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Predictive factors for Peritoneal Dialysis Catheter Survival: a ten-year single center study

(Facteurs prédictifs de la survie des cathéters de dialyse péritonéale : une étude monocentrique sur dix ans)

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Summary

Introduction and Objectives: Timely insertion and adequate management of peritoneal dialysis catheter (PDC) related complications are crucial for the success of Peritoneal Dialysis. The aim of this study was to review the peritoneal dialysis catheter outcomes at our center, identifying factors that influence catheter survival.

Materials and Methods: A retrospective study was conducted on 146 PD patients who received their first PDC between August/2012 and July/2022. The mean follow-up was 26.5 ± 22.7 months.

Results: Mean age was 55.1 ± 16.6 years, and 58.2% were male. Peritonitis occurred in 75 patients (51.4%), with 26 (34.7%) requiring catheter removal. Mechanical complications were observed in 66 patients (45.2%), with 16 requiring catheter removal. Catheter survival at 12, 24, and 36 months was 80.2%, 72.4%, and 61.6%, respectively. Non-infectious complications (p=0.006) and peritonitis episodes (p=0.017) were associated with higher rate of PDC-associated removal. In the multivariate analysis, non-infectious complications were the only independent variable significantly associated with catheter survival (Hazard ratio 2.53; 95% CI 1.383–4.624). No association was found between PDC survival and age, diabetic status, obesity, prior kidney transplant, previous abdominal surgery, or method of catheter insertion.

Conclusions: Despite the significant number of infectious complications, including peritonitis, these did not result in a substantial decrease in catheter survival in the multivariate analysis. These findings emphasize the importance of effectively managing non-infectious complications to ensure successful and long-term use of PDCs. Preventive measures, such as omentectomy simultaneously with PDC implantation, may be considered on a case-by-case basis

Keywords : Peritoneal dialysis; risk factors; survival, catheter

Résumé

Introduction et objectifs : L'insertion opportune et la gestion adéquate des complications liées au cathéter de dialyse péritonéale (DP) sont cruciales pour le succès de la dialyse péritonéale. Le but de cette étude était d'examiner les résultats des cathéters de dialyse péritonéale dans notre centre, en identifiant les facteurs qui influencent la survie des cathéters.

Matériels et méthodes : Une étude rétrospective a été menée sur 146 patients de dialyse péritonéale qui ont reçu leur premier cathéter de entre août 2012 et juillet 2022. Le suivi moyen était de 26,5 ± 22,7 mois.

Résultats : L'âge moyen était de 55,1 ± 16,6 ans, et 58,2 % étaient des hommes. Une péritonite est survenue chez 75 patients (51,4 %), dont 26 (34,7 %) ont nécessité le retrait du cathéter. Des complications mécaniques ont été observées chez 66 patients (45,2 %), dont 16 ont nécessité le retrait du cathéter. La survie des cathéters à 12, 24 et 36 mois était respectivement de 80,2 %, 72,4 % et 61,6 %. Les complications non infectieuses (p=0,006) et les épisodes de péritonite (p=0,017) ont été associés à un taux plus élevé de retrait associé au cathéter de DP. Dans l'analyse multivariée, les complications non infectieuses étaient la seule variable indépendante significativement associée à la survie du cathéter (Hazard ratio 2,53 ; 95% CI 1,383-4,624). Aucune association n'a été trouvée entre la survie du catheter de DP et l'âge, le statut diabétique, l'obésité, une transplantation rénale antérieure, une chirurgie abdominale antérieure ou la méthode d'insertion du cathéter.

Conclusions : Malgré le nombre important de complications infectieuses, y compris la péritonite, celles-ci n'ont pas entraîné une diminution substantielle de la survie des cathéters dans l'analyse multivariée. Ces résultats soulignent l'importance d'une prise en charge efficace des complications non infectieuses pour garantir une utilisation réussie et à long terme des cathéters de DP. Des mesures préventives, telles que l'omentectomie en même temps que l'implantation du cathéter, peuvent être envisagées au cas par cas.

