

Mean platelet volume and platelet-derived indices as prognostic indicators in patients with acute kidney injury: A prospective observational study

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Abstract

Background: Acute kidney injury (AKI) is a significant global health concern that leads to high rates of morbidity and mortality. Mean platelet volume (MPV), a measure of platelet size that is available in every blood count, is increasingly recognized as an important marker of platelet activity. Therefore, the present study was

conducted to evaluate MPV as a marker to predict the progression of AKI at tertiary care hospital.

Material and Methods: The study was designed as a cross-sectional study conducted at the Medicine, at tertiary care hospital. The study spanned from May 2023 to June 2024. The study population consisted of 300 patients with AKI over the age of 18 years. The

statistical software namely SPSS 22.0 used for the analysis of the data.

Results: The mean age of the patients was 47.89 ± 10.12 years. Among 300 patients, 207 patients (69%) were male with sepsis (45%) as the most common cause. MPV had significant correlation with serum creatinine, platelets and hospital stay.

Conclusion: The present study concludes that MPV is an inexpensive and practical marker that may predict the outcome of patients with AKI.

Keywords: Mean Platelet Volume, Acute Kidney Injury

Introduction

Acute kidney injury (AKI) refers to an abrupt decline in renal function that compromises the clearance of nitrogenous waste and leads to derangements in fluid balance, electrolytes, and acid–base homeostasis.

It continues to pose a considerable public-health burden internationally, contributing meaningfully to illness and death in both community-dwelling and hospitalised populations over the short and long term¹.

While the pattern of community-acquired AKI differs from one region to another, the condition is common among the critically ill, with a large proportion of cases surfacing early during an intensive care stay^{1,2}.

Even with improvements in supportive management, prognosis in AKI, particularly in those who progress to needing kidney replacement therapy, continues to be unsatisfactory. Recognising patients likely to have a poor outcome at an early stage is therefore important, as it allows clinicians to intervene promptly and tailor management accordingly³.

Platelets are central to haemostasis, and their activation has been shown to worsen renal damage. P-selectin is often described as the reference-standard marker of platelet activation, but its cost and the specialised

laboratory setup it demands limit its routine clinical use. Mean platelet volume (MPV), by contrast, is generated automatically as part of a standard complete blood count and is widely used as a surrogate indicator of platelet function and turnover. Larger platelets are more metabolically active, releasing greater amounts of thromboxane-A₂, β -thromboglobulin, and various adhesion molecules. Experimental evidence indicates that during ischemia-reperfusion injury of the kidney, DNA released from necrotic cells triggers platelet activation and platelet-granulocyte crosstalk, promoting neutrophil extracellular trap formation that further amplifies renal inflammation and tissue injury⁴.

Growing insight into the pathophysiological mechanisms underlying AKI over the past decade has driven the search for novel biomarkers, yet translation of most of these into everyday clinical practice remains constrained⁵.

Platelets can modulate their own activity through changes in granule morphology and content release. MPV is particularly informative in this regard, since heightened platelet turnover secondary to the underlying inflammatory process is a near-universal feature regardless of the specific pathology driving AKI.

In sepsis, platelet activation together with a heightened inflammatory response contributes substantially to the onset of AKI. An inverse relationship between platelet count and MPV has been repeatedly documented in critically ill patients, and several authors have proposed that evaluating both parameters together carries more clinical weight than either alone. This has led to interest in the MPV-to-platelet-count ratio (MPR) as a potential indicator linked to AKI.⁶⁻⁷

MPV denotes the mean size of circulating platelets as measured by an automated cell counter, with reference values conventionally cited as 7.2–11.2 fL.⁸

If MPV can be validated as a reliable predictor of outcome in AKI, it would offer a distinct advantage over serum creatinine as a simple, inexpensive, and readily available marker.

Aims and Objectives

Aim of the study is to study Mean Platelet Volume and related indices (MPV to platelet count ratio and RDW) as prognostic markers in AKI patients.

Objectives:

1. To study the correlation of Mean Platelet Volume and related indices in patients with Acute Kidney Injury.
2. To assess the diagnostic and prognostic significance of these indices with mortality in AKI.

