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Analysis of Peritoneal Dialysis Catheters Placed via Surgical Method: Single-Center Experience

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ABSTRACT

Objective: Peritoneal dialysis is a widely used renal replacement therapy for end-stage renal disease (ESRD). This study aims to evaluate the duration of use and complications associated with peritoneal dialysis catheters (PDC) placed using an open surgical method in a single-center experience.

Materials and Methods: This study included 127 ESRD patients who underwent PDC placement between 2018 and 2023. We analyzed the patients' clinical and demographic data, the reasons for transitioning to hemodialysis, and the complications leading to this transition. Patients with a body mass index (BMI) of 30 or higher were considered obese, and the impact of this condition on complications was specifically investigated. The PDC placement using the open surgical method was performed by the same surgical team.

Results: Of the 127 patients who had PDCs placed in the last five years, approximately 55.1% experienced various complications, leading to a transition to hemodialysis in 31 patients. Reasons for switching included catheter-related problems (35.4%), peritonitis (25.8%), ultrafiltration failure (19.3%), dialysis inadequacy (6.4%), and hernia (3.2%). No significant change in the overall risk of complications was observed in patients with a BMI of 30 or higher; however, a significant increase in the risk of peritonitis was noted in these patients.

Conclusion: The open surgical method is a preferred technique for PDC placement due to its ease of application and low complication rates. Notably, in patients with a BMI of 30 or higher, an increase in infection-related complications, such as peritonitis, was observed. Therefore, greater attention should be devoted to managing infection-related complications in the use of PDCs among obese patients.

Keywords: Peritoneal dialysis catheter, obesity, complications, renal disease, hemodialysis.

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INTRODUCTION

End-stage renal disease (ESRD) is increasingly prevalent worldwide.[1] Peritoneal dialysis (PD) has emerged as an effective renal replacement therapy for patients with ESRD, becoming the primary choice for many patients globally.[2] The success of PD implementation is closely linked to the proper placement and functionality of the peritoneal dialysis catheter (PDC). PDC placement can be performed surgically

or via the percutaneous method, available to nephrologists. The surgical placement procedure, which can be conducted under general or local anesthesia, is one of these options.[3]

Complications associated with catheter placement can hinder the widespread acceptance of this surgical method.[4] Furthermore, serious infections, along with complications like catheter malposition and obstruction, can significantly affect patient morbidity and mortality, while also escalating treatment costs.[5] Therefore, there is a need for more comprehensive data on both the short-term and long-term complications, as well as the duration of use of PDCs placed via the surgical method.

This study aims to provide a detailed analysis of both the short-term and long-term usage durations and complications associated with PDCs placed using the surgical method. It is intended to contribute to the improvement of treatment outcomes and the quality of life for patients.

MATERIALS AND METHODS

The study received approval from the Scientific Research Ethics Committee of Erciyes University (2023/448). Our university's nephrology clinic possesses significant expertise in PD. In this study, we retrospectively analyzed the data of 127 patients who underwent PDC insertion via open surgical methods in the past five years. Our study included patients who presented to our clinic between 2019 and 2023, underwent PDC insertion, and completed their follow-up and the PD process with us. Only patients who received PDC placement from the same surgical team were included. We excluded patients under the age of 18 and those whose follow-up was not conducted at our hospital.

We examined demographic data of the patients, including body mass index (BMI), duration of stay on PD, and routine hemogram and biochemical values before the surgical procedures for PDC placement. Furthermore, we conducted detailed investigations into the reasons for patients transitioning from peritoneal dialysis to hemodialysis and the complications associated with this transition. Patients with a BMI of 30 or higher were considered obese, and we retrospectively investigated whether this condition increased the risk of complications.

Data analysis was performed using the IBM Statistical Package for the Social Sciences (SPSS) Statistics 27.0 (Armonk, NY: IBM Corp.). Descriptive statistical methods, including frequency, percentage, mean, standard deviation, median, min-max, and Q1–Q3, were used to evaluate the study data. The Chi-square (χ^2) test was utilized for comparing qualitative data. The normality of the data was assessed using the Kolmogorov-Smirnov test, skewness-kurtosis measures, and graphical methods (histogram, Q-Q Plot, Stem and Leaf, Boxplot). For quantitative data showing a normal distribution, the Independent Samples t-test was used, while the Mann-Whitney U test was employed for non-normally distributed data. Logistic Regression (Binary Logistic Regression) was used to determine risk ratios. A significance level of α=0.05 was considered throughout the analysis.

