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Frequency, Microbiological and Clinical Analysis of Peritonitis Episodes in Patients Undergoing Continuous Ambulatory Peritoneal Dialysis: A Five-Year Retrospective Single-Center Experience

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Abstract

Objective: This study aimed to assess the frequency, microbiological profile, and clinical outcomes of peritonitis in patients receiving Continuous Ambulatory Peritoneal Dialysis (CAPD).

Methods: This retrospective, cross-sectional study included 52 adult PD patients followed at a tertiary hospital between January 2020 and December 2024. The diagnosis of peritonitis was based on cloudy dialysate, abdominal pain, fever, a dialysate leukocyte count >100 cells/mm^3, and a polymorphonuclear cell ratio ≥50%. Microbiological culture results, laboratory findings, and clinical outcomes were analyzed.

Results: Among the 52 CAPD patients included in the study, the mean age was 39.96 ± 17.91 years, with an equal gender distribution of 50% female and 50% male. The peritonitis rate was 34.6% (n=18), with 12 patients experiencing their first episode. All peritonitis cases were bacterial in origin, with two cases showing concomitant fungal coinfection. Microbiological cultures were positive in three patients, revealing Staphylococcus hemolyticus, coagulase-negative Staphylococcus, and Pseudomonas aeruginosa. The mean duration of peritoneal dialysis was 42.85 ± 25.97 months. Residual urine output was preserved in 65.4% (n=34) of patients. Diabetes mellitus was the most common cause of chronic kidney disease (38.5%), followed by hypertension (23.1%). Patients with peritonitis exhibited lower mean serum albumin (2.99 ± 0.90 g/L) and hemoglobin levels (9.75 ± 2.00 g/dL), while inflammatory markers procalcitonin (2.21 ± 3.41 µg/L) and ferritin (490.61 ± 473.26 µg/L) were elevated. The overall mortality rate was low at 3.8% (n=2), and 96.2% of patients (n=50) were discharged.

Conclusion: Peritonitis occurred in 34.6% of patients undergoing Continuous Ambulatory Peritoneal Dialysis (CAPD), predominantly of bacterial origin. Patients with peritonitis exhibited decreased serum albumin and hemoglobin levels, while inflammatory markers such as procalcitonin and ferritin were elevated. Although mortality was low, systemic effects related to infection were observed. These findings emphasize the importance of early diagnosis and infection control in CAPD patients.

Keywords: Peritoneal dialysis, peritonitis, CAPD, infection, clinical outcomes.

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Sürekli Ayaktan Periton Diyalizi Hastalarında Peritonit Ataklarının Sıklığı ile Mikrobiyolojik ve Klinik Analizi: Beş Yıllık Retrospektif Tek Merkez Deneyimi

Öz

Giriş: Peritonit, periton diyalizinin (PD) önemli bir komplikasyonu olup hastaneye yatış, tedavi maliyetlerinde artış ve uzun dönemde periton membran hasarına yol açabilmektedir. Bu çalışmada, Sürekli Ayaktan Periton Diyalizi (SAPD) uygulanan hastalarda peritonit sıklığı ve klinik sonuçlarının değerlendirilmesi amaçlanmıştır.

Yöntemler: Bu retrospektif, kesitsel çalışmaya Ocak 2020-Aralık 2024 tarihleri arasında üçüncü basamak bir hastanede takip edilen 52 erişkin PD hastası (%50 kadın, ortalama yaş 39,96 ± 17,91 yıl) dahil edildi. Peritonit tanısı bulanık diyalizat, karın ağrısı, ateş ve diyalizat sıvısında lökosit sayısının >100 hücre/mm^3 ve polimorfonükleer hücre oranının ≥%50 olması kriterlerine dayandırıldı. Mikrobiyolojik kültür sonuçları, laboratuvar bulguları ve klinik sonuçlar incelendi.

