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Outcomes of Percutaneous Peritoneal Dialysis Catheters Insertion by Interventional Radiologists: A Single-Institution Experience

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Abstract

Objectives This article evaluates the short- and long-term outcomes of percutaneous peritoneal dialysis (PD) catheters inserted by interventional radiology service and analyzes the factors that affect the sustainability of patent and functional PD catheters.

Materials and Methods Retrospective single-institution study between April 2015 and February 2021. A total of 131 patients (75 males) were enrolled with mean age of 50 ± 19.6 years with an average body mass index (BMI) of 28 ± 7 kg/m^2. Technical and clinical success were evaluated. Catheter-related complications were classified into mechanical and nonmechanical categories, including infectious complications. Indications for removal were analyzed.

Results Technical and clinical success were 100%. The average dwelling time for the entire cohort was 497.5 ± 462.3 days. Forty-six patients (35%) were on PD at the last follow-up with an average dwelling time of 492 days. PD-related complications were reported in 79/131 (60.3%) patients, including peritonitis (40.46%; 53/131), followed by malposition/migration (12.21%; 16/131), tunnel/exit site infection (10.69%; 14/131), and dysfunction (12.21%; 16/131). The incidence of peritonitis within 30 days postinsertion was 9.43% (5/53). The average interval between insertion and migration was 100.5 ± 144.8 days (95% confidence interval, 6.9–14.4). There was a trend for a higher rate of malposition/migration in patients with higher BMI ($p = 0.0561$). Causes for PD catheters removal were: (1) infection-related (24.4%; 32/131), (2) renal transplant recipients (16%; 21/131), (3) mechanical complications (13.7%; 18/131), and (4) patient's preference (7.6%; 10/131).

Conclusion Percutaneous PD catheter placement by interventional radiologists provides acceptable long-term outcomes and complication rates that meet the recommended standards.

Keywords
- interventional radiology
- image-guided interventions
- percutaneous catheter insertion
- peritoneal dialysis catheter
- peritoneal dialysis

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Introduction

A well-functioning peritoneal dialysis (PD) catheter is the ground for successful renal replacement therapy (RRT).[1] Statistically, Saudi Arabia (2020) reported 28,769 RRT patients, of them only 1,781 patients on PD.[2] Unlike facility-based hemodialysis,[3] PD as an option of home-based dialysis offers unique lifestyle benefits by increasing patient autonomy, facilitating mobility, and lowering dialysis costs.[4] In addition, improving patient-reported satisfactory outcomes.[5,6]

PD catheter insertion, whether surgical or percutaneous, has been subjected to constant developments.[3] PD insertion technique is determined by several factors, including patient comorbidities, health care provider's expertise, resource availability, and urgency for PD initiation.[7] Image-guided percutaneous PD insertion by vascular and interventional radiologists offers scheduling efficiencies and cost-effectiveness with relatively speedy recovery due to the percutaneous minimally invasive nature of catheter placement.[8]

The continuity of well-functioning PD primarily depends on proper insertion technique and meticulous postprocedural maintenance.[1,3] This begins with a preoperative evaluation to select the best candidates, determine the most applicable catheter configuration type, and determine both entry and anatomical exit sites. Proper planning and patient counseling facilitate performing the procedure, lower the risk of all mechanical and infectious complications, and allow permanent functional access for dialysis.[1,3,4] These complications, which are directly related to the PD insertion procedure, usually cause catheter failure and lead to substantial morbidity and mortality.[9]

This study was carried out to evaluate the short- and long-term outcomes of percutaneous PD catheters inserted by interventional radiology service and analyze the factors that affect the sustainability of patent and functional PD catheters.

Material and Methods

This retrospective study included patients who had image-guided percutaneous peritoneal catheter placement at the National Guard Health Affairs hospitals in Riyadh, Saudi Arabia. This included all patients who had their first PD catheter inserted by interventional radiology between April 2015 and February 2021. The institutional review board has granted approval for the study, and informed consent was waived. The analysis excluded patients who had a surgical placement, catheter changes, repositioning, and patients with missing follow-up data.

A total of 131 patients had new insertion of PD catheter by one of the consultant interventional radiologists with clinical experience ranging between 2 and 15 years.

Clinical and imaging data were collected from the electronic medical records and radiology information systems.

Patients' demographics included age, gender, weight, height, and body mass index (BMI). Clinical data included comorbidities, history of the previous hemodialysis, and prior abdominal surgery.

