JOJ
Urology & Nephrology
ISSN: 2476-0552

Juniper Publishers
key to the Researchers

Research Article
Volume 7 Issue 5 - January 2023
DOI: 10.19080/JOJUN.2023.07.555723

JOJ uro & nephron

The Effects of Platelet Indices on Early Mechanical Complications of Peritoneal Dialysis

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Submission: January 04, 2023; **Published:** January 17, 2023

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Abstract

Background and aim

Mechanical complications are important causes of drop-outs from peritoneal dialysis. There is a need of determining factors associated with higher complications rates of mechanical complications of peritoneal dialysis. In this study, we aimed to investigate the effects of platelet indices on mechanical complications of peritoneal dialysis.

Material and Methods

All patients who inserted a peritoneal dialysis catheter between the years 2010-2022 were retrospectively evaluated. Patients were divided into two groups in terms of the presence or absence of early mechanical complications. Platelet indices were compared between groups.

Results

This study included 104 patients who inserted a peritoneal dialysis catheter for starting planned peritoneal dialysis. Higher Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) were found to be independent risk factors for early mechanical complications of peritoneal dialysis (OR= 4.583, 95% CI= 2.103-9.987, p<0.001 and OR= 2.352, 95% CI= 1.181-4.687, p= 0.015, respectively).

Discussion and Conclusion

MPV and PDW are independent risk factors for early mechanical complications of peritoneal dialysis. When starting PD in patients with high MPV and PDW values, precautions should be taken to minimize the risk of complications, such as starting PD later and starting exchanges with less volumes.

Main Points

Mechanical complications of peritoneal dialysis are common problems in patients receiving kidney replacement therapy with peritoneal dialysis.

Platelets and platelet indices seem to play a role in the development of mechanical complications associated with peritoneal dialysis, due to their role in wound healing.

Higher mean platelet volume and platelet distribution width are independent risk factors for early mechanical complications of PD.

Keywords: Mean platelet volume; Peritoneal dialysis; Platelets

Introduction

Platelets are cells produced from megakaryocytes and play an active role in primary hemostasis. They are also important in wound healing and vascular remodelling [1]. Platelets contribute to wound healing by releasing some proteins in their granules by exocytosis [2]. Platelet indices (PIs) are parameters that can be reached as a result of a complete blood count and give an idea about the morphology and kinetics of platelets. Mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), and

platelet-large cell ratio (P-LCR) are the most commonly used PIs in recent studies [3-5]. Increased preoperative MPV was found to be predictive of poor wound healing following total abdominal hysterectomy [6]. PDW reflects the variability of platelet size and changes with platelet activation [7,8]. The simultaneous decrease in platelet count and PCT is considered as an indicator of platelet overconsumption [9]. P-LCR may be used for monitoring platelet activity [10].

Peritoneal dialysis (PD) can be a kidney replacement therapy option for patients who need urgent dialysis, but in clinical practice peritoneal dialysis is started more frequently in a planned and elective manner [11]. Catheter malposition, infusion and drainage problems, umbilical or inguinal hernias, dialysate leaks, and omental entrapping are mechanical complications of PD that may be encountered in one out of four patients who are initiated PD [12]. In patients who will be started on planned and elective PD, the patient is followed for at least 2-3 weeks without peritoneal dialysis after a peritoneal catheter is inserted in order to heal the peritoneum and to provide abdominal epithelialization [13]. Passing this 2-week period by resting the peritoneum also reduces the possibility of early mechanical complications such as leakage, herniation, omental wrapping, and filling-emptying problems. In our literature search, we did not find any study investigating the effects of PIs on the development of early mechanical complications of PD.

In this study, we aimed to investigate the effects of PIs on early mechanical complications in patients who started scheduled PD.

Material and Methods

Patients and PIs

Our study was designed as a retrospective, observational cohort study. The files of all patients who had a PD catheter insertion for kidney replacement therapy between 2010-2022 were evaluated. All patients were followed up with PD at least 3 months after initiation of PD. Patients who started emergency PD, using steroids, patients who shifted to hemodialysis or transplantation in less than 3 months, and with a diagnosis of hematologic or oncologic cancer were excluded from the study (Figure 1). Bloods taken from PD patients were all analyzed in the central laboratory of our hospital with the same automatic analyzer (Cobas 6000, Roche, Switzerland). The mean values of MPV, PDW, PCT, and P-LCR from the complete blood count samples taken at 3 different times before insertion of the PD catheter were recorded as final PIs. Demographic data, comorbidities, laboratory tests, and mechanical complications of PD were recorded.

