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# Mean Platelet Volume and Platelet Count in Patients with Type 2 Diabetes Mellitus and Impaired Fasting Glucose

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## ABSTRACT

**Background:** Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia and associated with long term macrovascular and microvascular complications. Platelet parameters such as mean platelet volume and platelet count are indicators of thrombotic potential. These parameters have been reported to be increased in diabetic patients, leading to increased risk of vascular complications. The objective of this study was to determine mean platelet volume and platelet count in patients with Type 2 Diabetes mellitus, impaired fasting glucose and non -diabetic controls, and compare mean platelet volume and platelet count between the three groups.

**Methods:** A hospital based cross-sectional observational study was conducted at KIST Medical College Teaching Hospital from February to May 2018. A total of 300 participants were included in the study which were grouped into Group 1,2 and 3 based on fasting blood glucose level as non -diabetic controls, impaired fasting glucose and Type 2 Diabetes mellitus respectively with 100 subjects each. Platelet count and mean platelet volume were compared between the three groups. Analysis of variance with post hoc Tukey test and Pearson correlation coefficient were used for statistical evaluation. Data were expressed as mean ± standard deviation. A p value <0.05 was considered as statistically significant.

**Results:** Mean platelet volume was significantly higher in diabetic and impaired fasting glucose group (7.40 ± 0.77 fl and 6.62 ± 0.58 fl), respectively as compared to non diabetic group (6.06 ± 0.41 fl) ($p<0.001$). There was no significant difference in the platelet count between the three groups ($p=0.869$). Significant correlation was seen between rising fasting blood sugar and mean platelet volume ($r=0.559$; $p<0.001$), while no correlation existed between platelet count and fasting blood sugar level ($r=0.037$; $p=0.526$).

**Conclusions:** Mean platelet volume is increased in patients with type 2 diabetes mellitus and impaired fasting glucose. This is a simple and cost effective test to predict vascular complications in type 2 diabetes mellitus.

**Keywords:** Diabetes mellitus; impaired fasting glucose; mean platelet volume; platelet count.

## INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disorder due to defects in insulin secretion, insulin action, or both.[1] DM is characterized by prothrombotic state due to enhanced platelet activation, increased coagulation protein and reduced fibrinolytic activity.[2] Impaired fasting glucose (IFG) is a glycemic disorder which is considered as prediabetic state.[3] Prediabetic individuals are at risk of developing diabetes as well as cardiovascular complications later in life.[4,5]

Platelet volume which is measured as mean platelet volume (MPV) by hematology analyzers is a marker of platelet function and activation.[6] Larger platelets with higher MPV produce increased amount of thromboxane A2.[7] Increased platelet activity is a risk factor for vascular complications.[8-11] The objective of our study was to determine MPV and platelet count in patients with Type 2 DM, IFG and non-diabetic controls, and compare MPV and platelet count between the three groups.

## METHODS

This was a hospital based cross-sectional observational study conducted in the departments of Pathology, Biochemistry and Medicine of KIST Medical College from 15th Feb-15th May 2018. Ethical clearance was obtained from Institutional Review Committee of KIST Medical College. The patients were divided into three groups- Non-diabetic controls (Group 1), IFG (Group 2) and Type 2 diabetes mellitus (Group 3). Three hundred

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samples were included in the study- 100 samples from non- diabetic controls, 100 samples from patients with impaired fasting glucose and 100 samples from diabetic patients. The cases and control were not matched for age and sex. Patients attending diabetes clinic were included in IFG and diabetic group. Patients with type 2 diabetes mellitus with more than six months were included in the study. Hospital staffs and healthy individuals who came for routine screening in the outpatient department with normal blood glucose level were included in the control group. Patients with hematological diseases, renal failure, hepatic failure, heart failure, acute illness, chronic infections and patients on medication altering platelet function were excluded from the study.

Blood samples were collected in EDTA vacutainer for estimation of platelet count and mean platelet volume. Fasting blood samples were collected in the morning following overnight fast in plain vacutainer. The samples were tested within one hour to minimize variations due to sample aging. Platelet count and MPV were measured using an automated blood counter (Nihon Kohden Celtac-ES five part analyzer). Blood glucose was tested in automated biochemistry analyzer (Siemens Dimension RxL Max). Diagnosis of DM was established using American Diabetes Association (ADA) criteria of fasting blood sugar (FBS) of 126 mg/dl or higher on two occasions. FBS values between 110 mg/dl and 125 mg/dl was allocated to IFG group. FBS less than 110 mg/dl was considered as normal. Platelet count and MPV were compared between the three groups. Data analysis was done using Statistical package for social sciences (SPSS), version 21 for Windows. Analysis of variance (ANOVA) with post hoc (Tukey) test and Pearson correlation coefficient were used for statistical evaluation. Data were expressed as mean ± standard deviation. A p value <0.05 was considered statistically significant.

