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Original Research Article

A Comparative Analysis of Haematological Parameters in Diabetics and Non Diabetics and their Correlation with Fasting Blood Sugar Levels and Glycated Haemoglobin

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Abstract

Background: Diabetes mellitus (DM) is a complex disease characterised by chronic hyperglycemia that leads to long term macrovascular and microvascular complications. Several studies have shown that DM affects the morphology and functioning of red blood cells, white blood cellsand platelets, which is reflected as aberrations in routinehaematological parameters. Thus the aim of this study was to determine the changes in haematological parameters in diabetic patients in comparison to healthy controls. *Materials and Methods:* A cross sectional study was conducted from Jan 2019 till June 2019, in Department of Pathology, SNMC, Bagalkoton 115 already diagnosed diabetic patientsand 115 age and sex matched apparently healthy individuals. Haematological indices, fasting blood glucose and glycated haemoglobin (HbA1c) levelswere determined. *p*-value less than 0.05 were considered as statistically significant. *Results:* Red cell distribution width was significantly increased in diabetic patients as compared to the control group (17.46 ± 1.75 *vs* 13.40 ± 1.69) with a *p*-value of 0.001. Both, mean cell volume and mean cell haemoglobin were reduced with average of 73.29 ± 7.36 and 27.18 ± 3.18 respectively in diabetic patients, as compared to the control group (p = 0.000). There was significant difference in red blood cell count between diabetics and control group (4.63 ± 0.911 vs 4.29 ± 0.67). All biochemical parameters, fasting blood sugar, post prandial blood sugar and HbA1c (149.55 ± 62.79, 234.77 ± 80.10 and 7.81 ± 2.35 respectively) were significantly higher in diabetic patients. Though mean platelet volume was higher in diabetic group (7.78 ± 0.953) as compared to control group (7.10 ± 1.207), it was not statistically significant (p = 0.107). Analysis of peripheral blood smear of diabetic patients showed changes in RBC morphology. Hypochromia and anisopoikilocytosis were seen. Of all the parameters, only MPV was statistically correlated with FBS levels (r = 0.285, p = 0.002). *Conclusion:* The study showed statistically significant difference in some haematological parameters of diabetic patients compared to controls. Thus, routine haematological profile checkup of diabetic patients is recommended as it may indicate towards the impending vascular complications associated with aberrations in haematological parameters.

Keywords: Type 2 Diabetes mellitus; Haematological indices; Fasting blood sugar; Glycated haemoglobin.

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Introduction

Diabetes mellitus is a global public health problem which encompasses heterogenous group of disorders characterised by hyperglycemia associated with metabolic, cellular, and blood disturbances leading to long term macrovascular and microvascular complications.

The WHO diagnostic criteria for DM include:

(1) A Fasting plasma sugar ≥ 126 mg/dl;

(2) Random plasma glucose ≥ 200 mg/dl(in patients with classic hyperglycemic signs);

(3) 2 hour plasma glucose ≥ 200 mg/dl during an oral glucose tolerance test (OGTT) with a loading dose of 75g;

(4) Glycated hemoglobin (HbA1c) levels ≥ 6.5%

The number of cases of Type 2 diabetes mellitus have been increasing due to aging population, urbanization and low physical activity. According to the international Diabetes Federation 2015 report, globally around 415 million people are suffering from DM and the number is expected to rise by 642 million by 2040. In India, a total 69.2 million people are living with diabetes.[1]

Several studies have shown that DM affects the morphology and functioning of red blood cells (RBC's), white blood cells (WBC's) and platelets, thus causing changes in the various haematological parameters. Also, recent studies have reported the role of haematological indices in contributing to the vascular injury in diabetic patients and predicting the possibility of impending acute events in them.

In a study by Sing and Shin, it was reported that erythrocytes remain in hyperglycemic environment throughout their life span, thus are subjected to series of compositional changes which in turn effect their flow properties through alteration of deformation at individual level.[2]

In another cross sectional study of adults with DM from the National Health and Nutrition Examination Study (NHANES), high red cell distribution width (RDW) values were associated with increased risk of cardiovascular disease and nephropathy, thus making RDW a useful clinical marker of vascular complications in DM.[3]

Mean platelet volume (MPV) is a marker of platelet function and activation. Altered platelet morphology and function can be reflected as a risk factor for macro and microvascular complications.

Epidemiological study has indicated a close relationship between white blood cell count and components of metabolic syndrome.

