



“STUDY OF MEAN PLATELET VOLUME IN RELATION TO PLATELET COUNT, PLATELETCRIT, PLATELETDISTRIBUTION WIDTH & PLCR IN HEALTH AND DISEASES”

Pathology

Dr. Inkal Gajera* Assistant Professor *Corresponding Author

Dr. Seema N Baxi Additional professor & I/C head of pathology department

Dr. Rutva Patel MD pathology

ABSTRACT

Introduction: Mean platelet volume (MPV) is a machine calculated measurement of the average size of platelets. It is generated during automated hematology cell counting along with platelet count & other platelet parameters like PCT, PDW, IPF, PLCR depending upon cell counter used. Until now only platelet count was considered important and used clinically. However MPV may be increased or decreased in various pathological conditions and is currently being investigated as a risk and/or prognostic factor for some diseases. **Aims and objectives:** To study Mean Platelet Volume in relation to platelet count and plateletcrit, platelet distribution width & PLCR in health and diseases with specific objectives of determining mean and range of MPV in health & in diseases and determining the relation of MPV in relation to platelet count and other platelet parameters. **Materials and methods:** A prospective hospital based cross sectional study on MPV in health and diseases was done. Range and mean were calculated for MPV in health and diseases. **Result:** The mean and range were 8.3fl and 8.75±1.25fl respectively in health. The mean and range for each category was not established in this study as cases with normal MPV value were excluded from the study. In all conditions MPV values correlated with PLCR and it was directly proportional to the MPV. But other platelet parameters showed no correlation with MPV. There was no range wise correlation of MPV with PC, PCT, PDW. Increased MPV were noted in all cases of viral fever, connective tissue disorders and poison and more than 70% in bacterial condition, COVID cardiovascular diseases, liver diseases and thalassemia cases. **Conclusion:** In present study more than 70% cases of COVID, thalassemia and viral fever other than dengue showed increased MPV, which is new findings among all other studies discussed in present study.

KEYWORDS

Mean Platelet Volume, MPV in health, MPV in disease, Platelet indices.

INTRODUCTION

Platelet indices (PI) are obtained as a part of an automatic blood count. PI are related to platelet's morphology and proliferation kinetics. Most commonly assessed PIs include the mean platelet volume (MPV), platelet distribution width (PDW), platelet-large cell ratio (P-LCR), plateletcrit (PCT). Different cell counters additionally gives immature platelet fragments (IPF)⁽¹⁾. Platelet parameters may alter in both acute and chronic diseases and are considered as markers of platelet activation. Until now only platelet count was considered important and used clinically. However with use of cell counters⁽²⁾, MPV value which is 8.3fl (7.5fl-10.0 fl) in healthy population is found to be increased or decreased in various pathological conditions^(2,3). It is also indicated as a risk and/or prognostic factor for some diseases in association with platelet count like in CVD, cerebral stroke, liver cancer, colorectal cancers etc^{(2),(3)}. Plateletcrit (PCT) measures total platelet mass as a percentage of volume occupied in the blood. The normal range for PCT is 0.22%–0.24%^(1,6). Platelet distribution width (PDW) is a marker of platelet anisocytosis and increases upon platelet activation⁽⁴⁾. Platelet larger cell ratio (P-LCR), is a percentage of platelets with a volume over 12fl in the bloodstream among all platelets. It normally ranges between 15% and 35%⁽⁵⁾.

Platelet indices are recently researched to be applied as potential novel biomarkers in terms of diagnostics and prognosis in various, acute and chronic diseases. PI can be measured inexpensively and are accessible at hand during routine blood counts⁽⁷⁾. Despite many attempts to establish both significant and applicable clinical correlations, these parameters are still not used extensively mainly because of the methodological problems in terms of standardization and determination of reference values⁽⁸⁾. A prospective study was studied in a tertiary care government hospital study of platelet indices was conducted to Study mean platelet volume in relation to platelet count and plateletcrit, platelet distribution width & PLCR in health and diseases with the specific objectives of determining mean and range of MPV in health & in diseases and determining the relation of MPV in relation to platelet count and other platelet parameters in diseases.

MATERIALS AND METHODS

After ethics committee approval an observational cross sectioned study MPV range in healthy population was obtained from 100 blood donor samples collected and run within 4 hours.

