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Review Article

How I Do It: Percutaneous Image-guided Peritoneal Dialysis Catheter Insertion

Abstract

Peritoneal Dialysis (PD) catheter insertion is traditionally performed using open surgical or laparoscopic techniques. The minimally invasive percutaneous PD catheter insertion techniques guided by fluoroscopy and ultrasound proved to provide comparable results in terms of catheter survival and dysfunction rates and lower incidence of catheter related peritonitis and leak. Percutaneous insertion by interventional radiologists offers more flexible scheduling and efficiency compared to surgical approaches that require operating room booking and general anesthesia. Here we report a step-by-step guide for percutaneous image-guided PD catheter insertion based on our institutional experience and previous best practice recommendations in the literature.

Keywords: *Image guided, interventional radiology, percutaneous insertion, peritoneal dialysis*

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Introduction

Peritoneal dialysis (PD) offers an effective alternative renal replacement therapy for patients with end-stage renal disease requiring or approaching dialysis. PD provides a better quality of life and more comfortable home dialysis independent from dialysis units. It has been shown to be more cost effective and provides survival benefit over hemodialysis in young and pretransplant candidates. PD catheter insertion is traditionally performed using open surgical or laparoscopic techniques. The minimally invasive percutaneous PD catheter insertion techniques guided by fluoroscopy and ultrasound proved to provide comparable results in terms of catheter survival and dysfunction rates[1] and lower incidence of catheter-related peritonitis and leak.[2,3] Percutaneous insertion by interventional radiologists offers more flexible scheduling and efficiency compared to surgical approaches that require operating room booking and general anesthesia.[4]

Here, we report a step-by-step guide for percutaneous image-guided PD catheter insertion based on our institutional experience and previous best practice recommendations in the literature.[4-6]

Preprocedure Evaluation

Candidates for PD catheter insertion should be screened for prior abdominal surgeries, presence of hernias, or abdominal infections. Review of cross-sectional imaging is essential to look for any space occupying pelvic masses that may preclude proper catheter placement and function. Patients should receive bowel preparation before the procedure to reduce constipation. Anticoagulation should be withheld for 5 days[4] and preoperative broad-spectrum antibiotics to be administered 1 h before the procedure.[7] Patients should fast for 6 h and empty their bladders immediately before the procedure.[4,5]

Catheter Description

There are several PD catheters in the market (Medcomp, Inc., Harleysville, PA, USA) (Merit Medical, South Jordan, UT, USA) and Argyle (Covidien, MA, USA) with different designs and shapes (straight, Swan Neck, Curl). However, no particular catheter design is proven to be better than another.[6] A common feature between catheters is the presence of one or two Dacron cuffs designed to anchor the catheter to the rectus muscle and subcutaneous tissues and prevent pericatheter leak [Figure 1]. The length of catheter is determined by the height and body habitus of the patient. In general, we use 62 cm curl catheter in majority of patients and 57 cm catheter in patients with shorter stature to avoid drain pain during fluid exchange.

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Insertion Technique

- Sedation: The procedure is done under local anesthesia after infiltrating the entry site with lidocaine 1% and the tunnel with lidocaine 1%/epinephrine 1:100,000. Moderate sedation is recommended as patients may experience pain during wire manipulation into the pelvis and sheath introduction through the rectus muscle
- Entry point: The choice of access side depends primarily on the patient's preference and beltline as he/she will be handling the catheter at home during the dialysis sessions. It is recommended to mark the exit site before the procedure in both sitting and standing positions. For a right-handed operator, access through the left rectus muscle is technically more favorable and provides easier control when directing the access toward the pelvis.

The skin entry point is typically 2–4 cm superolateral to the umbilicus. This renders the peritoneal entry point 2–4 cm inferiorly when the needle is directed caudally [Figure 2]. This entry courses obliquely through the thickest part of the rectus abdominis muscle,[8] which will act as valve to minimize pericatheter leak.