Bulgular: Çalışmaya dahil edilen 52 CAPD hastasının yaş ortalaması 39,96 ± 17,91 yıl olup, cinsiyet dağılımı %50 kadın ve %50 erkek olarak eşit dağıldı. Peritonit oranı %34,6 (n=18) olarak belirlendi ve 12 hasta ilk peritonit atağını yaşadı. Tüm peritonit vakaları bakteriyel kökenli olup, iki hastada eşlik eden mantar enfeksiyonu görüldü. Mikrobiyolojik kültürlerde üç hastada pozitif sonuç elde edildi; bu mikroorganizmalar Staphylococcus hemolyticus, koagülaz negatif Staphylococcus ve Pseudomonas aeruginosa idi. Ortalama periton diyaliz süresi 42,85 ± 25,97 ay olarak bulundu. Hastaların %65,4'ünde (n=34) rezidüel idrar çıkışı mevcuttu. Kronik böbrek hastalığının en sık nedeni diyabet (%38,5), bunu hipertansiyon (%23,1) takip etti. Peritonitli hastalarda serum albümin (2,99 ± 0,90 g/L) ve hemoglobin (9,75 ± 2,00 g/dL) düzeyleri düşüktü; inflamatuar belirteçler prokalsitonin (2,21 ± 3,41 µg/L) ve ferritin (490,61 ± 473,26 µg/L) ise yükselmişti. Genel mortalite oranı %3,8 (n=2) düşük bulundu ve hastaların %96,2'si (n=50) taburcu edildi.

Sonuç: Sürekli Ayaktan Periton Diyalizi (SAPD) uygulanan hastaların %34,6'sında peritonit görülmüş olup, vakaların çoğu bakteriyel kökenlidir. Peritonitli hastalarda serum albümin ve hemoglobin seviyeleri azalmış, prokalsitonin ve ferritin gibi inflamatuar belirteçler yükselmiştir. Mortalite düşük olmakla birlikte, enfeksiyona bağlı sistemik etkiler gözlenmiştir. Bu bulgular, SAPD hastalarında peritonitin erken tanısı ve enfeksiyon kontrolünün önemini vurgulamaktadır.

Anahtar kelimeler: Periton diyalizi, peritonit, SAPD, enfeksiyon, klinik sonuçlar.

INTRODUCTION

In recent years, the increasing prevalence of diabetes, hypertension, obesity, and metabolic syndrome has led to a significant rise in the incidence of CKD[1]. This trend has further highlighted the importance of renal replacement therapies for patients with kidney failure.

Peritoneal dialysis (PD) stands out as a more feasible treatment option compared to hemodialysis (HD), particularly because it can be performed at home. PD offers several advantages, including independence from treatment centers, suitability for patients with peripheral vascular issues, continuous treatment capability, and better preservation of residual kidney function[2-3]. Continuous Ambulatory Peritoneal Dialysis (CAPD), in particular, is considered an effective method due to its low cost and ease of application[4].

However, despite these advantages, PD treatment may be discontinued due to technical failures, recurrent or persistent peritonitis episodes, ultrafiltration failure, or inadequate dialysis. Among these, catheter exit-site infections are one of the leading causes of withdrawal from PD therapy[5]. Despite advances in diagnosis and treatment, PD-related infections remain a common and serious complication of peritoneal dialysis[6]. Peritonitis can lead to hospitalizations, increased treatment costs, and long-term structural and functional damage to the peritoneal membrane[7]. This condition may result in temporary loss of ultrafiltration, permanent membrane damage, catheter loss, transition to hemodialysis, and even death. Therefore, identifying the causative agent of peritonitis is crucial for guiding treatment[8].

In less economically developed areas—such as Mexico—PD has become the primary renal replacement therapy due to high costs and limited access to hemodialysis units (prevalence of 75%)[9]. In the U.S., the peritonitis rate among PD patients in the first year is 42%, whereas in Turkey, this rate was reported as 59% according to 2018 data[10]. In Turkey, 15-35% of PD patients are hospitalized due to peritonitis, and the likelihood of experiencing at least one peritonitis episode within the first six months of CAPD treatment is 45%, rising to 60-70% in the first year. Additionally, the recurrence rate of peritonitis within the first year after CAPD treatment ranges between 20% and 30%[11]. Although a decline in the number of PD-treated patients was observed globally and in Turkey in 2018, the number of patients receiving this treatment in Turkey was recorded as 3,192 (3.94%)[11]. Peritonitis episodes during CAPD treatment account for 1-6% of patient deaths[4].

We aimed to analyze the frequency, microbiological characteristics, and clinical outcomes of peritonitis among patients receiving Continuous Ambulatory Peritoneal Dialysis.

METHODS

The study was approved by the Ethics Committee of Gazi Yaşargil training and research Hospital with approval number 395 on March 28, 2025.

