# Ultrasound-Guided Peritoneal Dialysis Catheter Placement: A Probing Review

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The saying "Nice guys finish last" aptly captures the current global standing of peritoneal dialysis (PD) within the hierarchy of kidney replacement therapies (KRTs). Despite substantial evidence indicating its non-inferiority to hemodialysis across various metrics, including efficacy, and quality of life and superiority on other measures such as therapeutic convenience, home-based care, and the preservation of residual renal function, PD is employed in merely 10% of the patients requiring KRT for end-stage renal disease.[1]

A significant proportion of patients in developing countries present with advanced uremia for the first time directly to nephrologists. PD as a form of KRT is offered in only a minority of such patients. Even in those patients who consent to long-term PD, the protocol widely followed is first to initiate hemodialysis and stabilize them before the PD catheter is implanted. This dual approach has the potential to deviate the patient's preference away from PD toward hemodialysis permanently, which is a lost opportunity for patients to experience the benefits of PD. Emergent (exchanges within 48–72 hours) or urgent (exchanges within 14 days) start PD after catheter implantation has the potential to disrupt this protocol. Their efficacy and safety have been well documented.[2–4]

Proper implantation of PD catheters is the key factor in making them ready for exchanges immediately. The margin of error is low, and this is where imaging assistance becomes crucial. Blind percutaneous PD placement is associated with higher risks of blood vessel or bowel injury and catheter malpositioning, and hence cannot be recommended for routine practice.[5] Fluoroscopy-guided procedure has gained traction, yielding results akin to those achieved through surgical or laparoscopic methods; however, the accessibility of catheterization laboratories (cath labs) poses a significant hurdle for interventional nephrologists due to turf battles involving cardiologists and interventional radiologists.

This is where the study by Martínez-Sánchez *et al*.[6] from Mexico in this issue of the journal gains importance. The authors present an adapted technique for ultrasound-guided percutaneous placement of PD catheters, demonstrating its safety and efficacy in patients requiring urgent-start renal replacement therapy. A total of 74 patients were evaluated with a mean age of 54.2 years and a significant portion having increased body mass index (BMI). The mean BMI was 26.4 ± 5 kg/m$^2$, and 23% of the patients had a BMI >30 kg/m$^2$. An equal proportion had a history of abdominal surgery. They have made innovative use of color doppler imaging to monitor the intraperitoneal saline infusion. Complications were seen in around 20%, which included transient PD dysfunction, catheter migration, leakage, and peritonitis. These complications were not significantly increased in obese or those with prior abdominal surgery. Importantly, all of these had resolved before the discharge of patients and 93% of these catheters were still functional at six months follow-up. This study showcases excellent results in a group of patients typically referred for surgical PD catheter placement.

## Image assistance

Image assistance encompasses two methods as shown in Table 1. Nephrologists widely adopt fluoroscopic positioning of the PD catheter. The optimum position of the PD catheter is in the true pelvis within the rectovesical pouch, with the tip pointing downwards and beyond the reach of the greater omentum's tentacles. The inner cuff is placed inside the rectus sheath (not inside the peritoneal cavity, as suggested by some authors), and a purse-string suture is applied around it.



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**Table 1: Comparison of two modes of image guidance during PD catheter placement**

| Factor | Fluoroscopy | Ultrasonography |
|---|---|---|
| Identification of blood vessel in rectus sheath | No | Yes |
| Assessment of rectus muscle bulk | No | Yes |
| Needle entry of peritoneal cavity | Indirect by dye diffusion around bowel | Direct visualization |
| Deep cuff location | Not visible | Can be seen |
| Catheter tip position and kinks in the catheter | Easy to identify | Difficult to identify |
| Recognition of bowel or bladder injury | Easier | Difficult |
| Operator dependency | Low | High |

PD: Peritoneal dialysis

## Ultrasonogram-guided PD placement

There are some blind spots in fluoroscopy assistance. The depth and pathway of needle advancement are not picked up by fluoroscopy, where sonography can assist. Ultrasound for image guidance has been underutilized in PD catheter placement compared to hemodialysis catheters. It aids in various stages of catheter placement, from preoperative assessment to intraoperative guidance and postoperative evaluation. The integration of ultrasound into PD catheter placement procedures has the potential to reduce complications and improve patient outcomes. We explore the key aspects of ultrasound use in PD catheter placement, including enhanced visualization of anatomical structures below the skin entry point, the ability to identify potential complications before they arise, and precise catheter positioning.

## Rectus muscle and vessel localization

Deep cuff localization is of paramount importance in the long-term functioning of the catheter. When placed within the richly vascularized muscle, fibrous tissue ingrowth ensures a secure seal against pericatheter leaks. Ultrasound aids in identifying the rectus muscle bulk and the course of the inferior epigastric artery, which are crucial for minimizing complications such as vessel injury and pericatheter leaks. This technique ensures the optimal positioning of the internal cuff within the rectus muscle sheath, reducing the risk of dialysate fluid leakage. A lateral entry at the rectus muscle results in an improper seal and the possibility of inadvertent placement of the inner cuff inside the peritoneal cavity, which should be avoided.

## Two-step puncture technique

After selecting the proper entry point, real-time ultrasound guidance is used to safely puncture the peritoneal cavity. Free sliding movement of the parietal peritoneum and visualization of bowel loops are ensured to confirm no adhesions at the proposed entry site. Puncture can be safely performed with a 22-gauge micropuncture needle or Veress needle (safer), guided by a linear high-frequency probe of 5–15 MHz. The two-step puncture technique involves real-time ultrasound guidance for peritoneal space entry, followed by the infusion of half a liter of saline to minimize the risk of intestinal or vascular injury during catheter placement via a peel-away sheath.[7] The inner cuff in the rectus sheath is seen as an echogenic structure with after-shadow. Fluoroscopy and ultrasonography represent complementary diagnostic modalities; their integration can produce synergistic benefits. An ideal methodology would involve the application of ultrasound-guided needle puncture, which is subsequently followed by fluoroscopy-assisted catheter insertion. Contrast-enhanced ultrasound using microbubbles represents another advancement over conventional ultrasound for dynamic assessment of PD catheter dysfunction, peritoneal-pleural communication, and fluid leakage.

In India, the extensive access to ultrasonography in nearly all hospitals should enthuse nephrologists to employ it for PD catheter placements. Interactive workshops, mannequin-based demonstrations, and practice sessions at regional and national conferences should equip them with the essential skills.

In conclusion, this study stands out as a significant advancement aimed at bolstering the safety of percutaneous PD catheter placement, whether it is permanent or temporary, the latter being used for acute kidney injury. We confidently anticipate the emergence of similar research from India that will invigorate the field of PD, which has recently attracted diminished interest from nephrologists and patients.

### Conflicts of interest

There are no conflicts of interest.

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