Initial ultrasound examination of the abdominal wall is essential to assess the entry point and avoid the course of the inferior epigastric artery, which normally runs along the inner lateral surface of the rectus abdominis muscle [Figure 3]. On ultrasound, a hyperechoic line outlining the inner surface of the rectus muscle is identified. This line consists of the transversalis fascia and peritoneal reflection and immediately underlined by moving omental fat/bowel on real-time ultrasound [Figure 4].

- Access: A 21-G micropuncture needle is advanced under ultrasound guidance through the body of the rectus abdominis muscle in sagittal plane and directed 45°–60° caudally toward the pelvis. The needle should not be advanced more than 3–5 mm beyond the peritoneal reflection (hyperechoic line) to avoid localized contrast accumulation within the omentum. Once the fascia is pierced, contrast injection outlining the bowel confirms intraperitoneal position [Figure 5]. Localized contrast accumulation could be related to subcutaneous/intramuscular injection or within the omentum [Figure 6]. Following introduction of the micropuncture kit, infusion of 300–500 ml of normal saline into the pelvis is recommended to expand the pelvic cavity and allow for easier navigation of wire into the deep pelvis and proper positioning of the catheter's loop. Next, a stiff hydrophilic-tipped wire is negotiated in lateral projection into the posterior deep pelvic cavity (rectovesical or rectouterine pouch) [Figure 7]. Then, a 1–2 cm transverse skin incision is done around the wire, and the subcutaneous tissue is dissected bluntly. The peel-away sheath is then introduced over the wire toward the pelvis [Figure 8]. We prefer not to predilate the tract to ensure tight seal on the catheter and minimize the risk of pericatheter leak
- Catheter insertion: A double-cuffed silicone-type curl PD catheter is soaked and flushed with saline. The cuffs

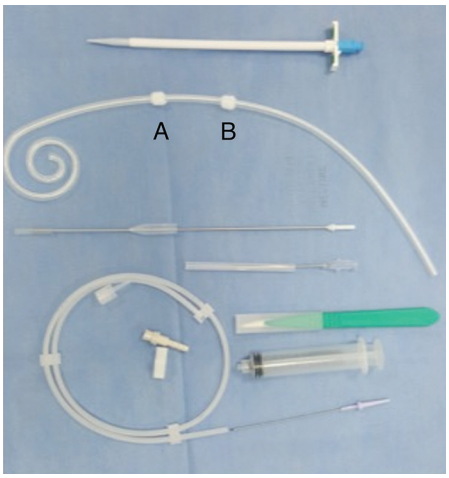

Figure 1: Components of curl peritoneal dialysis catheter kit with two Dacron cuffs; (A) rectus muscle cuff, (B) subcutaneous cuff

Figure 2: Photo showing the entry and exit sites and the course of the subcutaneous tunnel. The needle should point caudally toward the pelvis

Figure 3: Axial contrast-enhanced computed tomography image showing the normal right inferior epigastric artery along the inner surface of the right rectus abdominis muscle (long arrow) and a pseudoaneurysm of the left inferior epigastric artery as result of attempted peritoneal dialysis catheter insertion (short arrow)

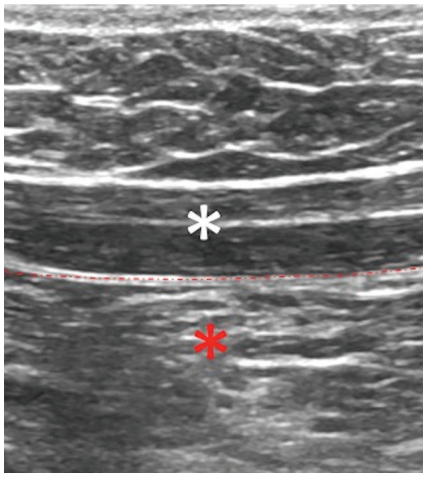

Figure 4: Sagittal ultrasound image of the abdominal wall showing the rectus muscle (white asterisk), transversalis fascia, and peritoneal reflection (red line) and immediately underlined by moving omental fat/bowel on real-time ultrasound (red asterisk)