The power analysis was conducted using the G*Power 3.1.9.7 statistical package, developed by Franz Faul at the University of Kiel, Germany. With sample sizes of n1=57 (mean: 3.9±0.8) and n2=87 (mean: 3.5±0.6), a significance level of α=0.05, and an effect size (d) of 0.56, the power was found to be 88%. This calculation was based on albumin values.

Within this data framework, analyses were performed on the short- and long-term use of PDCs inserted via surgical methods and the complications associated with these durations. The acquired data are expected to enhance clinical practices related to the surgical catheter placement procedure and the treatment processes for patients in the peritoneal dialysis field.

RESULTS

A total of 127 patients were included in our study. We compared patients with and without complications, considering their demographic and clinical characteristics; these data are presented in Table 1.

No significant difference was observed in the ages of patients with and without complications (56.0±16.3 and 57.2±14.8 years, respectively; p=0.663). Height, weight, BMI, and Peritoneal Equilibration Test (PET) results also showed no significant difference between the two groups.

Upon examining biochemical parameters, no significant differences were found in serum calcium, albumin, and uric acid levels (p>0.05). However, a statistically significant difference (p<0.05) was observed in the albumin and hemoglobin (Hgb) values between the groups when comparing complication statuses. In the Non-Complications patient group, values were higher in both instances where differences were detected (10.4±1.8 g/dL vs. 11.2±1.9 g/dL, p=0.026).

Although there was a difference in the duration of peritoneal dialysis between the groups with and without complications, this difference was not statistically significant (p=0.089). No significant differences in biochemical parameters were found between the two groups (p>0.05).

Regarding gender distribution, the group without complications had a higher percentage of male patients (71.9% vs. 60.0%); however, this difference was not statistically significant (p=0.111). In the group with complications, there were more obese patients, but again, this difference was not statistically significant (p=0.358).

Table 1. Demographic data and clinical characteristics of patients

	Mean±SD	%, Median (min–max)
Gender*		
Female	44	34.6
Male	83	65.4
Age (years) (n=127)**	56.7±15.5	59.0 (18.0–8.0)
Height (cm) (n=116)**	164.6±8.0	165.0 (144.0–186.0)
Weight (kg) (n=116)**	70.1±13.2	69.0 (37.0–97.5)
Obesity*		
No	96	75.6
Yes	20	15.7
PD Time (months) (n=127)**	14.5±15.0	9.0 (0.0–59.0)
Transition to hemodialysis*		
Not passing	96	75.6
Continue	60	62.5
Death	18	18.8
Transfer	10	10.4
Transplantation	8	8.3
Passing	31	24.4
Catheter-related	11	35.5
Peritonitis	8	25.8
UF insufficiency	6	19.4
Social	3	9.7
Dialysis failure	2	6.5
Hernia	1	3.2
Urine (n=125)**	1323.6±963.9	1000.0 (0.0–4.200.0)
KTV (n=87)**	4.2±17.7	2.2 (0.0–167.0)
CCL (n=86)**	90.5±38.0	85.0 (43.0–261.9)
PET (n=87)**	0.7±0.10.7 (0.3–1.0)	
Bun (n=119)**	61.4±23.5	58.0 (18.0–153.0)
Creatinine (n=120)**	5.5±3.1	4.7 (1.4–19.4)
Calcium (mg/dL) (n=120)**	8.6±1.1	8.7 (4.5–12.6)
Phosphate (n=120)**	4.8±1.8	4.5 (0.0–13.0)
Calcium* phosphate (n=120)**	41.5±13.1	39.5 (20.0–114.4)
Parathormone (n=113)**	251.8±238.4	195.0 (0.0–1293.0)
Total protein (n=120)**	6.6±1.3	6.8 (0.0–10.8)
Albumin (g/dL) (n=122)**	3.7±1.0	3.8 (0.0–6.2)
Uric acid (mg/dL) (n=122)**	6.9±2.3	6.8 (0.0–13.0)
Hemoglobin (g/dL) (n=119)**	10.7±1.9	10.0 (6.0–17.0)
C-reactive protein (n=118)**	22.8±37.1	9.0 (0.0–240.0)
Complications*		
No 57	44.9	
Yes 70	55.1	
Peritonitis	34	26.8
Exit site infection	14	11.0
Omental wrapping	2	1.6
Malposition	14	11.0
Cuff problems	15	11.8
Leakage	8	6.3
Hernia	25	19.7