## RESULTS

Out of 300 participants consisting of 100 non-diabetic controls, 100 IFG and 100 diabetic patients, 152 (50.66%) were males and 148 (49.33 %) were females. The age of the patients ranged from 18-84, 21-72 and 21-86 years in the control, IFG and diabetic group respectively. The mean age of the control, IFG and diabetic group was 43.13 ± 17.24, 52.34 ± 12.75 and 53.04 ± 14.33 years respectively. The gender distribution in three groups is shown in Fig. 1. The duration of diabetes mellitus ranged from 0.5-26 years with a mean duration of 7.14 ± 6.91 years.

The mean FBS in non-diabetic group was 83.83± 11.87 mg/dl, in IFG group was 117.37 ± 3.97 mg/dl and in diabetic group was 176.09 ± 49.35 mg/dl. The mean MPV in non-diabetic control, IFG and diabetic groups were 6.06 ± 0.41 fl, 6.62 ± 0.58 fl and 7.40 ± 0.77 fl respectively. The mean platelet count was 255.06 ± 76.44 x $10^9$/L in non-diabetic group, 259.95 ± 73.82 x $10^9$/L in IFG group and 254.55 ± 87.81 x $10^9$/L in diabetic group. (Table 1)

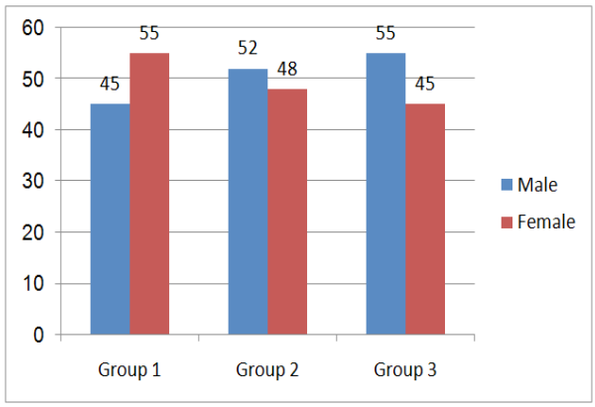


Figure 1. Gender distribution in non-diabetic controls (Group 1), Impaired fasting glucose (Group 2) and diabetic patients (Group 3).

Table 1. Comparison of different parameters between the three groups.

| Parameters | Non-DM (Group 1) | IFG (Group 2) | DM (Group 3) |
|---|---|---|---|
| Mean MPV (fL) | 6.06±0.41 | 6.62±0.58 | 7.40±0.77 |
| Mean platelet count (x$10^9$/L) | 255.06±76.44 | 259.95±73.82 | 254.55±87.81 |
| Mean FBS (mg/dl) | 83.83±11.87 | 117.37±3.97 | 176.09±49.35 |

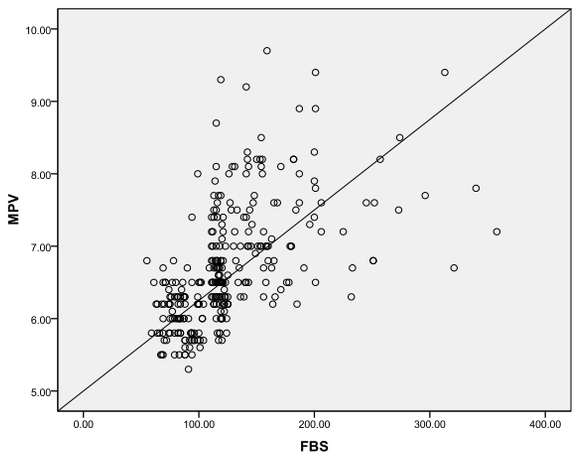


Figure 2. Relation between Fasting blood sugar (FBS) and Mean platelet volume (MPV) (r = 0.559; p<0.001).

Platelet count and MPV were compared in the three groups using ANOVA with post hoc (Tukey) test. The analysis showed highly significant difference in MPV between group 1 and 2, 2 and 3 and 1 and 3; all p value <0.001; however there was no significant difference in the platelet count between the three groups (p value 0.869).

