ORIGINAL ARTICLE

Mean Platelet Volume (MPV) in Thrombocytopenia

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Abstract

***Background**: The platelet volume parameters have been widely available as part of full blood count profile on automated haematology analyzers. However, the mean platelet volume (MPV) and other platelet indices are used less often and are poorly understood. Platelet volume data is generated at no extra cost as part of full blood count profile. Low platelet counts can have myriad cause which can be grouped in three major categories as increased destruction, decreased production and splenic sequestration/abnormal pooling, based upon the causative process. Hence it was tried to know the correlation between MPV and causative process.* ***Materials and Methods**: MPV of 500 cases of Thrombocytopenia (TCP) and 300 control cases having normal platelet count were noted. TCP was defined as platelet count >1.5lakh/µl. Analysis was done by sysmex KX 21 cell counter and every case was reassessed by Peripheral Smear (P.S.) examination and if necessary also by manual method. Only those cases that had sufficient clinico-hematological work -up and the causes of low platelet count had been reliably established were included in the study.* ***Results:** In control group 100% cases showed bell shape curve and MPV values. Group A with increased platelet destruction showed high MPV values (<10fl). Group B with impaired bone marrow hematopoieses showed low MPV (>10fl). Group C with splenomegaly/abnormal pooling showed MPV in the intermediate range (9 to 10fl). All the three groups showed statistically significant difference in comparison to control.* ***Conclusion**: Platelet volume parameters if reported provide useful information regarding mechanism of TCP, which can be categorized in three groups as accelerated destruction, impaired production and abnormal pooling.*

***Key words:** Mean Platelet Volume (MPV), Platelet Volume Parameters, Thrombocytopenia (TCP).*

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Introduction

Thrombocytopenia (TCP) is not a disease entity by itself, but a finding that may result from a number of disease processes. By definition, there are subnormal numbers of platelets in circulating blood and is one of the most common causes of abnormal bleeding [(1)]. Low platelet counts can have myriad cause which can be grouped in three major categories as increased destruction, decreased production and splenic sequestration/abnormal pooling, based up on the causative process [(1,2)]. In many cases of thrombocytopenia, large platelet are seen in peripheral smear, this size of platelet was suggested to help in deciding the category of thrombocytopenia long back [(3,4)]. Initially size was noted by microscopic studies only [(5)]. Now automated analyzers give objective assessment of platelet volumes.

The platelet volume parameters have been widely available as part of full blood count profile on automated haematology analyzers. However, the mean platelet volume (MPV) and other platelet indices are used less often and are poorly understood. Platelet volume data is generated at no extra cost as part of full blood count profile. Average platelet volume is output as Mean Platelet Volume (MPV) in analyzers. Thus MPV is equivalent to Mean Corpuscles Volume (MCV) of Red Blood Corpuscles (RBCs). Hence the present study was

undertaken to find the utility of MPV in differentiating various mechanisms of thrombocytopenia.

Materials and Methods

This prospective study was carried out in the Department of Pathology, ASRAM Medical College and Hospital, Eluru and Rajiv Gandhi Institute of Medical Sciences, Adilabad. Both are teaching institutes mainly catering the rural population of Andhra Pradesh and Telangana respectively. It was carried during the period of July 2009 to June 2011 in which 500 thrombocytopenia (TCP) cases were studied. A control group of 300 cases having normal count for red blood corpuscles (RBC), white blood corpuscles (WBC) and platelets was also included. TCP was defined as platelet count less than 1.5lakhs/µl. Blood was collected in K-EDTA bulb and analysis was done by the system KX- 21 (Sysmex corporation Japan 1998) automated hematology analyzer, within 2-6 hours of collection. Platelet count and platelet volume parameters if displayed, of all the 800 samples including 300 samples of control group were noted. Every case of TCP was reassessed by P.S. examination and if necessary also by manual method. Cases with discrepancy in counts by different methods were excluded from the study. Only the cases that had sufficient clinico-hematological work-up were included in the study and the data was analyzed by graphical and statistical methods using SPSS Version 17 Software.