For all conservative EDTA samples received in haematology lab for CBC from indoor patients of sir t hospital, Bhavnagar for 10 months

were run. Out of those samples, samples whose MPV value was out of normal range were recorded as cases from July 2020 to April 2021. Along with MPV other platelet parameters were also recorded. Clinical condition and drug history of those cases were taken from case file of patient. Then data was classified according to clinical conditions and tabulated in excel sheet.

Inclusion Criteria-

- For healthy population- Blood donor's samples from blood bank of sir t hospital.
- For diseased population- All consecutive blood samples whose MPV was out of range (Range, which was obtained in healthy population) from indoor patients for CBC in hematology lab of Sir T hospital over 10 months.

Exclusion Criteria:- Samples where history was not available.

RESULT

The MPV range in healthy population (100 blood donors) was 8.75±1.25fl. Further data of samples with low or high MPV was analysed. This comprised 325 cases.

Table 1: Clinical conditions showing decreases MPV.

Conditions	Cases	MPV(fl)		PDW(%)		PLCR(%)	
		%	Range	Me an	Range	Me an	Range
Bacterial	8	22.2	4.5-7.1	6.6	38.1-44.2	39.9	6.3-17.1
TB	4	66.6	6.6-7.0	6.9	37.4-39.6	38.2	11.9-17.2
ANC/PNC	22	41	4.1-7.4	6.5	35-44.2	40.5	7.2-19.9
DM	4	33.3	4.9-7.3	6.7	36.9-44.2	39.8	11.5-18.6
HTN	4	44.4	5.8-7.3	6.8	15.7-18.2	41.9	37.4-44.2
HTN+DM	4	44.4	4.6-7.1	6.1	38-44.2	41.4	12.1-15
CVS	2	13.3	7.0-7.4	7.2	39.4-43	41.4	17.2
Liver	8	27.6	3.9-7.2	5.8	31.2-44.2	39.4	9.4-14.4
Hemate	5	55.6	3.7-6.9	5.5	26.0-44.2	34.0	6.0-8.7
Renal	10	43.5	4.7-7.4	6.7	29.2-44.2	38.2	2.3-17.3
Injury	5	55.6	4.0-7.1	6.4	37.9-44.2	39.7	12.3-15.8
Autoimmune	1	33	4.5	4.5	44.2	44.2	10.2
Dangue	5	41.6	5.7-7.4	6.5	33.0-44.2	36.9	3.7-20.3
Art	16	47	3.9-7.4	6.5	37.7-44.2	40.8	10.1-22.4
COVID	3	17.6	6.4-7.3	7	36.9-39.8	38.3	9.7-17.7
Thal	3	17.6	5.1-7.2	6.5	39.4-44.2	42.2	14.9-18.2
Neonate	1	50	7	7	36.1	36.1	14.8

Table2: Clinical conditions showing increases MPV.

Conditions	Cases	%	MPV(fL)		PDW(%)		PLCR(%)	
			Range	Mean	Range	Mean	Range	Mean
Bacterial	28	77.8	10.5-12.6	11.1	41.4-46.5	43	37.4-68.5	48.6
TB	2	33.3	10.6-10.9	10.8	43.8-45	44	43.03-48.9	45.9
Viral	4	100	10.6-13.8	11.4	44.7-46.2	45.7	45.8-59.9	52.6
ANC/PN C	32	58.5	10.4-12.5	10.9	42-46.5	43.8	38.3-54.3	45.5
DM	8	66.6	10.5-12.3	11.2	42.5-46.8	40.7	43.7-60.7	50.4
HTN	5	55.5	10.7-12.1	11.2	44.3-57.1	44.1	43.3-45.1	50.4
HTN+D M	5	55.5	10.6-12.7	11.4	41.5-50.5	43.9	40.7-49.1	43.9
CVS	13	86.7	10.6-12.6	11.2	41.1-46.1	43.8	40.5-65.0	51.4
Liver	19	72.4	10.6-12.0	11	41.8-46.5	41.3	36.5-57.9	50.1
Hemate	4	44.4	10.6-16.8	10.6	43.7-46.9	43.7	44.1-70.7	44.1
Renal	13	56.5	10.6-13.2	11.5	41.3-46.6	44.7	40.5-62.9	50.5
Injury	4	44.4	10.9-12	11.5	40.7-46.5	43.9	41.4-50.8	48.1
Autoimmune	2	66	10.7-11.3	11	43.7-44.4	44.1	41.6-45.5	43.6
Dangue	7	58.3	10.6-12.9	11.6	34.1-43.1	45.1	51.4-63.2	57.4
Art	18	52.9	10.5-13.7	11.0	35.4-46.5	43.4	41.7-68.1	53.6
COVID	14	82.4	10.6-12.8	11	42.7-47.2	43.8	46.1-64.4	54.4
Thal	14	82.3	10.6-15.4	11.8	41.5-48.5	43.4	40.8-64.9	49.8
CTD	2	100	10.6	10.6	43.3-44.1	43.7	36.5-43.1	39.8
Neonate	1	50	12.6	12.6	45.6	45.6	55.2	55.3
Poison	3	100	10.6-11.4	11.1	43.8-46.8	45.7	42.0-46.2	44.5
Snake Bite	3	100	10.5-10.8	10.6	42.8-43.6	43.5	39.0-42.2	40.7