There was significant correlation between rising FBS and MPV (r = 0.559; p<0.001) as shown in Fig 2. Correlation between platelet count and FBS level was not statistically significant (r = 0.037; p = 0.526) Fig 3. No significant correlation was found between duration of diabetes mellitus and MPV (r = -0.066; p = 0.513) and duration of diabetes mellitus and platelet count (r = 0; p = 0.998)

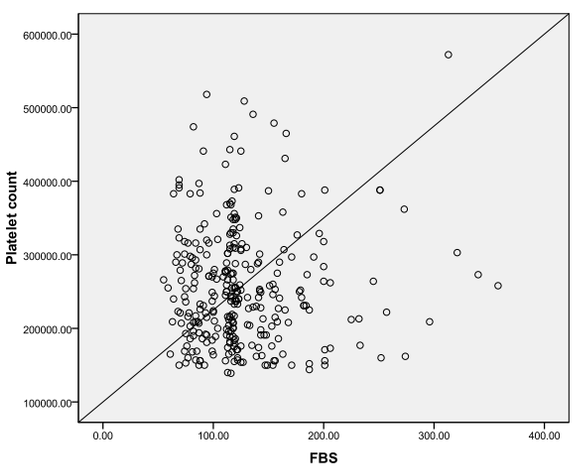


Figure 3. Relation between Fasting blood sugar (FBS) and Platelet count (r = 0.037; p = 0.526).

## DISCUSSION

MPV and platelet count are markers of thrombotic potential. MPV is an indicator of average size and activity of platelets. Larger platelets contain more dense granules and are more reactive due to increased prothrombotic contents such as thromboxane A2 which leads to aggregation of the platelets. They also secrete more serotonin and ß- thromboglobulin than smaller platelets. High MPV indicates large platelet size and is associated with thrombogenic activation and increased risk for microvascular and macrovascular complications.[2,12,13]

In the present study MPV was significantly higher in diabetic and IFG group compared to non-diabetic control group. It was also higher in diabetic group compared to IFG group (p<0.001). This finding was in agreement with other studies.[9,14,15] MPV value was found to be high in diabetic patients than in controls in studies by various authors.[6,16-19] Multiple factors contribute for increased MPV in DM such as osmotic swelling of platelets due to increased blood glucose, activation of protein kinase C, short life span of platelets and bone marrow stimulation to release large younger platelets.[10,18,20] Increase in MPV is associated with thromboembolic complications in diabetic patients. MPV was significantly increased in IFG group compared to control in our study. Hence, this group is also at increased risk of such complications.[9,14]

Platelet count depends on platelet production rate and platelet survival. In our study there was no significant change in mean platelet count among diabetic, impaired fasting glucose and control group. Similar observations were reported by various authors.[6,9,19] This is in contrast with the findings by other authors[16,18] who have reported significant difference in the platelet count in their study. Platelet count is dependent on mean platelet survival, platelet production rate and turnover rate. Poor metabolic control, low grade inflammation and hyperglycemia in type 2 DM have been suggested as factors leading to high platelet turnover.[19]

Insulin regulates platelet function via insulin receptor on platelets. Insulin reduces platelet response against procoagulant factors such as thromboxane A2, ADP and platelet activating factor. Therefore, insulin resistance causes platelet dysfunction. Hyperglycemia promotes non enzymatic glycation of platelet proteins which leads to platelet activation.[10,20] Association between impaired glucose regulation and MPV has been reported.[15] In our study there was significant correlation between rising fasting blood sugar with MPV similar to the study by other authors.[21,22]

## CONCLUSIONS

The present study revealed statistically significant difference in MPV in patients with IFG and DM. Significant correlation was found between rising FBS and MPV. Hence, MPV can be used as a simple and cost effective investigation to identify early thromboembolic events in patients with IFG and DM.