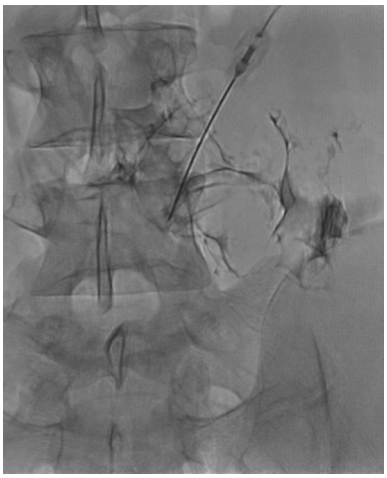

Figure 5: Initial puncture using 21-G needle. Contrast is seen outlining the bowel indicating intraperitoneal position

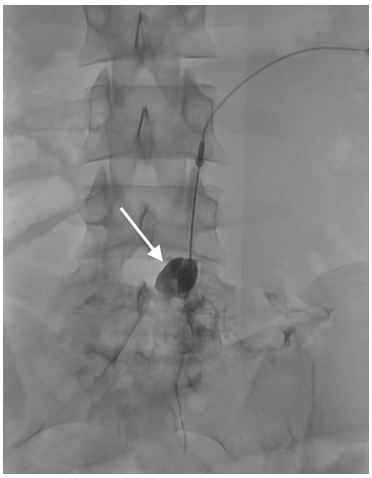

Figure 6: Focal accumulation of contrast (arrow) in the abdominal wall due to improper initial access. The needle was adjusted and contrast outlining the bowel confirmed intraperitoneal position

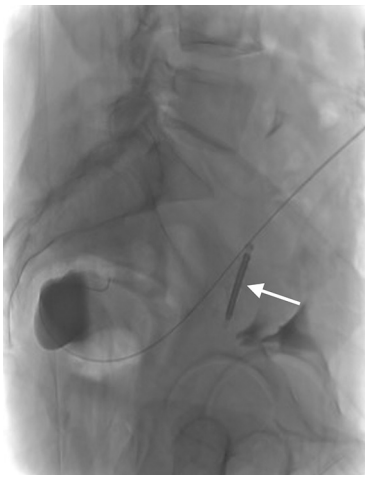

Figure 7: Lateral pelvic radiograph showing the wire directed into the rectouterine pouch, which is filled by contrast. The arrow marks the intrauterine device within the endometrial cavity

should be squeezed to completely eliminate trapped air. Once the sheath is fully inserted, the catheter is introduced over the wire, and the first (deep) cuff is sutured with 2-0 vicryl absorbable sutures [Figure 9]. This cuff is then sutured to the deep subcutaneous tissue/rectus sheath fascia after peeling the sheath away. This prevents movement of the catheter into the peritoneal cavity and minimizes the risk of pericatheter leak. Proper positioning of the catheter is confirmed by contrast before subcutaneous tunneling [Figure 10]

- Subcutaneous tunneling: Retrograde C-shaped lateral subcutaneous tunneling of the catheter is then done to secure the superficial cuff 2–4 cm from the skin exit site [Figure 2]. The exit site incision should be the smallest possible to avoid applying sutures at the exit site and to minimize the risk of infection [Figure 11]
- Flow assessment: The PD nurse should be onsite during the procedure to perform final flow assessment by infusing/draining of 2 L of dialysate solution to ensure sufficient inflow and outflow. The catheter's entry incision is sutured in two layers
- Postprocedure care: Our institutional protocol recommends dry period of 10 days before using the catheter to allow for wound healing and minimize the risk of pericatheter leak. However, catheter may be used immediately with low volumes in supine position in cases of "urgent-start PD" to avoid a tunneled hemodialysis catheter in relatively stable patients.[9,10] The catheter and wound are assessed at 5 days after initial insertion to check for signs of infection.