Insertion of PD catheters

Curled Tenckhoff catheters were used for PD in our clinic. All PD catheters were inserted by an experienced general surgeon under operating room conditions. The Modified Seldinger method was used for all patients. After the PD catheter was inserted, the patients were hospitalized and followed up until gas-stool discharge was observed. After insertion of the PD catheter, all patients were taken in a 3-week resting period.

PD prescription

All patients started PD with continuous ambulatory peritoneal dialysis (CAPD) with three or four daily exchanges. While initiating CAPD for all patients, it was aimed that patients learn to manuel changes so that they can use it when needed. The filling volume for all patients was 1.25-1.5 L/m^2, which corresponds to 2-2.5 liters filling volume. We did not use a filling volume of more than 2.5 L in any patients. Patients having a residual kidney function with at least 400 ml urine output daily were started CAPD with 3 exchanges and patients having less than 400 ml urine output daily were started CAPD with 4 exchanges. For daytime dwells we used 1.36%-2.27% dextrose solution and for nighttime dwell, we used an icodextrin.

Early mechanical complications

Catheter malposition, infusion and drainage problems, umbilical or inguinal hernias, dialysate leakages, and omental entrapping are called as early mechanical complications of PD when they occurred in the first 3 months of initiation of PD. A patient with at least one of these 5 complications was considered a patient with a composite early mechanical complication.

Ethics Approval

The study was approved at the meeting of the Local Ethics Committee dated 07.01.2022 (2022/1, decision number: 16).

Statistical Analysis

Statistical analyzes were done with SPSS 26.0 (IBM Corp. 2019 IBM SPSS Statistics for Windows, version 26.0. Armonk, NY: IBM Corp) package program. Categorical variables were presented as frequency and percentages. The chi-square test was used for comparing frequencies of categorical variables between groups. The normality of continuous variables was checked with the Kolmogorov Smirnov test and visual histograms. Normally distributed continuous variables were presented as mean±standard deviation, and non-normally distributed continuous variables were presented as median and interquartile range 25-75 (IQR 25-75). Mann-Whitney U test or independent samples t-test was used according to normally distribution when comparing continuous variables between groups. Logistic regression analysis was done for determining risk factors for composite early mechanical complications. The predictive power of PIs to develop composite early mechanical complications was investigated using the Receiver Operating Characteristic curve. The Youden index was used for determining the best cutoff value of PIs for predicting complications. All p values presented in the results are two-sided and a p-value of <0.05 was considered significant.

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Results

104 patients were included in the study (Figure 1). The median age of the patients was 63.5 years (IQR25-75= 51-73 years). Of the patients 55.8% (n= 58) were male. At least one of the early mechanical complications was seen in 26% (n= 27) of the patients. A total of 54 early mechanical complications were seen in these 27 patients within 3 months of the onset of PD. Early mechanical complications observed in the patients were infusion and drainage problems in 14.4% (n=15), umbilical or inguinal hernia in 11.5% (n=12), dialysate leakage in 11.5% (n=12), catheter malposition in 9.6% (n=12) and omental entrapping in 4.8% (n= 5).

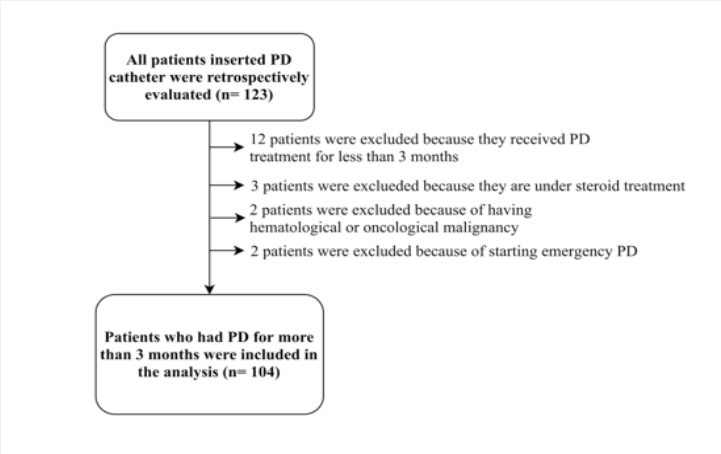

Figure 1: Study design.