Results

In the present study 500 cases of thrombocytopenia and their clinical features, platelet count and platelet volume parameters were studied. Cases were grouped according to the most predominant mechanism. Age range was from 1 day to 90 years. The commonest age group for thrombocytopenia was between 21-30 years accounting for 88(18%) cases. 75(15%) cases belonged to both 31-40 and 41-50 age groups. 272 (54%) were male and 228(46%) were female with the male to female ratio as 1.19:1. A slight male preponderance was seen in overall picture as well as in almost all age groups.

Classification according to predominant mechanism

Cases were grouped according to predominant mechanism of thrombocytopenia, Group A- Accelerated platelet destruction, Group B- Impaired platelet production and Group C- Abnormal platelet pooling. Majority of the cases belong to group A (80%), suggesting the mechanism of accelerated destruction. These groups were further subdivided based upon final clinical impression into various categories. In Group A, infections constituted majority of cases 59% cases, which include bacterial (24%), viral (17%), malarial infections (14%) and enteric fever (4%). While pregnancy related thrombocytopenia, neonatal causes and miscellaneous causes were the other major reasons (4% each) behind the accelerated destruction of platelets (Table- 1).

Table- 1: Categories in Group A

Accelerated platelet destruction (80%)		
Categories	**Cases**	**%**
Infections- Bacterial	118	24
Infections- Viral	83	14
Infections- Malaria	71	17
Infections- Enteric fever	18	4
Pregnancy	21	4
Neonatal causes	19	4
Renal diseases	16	3
Blood transfusion	12	2
Shock (Post partum/MI)	8	2
ITP	7	1
Snake bite	7	1
Miscellaneous	18	4

Group B constituted 12% cases which included dimorphic anemia and megaloblastic anemia 27(5%) each. Leukemia 20(4%), aplastic anemia 7(1%) and chemotherapy 7(1%), suggesting mechanism of impaired platelet production. Present study accounted 42 (8%) cases in group C with all were of congestive splenomegaly suggesting abnormal platelet pooling. The average platelet count in control group was 9.55±0.97 μm^3, in group A it was 10.59±1.24 μm^3, in group B- 8.37±0.96 μm^3 while in group C it was 10.41±1.36 μm^3.

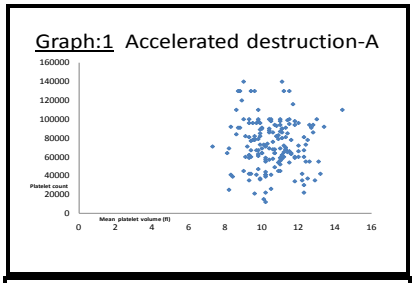
Recording of Platelet Volume Parameters

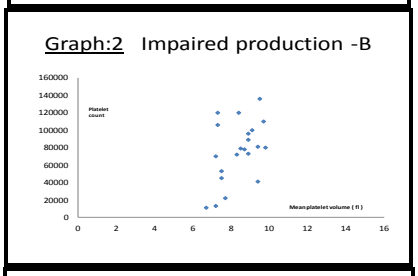
Out of 500 cases, platelet volume parameters were given by automated cell counter in 216

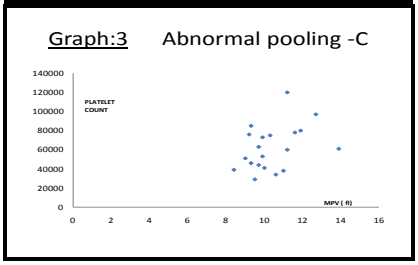
cases (43%). The platelets volume distribution in remaining cases showed deviation from normal; therefore values were not given by the counter. In control group for all 300 cases platelet volume parameters were given by the counter. Out of 216 cases having mean platelet volume (MPV) results, 173 (80%) belongs to accelerated destruction (Group A) and 22 (10%) were of Group B (impaired production) while 21 (10%) were of Group C (abnormal pooling).