Catheter Maintenance

Adequate PD is determined by technically successful catheter insertion and maintenance. Early recognition of potential causes of catheter dysfunction during the insertion procedure or dialysis sessions will reduce the need for future manipulation or exchange.

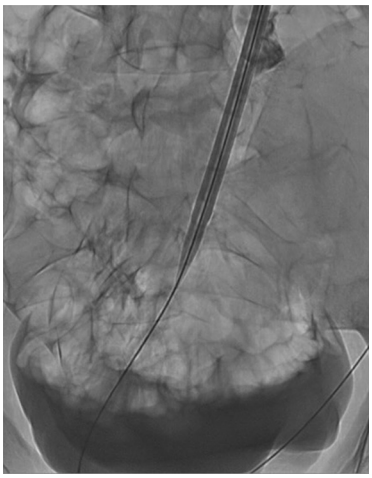

Figure 8: A 16 Fr peel-away sheath is inserted without predilatation over the wire aiming toward the pelvis

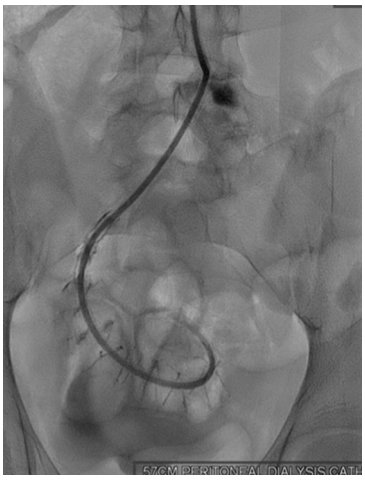

Figure 10: Contrast injection confirms well-positioned catheter with adequate inflow

- Catheter kink: This may occur in the subcutaneous tissues in obese patients or at the entry point and can be adjusted by advancing a stiff hydrophilic wire to eliminate the kink
- Tip malposition: The catheter's tip should be positioned within the deep posterior pelvic cavity that has a large capacity for sufficient fluid exchange. We stress on advancing the wire and catheter into the pelvis in lateral projection to avoid inadvertent deployment of the catheter in the anterior pelvic cavity. Anterior catheter position will result in adequate inflow but poor drainage since the catheter is not within the dependent aspect of the pelvic cavity where fluid accumulates [Figure 12]. Changing the patient position and excluding constipation may improve drainage. However, catheter manipulation or exchange may be required. In our experience, nearly 10% of catheters migrate upward after proper initial placement resulting in catheter dysfunction. Migrated or dysfunctional catheters may be manipulated using stiff wire[11,12] or a metallic stylet[13] restoring PD function in 50%–70% of cases. Failure to correct the catheter's position often requires catheter exchange over a wire and redirecting the tip into the pelvis
- Complex abdomen: Patients with previous abdominal surgeries may have adhesions and fibrosis of peritoneal membranes that preclude proper function of PD catheter. Nonetheless, percutaneous insertion remains a valid option despite the inability to visualize and lyse the adhesions.[14] Contrast loculation indicates adhesions that may not allow for free spillage of contrast into