Mots-clés : dialyse péritonéale facteurs de risque, surviev cathéter

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INTRODUCTION

Peritoneal dialysis (PD) is a well-established renal replacement therapy for patients with end-stage renal disease (ESRD). The success of peritoneal dialysis as renal replacement therapy depends on a well-functioning peritoneal catheter [1].

Complications associated with PD catheter (PDC) significantly contribute to patient morbidity, leading to interruptions in treatment and decreased dialysis efficacy [2,3]. These complications often cause the need to transfer to hemodialysis, hospitalization, and surgical procedures.

The success and longevity of PD are frequently challenged by both infectious and non-infectious complications [1,2].

Infections, particularly peritonitis, are widely recognized as major causes of technique failure and morbidity in PD patients [1,2,4,5]. Peritonitis not only compromises the immediate health but also has long-term implications on the functionality and survival of the PD catheter. Prevention and effective treatment of peritonitis is critical to reduce technique failure and the need for catheter removal [4].
Non-infectious complications, although less frequently discussed, also pose significant challenges to the survival of PD catheters and overall patient outcomes [3,6]. These include mechanical issues such as outflow failure, catheter migration, and omental wrapping, as well as hernias, hemoperitoneum, and dialysate leaks. 7Such complications can lead to recurrent interventions, increased healthcare costs, and reduced adherence to PD therapy [8].

This study aims to review the peritoneal dialysis catheter (PDC) outcomes at our center and to identify factors that significantly influence catheter longevity, providing insights that can enhance management strategies for maintaining PD efficacy.

MATERIAL AND METHODS

We conducted a retrospective study including all PD patients who had their first PD catheter implanted between the 1st of August 2012 and the 31st of July 2022 in our institution.

All catheters were double-cuffed, pig-tailed Tenckhoff catheters. Most PD catheters were placed surgically by two surgeons (mini-laparotomy or laparoscopy). A minority of catheters (n=8) were placed percutaneously by one nephrologist, using the Seldinger technique.

The medical records of the 146 patients included in the study were reviewed for their demographic and clinical characteristics including age, gender, underlying etiology of ESRD, comorbidities, and prior abdominal surgeries. During the follow-up, we collected data regarding infectious and non-infectious complications. Early complications were defined as those developing within 30 days after PDC insertion, whereas late complications were defined as those developing after 30 days.

The primary endpoint was PD catheter failure, defined as removal of the PD catheter due to catheter-related complications. The catheter-related complications were divided into infectious and non-infectious. PD catheter infectious complications included exit-site infections (ESI), tunnel infections (TI) and peritonitis. The non-infectious complications included outflow failure due to

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with catheter migration/ mal-positioning, omental wrap, catheter leakage, post-incisional hernia, hemoperitoneum and pleuroperitoneal shunt.
Catheter survivor was defined as a patient who had maintained PD by the end of follow-up or had PDC removal due to issues unrelated to PDC, such as patient death, kidney transplantation, patient demand, inadequate PD, or improved renal residual function.

Statistical analyses were performed using IBM SPSS, version 28 (SPSS, Chicago, IL, USA). Categorical variables are expressed as numbers and percentages, and continuous variables are expressed as mean ± standard deviation. The Pearson $\chi 2$ test or Fisher's exact test was used to analyze categorical variables. For continuous variables, the means were compared using the Student's t-test. Kaplan-Meier curves were used to estimate catheter survival. Cox regression model was used to identify factors that were independently associated with catheter survival. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Patient characteristics

The study population included 85 men (58.2%) and 61 women (41.8%). The mean age at the PDC insertion time was 55.1 ± 16.6 years (table 1).
The mean follow-up was 26.5 ± 22.7 months. Chronic glomerulonephritis was the most common etiology of stage 5 chronic kidney disease (n=49, 33.6%), followed by diabetes mellitus (n=41, 28%). Ninety patients (61.6%) had one or more comorbidities, and 51 (34.9%) of them had diabetes mellitus. Seventeen (11,6%) had previous abdominal surgery: cholecystectomy in 7, hysterectomy in 3, appendicectomy in 3, previous kidney transplant in 3 and total gastrectomy with Roux-en-y oesophagojejunostomy in one patient.