*: n/%; **: Mean±Standard deviation/median (minimum–maximum); CCL: Comparison of creatinine clearance; KTV: Dialyzer clearance of urea, dialysis time, volume of distribution of urea; PD: Peritoneal dialysis; PET: Peritoneal equilibration test; UF: Ultrafiltration.

In our study, we determined that 31 out of 127 patients transitioned from PD to hemodialysis (HD) due to catheter-related complications. The reasons for this transition are summarized in Table 2.

Additionally, peritonitis developed in 25.8% of the patients, significantly contributing to the transition to HD. This underscores the importance of infection control during the peritoneal dialysis process.

Other reasons for transitioning to HD included inadequate ultrafiltration (UF) (19.3%), social factors (9.6%), dialysis inadequacy (6.4%), and hernia (3.2%).

Throughout the study, various complications were observed in approximately half of the 127 patients undergoing PD treatment, with 70 patients (55.1%) experiencing complications. Multiple complications occurred in 23 of these 70 patients, bringing the total number of complications to 112. These complications are detailed in Table 3.

The most frequently encountered complication among them was peritonitis (30.3%). Exit site infections and malpositions, each accounting for 14%, were also significant among the complications. This underscores the critical importance of proper catheter placement and care for the success of PD treatment.

Cuff problems were observed in 13.3% of the patients, and leaks were noted in 7.1%. Additionally, 22.3% of the complications developed in patients were hernias.

This study also analyzed the potential impact of obesity on complications associated with PD, with findings presented in Table 4. In comparisons made according to obesity status, it was found that there was a statistically significant gender difference ($p<0.05$), with a higher rate of females in the obese patient group. Notably, while obesity may not significantly affect the overall risk of complications (odds ratio [OR]=1.3, p=0.534 univariate; OR=0.3, p=0.278 multivariate), it significantly impacts specific complications.

For instance, a significant relationship between obesity and peritonitis has been observed in both univariate (OR=3.4, p=0.015) and multivariate (OR=5.9, p=0.027) regression analyses. These findings suggest that obesity significantly increases the risk of peritonitis, potentially being an important factor in transitioning to hemodialysis.

The risk of other complications such as leakage (OR=3.1, p=0.141 univariate; OR=2.5, p=0.375 multivariate), malposition (OR=1.3, p=0.684 univariate; OR=1.4, p=0.717 multivariate), and hernia (OR=1.1, p=0.818 univariate; OR=0.9, p=0.943 multivariate) has not been significantly increased by obesity.

DISCUSSION

Peritoneal dialysis is considered a cost-effective, lifestyle-compatible, and globally effective renal replacement therapy compared to hemodialysis.[6] This holds true in our country as well, where peritoneal dialysis has been increasingly preferred in recent years. According to data from the Turkish Nephrology Society, out of 12,661 patients who began renal replacement therapy in 2021, 1,269 (10.02%) opted for peritoneal dialysis. The prevalence of peritoneal dialysis among the 84,128 patients is reported to be 4.06%.[7]

Various methods are used for the placement of PDC, including open surgical, percutaneous, and laparoscopic methods. A review of the literature reveals no significant difference in complication rates among these application methods.[3] The complication rates observed with the open surgical method preferred in our clinic also align with these general findings.

Currently, there is no consensus on the optimal approach for PDC insertion, leading to unclear and inconsistent clinical guidelines. Published guidelines from the Renal Association, European Best Practice Guidelines for Peritoneal Dialysis (PD), and others discuss the functionality of PDC and post-insertion complication thresholds.[8–10] However, a thorough assessment of their validity is yet to be conducted. The current guidelines from the Renal Association recommend timely surgical evaluation to facilitate PD access[8,10] but stop short of endorsing a specific technique due to insufficient evidence supporting the superiority of different approaches. Patients with a history of complicated abdominal surgery are advised to undergo surgery under direct vision, although this recommendation lacks robust supporting data. Additionally, some research supports the superiority of the laparoscopic method.[11,12] European guidelines highlight the difficulty of generalizing the best procedure for PDC placement, stating that center expertise should determine the most suitable method without recommending any particular one.[9] For these reasons, it is considered essential and crucial to share the outcomes of PD insertion techniques from centers that have a considerable history of monitoring patients and performing PDC insertions.