Table3: Correlation of MPV with other platelet parameters.

MPV RANGE (in fL)	PC RANGE (in lacs/cumm)	PCT RANGE (in %)	PDW RANGE (in %)	PLCR RANGE (in %)
3.7-4.0	0.2-3.0	0.01-0.33	31.4-44.2	9.0-12.3
4.1-5.0	0.4-6.8	0.01-0.33	19.7-44.2	6.3-15.4
5.1-6.0	0.1-9.9	0.01-0.51	26.0-44.2	3.7-18.2
6.1-7.0	0.2-6.0	0.01-0.57	6.0-44.2	2.3-22.0
7.1-7.5	0.8-6.1	0.08-0.76	36.9-43.0	13.52-19.94
10.5-11.0	0.4-5.1	0.06-1.3	15.5-46.2	35.06-62.9
11.1-12.0	0.1-6.5	0.01-0.64	16.8-47.2	32.8-68.1
12.1-13.0	0.6-6.5	0.01-0.89	5.6-47.0	48.7-70.7
13.1-14.0	1.4-5.3	0.03-0.74	12.3-44.9	52.6-61.1
14.1-15.0	-	-	-	-
15.1-16.0	3	0.45	47.3	64.98
16.1-17.0	OVER	3.8	14	-

MPV showed correlation with PLCR, it increases or decreases almost proportionally with MPV. However there was no range wise correlation of MPV with PC, PCT, PDW.

Table 4: Cases in which MPV was higher than 13.0fl present study.

Diagnosis	HB	TLC	DLC	PC	PCT	MPV	PDW	PLCR
Renal Failure	12	9000	75/20/2/3/0	2.8	0.24	13.0	41.3	19.06
Viral Fever	8	7500	65/29/2/4/0	1.9	0.25	13.1	44.7	58.74
Gaucher's Disease	8	18000	69/25/3/3/0	1.6	0.03	13.1	12.3	58.71
AKI	12	9000	72/23/1/4/0	3.8	0.17	13.2	44.9	61.11
ART	12.5	5600	69/25/3/3/0	3.0	0.32	13.3	35.4	52.6
ART	14	5300	66/28/2/4/0	1.4	0.26	13.7	44.5	60.45
Thalassemia	8.9	71000	50/45/2/3/0	5.3	0.74	14.0	5.6	58.2
Thalassemia	7	12000	60/35/2/3/0	3.0	0.45	15.4	47.3	64.98
Essential thrombocythemia	7.1	15000	78/20/1/1/0	Over	3.8	16.8	14.0	-

Reason for moderately high MPV values of each condition could not be ascertained.

Other findings in this study:

(1) ANC: overall 33.96% had high TC which was highest amongst all

categories that were studied. Only 8 out of 54 cases showed thrombocytopenia. This is in contrast to known findings.