Table 1. Patient demographic and clinical characteristics

BASELINE CHARACTERISTICS	
Age (years), mean (SD)	55.1 16.7
Sex (male), n (%)	85 (58.2)
Etiology of chronic kidney disease, n (%)	
Chronic glomerulonephritis	49 (33.6)
Diabetes mellitus	41 (28)
Chronic tubulointerstitial nephritis	17 (11.6)
Polycystic kidney disease	5 (3.4)
Hypertension	4 (2.7)
Others	9 (6.2)
Unknown	21 (14.4)
One or more comorbidities, n (%)	90 (61.6)
Diabetes mellitus	51 (34.9)
Major cardiovascular disease*	38 (26)
Obesity	32 (21.9)
Prior kidney transplant	19 (13.0)
Previous abdominal surgery, n (%)	17 (11.6)
PD catheter insertion technic, n (%)	
Mini-laparotomy	90 (61.6)
Laparoscopy	48 (32.9)
Seldinger (percutaneously)	8 (5.5)

** Major cardiovascular disease defined as ischemic heart disease, cerebrovascular disease and/or peripheral arterial disease.*

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In 90 patients (61.6%), the PDC was inserted using a mini-laparotomy approach, whereas the laparoscopic method was used in 48 patients (32.9%). Only 8 patients (5.5%) had their catheter placed percutaneously using the Seldinger technique.

PD-related infectious complications

The total number of patients who experienced one or more episodes of peritonitis during the follow-up period was 75 (51.4%). Among these, 48 patients had a single episode, while 27 patients had more than one episode of peritonitis. Twenty-six patients (34.7%) required removal of their peritoneal dialysis catheter due to refractory peritonitis.

Thirty-four patients (23.3%) had a single episode of PD catheter-related exit site or tunnel infection, while 43 (29.5%) had more than one event. The number of early ESI/TI was one. Nineteen cases of ESI/TI that required intervention (shaving). One patient required catheter removal due to refractory tunnel infection.

PD-related non-infectious complications

Sixty-six patients (45.2%) had PD-related mechanical complications, mostly due to outflow failure (19 patients with catheter migration, 11 with omental wrapping). In 16 cases of outflow failure (53.3%), the catheter had to be removed due to failure of conservative management, such as enema and ambulation. In fourteen patients, the PDC salvage was possible, namely by repositioning the catheter with fluoroscopic technique in 8 patients and by surgical repositioning in 6. There was no association between outflow failure and diabetic status (p=0.983), obesity (p=0.487), previous abdominal surgeries (p=0.756) or method of catheter insertion (p=0.121).

The remaining non-infectious complications were post-incisional hernia (n=20, 13.7%), hemoperitoneum (n=8, 5,5%), leakage (n=4, 2.7%), and pleuroperitoneal shunt (n=4, 2.7%). All cases of pleuroperitoneal shunt were exchanged to hemodialysis, except for one female who was expecting a living-donor kidney transplant. The patients with leakage were temporarily transferred to hemodialysis, except for two cases where the PDC was removed and a new one was implanted simultaneously.

The total number of patients with early and late mechanical complications was 20 (13.7%) and 53 (36.3%), respectively.

Survival analysis and factors associated with catheter survival

Overall PD catheter survival rates over 12, 24 and 36 months were 80.2%, 72.4% and 61.6%, respectively (*Figure 1*).

Removal of the PDC due to catheter-related complications was required in 49 patients (33.6%).