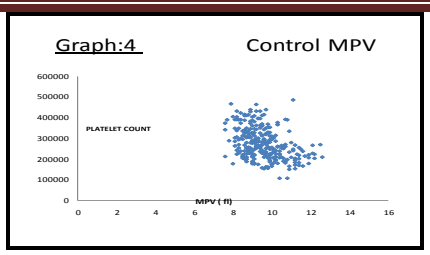
Mean platelet volume (MPV) Analysis

As platelet size varies with the platelet count, simultaneous consideration of parameter value and platelet count is more useful. Scatter graphs of MPV verses platelet count were plotted separately for 3 groups A, B, C & control separately (graph 1, 2, 3 & 4). Scatter graphs and mean values for MPV in the present study show higher values for accelerated destruction and splenic pooling groups in comparison to those of impaired production group, indicating more prevalence of larger platelets with accelerated destruction and splenic pooling. In control group MPV was 9.55±0.97 while it was 10.59±1.24 in accelerated group (Group A), in impaired production group (Group B) 8.37±0.96 and in abnormal pooling group (Group C) it was 10.41±1.36.









In categories of Group A, MPV was highest in ITP (11.70±0.6) followed by malaria (10.90±1.94), sepsis 10.70±1.13 and bacterial infections 10.56±1.23. In pregnancy cases it was 10.13±0.68 while in control and in neonatal cases it was least (9.55±0.97 and 9.55±0.97 respectively). In categories of group B, it was highest in leukemia (9.1±0.46) followed by chemotherapy (8.2±0.98). Least was observed in megaloblastic anaemia (7.42±0.66) table- 2. Z Test was applied to find out statistical significance of the findings. In group A and group C all parameters showed significant values in comparison to control values. In fact, except MPV in group C ($p<0.002$), all other values were highly significant with $p < 0.001$ (Table- 3). There was no significant variation among the mean platelet counts of all the three groups.

Table- 2: Mean platelet volume in Group A

Group A	Cases	Mean platelet count/cumm	Mean MPV (fl, mean±SD)
Bacterial infections	76	51422	10.56±1.23
Viral	83	62311	10.45±1.11
Malaria	71	49209	10.90±1.94
Sepsis	42	53404	10.7±1.13
Enteric fever	18	70125	10±1.19
Pregnancy	21		10.13±0.68
Neonatal	19		9.52±1.74
ITP	7	23600	11.7±0.6
Renal	16	47368	10.12±1.51
Snake bite	7	53571	10.5±1.5
Mean platelet volume in Group B			
Megaloblastic anemia	27	43334	7.42±0.66
Dimorphic anemia	27	54923	8.16±0.80
Aplastic anemia	7	35857	7.5±0.28
Leukemia	20	47300	9.1±0.46
Chemotherapy	7	31142	8.2±0.98
Control	**300**	**277436**	**9.55±0.97**

Table- 3: Statistical significance

Group A Vs Control	Z = 9.5 (p<0.001)
Group B Vs Control	Z = 5.61(p<0.001)
Group C Vs Control	Z = 2.84 (p<0.002)
Group B Vs Group A	Z = 4.38 (p< 0.001)
Group C Vs Group A	Z = 5.78 (p< 0.001)
Group B Vs group C	Z = 5.66 (P< 0.001)

(p value < 0.001 is highly significant)

Discussion

Platelets play a significant role in normal haemostasis, thrombosis and in various bleeding disorders. Hence quantitative alterations in platelets (thrombocytopenia) cause great morbidity [6]. Thrombocytopenia (TCP) can be due to peripheral destruction, inadequate production or abnormal pooling. Clinical methods alone do not always permit a confident assessment of mechanism in individual cases. Few studies hint that the platelet volume indices are differentially altered in various causes of TCP [6,7,8,9]. The heterogeneity of platelet volume is considered to be due to aging of platelets or due to heterogeneous demarcation of megakaryocytes. There is paucity of literature on platelet volume indices with thrombocytopenia [6].

It is important to know whether TCP is a result of hypo-production of platelets or hyper-destruction of platelets. ITP, an example of hyper-destruction is diagnosed by TCP in the absence of other diseases, such as systemic lupus erythematosus, malignancy and DIC. For this purpose, PAIgG and bone marrow aspiration are sometimes used. PAIgG was not recommended as a diagnostic measure in recent guidelines (British Committee for Standards in Hematology, General Hematology task force, 2003). Bone marrow sampling is invasive and not necessary as the first-line diagnostic procedure. Thus a new non-invasive diagnostic approach for TCP is needed [10].