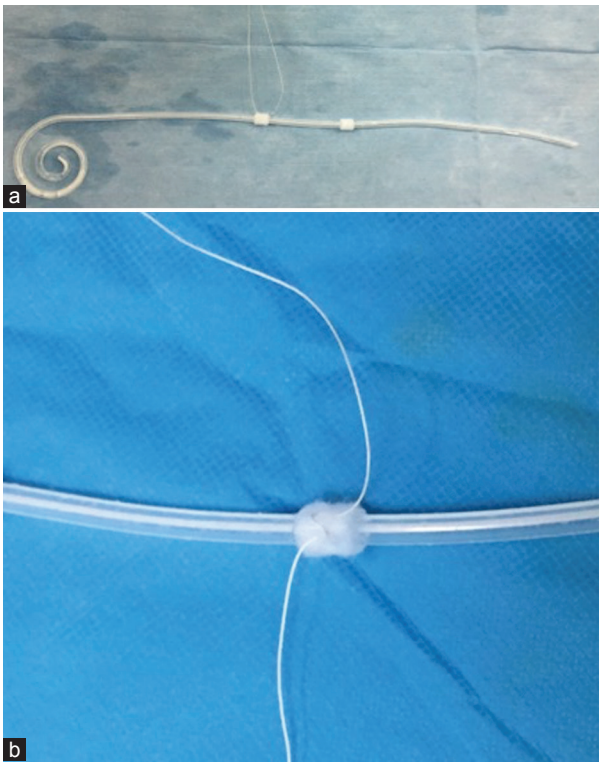

Figure 9: (a and b) Photos showing the absorbable anchoring suture on the deep cuff that will be secured to the subcutaneous tissues or the fascia

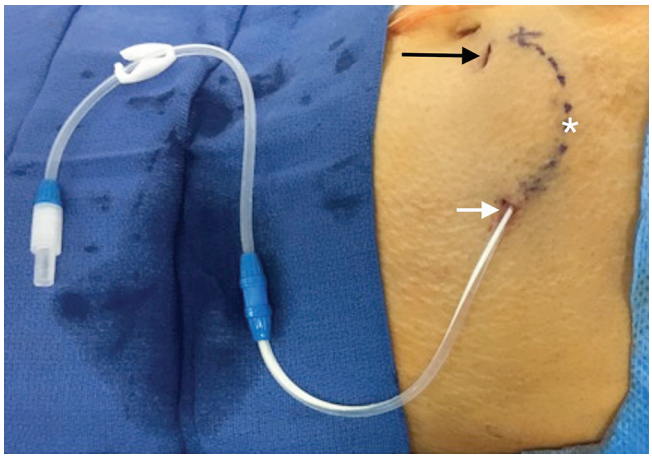

Figure 11: Photo showing the peritoneal dialysis catheter after insertion. The long black arrow marking the entry point superolateral to the umbilicus and the short white arrow indicating the exit site and the superficial subcutaneous cuff (asterisk)

the peritoneal cavity. Operator should try to deploy the catheter into the largest pocket that allows free communication with the rest of the abdominal cavity. Completely isolated pockets require changing the access point [Figure 13]

- Catheter occlusion: Abdominal radiograph should be initially obtained to exclude catheter malposition and constipation that may impair catheter's function [Figure 14]. Intraluminal occlusion could be related to fibrin strands, blood clots, or debris. This may be eliminated by catheter massage, heparinized saline flush, thrombolytic infusion,[15] or wire manipulation.[12] If intraluminal causes are excluded, then extrinsic fibrin sheath or omental wrapping may be diagnosed by catheterography[16] and released laparoscopically[17] or by wire manipulation.[11]

Special Conditions

- Ascites: PD catheter insertion can be done successfully and safely in patients with ascites secondary to chronic liver disease or congestive heart failure. In fact, PD maybe better tolerated than hemodialysis and may offer better hemodynamic stability and ascites control. Peritoneal protein loss in cirrhotic patients can be initially high but decreases over time. The risk of peritonitis is similar or slightly higher than other patients requiring PD[18,19]
- Pregnancy: Pregnancy during PD is less likely compared to patients on hemodialysis.[20-23] This could be related to less adequate dialysis, increased intra-abdominal pressure, and instability of ova within the peritoneal fluid. In those patients who successfully conceive while on PD, pregnancy outcomes are not significantly different compared to hemodialysis. PD during pregnancy potentially offers prolonged dialysis sessions avoiding hypotensive episodes without the need for anticoagulation. On the other hand, the enlarging uterus may result in catheter blockage or require reducing the dialysis fluid that may compromise the quality of dialysis.[20-23] Surgical or laparoscopic PD catheter placement during pregnancy is the method of choice since percutaneous placement requires fluoroscopy with potential radiation hazards to the fetus
- Postpartum: Pregnant patients on PD dialysis are considered high risk and likely to be delivered through cesarean section. PD can be resumed 2 days after delivery, with the use of small dialysate volumes and frequent exchanges.[21] During the postpartum period, the uterus returns to the pelvis in 2 weeks and returns to prepregnancy size after 6 weeks. Therefore, we advise for percutaneous PD catheter placement after 2 weeks of delivery.