- (2) Bacterial condition: Of total 36 cases of bacterial infection, 8 had a low platelet count 3 of the cases with leucocytosis showed a low MPV whereas 8 cases with leucocytosis showed a high MPV, 7 of which had a MPV of 10.6-10.9. High MPV >12 was seen in 2 cases who had TC on lower side and depleted platelet count. There was eosinopenia in many cases. No correlation between bacterial infection and PC, MPV, PLCR, or PDW, PCT could be noted..
- (3) Tuberculosis: All cases of tuberculosis had mild anaemia, leucocytosis, most had neutrophilia, eosinopenia and normal platelets count.
- (4) Viral fever: All 4 cases had a moderate anaemia, normal TC, DC and all had high MPV.
- (5) Dengue: All cases except 2 had anaemia of varying degrees, a normal or low TC, moderate to severe thrombocytopenia. There was eosinopenia in many cases.
- (6) ART: Most cases of ART had mild to moderate anaemia, normal TC, platelets.
- (7) Covid: 90 % had low to moderate anaemia, 50 % had mild leucocytosis, neutrophilia, eosinopenia.
- (8) DM: Majority cases of DM had moderate anaemia. All with complications of DM had moderate leucocytosis and 50% cases of DM with complications had thrombocytosis. Of 12 cases majority had TC ≥10000 and only 4 out of 12 cases showed low PC.
- (9) HTN: Most cases had mild anaemia, normal TC and DC and platelets, MPV, PLCR.
- (10) CVD: All cases of CVD had mild to moderate anaemia. 3 of cases of MI had leucocytosis. 50% had low platelet count.
- (11) CKD: Most cases had mild to moderate anaemia, most had normal platelet count. Many had low MPV and many had high (highest values of MPV were seen).

The mean and range were not established in this study as cases of each category with normal MPV value were not considered.

Conditions	Low:High MPV (Ratio of number of cases)	Other findings
Bacterial condition	2:8	Eosinopenia in many cases
Tuberculosis	6.6:3.3	Mild anaemia, leucocytosis, neutrophilia, eosinopenia, normal platelets
Viral fever	All high MPV	Moderate anaemia, normal TC, DC
Dengue	4.7:5.2	Anaemia, normal/low TC, moderate to severe thrombocytopenia
Covid	1.7:8.2	Low to moderate anaemia, mild leucocytosis (50%), neutrophilia, eosinopenia
ANC	4:6	Highest TC amongst all conditions, very few cases of thrombocytopenia
DM	4.1:5.8	Moderate anaemia, borderline leucocytosis, thrombocytosis (50%)
HTN	4.4:5.5	Mild anaemia, normal TC, DC and platelet count
DM+HTN	4.4:5.5	Mild anaemia
CVD	1.3:8.6	Mild to moderate anaemia, normal platelet count
Liver diseases	2.7:7.2	-
Chronic kidney disease	4.3:5.6	Mild to moderate anaemia, normal platelet count
Haematological condition	5.5:4.4	-
Thalassemia	1.7:8.2	-
Injury	5.5:4.4	-
Autoimmune disease	3.3:6.6	-
CTD and 1 case of LBW	high MPV	-
Poison	high MPV	-

- In all conditions MPV values correlated with PLCR and it was directly proportional to the MPV.

- Other platelet parameters showed no correlation with MPV.
- There was also no range wise correlation of MPV with PC, PCT, PDW.

DISCUSSION

Significance was not derived because cases numbers were not that much to compared with control group.

Table 4: Comparison of present study with other previous studies.

Conditions	Present study		Kim et al(1986)(2)		Shah et al (2013) (9)	Buch et al(2020) (10)	Patel V et al. (2018) (11)	Afsar et al. (2017) (12)	Gunluoglu et al (2014)(13)	Sevgi Yavuz et al (2014) (14)
ITP	Acute	1	10.6	20	9.76±1.18					
	Chronic	-	-	11	11.12±1.48					
Aplastic anaemia	1	3.7	13	7.23±0.80						
ALL	1	11.3	55	7.47±1.16	23	7.5±0.15				
Nephrotic syndrome	1	11	11	8.05±1.11						
Renal failure	10	6.05±1.35	11	8.84±2.29						
	12	11.9±1.3								
Pregnancy related	22	5.75±1.65	75	8.45±1.21	88	9.9±0.7				
	32	11.5±1.1								
Rheumatic heart disease	2	11±0.3	19	9.59±1.40						
Angina pectoris	1	10.8	17	8.84±0.78						
Myocardial infarction	9	11.6±1.0	20	9.06±0.76						
DM	4	6.4±1.2	9	9.60±1.42	78	8.8±1.9				
Carcinoma	0	-			92	9.1±0.8				
Infectious conditions	8	5.8±1.3			228	9.6±1.1				
Hypertension	28	11.55±1.05								
	4	6.55±0.75			89	9.9±1.3				
IHD	5	11.4±0.7								
	10	11.6±1.0			63	11.1±1.5				
AML	0	-			17	8.9±0.4				
Bleeding disorder	1	10.6			9	9.9±0.9				
TTP	0	-			6	10.4±2.03				
DM with complication	-	-				138	11.31±1.96			
DM without complication	1	7.2				162	9.94±1.97			
	7	11.4±0.9								
Diabetic foot	3	6.1±1.2				6	12.22±1.98			
	1	11.1								
Cerebrovascular stroke		10.6					9.78±1.25			
Acute inflammation		5.8±1.3						6.8-10.6		
		11.55±1.05								
Pulmonary tuberculosis		6.8±0.2							7.74±1.33	
		10.6								
SLE		11.3								9.43±2.7
Control	100	8.75±0.85	167	8.11±0.85		200	8.48±1.01	8.30±1.14	8.7±1.9	8.20±1.13