## REFERENCES

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2011;34:62-69. [DOI]

2. Colwell JA and Nesto RW. The platelet in diabetes: focus on prevention of ischemic events. Diabetes Care. 2003;26(7):2181-8.[DOI]

3. Bock G, Dalla Man C, Campioni M, Chittilapily E, Basu R, Toffolo G et al. Pathogenesis of pre-diabetes: mechanisms of fasting and postprandial hyperglycemia in people with impaired fasting glucose and/ or impaired glucose tolerance. Diabetes. 2006;55(12):3536-49.[DOI]

4. DeFronzo RA, Abdul-Ghani M. Assessment and treatment of cardiovascular risk in prediabets: impaired glucose tolerance and impaired fasting glucose. Am J Cardiol. 2011;108:3B-24B.[DOI]

5. Ford ES, Zhao G, Li C. Pre-diabetes and the risk for cardiovascular disease: a systematic review of the evidence. J Am Coll Cardiol. 2010;55(13):1310-7.[DOI]

6. Hekimsoy Z, Payzin B, Ornek T, Kandogan G. Mean platelet volume in type 2 diabetic patients. J Diabetes complications. 2004;18(3):173-6.[DOI]

7. Vizioli L, Muscari S, Muscari A. The relationship of mean platelet volume with the risk and prognosis of cardiovascular diseases. Int J Clin Pract. 2009;63(10):1509-15.[DOI]

8. Park Y, Schoene N, Harris W. Mean platelet volume as an indicator of platelet activation: methodological issues. Platelets. 2002;13:301-6.[DOI]

9. Zuberi BF, Akhtar N, Afsar S. Comparison of mean platelet volume in patients with diabetes mellitus, impaired fasting glucose and non-diabetic subjects. Singapore Med J. 2008;49(2):114-6.[PubMed]

10. Vinik AI, Erbas T, Park TS, Nolan R, Pitenger GL. Platelet dysfunction in type 2 diabetes. Diabetes Care. 2001;24(8):1476-85.[DOI]

11. Tavil Y, Sen N, Yazici HU, Hizal F, Abaci A, Cengel A. Mean platelet volume in patients with metabolic syndrome and its relationship with coronary artery disease. Thromb Res. 2007;120(2): 245-50.[DOI]

12. Ates O, Kiki I, Bilen H, Keles M, Kocer I, Kulacoglu DN et al. Association of Mean Platelet Volume with the degree of retinopathy in patients with Diabetes Mellitus. Eur J Gen Med. 2009;6(2):99-102.[Full Text]

13. Chang HA, Hwang HS, Park HK, Chun MY, Sung JY. The role of Mean Platelet Volume as a predicting factor of asymptomatic coronary artery disease. Korean J Fam Med. 2010;31(8):600-6.[DOI]

14. Coban E, Bostan F, Ozdogan M. The mean platelet volume in subjects with impaired fasting glucose. Platelets. 2006;17(1):67-9.[DOI]

15. Ozder A, Eker HH. Investigation of mean platelet volume in patients with type 2 diabetes mellitus and in subjects with impaired fasting glucose: a cost-effective tool in primary health care? Int J Clin Exp Med. 2014;7(8):2292-7. [PubMed]

16. Demirtunc R, Duman D, Basar M, Bilgi M, Teomete M, Garip T. The relationship between glycemic control and platelet activity in type 2 diabetes mellitus. J Diabetes Complications. 2009;23(2):89-94.[DOI]

17. Ulutas KT, Dokuyucu R, Sefil F, Yengil E, Sumbul AT, Rizaoglu H, Ustun I et al. Evaluation of mean platelet volume in patients with type 2 diabetes mellitus and blood glucose regulation: a marker for atherosclerosis? Int J Clin Exp Med. 2014;7(4):955-61.[PubMed]

18. Kodiatte TA, Manikyam UK, Rao SB, Jagadish TM, Reddy M, Lingaiah HK et al. Mean platelet volume in Type 2 diabetes mellitus. J Lab Physicians. 2012;4(1):5-9.[DOI]

19. Biadgo B, Melku M, Abebe SM, Abebe M. Hematological indices and their correlation with fasting blood glucose level and anthropometric measurements in type 2 diabetes mellitus patients in Gondar, Northwest Ethiopia. Diabetes Metab Syndr Obes. 2016;9:91-9.[DOI]

20. Schneider DJ. Factors contributing to increased platelet reactivity in people with diabetes. Diabetes Care. 2009;32(4):525-7.[DOI]

21. Shimodaira M, Niwa T, Nakajima K, Kobayashi M, Hanyu N, Nakayama T. Correlation between mean platelet volume and fasting plasma glucose levels in prediabetic and normoglycemic individuals. Cardiovasc Diabetol. 2013;12:12-14. [DOI]

22. Archana Shetty, C Vijaya, V J Jayalakshmi, M B Lekha. Comparison of Mean platelet volume, platelet count, total leukocyte and neutrophil counts in normoglycemics, impaired fasting glucose and diabetics. Int J Sci Stud. 2014;2(2):24-7.[FullText]