Diabetes mellitus and chronic obstructive pulmonary disease were seen significantly higher in patients with a composite early mechanical complication than without a complication (77.8% to 27.3% for diabetes mellitus and 18.5% to 3.9% for chronic obstructive pulmonary disease). Body mass index was also significantly higher in patients with a composite early mechanical complication (27.17±4.9 to 24.87±3.1). The general characteristics of the patients according to the composite early mechanical complication groups are presented in Table 1.

Table 1: General characteristics zaof the patients.

		Early Mechanical Complication		
Characteristics	All patients	Present	Absent	p
Median age (IQR25-75)	63.5(51-73)	63(51-73)	65(55-75)	0.256
Male gender, %-n	55.8-58	51.9-14	57.1-44	0.659
Smoking, %-n	26-27	40.7-11	20.8-16	0.072
BMI, mean±SD	25.47±3.8	27.17±4.9	24.87±3.1	0.021
HIAS, %-n	3.8-4	11.1-3	1.3-1	0.053
Diabetes mellitus, %-n	40.4-42	77.8-21	27.3-21	<0.001
Hypertension, %-n	56.7-59	55.6-15	57.1-44	1
CAD, %-n	4.8-5	7.4-2	3.9-3	0.603
COPD, %-n	7.7-8	18.5-5	3.9-3	0.027

BMI= Body Mass Index, HIAS= History of Intraabdominal Surgery, CAD= Coronary Artery Disease, COPD= Chronic Obstructive Pulmonary Disease

MPV and PDW were found to be significantly higher, PCT and P-LCR were significantly lower in patients with a composite early mechanical complication than in patients without any mechanical complications. Table 2 shows comparisons of the laboratory measurements of the patients.

It was found that an MPV value of 11.8 fl could predict composite early mechanical complication with 85.2% sensitivity and 97.4% specificity and a PDW value of 16.55 fl could predict composite early mechanical complication with 81.5% sensitivity and 83.1% specificity. Figure 2 shows ROC curve for MPV and PDW to predict composite early mechanical complications.

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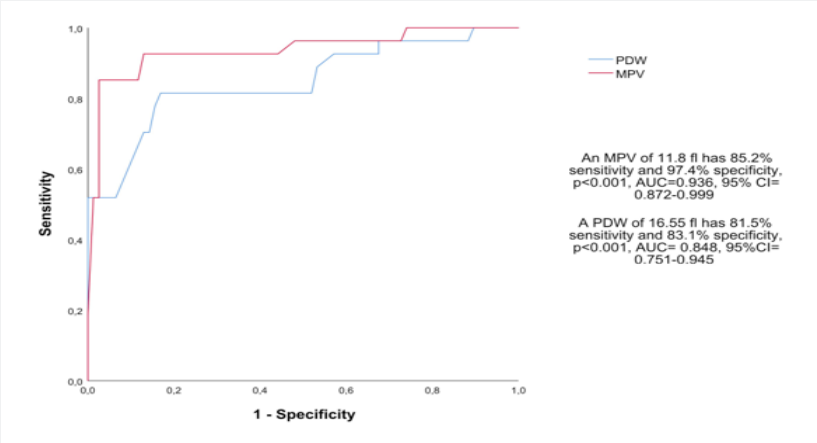

Figure 2: ROC curve for predicting composite early mechanical complication.

Table 2: Comparisons of patients in terms of laboratory measurements.

