ORIGINAL RESEARCH

Mean Platelet Volume- A Useful Marker in Predicting Prognosis of Acute Kidney Injury in children

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ABSTRACT

Introduction: Acute Kidney Injury (AKI) is more common in critically ill children. Early identification and prompt management is needed as acute kidney injury is associated with poor outcome. It becomes essential for a reliable prediction tool to quantify the disease. Our goal was to study the mean platelet volume (MPV) and platelet distribution width (PDW) as a prognostic predictor of AKI in children. **Material and Methods:** A prospective observational study which included children aged 1 month to 12 years admitted to Paediatric intensive care unit(PICU) of a tertiary care teaching hospital, Madurai over a period of 1 year. Completebloodcountincluding Mean Platelet Volume and other laboratory investigations were measured and compared. P-RIFLE criteria was used to classify AKI severity. **Results:** A total of 342 children were included in the study. The incidence of AKI was 30.1%. Risk, Injury and Failure categories included 34%, 30% and 36% respectively.MPV value of <8.5 was associated with poor renal functions with sensitivity 71.3% and specificity 88.4%. AUC was 0.84 (95%CI, 0.80 – 0.88). Thrombocytopenia was not associated with poor prognosis in AKI. **Conclusions:** Our study reveals that increase in MPV is associated with poor outcomes in Acute kidney injury patients. Therefore, including MPV in risk quantification of AKI would be beneficial in managing patients.

Keywords: Acute Kidney Injury,Mean Platelet Volume, Platelets, Prognosis.

INTRODUCTION

AcuteKidney Injury(AKI) is more common, especially amongchildren indeveloping countries (1). Acute kidney injury results from an abrupt reduction in glomerular filtration rate (GFR) and tubular function. This leads on to a decreased waste product excretion which alters the body fluid homeostasis. A classification system exists to standardise the definition of Acute kidney injury based on serum creatinine, changes in glomerular filtration rate and urine output called p-RIFLE (2). P-RIFLE considers three severity classes of AKI (Risk, Injury and Failure) and two outcome classes (Loss of kidney function and End-stage kidney disease). In developing countries like India, high mortality rates have been consistently reported in critically ill children with AKI (3,4). Therefore, it is crucial, to detect the development of AKI as early as possible and to initiate containment measures. This urges the researchers to ensure discovery of a rapid, easily accessible and least expensive biomarker which quantifies the severity of AKI.

From literature, it is clear that platelets are markers of inflammation. This is supported by the fact that platelet turnover in the bone marrow increases with inflammation (5). Mean platelet volume (MPV),which is commonly used as a measure of platelet size, indicates the rate of platelet production and platelet activation. The normal range for MPV is between 7.2 – 11.2 fL (6). Increase in the MPV indicates platelet activation, platelet aggregation and a resulting prothrombotic state (7).Inflammatory bowel

disease, immune thrombocytopenic purpura(ITP), myeloproliferative diseases and Bernard-Soulier syndrome are few conditions with increased MPV. Low MPV values usually correlate with thrombocytopenia.These changes may represent organ injury and adverse outcomes. MPV is easily available with routine blood tests and might serve as a simple method of assessing platelet function. This study aims to use MPV as a marker to predict the prognosis of Acute kidney injury in children admitted to critical care units.

MATERIALSAND METHODS

A prospective observational study which included critically ill children aged 1 month to 12 years admitted to Paediatric Intensive care Unit (PICU) of a tertiary care teaching hospital, Madurai, India over a period of 1 year. Institutional ethical committee clearance was obtained. Patients with known chronic kidney disease, bilirubin level >5 mg/dl were excluded from the study. Sample size was calculated using the formula $4pq/d^2$, where p=30 and d=5. The study subjects were enrolled consecutively until the sample size was achieved. Data collected includes demographic information, admission diagnoses/final diagnosis and co-morbidities, serum creatinine at the time of admission, other hematological and metabolic parameters. The data collected regarding all the selected cases were entered in Microsoft excel sheet 2010. Results were analyzed using the SPSS version 19. Continuous data were reported as mean ± SD (if normally distributed) and median (range) (if non-normally distributed). Categorical variables were expressed as proportions. The incidence of AKI was defined as its occurrence as a proportion of total admissions. P value of <0.05 was considered significant.

RESULTS

A total of 342 children were included into the study, of which 103 children developed AKI using p-RIFLE classification giving an incidence of 30.1%. The study population included 198 (57.9%) males and 144 (42.1%) females. Of the 103 children who developed AKI, 58 (56.3%) were males and 45 (43.7%) were females as shown in table I. The median age in children with AKI was 36 months. According to p-RIFLE classification, 35 (34%) children were included in Risk category, 31 (30.1%) were included in the Injury category and 37 (35.9%) were included in the Failure category as shown in table II. Three cases of Risk category progressed to Injury category and three cases to Failure category while one case from Injury category progressed to Failure category. The mean level of maximum creatinine value in AKI children was estimated to be 2.1±1.7 mg/dl.

The most common cause of AKI in our study was sepsis (58.3%). Other causes included cardiac diseases (8.7%), snake envenomation (6.8%). Few other conditions included scorpion sting, nephrotic syndrome and acute glomerulonephritis as shown in table III. Mean duration of stay among the children who developed AKI (n=103) was 9.4 ± 4.5 days as against 5.6 ± 3.2 days stay in children without AKI.Anemia was present in 55.7% patients with AKI. Thrombocytopenia was observed only in 23.6% patients with AKI. The overall mortality from AKI was 43.7% as shown in table IV. Renal replacement therapy was given to 28 (27.2%) children.