conditions. We have not included any normal MPV this study. This is the only such study, hence it is difficult to get exact comparative studies. Single case of ITP in present study showed increased MPV, same was noted in 31 cases of ITP in Kim et al. Other conditions like aplastic anaemia, ALL, nephrotic syndrome, renal failure, pregnancy related, rheumatic heart disease, angina pectoris, MI and DM studied by Kim et al. show MPV in normal range, although many studies indicate that MPV is increased in ITP, MI, DM etc.

Shah et al. have taken an average of all MPV values in all the conditions they studied. Their study showed, they have considered value above 8.8fl as high MPV. This study showed increased in MPV in all conditions like ALL, pregnancy related, DM, carcinoma, infectious conditions, hypertension, IHD, AML, bleeding disorder and TTP mentioned in above table but in present study only IHD showed increased MPV. All other conditions in our study have both increased as well as decreased MPV. In present study 77.8% cases of Infectious conditions, 50% of cases of hypertension, 57.1% cases of diabetes had high MPV. Rest of the cases in each condition had decreased MPV.

Shah et al found High MPV in bleeding disorders and ITP where as a normal value in ALL and AML. This study had very few cases of haematological conditions for any significant deductions and further discussion.

Control value of MPV of Kim et al, Buch et al, Patel V et al, Afsar et al and Gunluoglu et al were 8.11±0.85, 8.48±1.01, 8.30±1.14, 8.7±1.9 and 8.20±1.13 respectively. Which is almost close to present study's control value 8.75±0.85.

Most studies has taken average range of all cases where as our study has included increased or decreased cases for each of the case

Buch et al had high MPV in DM without complication and DM with complications. Present study also showed high MPV in DM without complications. Our study had very few cases of DM related complications for further discussion.

Study of Patel V et al. had a significant correlation of MPV in ischemic stroke with p value of <0.0001. Present study also had a high MPV in cerebrovascular stroke patients.

In acute inflammatory conditions Afsar et al. had MPV values ranging from low to high similar to present study.

MPV was lower in patient with PTB than in control (p=0.005) in the study of Gunluoglu et al. In present study also MPV was low in PTB patients. But 1 case which had DM in addition to PTB in present study showed increased MPV.

Both present and Sevgi Yavuz et al studies showed increased MPV in SLE.

CONCLUSION

- (1) The mean and range were 8.3fl and 8.75±1.25fl respectively in health.
- (2) Increased MPV was noted in all cases of viral fever, connective tissue disorders and poisoning and more than 70% in bacterial

infections, COVID, cardiovascular diseases, liver diseases and thalassemia cases. This appears to be the first study documenting increased MPV in COVID, thalassemia and viral fever other than dengue.

- (3) MPV correlated proportionally with PLCR. But no correlation between MPV and PCT, PDW was found.

Limitations:

- (1) Only those conditions were studied where there was a deviant MPV. So for each condition, study doesn't have data of how many % of each condition had a normal MPV.
- (2) In each group, further history, reason for low or high MPV in each case could not be taken due to the COVID conditions.