Material and Methods

This was a prospective observational study conducted in the Department of Nephrology, Sri Aurobindo Medical College and PG Institute, Indore(M.P.) after obtaining approval by the institutional ethical committee. The study was conducted during the period from May 2023 to June 2024.

Inclusion Criteria

Adult patients aged more than 18 years admitted in Sri Aurobindo Institute Of Medical Sciences and PG Institute, Indore with the diagnosis of Acute kidney injury as per Kidney Disease: Improving Global Outcomes (KIDGO) guidelines and given consent for study were included in this study.

Exclusion Criteria

Patients with

1. Chronic Kidney Disease(CKD)
2. On Hemodialysis

3. Hematological disorders
4. Patients on chemotherapeutic agents or drugs causing bone marrow suppression
5. History of platelet transfusion within 24 hours
6. Chronic smokers
7. Patients on Anticoagulants or Antiplatelet therapy.
8. Failure to give written consent for participation in the study.

The clinico-epidemiological data of patients were recorded in a prestructured proforma. The cause was noted in each patient. The duration of hospital stay, need for dialysis, the number of days in the hospital and patient outcome were noted. A complete hemogram including mean platelet volume (MPV), MPV to Platelet count Ratio, Red cell distribution width, neutrophil ratio(NLR), and Hemoglobin was recorded.

AKI was diagnosed as per KIDGO guidelines.

All patients with confirmed diagnosis of AKI without any exclusion criteria were included. The data collected was entered and analyzed using SPSS version 22.0. Comparison between the two groups were done by students unpaired t test. Correlation between MPV, RDW and other variables were done by Pearson coefficient of correlation.

P<0.05 was considered significant.

Result

A total of 300 cases were included during the study period. The mean age of the patients was 47.89 ± 10.12 years. Among 300 patients, 207 patients (69%) were male and 93 patients (31%) were female with male to female ratio of 2.22:1. The majority of patients with AKI had cause of sepsis (45%) followed by hepatorenal syndrome. (17%) It was observed that most of the patients were in Stage 3 AKI (53.67%) (Table 1)

Table 1: Distribution according to cause and stage of AKI:

Parameter		No. of patients (n=300)	Percentage
Cause of AKI	Sepsis	135	45.00
	Hepatorenal syndrome	51	17.00
	Acute gastroenteritis	39	13.00
	Dengue	23	07.67
	Cardiac failure	17	05.67
	Glomerulonephritis	11	03.67
	Toxins	09	03.00
	Post renal obstruction	08	02.67
	Others	07	02.33
Stage of AKI	Stage 1	33	11.00
	Stage 2	106	35.33
	Stage 3	161	53.67

Table 2: Association of demographic characters and MPV among patients:

Variables		Mean MPV ($\pm$ SD)	P value
Age (years)	<40	8.88 $\pm$ 1.38	0.73
	$\geq$ 40	9.17 $\pm$ 1.62	
Gender	Male	8.65 $\pm$ 1.43	00.11
	Female	9.52 $\pm$ 1.89	

Table 2 shows association of demographic characteristics and MPV values among patients. It was observed that age and MPV showed no statistical significance. There was no association of gender with MPV. ($P>0.05$). Among 300 patients, 73 (24.33%) patients died in the hospital. Among these, 36 patients had cardiac disease, 30 had diabetes mellitus, 4 were hypertensives, 2 had history of old CVA and 1 had Chronic Liver Disease.

Table 3: Associated Comorbidities

Associated Comorbidities	Cohort
Diabetes Mellitus	85(28.3%)
Hypertension	102(34%)
Chronic Liver Disease	22(7.3%)
Cardiac Disease	63(21%)
Hypothyroidism	18(6%)
CVA	10(3.3%)