Aim

The aim of this study is to compare the haematological parameters in diabetic group and non diabetic (control) group and their correlation with fasting blood sugar levels and HbA1c. Also to estimate the prevalence of red cell morphological changes in diabetic patients.

Materials and Methods

A comparative cross-sectional prospective study was conducted over a period of 6 months, from Jan 2019 till June 2019 which was undertaken in the department of pathology, SNMC, Bagalkot.

The study was done on 115 already diagnosed diabetic patients (100 males and 15 females) aged between 15–77 yrs selected by non parametric sampling. 115 age and sex matched apparently healthy individuals with no previous history of chronic diseases were taken as control subjects.

Venous blood samples were collected in dipotassium EDTA vacutainers and tested within 1hour of collection to minimise variations due to sampling aging. Complete blood count and HbA1c levels of diabetics and control groups were done using an automated analyser Horiba Pentra ES 60 and Bio Rad D-10 respectively. Samples for fasting blood glucose were collected in sodium fluoride vacutainersand plasma glucose levels were estimated by glucose oxidase method in an auto analyser Bio Systems A 25.

Statistical analysis

Data are represented as mean and SD for continuous variables. Statistical analysis was carried out with SPSS version software and *p*-value less than 0.05 were considered as statistically significant. The study analyses relationship between haematological

parameters in diabetics and non diabetics using Pearson correlation coefficient.

Results

A total of 115 study subjects (diabetics) were included in this study. Of the total T2DM patients, 15 (13.05%) were females and 100 (86.95%) males. They were aged between 15 to 77 years, median age 54.03 years with history of diabetes between one year and 25years. Similarly the subjects of control group were 15 females and 100 males, aged between 20 to 80 years. The groups were similar in terms of age distribution.

Of all the haematological parameters, red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and RDW were statistically significant when compared to the control group.

Of the three RBC indices, MCV and MCH were reduced in diabetics with the average of 73.29 ± 7.365 and 27.18 ± 3.178 respectively, as compared to the control group with average of 84.17 ± 6.918 and 29.45 ± 2.826, which were statistically significant (p = 0.001).

RBC count was higher in diabetic group (4.63 ± 0.911) in comparison to the control group (4.29 ± 0.67).

Regarding RDW, statistically significant increase was noted in the diabetic patients with average of 17.46 ± 1.754 (p = 0.000). Though MPV was higher in diabetic group (7.7 ± 0.79) as compared to the control group (6.8 ± 1.35), it was statistically insignificant (p = 0.107) in this study.

In the analysis of peripheral blood smear of diabetic patients, hypochromia, anisocytosis and poikilocytosis were seen more often than in healthy control individuals. Prevalence of anisocytosis and poikilocytosis in the study (diabetic) group was seen in 40 patients (34.7%) out of 115 as compared to the control group where only 7 (6.08%) patients showed it.

All biochemical parameters, fasting blood sugar (FBS), post prandial blood sugar (PPBS) and glycated hemoglobin(HbA1c) were higher in diabetic patients (149.55 ± 62.791, 234.77 ± 80.103 and 7.81 ± 2.350 respectively) than the control group (98 ± 10.422, 127.66 ±1 0.364 and 5.02 ± 0.662 respectively) (Table 1).

Table 1: Comparison of haematological and biochemical parameters between diabetics (study group) and non diabetic patients (control group)

Parameters	Test (DM) (n = 115)	Control (n = 115)	p-value
Hb	12.38 ± 2.16	12.69 ± 2.02	0.272
RBC	4.63 ± 0.911	4.29 ± 0.67	0.001
MCV	73.29 ± 7.36	84.17 ± 6.91	0.000
MCH	27.18 ± 3.18	29.45 ± 2.83	0.000
MCHC	37.01 ± 1.56	35.16 ± 1.94	0.101
RDW	17.46 ± 1.75	13.40 ± 1.69	0.000
Hct	33.52 ± 5.41	36.16 ± 5.44	0.100
WBC count	8992.17 ± 2982.85	8827.27 ± 3482.49	0.810
Platelet count	250243.48 ± 78541.81	236873.68 ± 112589.93	0.322
MPV	7.78 ± 0.95	7.10 ± 1.20	0.107
FBS	149.55 ± 62.79	98.00 ± 10.42	0.000
PPBS	234.77 ± 80.10	127.66 ± 10.36	0.000
HbA1c	7.81 ± 2.35	5.02 ± 0.66	0.000

Data is expressed as mean ±SD. DM-diabetes mellitus; Hb-hemoglobin; RBC-red blood cell count; MCV-mean corpuscular volume; MCH- mean corpuscular hemoglobin; MCHC-mean corpuscular hemoglobin concentration; RDW-red cell distribution width; Hct-haematocrit; WBC count- white blood cell count; MPV-mean platelet volume; FBS-fasting blood sugar; PPBS-post prandial blood sugar; HbA1c- glycated hemoglobin

Note: $p < 0.05$ is significant

In the correlation of FBS with haematological parameters, only correlation between FBS and MPV was statistically significant (p = 0.002) in the study (diabetic) group (Table 2). No statistically significant correlation was observed between haematological parameters and HbA1c in both the groups (Table 4).

