. The presence of a hypoechoic/anechoic area with a thickness of 1 mm is suggestive of infection;
- in the presence of signs of inner cuff involvement or peritonitis, following exit site surgery, replacement of the peritoneal catheter is recommended;
- the patient must be informed of the increased risk of peritonitis following exit site and tunnel surgery;
- the patient should be on specific systemic antibiotic therapy for at least 2-3 weeks, starting from before the procedure;
- the persistence of positive wound culture tests following the procedure, shows that the surgery has been unsuccessful;
- the success of local surgical treatment combined with systemic antibiotic therapy is lower in the presence of gram-negative pathogens.
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16. PERITONEAL DIALYSIS CATHETER REMOVAL

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INTRODUCTION AND LITERATURE REVIEW

In an ideal world, peritoneal dialysis (PD) catheter removal would be necessary only after a successful kidney transplant. This is often, but unfortunately not always, the case. In one recent case series, although kidney transplantation was the second cause for catheter removal (21.4% of cases), it was a long way behind peritonitis and exit site and tunnel infections (57.1%). Other causes for removal included malfunction (7.1%), dialytic inadequacy (7.1%), the patient’s wish to change dialysis technique (4.8%) and suspension of PD due to an improvement in renal insufficiency (2.4%) (1).
The removal technique, which was described in the past by Ash, involves the use of a room in the dialysis unit, applying standard sterility procedures and without involving a surgeon. The author claims that a suitably trained nephrologist is able to remove a catheter autonomously, in absolute safety (2). Although this is undoubtedly true, this type of procedure should not be undertaken too lightly: all possible precautions and measures must be taken, as, although they are rarely reported in the literature, complications do exist. It is therefore preferable and advisable, where possible, to use an operating theater.

In one retrospective study of 40 catheter removals performed by senior surgeons at a center in Tel Aviv, Israel, a 25% early complication rate was reported, most of which were hemorrhagic (50%) and infectious (20%), and the majority of which required repeated surgery (3). The most common later complications observed were cellulitis and abscesses, but these were most frequently seen with a technique that was popular pre-2000 that involved pulling the catheter out, leaving one or both Dacron cuffs in place. One explanation for this could be that, in most of the patients experiencing this type of complication, the reason for catheter removal was peritonitis or an exit site infection (4). One subsequent publication suggested reserving this technique, which is considered safe and well tolerated (it was introduced to avoid the need for general anesthesia) for patients whose catheters are removed following kidney transplantation, rather than for cases of catheter removal for peritonitis or exit site infections (5, 6).

**Technique**

Having kept the catheter soaking in a pad of gauze soaked in Sodium hypochlorite (2% solution) for 5-10 minutes, prepare the sterile field by disinfecting it with a 10% iodo-ovidone solution and arrange the surgical drapes. Place the catheter in a sterile plastic bag to obtain the greatest possible sterility (Fig. 1).

Apply local anesthetic to the area around the scar of the previous implantation procedure, attempting to go slightly deeper (Fig. 2). Make an incision in the skin, including the scar (Fig. 3) then through the subcutaneous tissue, with an electric scalpel (Fig. 4) and/or surgical scissors using a blunt technique (Fig. 5) isolate the anterior fascia of the rectus abdominis muscle (Fig. 6). Use a finger to locate the catheter’s position (Fig. 7) and as soon as it has been identified, grasp it using Pean forceps (Fig. 8). Infiltrate the tissues with local anesthetic while working through the layers below.

Holding the catheter with Pean forceps and following its course, locate the inner cuff, using surgical scissors and a primarily blunt technique, but cutting when necessary (Fig. 9). Once the cuff has been located (Fig. 10), isolate it as far as possible, again using surgical scissors. It may also be necessary to use the electric scalpel, taking care not to use it on the muscle fibers, unless coagulation is required.

When removing the catheter, it is important to bear in mind that it is often difficult to recognize the deep anatomical planes (fasciae, muscles and peritoneum), as they tend to be incorporated into the scar tissue that forms around the cuff. Proceed with the isolation of the cuff to its lower margin and, making small cuts, free it from the peritoneum (Fig. 11); at this point, the catheter can be removed from the abdominal cavity (Fig. 12). It is not necessary to close the entry hole, unless a new catheter has to be replanted for immediate or imminent use; in which case, suture with 2 button stitches.

At this point in the procedure, cut the catheter between the 2 cuffs, holding the end still connected to the cuff firmly with Pean forceps (Fig. 13). Pulling gently on the catheter, follow its subcutaneous course detaching the tissue using a blunt and/or cutting technique (Fig. 14), to reach the outer cuff, which should, in turn, be isolated by cutting through the scar tissue that has formed around it (Fig. 15). As soon as the cuff has been released, cut the catheter immediately above its proximal margin (Fig. 16), to remove it from the subcutaneous side (Fig. 17) and remove the outer part of the catheter from the skin side (Fig. 18). Now suture the rectus abdominis fascia (where possible given the anatomical sequelae) (Fig. 19), the subcutaneous tissue and the skin. If the catheter is being removed due to exit site infection, blot a segment about 2-cm long with a small iodoform gauze pad (Fig. 20), to be replaced and removed during the dressing changes that will be performed on the second and fourth days postprocedure, respectively. The sutures will be removed on day 7 or 8.