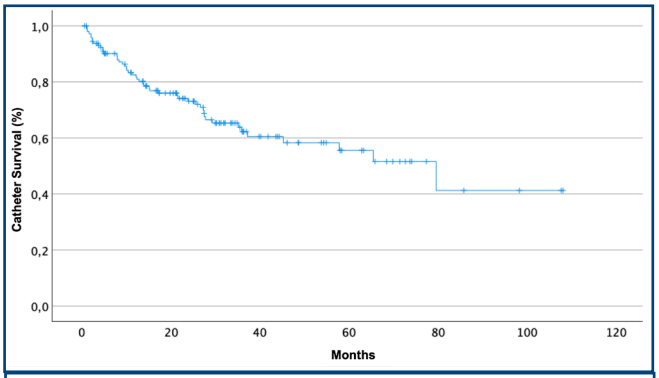

Figure 1. Actuarial PD catheters survival

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The leading cause of catheter removal was infection (n=27, 55.1%): peritonitis in 26 patients and refractory tunnel infection in 1. Non-infectious complications were also a significant factor, accounting for 44.9% of the removals (n=22): outflow failure in 16 patients, pleuroperitoneal shunt in 4 and dialysate fluid leaks in 2.

We compared patients with and without PDC removal due to catheter-related complications, searching for factors associated with this phenomenon (*Table II*).

Table II. Comparison of patients with and without PDC removal due to catheter-related complications

		PDC-associated removal	No PDC-associated removal	P value
Sex	Male	31 (63.3%)	54 (55.7%)	0.380[a]
	Female	18 (36.7%)	43 (44.3%)	
Age		52.2 ± 17.1	56.6 ± 16.3	0.312[b]
Diabetes mellitus	Yes	19 (38.8%)	32 (33%)	0.489[a]
	No	30 (61.2%)	65 (67%)	
Polycystic kidney disease	Yes	1 (2%)	4 (4.1%)	0.513[a]
	No	48 (98%)	93 (95.9%)	
Obesity	Yes	10 (20.4%)	22 (22.7%)	0.312[a]
	No	39 (79.6%)	75 (77.3%)	
Prior kidney transplant	Yes	7 (14.3%)	12 (12.4%)	0.745[a]
	No	42 (85.7%)	85 (87.6%)	
Previous abdominal surgery	Yes	5 (8.2%)	12 (12.4%)	0.700[a]
	No	44 (89.8%)	85 (87.6%)	
Infectious complications*	Yes	34 (69.4%)	65 (67%)	0.772[a]
	No	15 (30.6%)	32 (33%)	
Peritonitis	Yes	32 (65.3%)	43 (44.3%)	**0.017[a]**
	No	17 (34.7%)	54 (66.7%)	
Non-infectious complications	Yes	30 (61.2%)	36 (37.1%)	**0.006[a]**
	No	19 (38.8%)	61 (62.9%)	
PD catheter insertion technic	Mini-laparotomy	29 (59.2%)	61 (62.9%)	0.942[c]
	Laparoscopy	17 (34.7%)	31 (32%)	
	Seldinger	3 (6.1%)	5 (5.1%)	

*[a] Pearson χ2 test; [b] Student's t-test; [c] Fisher exact test; *Infectious complications including peritonitis and exit site/ tunnel infection. PDC : Peritoneal Dialysis Catheter*

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As expected, patients who underwent PDC-associated removal were more likely to have had a PDC-related non-infectious complication (p=0.006). Infectious complications were not associated with higher rate of PDC-associated removal (p=0.772), however, there was a statistically significant association between peritonitis episodes and PDC-associated removal (p=0.017). No significant association was observed between the PDC-associated removal and age, gender, diabetic status, obesity, autosomal dominant polycystic kidney disease, prior kidney transplant, previous abdominal surgery, or method of catheter insertion.