		Early Mechanical Complication		
Parameters	All patients	Present	Absent	p
Urea (mg/dl)	120.84±53.7	117.24±58.4	122.11±52.4	0.617
Creatinine (mg/dl)	6.04±2.4	5.96±2.5	6.11±2.3	0.434
Sodium (mEq/l)	138.9±6.3	139.3±5.3	138.7±6.7	0.877
Potassium (mEq/l)	4.64±0.66	4.6±0.6	4.66±0.7	0.546
White blood cell (x103/ul)	8.16±3.1	8.19±3.2	8.11±2.8	0.548
Hemoglobin (g/dl)	10.09±1.5	10.3±2.1	10.01±1.3	0.538
Platelets (x103/ul)	225.93±86.2	206.1±77.6	232.92±88.5	0.189
MPV (fl)	10.35±1.8	12.47±1.3	9.6±1.3	<0.001
PDW (fl)	14.91±2.7	16.86±1.8	14.22±2.6	<0.001
PCT (%)	24.55±4.3	22.69±2.6	25.2±4.6	0.01
P-LCR (%)	26.58±6.6	23.66±4.1	27.6±7.1	0.018

MPV= Mean Platelet Volume, PDW= Platelet Distribution Width; PCT= Plateletcrit, P-LCR= Platelet to large cell ratio

Since PCT and P-LCR were found to be lower in patients with a complication, the predictive power of not developing complications was evaluated for these two parameters. A PCT value of 25.1% could predict not developing any early mechanical complications with 51.9% sensitivity and 85.2% specificity. A P-LCR value of 28.2% could predict not developing any early mechanical complications with 44.2% sensitivity and 92.6% specificity. Figure 3 shows the ROC curve for PCT and P-LCR to predict not developing composite early mechanical complications.

All of the 10 candidate parameters that were significantly different between groups were entered into a regression model as candidate predictors of composite early mechanical complication. A model constructed by smoking status, body mass index, history of intraabdominal surgery, diabetes mellitus, chronic obstructive pulmonary disease, platelet count, and PIs were analyzed as candidate risk factors for composite early mechanical complications. Multivariate logistic regression analysis showed that MPV and PDW were independent risk factors for composite early mechanical complications (OR= 4.583, 95% CI= 2.103-9.987, p<0.001 and OR= 2.352, 95% CI= 1.181-4.687, p= 0.015, respectively). Table 3 shows logistic regression analysis results.

Discussion

In our study, we found that higher MPV and PDW are independent risk factors for early mechanical complications after initiating PD. Although the best option of kidney replacement therapy is kidney transplantation, still there is not enough kidney donors in all around the world [14]. Most patients reached to chronic kidney disease G5 stage and need one of the other two kidney replacement methods; PD or hemodialysis. PD has some

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survival advantages during the first 2 years of kidney replacement therapy [15]. Early mechanical complications of PD may lead to drop-out from PD [16]. Therefore factors that may increase the risk of developing early mechanical complications need to be determined.

Table 3: Logistic regression analysis for determining risk factors of composite early mechanical complications.

	Univariate		Multivariate	
Parameters	OR(95%CI)	p	OR(95%CI)	p
Smoking				
Present	2.621(1.019-6.741)	0.046	1.393(0.103-18.919)	0.803
Absent (reference)				
BMI, per kg/m²	1.175(1.038-1.329)	0.011	0.867(0.672-1.118)	0.27
HIAS				
Present	9.500(0.944-95.632)	0.056		
Absent (reference)				
Diabetes mellitus				
Present	9.333(3.310-26.318)	<0.001	3.320(0.436-25.309)	0.247
Absent (reference)				
COPD				
Present	5.606(1.240-25.337)	0.025	0.527(0.017-16.302)	0.714
Absent (reference)				
PLT, per 103/µL	0.996(0.990-1.002)	0.165		
MPV, per fL	6.095(2.933-12.667)	<0.001	4.583(2.103-9.987)	<0.001
PDW, per fL	2.100(1.390-3.174)	<0.001	2.352(1.181-4.687)	0.015
PCT, per %	0.001(0.001-0.035)	0.012	0.001(0.001-5038.716)	0.189
P-LCR, per %	0.892(0.817-0.973)	0.01	0.873(0.701-1.088)	0.228

BMI= body mass index, HIAS= history of intraabdominal surgery, COPD= chronic obstructive pulmonary disease, PLT= platelet, MPV= mean platelet volume, PDW=platelet distribution width, PCT= plaeletcrit; P-LCR= platelet to large cell ra.