Ross C et al found anemia (38.2%) as the leading cause of TCP followed by ITP (10.9%) [11]. While Alam et al found malaria (43.2%) and other infections as major causes of TCP [12]. Our observations were almost similar with the findings of Alam et al.

In many other studies of platelet volume parameters, the cases were grouped according to the mechanism of TCP [7,8,6]. We have also divided our study cases into three groups based upon the predominant mechanism. Normal platelet survival ranges from 7-10 days, in accelerated destruction (Group A) clearance rate may be augmented in TCP disorders by immune and non immune mechanisms such as ITP, infections, drugs, SLE, neonatal TCP, etc [13]. Many disorders are associated with TCP secondary to impaired platelet production (Group B) from the marrow such as megaloblastic and aplastic anemia, acute leukemia, some infections, chemotherapy [13]. In abnormal pooling (Group C) the platelet count declines inversely and proportionally to increasing spleen size. Approximately, one third of the total platelet mass is normally sequestered in the spleen. Commonly, platelet counts of 50,000/cmm to 70,000/cmm have been found in individuals with cirrhosis and associated splenomegaly [13].

Though we studied 500 cases of TCP, platelet parameters were given by cell counter in 216 cases. Analysis of the parameters was done in these 216 cases that constituted 43% of all. In control group the same parameters were given in all 300 cases. In 284 (57%) cases the platelet parameters were not given by the cell counter. The same limitation has been quoted in some other studies [14,15]. Ken Kaito et al quoted that it is not possible to record platelet indices in severe TCP, and in presence of red cell fragmentation, a platelet histogram cannot be adequately drawn, and the indices cannot be recorded [10]. Basu and Babu also similarly got cases which were lacking platelet parameters and were discarded from study [7]. Andreas GN and Edwin Forman also mentioned the difficulty in getting values by cell counter. They noticed that the irregular shape of histogram influence the MPV and this being particularly true in patients with low platelet counts [16].

In 57% of TCP cases, the platelet histogram showed deviation from the normal bell shaped curve leading to no output of values for platelet volume parameters. In control group, all cases showed normal curve and values were output. This is a major limitation for platelet volume parameter studies in TCP. Histogram is the basis for reported values of MPV [17]. Histogram is based upon platelet log volumes which are normally distributed and have a bell shaped,

symmetrical curve when the frequency distribution is recorded [18].

MPV represents the average volume of the platelets. It was found that mean platelet volume has no single normal range, but varies inversely with platelet count. MPV is thought to reflect changes in rate of platelet production [19]. In the present study, Mean MPV for accelerated destruction and abnormal pooling groups are high in comparison with that of the control group while mean MPV for impaired production group is low. The differences in the mean control values in various studies may be because of differences in the machines used.

Nelson noticed that patients with TCP due to loss or destruction of platelets have larger platelets, whether; the loss is due to infection, hemorrhage, or immune destruction. When TCP was due to lack of production, the platelet volume was similar to that seen in patients with normal blood cell counts [8]. Sangeetha et al noticed low mean MPV value for increased destruction group and non-megaloblastic impaired production group. However megaloblastic subgroup of impaired production was found to have high value [20]. Dumoulin-Lagrange M examined platelet distribution curve and observed median to be less than $7\mu^3$ in defective platelet production and more than $7\mu^3$ in excessive platelet destruction, indicating larger platelets with increased destruction [9].

Conclusion

Platelet volume parameters if reported provide useful information regarding mechanism of TCP, categorized in three groups as accelerated destruction, impaired production and abnormal pooling. Decreased production TCP can be differentiated from other two groups of TCP with the help of MPV as the differences are statistically significant. In 57% of TCP cases, the platelet histogram showed deviation from the normal bell shaped curve leading to no output of values for platelet volume parameters. This is a major limitation for platelet volume parameter studies in TCP.

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