The catheter placement technique is previously described in details.[10]

The catheter's dwell time was calculated from the day of insertion till the last clinical follow-up, removal, exchange, repositioning, or death. Catheter-related complications were classified into mechanical and nonmechanical categories. Mechanical complications included dysfunction, malposition or migration, and blockage. Nonmechanical complications included bleeding, tunnel or exit site infection, and peritonitis. Additional data about the infectious organisms causing peritonitis are gathered. Technical success was defined as successful catheter placement with confirmed adequate inflow and outflow at the time of insertion. Clinical outcomes at the time of final follow-up included removal, ongoing PD dialysis, or death. Indications for removal were analyzed.

PD catheter-related peritonitis is defined as any positive peritoneal culture during the presence of the catheter.

Results

A total of 131 patients (76 females, 58%; 55 males, 42%) were enrolled in this study. The mean age was 50 ± 19.6 years old. The average height was 159 ± 9.3 cm, weight was 71 ± 20.1 kg, and BMI 28 ± 7 kg/m^2. The average dwelling time was 497.5 ± 462.3 days (►**Table 1**).

Technical and clinical success was 100%. Forty-six patients (35%) were on PD at the latest follow-up, with an average dwelling time of 492 days. PD-related

Table 1 Patient demographics

		Patients
		131 (100%)
Gender		
	Females	76 (58%)
	Males	55 (42%)
Age		49.95 y (15–96)
Height		159 ± 9.3 cm
Weight		71 ± 20.1 kg
BMI		28 ± 7 kg/m^2
DM		65 (49.6%)
HTN		111 (84.7%)
Heart failure		25 (19%)
CABG		14 (10.7%)
Dyslipidemia		30 (22.9%)
History of abdominal surgeries		14 (10.7%)
History of regular HD before PD		37 (28.2%)

Abbreviations: BMI, body mass index; CABG, coronary artery bypass graft; DM, diabetes mellitus; HD, hemodialysis; HTN, hypertension; PD, peritoneal dialysis.

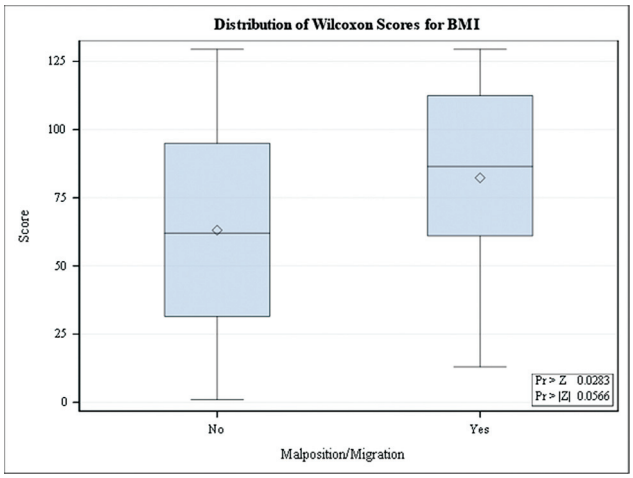

Fig. 1 Distribution of mean body mass index (BMI) values for different peritoneal dialysis (PD) patients who had or did not have catheter migration suggests a trend to higher rate of migration with higher BMI values.

complications were reported in 79/131 (60.3%) patients, including peritonitis (40.46%; 53/131), followed by malposition/migration (12.21%; 16/131), tunnel/exit site infection (10.69%; 14/131), and dysfunction (12.21%; 16/131). Early peritonitis was documented in 3.8% (5/131). The incidence of peritonitis within 30 days post-insertion was 9.43% (5/53), as compared to 90.57% (48/53) after 30 days postinsertion. The average interval of insertion to first peritonitis was 326.6 ± 264 days. The majority of early peritonitis cases were managed medically and catheter was removed in only one case. The most isolated organism was *Staphylococcus epidermidis* in 15 of 70 peritonitis episodes (21.4%), followed by coagulase-negative staph in 9/70 episodes (12.8%) and *Staphylococcus aureus* in 6/70 episodes (8%), Staph viridans (8%), *Pseudomonas aeruginosa* (8%), and *Klebsiella pneumoniae* (8%).

The average interval between insertion and migration was 100.5 ± 144.8 days (95% confidence interval, 6.9–14.4). There was a trend for higher rate of malposition/migration in patients with higher BMI ($p = 0.0561$; Kruskal–Wallis test) (►**Fig. 1**). There was no correlation between migration and peritonitis (chi-square test, $p = 0.79$) nor catheter length of 57 cm versus 62 cm (Fisher's exact test, $p = 0.38$). PD catheter removal was done in 51 patients within 12 months of insertion and in 81 patients during the follow-up period. Causes for PD catheters removal were: (1) infection-related (24.4%; 32/131), (2) renal transplant recipients (16%; 21/131), (3) mechanical complications (13.7%; 18/131), and (4) patient's preference (7.6%; 10/131) (►**Table 2**).