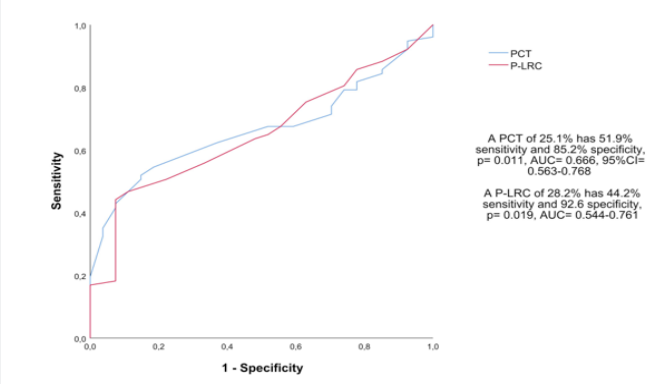

Figure 3: ROC curve for PCT and P-LCR for not developing composite early mechanical complications.

PIs have been investigated in kidney diseases in various clinical situations [17-19]. In our literature review, we could not find any study investigating the effects of PIs on mechanical complications in PD patients. MPV and PDW are two PIs that can be achieved with a simple complete blood count that does not require additional expenditure. Our study revealed that patients having higher MPV and PDW had higher mechanical complications after initiating PD. After multivariate analysis MPV and PDW were found to be independent risk factors for mechanical complications.

Platelets are one of the first cell types that migrate towards the injured area and contribute to tissue repair [20]. In addition to being the main cell that provides primary hemostasis for tissue healing, platelets mediate the release of cytokines so that

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other cells necessary for tissue healing migrate to the damaged area [21]. Platelets newly released from megakaryocytes tend to be larger than mature platelets [22]. Based on the view that PIs may reflect the activities of platelets, we planned our study to investigate the effects of PIs on mechanical complications of PD. Previously Akca et al showed that increased preoperative MPV may predict poor wound healing after total abdominal hysterectomy [6]. They studied 100 patients who underwent total abdominal hysterectomy and found that patients who had delayed wound healing had higher MPV values than patients who healed earlier. We found that higher MPV increases the risk of mechanical complications 4.5-fold after starting PD. This finding may be due to increased MPV leading to insufficient tissue healing.

PDW is a PI that reflects platelets' volume variability [23]. Studies have been conducted with PDW in many clinical conditions related to the kidney. Ruijan et al showed that PDW is associated with cardiovascular and all-cause mortality in patients treated with hemodialysis [24]. In a study of Yu et al, PDW was shown to be a marker for predicting lupus nephritis [25]. RDW had also been found to be a risk factor for contrast-induced nephropathy in patients undergoing primary percutaneous coronary intervention [26]. All these studies show that PDW may be an important marker in kidney diseases. Our study shows that higher PDW is an independent risk factor for mechanical complications of PD.

In a meta-analysis of 16 studies involving nearly 3,000 patients, it was found that infusion and drainage problems increased 1.44 times, omental dressing 1.89 times, catheter malposition 3 times, and dialysate leaks 3.9 times in patients who started emergency PD compared to patients who started elective PD [27]. The greatest risk factor for the development of these complications is increased intra-abdominal pressure, but insufficient healing of peritoneum and abdominal integrity, which is impaired by catheter placement, is also effective in the development of these complications. The high MPV and PDW values in patients with mechanical complications in our study suggest that these platelet indices may be an indirect indicator of inadequate wound healing.

In our study, univariate analysis showed that PCT, P-LCR, smoking, obesity, diabetes mellitus, and chronic obstructive pulmonary disease are related to early mechanical complications of PD but in multivariate analysis, these parameters are not found to be independent risk factors.

Retrospective design and the small number of patients are the limitations of our study. Also, not including blood leakage data can be considered a limitation. Due to the retrospective design of our study, it is not possible to establish a cause-effect relationship. But our study is important because this is the first study investigating the effects of PIs on mechanical complications of PD. In conclusion, higher MPV and PDW are independent risk factors for early mechanical complications of PD. When starting PD in patients with high MPV and PDW values, precautions should be taken to minimize the risk of complications, such as starting PD later and starting exchanges with fewer volumes. Prospective and larger studies may reveal the relationship between platelet indices and mechanical complications of PD more clearly.

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