Table 4: Association of outcome with MPV, RDW and MPR

Variables		Mean MPV	P value	Mean RDW	P value	Mean MPR	P value
Dialysis Required	Yes	8.12 ± 1.72	0.002	15.94±1.84	0.03	9.7±3.36	0.03
	No	9.89 ± 1.18		13.3±1.54		7.82±3.45	
Outcome	Survived	9.86 ± 1.78	0.003	15.54±1.63	0.02	9.13±3.36	0.042
	Died	8.23 ± 1.18		16.9±1.85		11.73±3.21	
Stage of AKI	Stage 1	9.88± 1.17	0.003	15.4±1.84	0.03	9.15±2.85	0.04
	Stage 2	8.10 ± 1.71		16.8±1.67		9.89±3.24	
	Stage 3	7.13 ± 1.65		17.3±1.45		11.24±3.24	

The above table no. 4 shows association of outcome with MPV, RDW and MPR. It was observed that MPV among dialysis required and not-required was 8.12 ± 1.72 and 9.89 ± 1.18 and showed statistical significance difference. MPV among survived patients was more (9.86 ± 1.78) compared to died patients (8.23 ± 1.18) with significant association. (P<0.05). MPV was significantly lower in Stage 3 AKI compared to Stage 1, with a statistically significant difference.

It was observed that RDW among dialysis required and not-required was 15.94 ± 1.84 and 13.3 ± 1.54 and

showed statistical significance difference. RDW among survived patients was less (15.54 ± 1.63) compared to died patients (16.9 ± 1.85) with significant association (P 0.042). RDW was significantly higher in Stage 3 AKI compared to Stage 1, with a statistically significant difference. MPR showed statistical significant difference among patients who dialysis required (9.7±3.36) and patients who did not required dialysis (7.82±3.45). MPR was significantly higher in Stage 3 AKI compared to Stage 1, with a statistically significant difference.

Table 5: Correlation of MPV and various comorbidities among patients:

Comorbidities	Present/Absent	Mean±SD	P Value
Diabetes Mellitus	YES	8.42±1.14	<0.005
	NO	9.1±1.18	
Hypertension	YES	8.65±1.24	<0.001
	NO	9.85±1.76	
Chronic Liver Disease	YES	8.10±1.73	<0.001
	NO	8.88±1.34	
Cardiac Disease	YES	7.42±1.23	<0.0005
	NO	8.87±1.65	
Hypothyroidism	YES	7.98±1.24	0.89
	NO	8.56±1.2	
CVA	YES	8.76±1.56	0.45
	NO	8.99±1.87	

Table 6: Correlation of MPV and variables among patients:

Parameters	Pearson correlation (R)	P-value
Age	0.028	0.581
Hemoglobin	0.098	0.068
RDW	-0.076	0.381
Urea	0.134	0.012*
Creatinine	-0.291	0.001*
Platelet	-0.321	<0.0001 *
Hospital stays	-0.359	<0.0001 *

The table no. 6 showed that, the correlation of MPV and variables among patients with AKI. It was observed that serum creatinine, platelets and hospital stay showed strong significant negative correlation with MPV. Age, hemoglobin and RDW showed no correlation with MPV.

Discussion

This prospective observational study evaluated the prognostic utility of mean platelet volume (MPV) and related platelet indices in adults with acute kidney injury treated at a tertiary care centre.

Most participants were middle-aged, with a predominance of male patients. The demographic profile was broadly comparable with that reported in previous studies evaluating MPV in AKI.

Sepsis (45%) was the leading cause of AKI in our cohort, followed by hepatorenal syndrome, and more than half of the patients presented with Stage 3 AKI (Table 1). These observations are consistent with results of Venu Gopala et al¹, where sepsis was the leading cause of AKI. However in a study by Goswami S et al¹⁹ among the medical causes, hypoperfusion (57.4%) was the most common cause of AKI followed by sepsis (26.69%). Lower MPV values were associated with dialysis requirement and in-hospital mortality, suggesting that reduced MPV may reflect greater disease severity.