There was one incident of intraprocedural bleeding due to inferior epigastric artery injury resulting in pseudoaneurysm, which was managed by thrombin injection with successful subsequent catheter insertion. A total of 13 patients (9.9%) died during the follow-up period (four of them during the first year of insertion), and three patients (2.3%) were lost to follow-up.

Table 2 Causes of PD removal during the study period

	30 d	1 y	Overall
Peritonitis	1	11	28
Tunnel/exit site infection	0	3	4
Mechanical	2	11	18
Patient/team preference	4	10	10
Transplant	0	16	21
Total	7	51	81

Abbreviation: PD, peritoneal dialysis.

Discussion

Proper placement of PD catheter is the key to optimal function and maintenance of adequate dialysis. The International Society of Peritoneal Dialysis (ISPD) recommends an audit of catheter placement outcomes on annual basis. This retrospective study aims to audit the technical and clinical success and long-term outcomes of percutaneous PD catheter placement by interventional radiologists at a tertiary care center. The ISPD suggests several clinical goals to optimize PD care. These goals include catheter patency at 12 months of $> 95\%$ for advanced laparoscopic placement and $> 80\%$ for all other catheter insertion methods; exit-site/tunnel infection within 30 days of catheter insertion: $< 5\%$; peritonitis within 30 days of catheter insertion: $< 5\%$; visceral injury (bowel, bladder, solid organ): $< 1\%$; significant hemorrhage requiring transfusion or surgical intervention: $< 1\%$.[11]

In this cohort, the incidence of early peritonitis within 30 days postinsertion was 3.8%, which falls within the recommended threshold by ISPD. Most of our early peritonitis patients were managed medically, and the catheter was removed in only one case. Likewise, the incidence of significant hemorrhage was within acceptable limits proposed by the ISPD.

Although PD-related peritonitis was the most observed complication among this cohort, there was no identifiable technical risk factor such as insertion technique or mechanical complications. Proper catheter maintenance and adherence to hygiene precautions remain the key in prevention from peritonitis.

In this cohort, catheter malposition/migration was found to be the second leading cause of PD complications. Various observational studies propose that the incidence of malpositions/migrations and dwelling time of PD catheters are invariably linked with the patient's BMI.[12–15]

Similar tendency for a higher rate of malposition/migration with higher BMI is observed in this cohort (►**Fig. 1**).

Therefore, a high BMI > 28 is being suggested as a relative contraindication for PD insertion.[12,16–18] Sayer et al[14] have suggested placing a PD catheter in the upper abdomen with an extended catheter that might reduce the possibility of relocation[14] Other reported PD catheter complications from our sample included tunnel/exit site infection and catheter

dysfunction, which were less encountered and within the recommendation of ISPD.

In our cohort study, the PD catheter type was curl type. Hagen et al[19] conducted a systematic review and meta-analysis of 13 randomized controlled trials (RCTs) and concluded that the type and/or configurations of PD catheter does influence the survival of PD catheters. Despite no risk difference in outcome measures and complications between single versus double cuff catheters, only a small advantage in favor of PD catheters with a straight intraperitoneal segment versus coiled versus swan neck catheter.[19] Other previously reported contributing factors of PD catheter outcomes include the operator's expertise, previous PD insertion/s, previous abdominal surgery, and the circumferential abdominal volume.[20]

There are various means of PD catheter placements (e.g., percutaneous, laparoscopic, and open/surgical catheter placement), varying in their invasiveness, postoperative pain, and recovery time. Agarwal et al[21] conducted a meta-analysis to compare the rates of complications among surgical and percutaneous insertion methods. They meta-analyzed two RCTs and 20 observational studies that found percutaneous insertion had significantly lower incidences of early infectious complications compared to surgical option. Nevertheless, our study is limited by the small sample size, its retrospective nature, and the lack of comparison to other insertion methods such as laparoscopic or open surgical techniques.

Conclusion

Our facility-based audit shows that image-guided percutaneous insertion of PD catheters by vascular interventional radiologists achieves goals of catheter patency and function with complications rates that fall within the recommended thresholds proposed by the ISPD. Facilities that provide PD catheter placement are encouraged to effectively apply annual internal audits that monitor patient outcome indices to evaluate aggregate results and improve quality of care.

Ethical Approval and Consent to Participate

The article, in its entirety and detail, does not include disclosing the identity of individuals or information indicating them. This medical/educational report is intended to develop or contribute to generalizable knowledge and does not represent the development, testing. Given the purely descriptive and retrospective nature of the study, and in compliance with the Helsinki Declaration, informed consent was waived.

Availability of Data and Materials

The principal investigator is responsible for sharing the study-related data publicly upon reasonable request from the publishing journal.

Authors' Contributions

All authors conducted all aspects of this study and agree to be accountable for all aspects of the work that has been reported in the article.

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Conflict of Interest

None declared.

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