In the correlation of PPBS with haematological parameters, correlation between PPBS and MPV and PPBS and MCH were statistically significant (Table 3) in diabetic patients.

Table 2: Relationship between haematological parameters and FBS in diabetic (study) and non diabetic (control) groups (n = 115)

Variables	Diabetic Group *r* (*P*)	Control Group *r* (*P*)
FBS & MCV	–0.119 (0.204)	–0.046 (0.629)
FBS & MCH	–0.151 (0.108)	–0.007 (0.942)
FBS & MCHC	–0.079 (0.400)	0.158 (0.092)
FBS & RBC count	0.153 (0.103)	0.013 (0.894)
FBS & Hct	0.000 (0.999)	–0.005 (0.959)
FBS & MPV	0.285 (0.002)	0.076 (0.418)

Note: *r* = Pearson's correlation; $p < 0.05$ is significant

Table 3: Relationship between haematological parameters and PPBS indiabetic (study) and non diabetic (control) groups (n = 115)

Variables	Diabetic Group *r* (*P*)	Control Group *r* (*P*)
PPBS & MCV	–0.159 (0.090)	0.086 (0.360)
PPBS & MCH	–0.212 (0.023)	0.115 (0.223)
PPBS & MCHC	–0.170 (0.069)	0.172 (0.066)
PPBS & RBC count	0.148 (0.115)	–0.072 (0.448)
PPBS & Hct	0.004 (0.968)	–0.040 (0.671)
PPBS & MPV	0.326 (0.000)	0.169 (0.071)

Note: *r* = Pearson's correlation; $p < 0.05$ is significant

Table 4: Relationship between haematological parameters and HbA1c in diabetic (study) and non diabetic (control) group (n = 115)

Variables	Diabetic Group *r* (P)	Control Group *r* (P)
HbA1c & MCV	–0.135 (0.150)	0.059 (0.533)
HbA1c & MCH	–0.147 (0.117)	0.090 (0.341)
HbA1c & MCHC	0.017 (0.856)	0.182 (0.052)
HbA1c & RBC count	0.057 (0.544)	0.107 (0.255)
HbA1c & Hct	–0.026 (0.784)	0.082 (0.383)
HbA1c & MPV	0.154 (0.101)	0.020 (0.833)

Note: *r* = Pearson's correlation; $p < 0.05$ is significant

Discussion

Several studies have suggested that haematological indices are altered in patients with T2DM. In diabetic patients, RBC's are constantly exposed to increased levels of glucose, resulting in glycation of hemoglobin and other proteins involved in clotting mechanism, which is reflected as changes in the haematological parameters on CBC.

In the present study, RBC count is increased in diabetic patients as compared to the control group, which was similar to the study done by Biadgo et al. (2016).[4] There was no statistically significant difference in haemoglobin levels between T2DM patients and control group.

In contrast to this study, several studies done on patients with T2DM showed a decrease in RBC count associated with microvascular complications.[5] Possible explanation for this might be that chronic hyperglycemia causes non enzymatic glycosylation of RBC membrane proteins leading to accelerated aging of RBC's.[4] Similarly, a study done in Tobago showed reduced RBC count, haemoglobin levels and hematocrit in T2DM patients.[6]

Among RBC indices, RDW values were statistically significantly increased in diabetics (p = 0.000) which was in accordance with the previous studies[7,8]. The possible explanation for this can be that RDW indicates impaired erythropoiesis, reflecting chronic inflammation and increased levels of oxidative stress, both of which are signs of DM, resulting in RBC size variation.[4] However, some studies have reported that no significant difference was seen in RDW levels between diabetics and control group.[9]

In contrast to the other studies, this study documented reduced MCV and MCH in diabetic group, which were statistically significant (p = 0.000). The probable explanation might be due to diabetic nephropathy leading to impaired erythropoietin but the duration of diabetes and its complications were not considered in this study.