MPV demonstrated significant inverse correlations with serum creatinine, platelet count, and duration of hospital stay, whereas no meaningful association was observed with age, haemoglobin, or RDW in our cohort. A study by Gunluoglu G et al [5] reported a moderate ($r=0.25$) and statistically significant ($p = 0.015$) inverse correlation between MPV and platelet count in healthy controls whereas in patients with PTB, there was an inverse relationship between these parameters, but it was not statistically significant ($p = 0.8$). In a study by Kapsoritakis et al¹⁴ mean platelet count was increased in patients with active compared to inactive ulcerative colitis ($p < 0.05$), and in patients with active compared to inactive Crohn's disease ($p = 0.0002$) or healthy controls ($p < 0.0001$). On the other hand, mean platelet volume was significantly decreased in patients with active compared to inactive ulcerative colitis ($p = 0.02$) or healthy controls ($p < 0.0001$), and in patients with active compared to inactive Crohn's disease ($p = 0.0005$) or healthy controls ($p < 0.0001$). Mean platelet volume was inversely correlated with the white blood cell count ($r = -0.17$, $p = 0.02$), C-reactive protein ($r = -0.46$, $p = 0.009$) and erythrocyte sedimentation rate ($r = -0.28$, $p = 0.008$). Reduced MPV during severe inflammatory states may result from preferential consumption of larger, more active platelets at sites of inflammation together with alterations in megakaryocyte function and platelet production.

Our finding that a lower MPV was associated with dialysis requirement, higher AKI stage, and in-hospital death is in keeping with the observations of Venu Gopala et al¹, who similarly reported MPV as a useful prognostic factor in AKI. Kumar et al¹⁰, in a comparable cohort of AKI patients, likewise found significantly lower MPV among those who died compared with

survivors, and identified an optimum cut-off value close to that observed in our study, with good sensitivity and specificity for predicting a fatal outcome. A paediatric study by Yousefichaijan et al¹¹ reported a similar direction of association, reinforcing that a fall in MPV, rather than a rise, tracks with a poorer renal outcome across different age groups. In contrast, Han et al¹², studying AKI patients who required continuous renal replacement therapy with predicted mean MPV >10.2fL was associated with 28 -day all-cause mortality. This is in contradiction with our study because we have a negative correlation of MPV with requirement of dialysis. This discrepancy may reflect differences in the study populations, as their cohort comprised critically ill patients already established on renal replacement therapy, in whom extracorporeal circuits and heparin exposure could influence platelet size, whereas our cohort included AKI patients across all stages of severity with MPV recorded closer to presentation. Such differences underscore that the relationship between MPV and outcome in AKI may vary with disease severity, aetiology, and the timing of sample collection, and highlight the need for serial MPV measurements in future studies to clarify its trajectory over the course of illness.

Studies have found a positive correlation between RDW and MPV in AKI patients, indicating that as RDW increases, MPV also tends to increase. ^[13,14] The correlation between RDW and MPV has been linked to the severity of AKI, with higher values associated with more severe kidney injury. Some studies suggest that the combination of RDW and MPV may have predictive value for AKI outcomes, such as mortality or dialysis requirement.

Studies have also described a relationship between platelet count and MPV in both pathological and physiological conditions, suggesting that the body tends to maintain haemostasis by regulating the platelet mass. ^[15] In inflammatory conditions, a high rate of platelet production combined with a lack of time for growth can lead to the accumulation of large platelets at sites of inflammation, which are rapidly used up. Liu et al¹⁵ likewise reported a significant decrease in MPV with Crohn's disease compared with healthy controls ($P < 0.0001$), but statistical difference was not found between active and inactive crohn's disease groups. ^[16] These rapid changes in platelet size and number may be due to the actions of prothrombotic and pro-inflammatory mediators in platelets and the role of platelet granules in sympathetic activation and stress of exercise. ^{17,18,19}

The present study had various limitations like single-centre analysis, lack of control group, lack of long-term follow-up, lack of analysis of confounding factors, and no assessment of the underlying mechanisms. However, the inclusion of etiologies was one major strength of this study. This is especially important in the Indian context where the etiologies vastly differ from developed countries. Therefore, to gain a better understanding of AKI, we suggest conducting large-scale, multi-centric studies focused on the etiology of AKI.

Conclusion

The study concludes that MPV among patients with AKI is strongly associated with mortality. MPV had significant correlation with serum creatinine, platelets and hospital stay. MPV is an inexpensive and practical marker that may predict the outcome of patients with AKI.

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