In the Cox regression model (*TableIII*), PD catheter-related non-infectious complications were the only independent variable significantly associated with catheter survival censored to the competing events (patient death, kidney transplantation, etc) (cs-HR 2.53; 95% CI 1.383–4.624). Other risk factors, including age, gender, diabetic status, previous abdominal surgery, method of catheter insertion and peritonitis were not independently associated with catheter survival.

Table III: Predictive factors for peritoneal dialysis catheter survival

Variable	cs-Hazard Ratio	95% confidence interval	P value
Sex	0.733	0.397 – 1.352	0.320
Age	0.982	0.961 – 1.0	0.087
Diabetes mellitus	1.89	0.970 – 3.689	0.061
Previous abdominal surgery	0.897	0.333 – 2.420	0.830
Peritonitis	1.19	0.633 – 2.254	0.583
Non-infectious complications	2.53	1.383 – 4.624	0.003
PD catheter insertion technic	0.792	0.485 – 1.294	0.353
cs-Hazard Ratio: cause specific Hazard Ratio			

DISCUSSION

The present study enrolled 146 incident PD patients who received first-time PDC insertion at our center over a ten-year period. The 1-year, 2-year and 3-year PD catheter survival was 80.2%, 72.4% and 61.6%, respectively. This represents a better PD catheter outcome compared to what has been reported in some earlier studies9,10. A prospective study conducted on 72 patients who had their first peritoneal dialysis catheters surgically inserted between 1992 and 1995, reported 1-year, 2-year, and 3-year survival rates of 62.5%, 41.5%, and 36%, respectively9. The higher catheter failure rate observed in this study is likely attributed to the significant number of persistent peritonitis leading to the removal of functioning PD catheters. In a larger trial that included 203 patients and ran from 1982 to 1995, one-year and three-year survival rates for the first catheters were reported to be 75% and 37%, respectively [10].

Conversely, our PDC survival rate is lower than the one demonstrated in two more recent studies [6,11]. Singh et al. conducted a retrospective study on 315 patients who had their first PD catheter placed between January 2001 and September 2009, showing a 1-year, 2-year and 3-year PD catheter survival rate of 92.9%, 91.9% and 91.1% respectively [6]. The significantly lower number

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of peritonitis described in this study (39.5% of patients with at least one episode of PDP vs 51.4% in our population) may have contributed to this difference in survival rates. Kang et al reported a 1-year and 5-year survival of 97.1–97.8% and 87.0–91.1%, respectively [11]. The total number of patients with one or more PDP events was comparable to ours (40-50.0% vs 51.4%), however only a small proportion of patients with infectious complications required catheter removal. Additionally, only a minority of patients with mechanical complications had their PDC removed11. Together, these two factors may explain the difference in PDC survival rates. Notably, in our study, a significant proportion of complications, especially non-infectious ones, resulted in catheter removal/ replacement. This could indicate suboptimal salvage maneuvers, such as catheter recovery attempts using fluoroscopic guidance.

PD catheter-related non-infectious complications was the single covariate that significantly reduced the catheter survival time. Each PDC-related non-infectious complications increased the risk of catheter failure more than 2 times (Hazard ratio 2.53). Singh et al described similar results, with PDC-related non-infectious complication as the only variable independently associated with catheter survival (Hazard ratio 22.467) [6]. In our study, approximately half the cases of outflow failure required catheter removal, largely contributing to the impact of non-infectious complications on PDC outcomes. Omental wrapping was a very common cause of catheter dysfunction in our population (22.4%). Some authors suggest performing an omentectomy during catheter placement to avoid wrapping and the need for secondary interventions [3,12]. In fact, in a study from Mexico that included 235 PD patients, omentectomy was found to have a protective effect against catheter dysfunction and removal, probably due to the reduced rate of obstruction from omental wrapping [3].