**Discussion**

The peritoneal catheter removal procedure can be performed autonomously by a nephrologist, whatever the cause underlying the surgical indication. Up-to-date guidelines would be:

- use an operating theater whenever possible;
- based on the extent of the area involved, local anesthesia may be inadequate, and consequently the assistance of an anesthetist would be recommended for the administration of pharmacological sedation;
- considering that the most common early complica-
Best Practice on: The peritoneal dialysis catheter

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6
tions are bleeding and infections, it is important to give the following aspects due consideration:

- suspension of oral anticoagulants and antiplatelet medications (see section “Anesthesia Assessment of the Patient”);
- take great care with hemostasis and to avoid damaging the epigastric artery;
- administer preoperative antibiotic prophylaxis and, when the procedure is being performed for an exit site infection, continue current antibiotic therapy for a few weeks (see chapters on exit site infections).

REFERENCES


17. SIMULTANEOUS REPOSITIONING AND REMOVAL OF PERITONEAL DIALYSIS CATHETERS

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INTRODUCTION

The repositioning and removal of a peritoneal dialysis catheter in a single procedure has several advantages. Most importantly, it minimizes the need for temporary hemodialysis and the risks associated with the placement and use of a central venous catheter, as well as making it possible to avoid a second surgical procedure.

LITERATURE REVIEW

The first experiences involving simultaneous repositioning and removal due to infections associated with peritoneal dialysis were published between 1986 and 1989. The first 3 studies were conducted on small case series (11-12 cases), and the results were encouraging: the techniques used were surgical (1-3). Other experiences had been reported previously, all of them referring to simultaneous repositioning and removal for malfunction due to mechanical causes. One of the first studies with a large case series was that published in 1991 by Swartz et al (4), who, us-
ing the percutaneous technique (20 cases) or surgical technique (10 cases), performed simultaneous catheter repositioning and removal in 36 patients with tunnel and exit site infections and refractory and recurrent peritonitis.

In 30 cases, the method was successful, and there was no recurrence of infection during the first 3 months; in 6 patients, however, it was unsuccessful, with a persistence of infection in 2 cases, leakage in 1 instance and intestinal perforation in 3 cases (all of which were performed using the percutaneous technique).

The infections treated were *Staphylococci* in 70% of cases, gram-negative bacteria in 17%, *Pseudomonas* in 6% and other bacteria in the remaining 8% of cases. However, the authors advised against using the technique in the case of fungal and *Pseudomonas* infections.

One Italian experience published in 1994 by Canca-rini et al (5) presented the results for a larger case series concerning 68 patients with tunnel infections (26 cases), tunnel infections complicated by peritonitis (22 cases), refractory peritonitis (12 cases) and recurrent peritonitis (8 cases). The surgical technique was employed to treat all of the types of infection observed, including 4 cases of *Pseudomonas*, 3 fungal and 2 mycobacteria infections.

The results, evaluated as eradication of the infection and nonrecurrence in the following 2 months, were excellent for all infection types, with the exception of refractory peritonitis, for which, of the 12 cases treated, there were 10 failures, all of them involving fungi and mycobacteria.

In a later Dutch experience published in 1998, Post-huma et al (6) performed 40 simultaneous repositioning and removal procedures using the peritoneoscopic technique, excluding refractory peritonitis.

Most of the infections were caused by *Staphylococcus aureus* (22 cases) and *Pseudomonas aeruginosa* (9 cases). The reported results were very good, as the infection was resolved in 38 out of 40 cases, including all *Pseudomonas* infections. Another study was published in 2005 by Lui et al (7), who performed simultaneous treatment, using the surgical technique, in exit site infections involving *Pseudomonas aeruginosa* only. None of the 37 patients treated developed recurrent infections within a month of the procedure, and 3 patients had a relapse between the 24th and the 40th week.

In 3 of the abovementioned studies (4-6), the authors preferred to position the new catheter before removing the old one (“clean procedure”) rather than the other way round (“dirty procedure”), in the conviction that this would reduce the risk of contaminating the new catheter with the old infected one.

Others, such as Lui et al (7), preferred to remove the old catheter before implanting the new one.

In all of these experiences, almost all patients continued peritoneal dialysis in the postoperative period with small fills and without a break-in period, which prevented the need for even brief use of hemodialysis treatment.

**Discussion**

The repositioning technique used can be standard surgery, low surgery (Vicenza catheter) or video-guided laparoscopy: this last solution should be preferred in cases of peritonitis to evaluate the appearance of adhesions secondary to the infection.

Percutaneous techniques should be avoided given their greater risk of perforation.

For the procedure to be successful, it is important to observe the following recommendations:

- It is widely believed that the removal of the old catheter should be performed after the new one has been implanted (as discussed above), according to the consolidated surgical practice of performing “clean” procedures before “dirty” ones.
- The infected catheter, from which the solution transfer set has been removed, should be wrapped in a pad of Sodium hypochlorite soaked gauze and, once the sterile field has been created, covered with another sterile drape. Once the new catheter has been positioned, it should be covered with another sterile drape. Take away the drape covering the old catheter and remove the catheter itself.
- The choice of local vs. general anesthesia depends on the type of technique used, patient comorbidity and the thickness of the subcutaneous tissue, as, in patients with very thick subcutaneous tissue, the amount of local anesthetic required for the 2 surgical times could be excessive. The type of anesthesia to be used should always be discussed in advance with the anesthetist.

For technical notes and photographs, see the corresponding sections.
REFERENCES


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