Abbreviations

PI- Platelet indices

MPV- Mean platelet volume

PDW- Platelet distribution width

PLCR- Platelet large cell ratio

PCT- Plateletcrit

IPF- Immature platelet fraction

PC- Platelet count

fl- Femtoliter

CBC- Complete blood count

HB- Hemoglobin

TLC- Total leukocyte count

DLC- Differential leukocyte count

ANC- Antenatal care

TB- Tuberculosis

ART- Antiretroviral therapy

IHD- Ischemic heart disease

CVD- cardio vascular diseases

CVS- Cardio vascular system

THAL- Thalassemia

CTD- Connective tissue disorders

HTN- Hypertension

CKD- Chronic kidney injury

ITP- Idiopathic thrombocytopenic purpura

TTP- Thrombotic thrombocytopenic purpura

IHD- Ischemic heart disease

ALL- Acute lymphocytic leukemia

DM- Diabetes mellitus

SLE- Systemic lupus erythematosus

ALL- Acute lymphocytic leukemia

LBW- Low birth weight

REFERENCES

- Budak YU, Polat M, Huysal K. The use of platelet indices, plateletcrit, mean platelet volume and platelet distribution width in emergency non-traumatic abdominal surgery: a systematic review. *Biochem Med* 2016;26(2): 178–93.
- Kim KY, Kim KE, Kim KH. Mean Platelet Volume in the Normal State and in Various Clinical Disorders. *Yonsei Med J*. 1986 Sep;27(3):219–226.
- Aleksandra Korniluk, Olga Martyna Koper-Lenkiewicz, Joanna Kamińska, Halina Kemona, and Violetta Dymicka-Piekarska, "Mean Platelet Volume (MPV): New Perspectives for an Old Marker in the Course and Prognosis of Inflammatory Conditions," *Mediators of Inflammation*, vol. 2019, Article ID 9213074, 14 pages, 2019.
- Osselaer JC, Jamart J, Scheiff JM. Platelet distribution width for differential diagnosis of thrombocytosis. *Clin Chem* 1997;43(6):1072–6.
- Hong H, Xiao W, Maitta RW. Steady increment of immature platelet fraction is suppressed by irradiation in single-donor platelet components during storage. *PLoS One* 2014;9(1):e85465.
- Gao Y, Li Y, Yu X, Guo S, Ji X, Sun T, et al. The impact of various platelet indices as prognostic markers of septic shock. *PLoS One* 2014;9(8):e10376.
- Tang J, Gao X, Zhi M, Zhou HM, Zhang M, Chen HW, et al. Plateletcrit: a sensitive biomarker for evaluating disease activity in Crohn's disease with low hs-CRP. *Journal of Digestive Diseases* 2015;16(3):118–24.
- Giovanetti TV, Nascimento AJ, Paula JP. Platelet indices: laboratory and clinical applications. *Rev Bras Hematol Hemoter* 2011;33(2):164–5.
- Amar R, Shah I, Sanjay N, Chaudhari2, Menka H, Shah3, Role Of Platelet Parameters In Diagnosing Various Clinical Conditions, *National Journal Of Medical Research*, Apr – June 2013
- Archana Buch, Supreet Kaur, Rahul Nair, Ambuj Jain, Platelet volume indices as predictive biomarkers for diabetic complications in Type 2 diabetic patients, *Journal of Laboratory Physicians - Volume 9, Issue 2, April-June 2017* 85
- Vitan Patel, A study on mean platelet volume in ischemic cerebrovascular stroke, *International Journal of Advances in Medicine* Patel V et al. *Int J Adv Med*. 2018 Apr;5(2):316–320
- Nabila Afsar, Idress Akhtar, Afroze, Habeebunnisa tahniath akia Abid, Role of Mean Platelet Volume As An Adjunct in Evaluation of Acute Inflammation, *Annals of pathology and laboratory Medicine*, Vol. 4, Issue 4, July-August, 2017.
- Gulshah Gunluoglu1, Esra Ertan Yazar1, Nurdan Simsek Veske1, Ekrem Cengiz Seyhan2 and Sedat Altin1, Mean platelet volume as an inflammation marker in active pulmonary tuberculosis, *Multidisciplinary Respiratory Medicine* 2014, 9:11
- Sevgi Yavuz & Aydin Ece, Mean platelet volume as an indicator of disease activity in juvenile SLE, *Clin Rheumatol* (2014) 33:637–641