Peritonitis has been widely recognized as a leading cause of catheter and technique failure in PD patients, contributing to catheter loss and increased morbidity [1,2,5]. In a large study involving 473 CAPD patients, the primary cause of PD catheter removal was peritonitis [5]. It is suggested that the formation of biofilm on the PD catheter is an obstacle to the continuation of PD in these cases. A different team of researchers examined the impact of 579 episodes of peritonitis on PD catheters and described that only 12% of the peritonitis episodes led to removal of the PD catheter [13]. Notably, this study demonstrated that concurrent tunnel or exit-site infections increased the likelihood of catheter loss [13]. Nevertheless, Singh et al. showed that PD-related peritonitis were not significantly associated with PD catheter survival [6]6. In our study, patients with peritonitis were more likely to have PDC-associated removal (p=0.017). However, in the multivariate analysis, peritoneal infections were not significantly associated with PD catheter survival. The most likely explanation is that the negative impact on the catheter outcome may have been mitigated by quick and effective treatment of the PDP. Additionally, the greater impact of non-infectious complications on PDC survival may have minimized the effect of peritonitis on PDC survival time. Although our study highlights the significant impact of non-infectious complications on catheter survival, educating patients on recognizing the signs and symptoms of both infectious and non-infectious complications is crucial for ensuring timely medical intervention and potentially preventing the need for catheter removal or replacement.

None of the other demographic (age, gender) or clinical characteristics (diabetic status, obesity, previous abdominal surgeries, method of catheter insertion) were found to be independently associated with the PD catheter survival.

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It has been suggested that previous abdominal surgeries increase the risk of PD catheter mechanical complications and could impact their survival [14]. In our study, although only a small percentage of patients (11.6%) had a history of prior abdominal surgery, we found no significant association between these surgeries and PD catheter survival. Our results align with the findings of previous studies [3,6,15]. In the studies by both Singh et al. and Martinez et al., previous abdominal procedures had no discernible impact on catheter survival [3,6].

Decisions regarding the choice of dialysis modality are influenced by various factors, including social, economic, and medical considerations, such as the patient's comorbidities [16]. Obesity is often considered a relative contraindication for peritoneal dialysis. However, a recent study involving 231 PD patients evaluated the effect of patient weight on PD catheter survival and found that obesity did not increase complications or shorten PDC survival, regardless of the operative technique used [17]. Tiong et al. analyzed several factors related to catheter dysfunction and found that patients with a history of diabetes and glomerulonephritis had a higher probability (OR: 3.24; 6.52, respectively) of early complications [14]. Conversely, more recent studies found no association between comorbidities, such as diabetes, and PD catheter survival [3,6], suggesting that comorbidities should not affect patient selection for PD. Similarly, we did not observe any relationship between pre-existing medical conditions, including obesity and diabetes mellitus, and PDC survival.

We found no significant association between the method of catheter insertion and catheter survival time, although the small number of patients in each group may limit the generalizability of these results. Additionally, there was no association between catheter insertion technique and development of outflow failure. Recent meta-analyses have shown no advantages of one technique over the others, except for the laparoscopic method [18,20]. Therefore, the International Society for Peritoneal Dialysis recommends that the choice of PDC insertion method should be based on patient factors, facility resources, and operator expertise [21].

The present study has a few limitations. Being a retrospective and single-center study, the generalizability of our findings may be limited. Limitations related to the retrospective design of the study include potential biases in patient selection and data collection and the absence of a control group further limits the robustness of our conclusions. Future prospective, multicenter studies are needed to validate our findings and explore additional factors influencing PD catheter survival.

CONCLUSIONS

In conclusion, non-infectious complications were the only independent factor significantly associated with PDC survival. Despite the significant number of infectious complications, including peritonitis, these did not result in a substantial decrease in catheter survival in the multivariate analysis. These findings emphasize the importance of effectively managing non-infectious complications to ensure successful and long-term use of PDCs. Preventive measures, such as omentectomy simultaneously with PDC implantation, may be considered on a case-by-case basis.

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