This research is a descriptive, cross-sectional study. The medical records of all patients (n=52) aged 18 and above who were diagnosed with peritonitis episodes associated with Continuous Ambulatory Peritoneal Dialysis (CAPD) and followed up/treated in the peritoneal dialysis unit of a tertiary-level training and research hospital between January 1, 2020, and December 31, 2024, were retrospectively reviewed. Prior to the study, ethical committee approval and institutional permission were obtained in accordance with the Helsinki Declaration.

The diagnosis of peritonitis was made based on the presence of at least two of the following findings: cloudy dialysis fluid, symptoms associated with peritonitis (such as abdominal pain and high fever), and a cell count in the dialysis fluid of ≥100 cells/mm^3 with polymorphonuclear cells (PMN) accounting for more than 50% of the total cells9. A 50 cc peritoneal fluid sample was collected from the patients and analyzed by a microbiology specialist in the microbiology laboratory. The peritoneal fluid was directly inoculated onto solid culture media [blood agar, Eosin Methylene Blue (EMB), and Sabouraud Dextrose Agar (SDA)]. Subsequently, blood agar and EMB media were incubated at 37°C for 48 hours, while SDA was incubated for seven days. An automated blood culture system (BACTEC 9050) was used for blood cultures.

In the study, patients demographic characteristics (age, sex, education level, marital status, place of residence), clinical findings (physical examination, fever, inflammation at the catheter exit site, abdominal tenderness, nasal and catheter exit site culture results, and whether dialysis catheters were removed following peritonitis episodes), and laboratory results were examined. Additionally, parameters such as underlying chronic diseases at the time of admission, type of peritoneal catheter, peritoneal dialysis solution used and its type, total duration of CAPD treatment, and number of peritonitis episodes were evaluated.

Tests performed at the time of admission included complete blood count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), biochemical parameters [blood urea nitrogen (BUN), creatinine (Cr), calcium, phosphorus, albumin, HDL, LDL, triglycerides], and microbiological culture results. Hemogram levels were measured using the Sysmex XN-1000 device, while biochemical tests were analyzed using the Beckman Coulter AU 5800 device.

Patients included in the study were those who were 18 years or older at the start of peritoneal dialysis (PD) treatment and had received PD therapy for at least three months. Patients who did not meet these criteria were excluded. The study was designed to evaluate peritonitis episodes and associated factors.

RESULTS

Among the 52 peritoneal dialysis patients included in the study, 50% were female, and the mean age of all participants was 39.96 ± 17.91 (minimum 18, maximum 77). The peritonitis rate was 34.6% (n=18), with 12 of these patients experiencing their first peritonitis episode. All patients who had peritonitis (n=18) had bacterial infections, two of which were both fungal and bacterial in origin. Peritoneal fluid culture results from peritonitis patients showed growth in 3 cases: Staphylococcus hemolyticus in one patient, coagulase-negative Staphylococcus in another, and Pseudomonas aeruginosa in the third.

The mean duration of peritoneal dialysis was 42.85 ± 25.97 months (minimum 5, maximum 108). Residual urine output was present in 65.4% (n=34) of the patients. Diabetes mellitus was the most common cause of chronic kidney disease (38.5%), followed by hypertension (23.1%). Approximately two-thirds of patients had preserved residual urine output. The overall mortality rate was low (3.8%), and the majority of patients were discharged (96.2%) (Table 1).

Table I: Descriptive characteristics and clinical outcomes of CAPD patients

	n	%
Gender		
Male	26	50.0
Female	26	50.0
Number of peritonitis episodes		
0	34	65.4
1	12	23.1
2	4	7.7
3	2	3.8
Cause of chronic renal failure		
Diabetes mellitus (DM)	20	38.5
Hypertension (HT)	12	23.1
Nephrotic syndrome	6	11.5
Other *	14	26.9
Residual urine		
Yes	34	65.4
No	18	34.6
Clinical outcomes		
Death	2	3.8
Discharge	50	96.2
Total	**52**	**100.0**

**Polycystic kidney disease (4), DM + HT (3), Renovascular HT (2), VUR (2), Neurogenic bladder (1), Nephrolithiasis (1), Alport syndrome (1).*

When stratified by peritonitis status, there were no notable differences in age or sex distribution between groups. The rates of diabetes (44.4%), hypoalbuminemia (61.1%), and hypophosphatemia (16.7%) in patients with peritonitis were similar to those without peritonitis (38.2%, 55.9%, and 14.7%, respectively). Mortality was low in both groups (5.6% vs. 2.9%), and most patients were discharged (94.4% vs. 97.1%). The distribution of chronic kidney disease etiology was also comparable across groups, although diabetes and nephrotic syndrome were slightly more common in the peritonitis group, while hypertension was more frequently observed in those without peritonitis (Table 2).