MPV values were 7.76 ± 1.3 in the AKI group and of the non AKI group was 10.64 ± 8.07. MPV <8.5 predicted the progression of AKI in children with a sensitivity of 71.3% and specificity of 88.4% as shown in table V. Our study had an AUC of 0.84 (95% CI 0.80 – 0.88). Further, MPV was found to be low in patients with loss and failure criteria of AKI compared to other criteria.

TABLE I: SEX DISTRIBUTION

SEX	AKI	NON-AKI	TOTAL
MALE	58 (56.3%)	140 (58.6%)	198 (57.9%)
FEMALE	45 (43.7%)	99 (41.4%)	144 (42.1%)
TOTAL	103 (100%)	239 (100%)	342 (100%)

TABLE II: CASE DISTRIBUTION BY p-RIFLE CRITERIA

RIFLE CLASSIFICATION	CASES
RISK	35 (34%)
INJURY	31 (30.1%)
FAILURE	37 (35.9%)
TOTAL	103 (100%)

TABLE III: ETIOLOGICAL FACTORS OF AKI CASES

ETIOLOGY	N (%)
Infections	60 (58.3%)
Cardiac causes (Congenital heart disease and Congestive Cardiac Failure)	9 (8.7%)
Snake envenomation	7 (6.8%)
Surgical causes (PUJ obstruction, Hydroureteronephrosis, Hypoplastic kidney, Ewings sarcoma)	5 (4.9%)

Acute Glomerulonephritis	4 (3.9%)
Scorpion sting	4 (3.9%)
HUS d+	3 (2.9%)
Nephrotic syndrome	3 (2.9%)
Poisoning (Organophosphorus, Abrusprecatorius, Native Medication)	3 (2.9%)
Status Epilepticus (Seizure disorder, Febrile Seizures, Toxin induced)	2 (1.9%)
Diabetic Ketoacidosis	2 (1.9%)
Acute severe asthma	1 (0.9%)

TABLE IV: MORTALITY IN AKI

RIFLE CLASS	SURVIVORS	DEATH	TOTAL	ODDS RATIO	95% CI	P value
RISK	22 (62.9%)	13 (37.1%)	35 (100%)	0.537	0.20-1.42	0.209
INJURY	19 (61.3%)	12 (38.7%)	31 (100%)	0.502	0.19-1.28	0.152
FAILURE	17 (46%)	20 (54%)	37 (100%)	1.863	0.70-4.91	0.209
TOTAL	58 (56.3%)	45 (43.7%)	103(100%)			

TABLE V: PERFORMANCE OF MPV<8.5 IN PREDICTION OF PROGNOSIS OF AKI

DATA	OUR STUDY
SENSITIVITY %(95% CI)	71.3 (62.2 – 78.3)
SPECIFICITY %(95% CI)	88.4 (74.1 – 95.8)
AUC (95%CI)	0.84 (0.80– 0.88)

DISCUSSION

In this study, we aimed to find the correlation between MPV and progression of AKI in children. The incidence of Acute Kidney Injury in critically ill children admitted to PICU in our institute was found to be 31% using p-RIFLE criteria. The incidence in this study was comparable with a study done by Srinivasa S et al (8), where the incidence was reported to be 26.1%. Of the 103 children who developed AKI, 58 (56.3%) were males and 45 (43.7%) were females. In the study by Sriram Krishnamurthy et al (9), among the AKI population, 53.7% were males and 46.3% were females which was comparable. The length of stay in hospital was higher in Acute Kidney Injury group. Similar observations were made in studies done by Shweta naik et al (10). In our study, the mortality from AKI was found to be 43.7% which was comparable to a study done by Martin et al (11), where the mortality was found to be 44%. In our study, a total of 28 children (26.4%) required dialysis in the form of peritoneal dialysis. In a study by Sriram Krishnamurthy et al (9), a total of 27.8% required dialysis which was comparable. Our study reported a lower MPV value in patients with AKI when compared to non AKI patients. Similar observations were made by Manish Kumar et al (12) in their study and reported lower MPV values in AKI patients who required dialysis and in patients who required prolonged stay in hospital. Yousefichaijan P et al (13) also reported lower MPV values in patients with AKI. Beyazit Y et al (14), in their study on the correlation between MPV and severity of inflammation in acute pancreatitits found that a lower MPV was associated with more severe pancreatitis. Yousefichaijan P et al (13) found that MPV values <8.2 was associated with poor outcome. In our study, MPV <8.5 was significantly associated with poor outcomes with a sensitivity of 71.3% and specificity of 88.4%.

In response to any type of inflammation, platelets tend to increase as an acute phase reaction (15). This elevation may represent an interleukin mediated increased activity of bone marrow cells during the inflammatory phase (16). During these inflammatory episodes, the rate of production of platelet and the lack of time for its growth leads on to aggregation of large platelets at the site of inflammation (17). These accumulated platelets are taken up rapidly which may be due to the actions of prothromboticand pro-inflammatory mediators in platelets and to some extent due to the role of platelet granules in sympathetic activation (18).

Our study had few limitations like single centre observational study, small sample size, no control group, lack of long term follow up and lack of estimated assessments of underlying mechanisms. We suggest to conduct large scale multi centric studies to evaluate the underlying mechanisms in using MPV as a prognostic marker in AKI

CONCLUSION

In our study, we found that MPV is a valuable marker in predicting the prognosis of acute kidney injury patients and a useful clinical tool in management of these patients. However, more extensive research is warranted to confirm these findings and to evaluate the underlying mechanisms linking MPV to acute kidney injury.

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