In our study, 35.4% of patients transitioning to hemodialysis cited catheter-related complications as their primary reason for the switch. Among these complications, peritonitis was the most frequently encountered, affecting 30.3% of patients. This is consistent with previous studies that identify catheter complications as the most common reason for patients transitioning from PD to HD.[13,14] These findings underscore the critical importance of proper placement and care of the PDC for successful treatment.[15]

Cuff problems were observed in 13.3% of patients, leaks in 7.1%, and hernias constituted 22.3% of the complications.

Table 2. Comparisons based on complication status

	Non-complications (n=57)	Complications (n=70)	p
Gender			
Female	16 (28.1%)	28 (40.0%)	0.223[a]
Male	41 (71.9%)	42 (60.0%)	
Age (years)	56.0±16.3	57.2±14.9	0.663[b]
Height (cm)	166.1±8.2	163.5±7.8	0.090[b]
Weight (kg)	70.2±13.1	70.1±13.3	0.977[b]
Obesity			
No	42 (73.7%)	54 (77.1%)	0.637[a]
Yes	7 (12.3%)	13 (18.6%)	
PD time (months)	12.0±13.8	16.6±15.8	0.089[b]
Transition to hemodialysis			
Not passing	46 (80.7%)	50 (71.4%)	0.316[a]
Continue	30 (65.2%)	30 (60.0%)	
Death	7 (15.2%)	11 (22.0%)	
Transfer	4 (8.7%)	6 (12.0%)	
Transplantation	5 (10.9%)	3 (6.0%)	
Passing	11 (19.3%)	20 (28.6%)	
Catheter-related	1 (9.1%)	10 (50.0%)	
Peritonitis	3 (27.3%)	5 (25.0%)	
UF insufficiency	4 (36.4%)	2 (10.0%)	
Social	2 (18.2%)	1 (5.0%)	
Dialysis failure	1 (9.1%)	1 (5.0%)	
Hernia	0 (0.0%)	1 (5.0%)	
Urine	1304.5±1020.8	1339.1±922.5	0.842[b]
KTV	2.3 (1.8–2.6)	2.2 (1.8–2.6)	0.823[c]
CCL	82.0 (58.2–106.0)	85.0 (66.0–103.0)	0.517[c]
PET	0.7 (0.6–0.7)	0.7 (0.6–0.8)	0.087[c]
BUN	62.5±25.5	60.5±21.9	0.653[b]
Creatinine	5.0 (3.7–6.1)	4.6 (3.1–7.1)	0.449[c]
Calcium (mg/dL)	8.7 (8.4–9.2)	8.6 (8.1–9.0)	0.204[c]
Phosphate	4.7 (3.8–5.4)	4.4 (3.7–5.5)	0.710[c]
Calcium* phosphate	40.0 (34.8–47.3)	38.5 (31.8–45.0)	0.360[c]
Parathormone	226.0 (88.5–309.0)	183.5 (98.5–356.0)	0.873[c]
Total protein	7.1 (6.2–7.6)	6.8 (5.9–7.2)	0.112[c]
Albumin (g/dL)	4.0 (3.5–4.4)	3.7 (3.2–4.2)	**0.023**[b]
Uric acid (mg/dL)	7.1±2.2	6.7±2.3	0.429[b]
Hemoglobin	11.2±1.9	10.4±1.8	**0.026**[b]
C-reactive protein	8.5 (2.0-27.3)	9.5 (2.8-29.8)	0.678[c]

a: Chi-Square Test (n (%)); b: Independent Samples t-Test (Mean±SD); c: Mann-Whitney U test (Median (Q1–Q3)); CCL: Comparison of creatinine clearance; KTV: Dialyzer clearance of urea, dialysis time, volume of distribution of urea; PET: Peritoneal Equilibration Test; UF: Ultrafiltration.