Table II: Distribution of risk factors and clinical outcomes according to peritonitis status in CAPD patients

	Peritonitis (+) n(%) (n=18)	Peritonitis (-) n(%) (n=34)
Age (mean±SD)	36.33±15.44	41.88±19.03
Gender n(%)		
Female	9(50.0)	17(50.0)
Male	9(50.0)	17(50.0)
Diabetes mellitus (DM)		
Yes	13(38.2)	8(44.4)
No	21(61.8)	10(55.6)
Hypoalbuminemia (< 3.5 g/L)		
Yes	19(55.9)	11(61.1)
No	15(44.1)	7(38.9)
Hypophosphatemia (< 3.5 mg/L)		
Yes	5(14.7)	3(16.7)
No	29(85.3)	15(83.3)
Causes of chronic renal failure n(%)		
Diabetes mellitus (DM)	8(44.4)	12(35.3)
Hypertension (HT)	2(11.1)	10(29.4)
Nephrotic syndrome	3(16.7)	3(8.8)
Polycystic kidney disease	2(11.1)	2(5.9)
DM+HT	-	1(2.9)
Renovascular HT	1(5.6)	1(2.9)
Vesicoureteral reflux (VUR)	1(5.6)	3(8.8)
Neurogenic bladder	-	1(2.9)
Nephrolithiasis	1(5.6)	-
Alport Syndrome	-	1(2.9)
Clinical outcomes		
Death	1(5.6)	1(2.9)
Discharge	17(94.4)	33(97.1)

In laboratory analyses, patients with peritonitis had lower mean serum albumin (2.99 g/L) and hemoglobin (9.75 g/dL) levels compared to those without peritonitis. In contrast, procalcitonin (2.21 µg/L) and ferritin (490.61 µg/L) levels were markedly higher in the peritonitis-positive group. Other laboratory parameters did not show notable differences between groups. These findings suggest that hypoalbuminemia and anemia, along with elevated inflammatory markers such as procalcitonin and ferritin, were more prominent among patients with peritonitis (Table 3).

Table III: Laboratory results of peritoneal dialysis patients

	Total (n=52) (mean ± standard deviation)	Peritonitis (+) (n=18) (mean ± standard deviation)	Peritonitis (-) (n=34) (mean ± standard deviation)	Reference Range
Urea (mg/dL)	104.69±39.84	95.06±31.82	109.79±43.06	19-44
Creatinine (mg/dL)	8.26±2.97	7.83±2.61	8.49±3.15	0.67-1.17
Calcium(mg/dL)	9.05±0.85	9.28±0.72	8.93±0.89	8.8-10.6
Phosphorus (mg/dL)	4.76±1.31	4.67±1.36	4.80±1.30	3.5-5
Albumin (g/L)	3.19±0.61	2.99±0.90	3.18±0.60	3.5-5
HDL(mg/dL)	38.33±12.00	40.33±14.14	37.26±10.80	40-50
LDL(mg/dL)	99.25±42.15	89.89±38.48	104.21±43.70	0-130
Triglyceride(mg/dL)	169,08±99,15	159,83±70,90	173.97±112.20	0-200
WBC10^3 (u/L)	8.96±4.66	9.87±6.71	8.47±3.12	3.7-10.1
Hemoglobin (g/dL)	10.20±1.78	9.75±2.00	10.43±1.63	12.9-14.2
Platelet (10^3 u/L)	248.25±64.28	226.61±65.05	259.71±61.80	155-366
Procalcitonin (µg/L)	1.39±2.61	2.21±3.41	0.95±1.98	0-0,05
Ferritin ug/L	374.69±443.59	490.61±473.26	313.32±421.32	22-322

DISCUSSION

In this study, the frequency of peritonitis associated with Continuous Ambulatory Peritoneal Dialysis (CAPD) and its clinical outcomes were evaluated. According to the Turkish Nephrology Association (TND) 2021 year-end data, the most common etiology in patients undergoing peritoneal dialysis (PD) is hypertension (HT), followed by diabetes mellitus (DM), idiopathic causes, glomerulonephritis, polycystic kidney disease (PKD), obstructive uropathy, amyloidosis, renovascular disease, and tubulointerstitial nephritis[12]. However, in our study, the most common cause was found to be DM, which differs from the literature.