In summary, percutaneous image-guided placement of PD catheter is a minimally invasive alternative to laparoscopic or surgical approaches. Optimization of techniques and postprocedure care helps in minimizing catheter dysfunction and catheter-related complications.

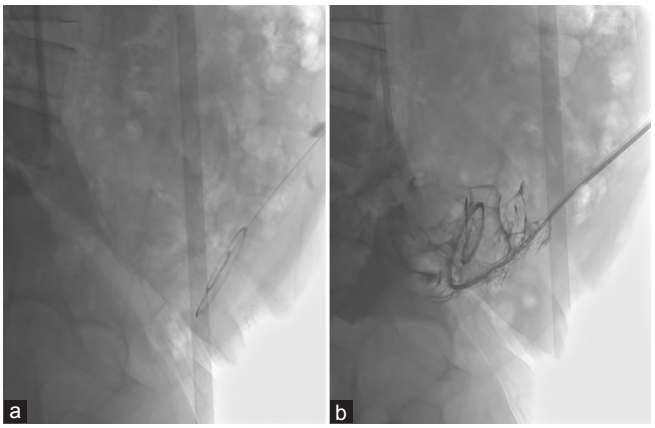

Figure 12: (a) Lateral pelvic radiograph showing malpositioned catheter into the anterior abdominal cavity, which resulted in poor outflow. (b) Postwire manipulation with stiff glide to reposition the tip into the pelvis

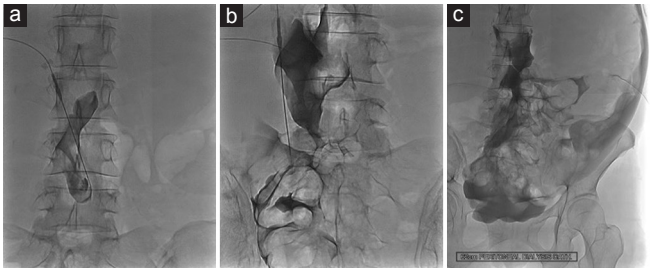

Figure 13: A 50-year-old woman with known end-stage renal disease on long-term peritoneal dialysis through a surgically placed catheter, which was removed due to peritonitis. (a) Initial access during percutaneous re-insertion of peritoneal dialysis catheter showing loculated contrast accumulation. (b) Another access demonstrating free spillage of contrast outlining the bowel. (c) Pelvic radiograph showing free contrast in the pelvis and left paracolic gutter

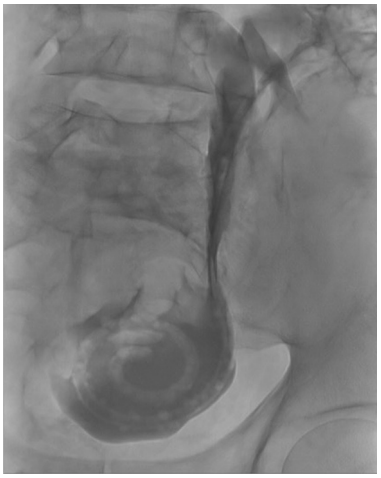

Figure 14: Catheterography showing contained contrast around the catheter due to constipation. Catheter function improved after laxatives

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Nil.

Conflicts of interest

There are no conflicts of interest.

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