Table 3. Percentage of complications developed among patients

Complication	n=112
Peritonitis	34 (30.3%)
Exit Site Infection	14 (12.5%)
Omental Wrapping	2 (1.7%)
Malposition	14 (12.5%)
Cuff Problems	15 (13.3%)
Leakage	8 (7.1%)
Hernia	25 (22.3%)

These statistics reflect the potential complications associated with PDC placement and the prevalence of these issues. Understanding the rate of each complication can help in better grasping the risks in clinical practice within this field and in devising strategies to manage these risks.

Obesity is an escalating global public health issue.[16] Recent studies have shown that obesity not only leads to metabolic diseases but also to Sleep-Disordered Breathing (SDB).[17] Although the exact mechanisms by which obesity causes kidney disease are not fully understood, inflammation, glomerular hyperfiltration, and lipotoxicity are thought to be significant factors.[18] Beyond the increased risk of SDB in obese individuals, there is ongoing debate about the most suitable dialysis treatment for these patients.[17] When evaluating treatment options for obese individuals, comparing HD and PD, the literature highlights potential advantages of PD in this population due to the anatomical and physiological challenges posed by obesity.[19] PD may offer benefits for obese patients with difficult vascular access and a higher risk of vascular complications.[20] Moreover, the flexibility and freedom associated with PD can significantly enhance the quality of life.[21] However, alterations in the surface area of the peritoneal membrane and other factors could impact PD's effectiveness.[22] Despite these potential advantages, there are concerns in the literature about PD's use in obese individuals. Specifically, studies have indicated a higher technical failure rate of PD in obese patients, which could increase the likelihood of transitioning to HD.[20] Additionally, there is heightened concern regarding the elevated risk of infection associated with PD in this demographic.[20] In our study, focusing on complications encountered, we found that peritonitis was the most common issue leading to PD discontinuation. This aligns with the wider consensus that peritonitis is the most common complication linked with PD, prompting a switch to HD.[23] Our research revealed a significantly higher rate of complications, especially peritonitis, in patients with a BMI of 30 or above. By paying closer attention to infection-related complications like peritonitis in these patients, the duration of PDC use may be extended.

Table 4. Analysis of complications in patients by obesity status

	Obesity		p
	(-) (n=96)	(+) (n=20)	
Gender			
Female	27 (28.1%)	14 (70.0%)	**0.001**[a]
Male	69 (71.9%)	6 (30.0%)	
Age (years)	56.8±16.3	57.2±8.8	0.878[b]
PD time (months)	15.1±15.0	17.5±17.1	0.529[b]
Complications			
Non-complications	42 (43.8%)	7 (35.0%)	0.637[a]
Complications	54 (56.3%)	13 (65.0%)	
Peritonitis	22 (40.7%)	10 (76.9%)	**0.029**[a]
Exit site infection	14 (25.9%)	0 (0.0%)	0.124[a]
Omental wrapping	1 (1.9%)	0 (0.0%)	1.000[a]
Malposition	11 (20.4%)	3 (23.1%)	0.707[a]
Cuff problems	14 (25.9%)	1 (7.7%)	0.463[a]
Leakage	5 (9.3%)	3 (23.1%)	0.139[a]
Hernia	21 (38.9%)	4 (30.8%)	1.000[a]

a: Chi-Square Test (n (%)), b: Independent Samples t-Test (Mean±SD), c: Mann-Whitney U test (Median (Q1–Q3)), PD: Peritoneal dialysis.

CONCLUSION

The insertion of a PDC is regarded as a relatively straightforward surgical procedure. Its advantages, including short placement time, low risk of complications, and simplicity, have made the open surgical method the preferred approach in our clinic. The literature suggests that obesity can elevate the risk of complications across all surgical procedures, even in the absence of other risk factors.[24] In our experience, despite no significant variance in complication rates attributable to surgical technique for PDCs inserted by our skilled surgical team, unavoidable complications such as peritonitis were notably more common among obese patients. Given the scarcity of studies in the literature that compare PDC complications in the context of obesity, this study offers a unique contribution.

Ethics Committee Approval: The Erciyes University Scientific Research Ethics Committee granted approval for this study (date: 12.07.2023, number: 2023/448).

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