Consistent with the study by Htay H et al., we observed elevated procalcitonin and ferritin levels in patients experiencing peritonitis[13].

The majority of peritonitis cases are of bacterial origin. Gram-positive microorganisms were identified as the causative agent in 45-65% of cases, while gram-negative microorganisms were detected in 15-35%[14-15]. Among gram-positive pathogens, coagulase-negative staphylococci were the most common. In the study by Engin et al., Pseudomonas aeruginosa was detected in one patient, which is consistent with our findings[16].

Fungal peritonitis cases vary between centers, occurring in 1-15% of cases[17]. In the study by Fang et al., fungal peritonitis was detected in 11 out of 124 peritonitis patients (8.87%), a rate similar to our study[18]. In the study by Vidimliski et al., fungal peritonitis was found in 3 out of 54 patients (1.9%)[19].

In the study by Engin et al., 18 out of 33 patients (55%) experienced their first peritonitis episode. In our study, 11 out of 17 patients

(64%) with peritonitis had their first episode. In the study by Vidimliski et al., 24 out of 54 peritonitis patients (44.4%) had their first episode[19]. These findings indicate differences in the frequency and recurrence rates of peritonitis episodes among centers.

According to TND 2021 year-end data, peritonitis cases were observed in 52.59% female and 47.41% male patients[13]. In our study, the gender distribution was equal, with peritonitis detected in 50% male and 50% female patients. According to TND 2021 data, among 3,417 PD patients in Turkey, 64.88% were on CAPD, while 34.12% were on automated peritoneal dialysis (APD)13. In our study, the distribution of treatment modalities was similarly in favor of CAPD. APD is considered a more advantageous treatment modality than CAPD in terms of peritonitis frequency[20].

Culture-negative peritonitis rates vary across studies. In the study by Nardelli et al., this rate was 25%[21], while in the study by Öztürk et al., it was 36.7%[22]. In our study, it was found to be 59%. This high rate may be attributed to recent antibiotic exposure, inadequate sample collection, or insufficient culture techniques.

In the study by Çeltik et al. involving 34 patients, residual renal function loss was detected in 29.4% of patients after an average of 22.1±9.8 months following PD initiation[23]. This finding is consistent with our study. Additionally, lower peritonitis rates have been reported in larger centers and those with higher PD utilization[24,25].

In the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS), the peritonitis episodes per patient-year in participating countries were as follows: Thailand (40%), the United Kingdom (38%), Australia (35%), Canada (29%), Japan (27%), and the United States (26%)[25]. A multicenter study in Scotland found that 42.6% of PD patients were transferred to hemodialysis (HD) due to refractory or recurrent peritonitis, demonstrating a significant correlation between peritonitis and technical failure[26].

For successful treatment of peritonitis, rapid clinical diagnosis and early initiation of antibiotic therapy are critical. The International Society for Peritoneal Dialysis (ISPD) guidelines recommend initial empirical antibiotic therapy covering both gram-positive and gram-negative organisms, with subsequent adjustment based on antibiotic susceptibility9. Patients presenting with cloudy dialysate should be presumed to have peritonitis and treated accordingly until the diagnosis is confirmed or ruled out.

Our study has some limitations, including a small sample size, single-center design, and retrospective nature, which may affect the generalizability of the results. Additionally, the low rate of positive microbiological cultures may have been influenced by prior antibiotic use or sample processing conditions. Future prospective, multicenter studies with larger patient cohorts are recommended to validate these results and to investigate interventions aimed at reducing the incidence of peritonitis.

CONCLUSION

This study demonstrated that peritonitis episodes occurred in 34.6% of patients undergoing Continuous Ambulatory Peritoneal Dialysis (CAPD), with the majority of cases being bacterial in origin and some accompanied by fungal infections. Patients with peritonitis showed decreased serum albumin and hemoglobin levels, alongside increased inflammatory markers such as procalcitonin and ferritin. Although mortality rates were generally low, systemic effects related to infection were evident in peritonitis patients. These findings underscore the importance of early diagnosis of peritonitis in CAPD patients and highlight the need for the development of preventive strategies aimed at infection control.

Ethics Committee Approval: The study was approved by the Ethics Committee of Gazi Yaşargil training and research Hospital with approval number 395 on March 28, 2025.

Conflict of Interest: The authors declared no conflicts of interest.

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