Several studies have suggested an association between increased WBC count, diabetes mellitus and development of vascular complications in diabetics.[4,10,11] In contrast to these studies, present study did not show significant increase in WBC count in diabetic patients.

With reference to platelet indices between the control and the diabetic patients, we observed no significant difference in platelet count, similar to the study done by Biagdo et al.[4] However, MPV was increased in diabetics though not statistically significant.

Jabeen et al. did a study on 170 diabetic patients to determine the relationship of glycemic control on hematological parameters in diabetes mellitus patients and reported that among hematological parameters MPV were significantly increased in diabetes patients as compared to non-diabetics. Similarly, several studies have documented increase in MPV with increased number of circulating large platelets in diabetics as compared to the controls.[12–14]

Increased MPV may be related to the vascular complications in DM patients. Small vascular bleeds due to rupture of a therthrombotic plaques leads to bone marrow stimulation and recruitmentof larger hyperactive platelets. These platelets contain denser granules, secrete more serotonin and TXA2, and have a pro coagulant effect.[4] Also osmotic swelling of platelets, as a result of hyperglycemiacontributes to platelet size variation and increased MPV in T2DM patients.

Increase in MPV is now emerging as an independent risk factor for thromboembolism, stroke and myocardial infarction.[15]

In the correlation of FBS and HbA1c with haematological parameters, only significant correlation was found between FBS and MPV (p = 0.002).

In the analysis of peripheral blood smear of diabetic patients, hypochromia, anisocytosis and poikilocytosis were seen more often than in healthy individuals, similar to the study done by Marius et al. in 2015.[16]

Conclusion

In conclusion, FBS, PPBS, HbA1c, RDW and RBC count were found to be significantly higher among diabetic patientsas compared to the apparently healthy controls. This is a reflection of poor glycaemic control and prolonged duration of exposure to high levels of glucose. MCV and MCH were reduced in diabetic patients in this study.

The results also show that the morphological changes in the RBC's are highly present in the diabetic patients as compared to the control. These changes may have direct impact on erythrocyte function and may contribute to patient complex pathology.

These parameters are easily measurable and conclude by suggesting that diabetic patients should undergo routine haematological profile check up which may indicate the status of diabetic control and hence indicate towards the impending complications associated with aberrations in haematological parameters.

Limitation of this study is that duration of diabetes and its associated complications are not considered.

Conflict of interests: The authors declare that they have no conflict of interests.

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References

1. Shukhla DK, Chandra K, Pawah A. Study of haematological indices in patients with diabetes mellitus and hypertensive diabetes mellitus. Int J Med Res 2016 Sep;1(4):28–31.
2. Sing M, Shin S. Changes in erythrocyte aggregation and deformability in diabetes mellitus: A brief review. Indian J ExpBiol 2009;47(1):7–15.
3. Malandrino N, Wu WC, Taveira TH et al. Association between red blood cell distribution width and macrovascular and microvascular complications in diabetes. Diabetologia 2012;55:226–35.
4. 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, Metabolic Syndrome and Obesity: Targets and Therapy 2016;9:91–9.
5. Wang ZS, Song ZC, Bai JH, et al. Red blood cell count as an indicator of microvascular complications in Chinese patients with type 2 diabetes mellitus. Vasc

Health Risk Manag. 2013;9:237–243.

6. Ezenwaka CE, Jones-LeCointe A, Nwagbara E, et al. Anemia and kidney dysfunction in Caribbean Type 2 diabetic patients. Cardiovasc Diabetol 2008;7:25.
7. Malandrino N, Wu WC, Taveira TH, et al. Association between red blood cell distribution width and macrovascular complications in diabetes. Diabetologia 2012;55:226–35.
8. Sherif H, Ramadan N, Radwan M, et al. Red cell distribution width as a marker of inflammation in Type 2 diabetes mellitus. Life Sci J 2013;10(3):1501–507.
9. Dada OA, Uche E, Akinbami A, et al. The relationship between red blood cell distribution width and blood pressure in patients with Type 2 diabetes mellitus in Lagos, Nigeria. J Blood Medicine 2014;5:185–89.
10. Chung FM, Shin SJ, Tsai JC, et al. Peripheral total and differential leucocyte count in diabetic nephropathy. Diabetes Care 2005;28(7):1710–17.
11. Gkrania-Klotsas E, Ye Z, Cooper AJ, et al. Differential white blood cell count and type 2 diabetes: systematic review and meta-analysis of crosssectional and prospective studies. PLoS ONE. 2010;5(10):e13405.
12. Jabeen F, Rizvi HA, Aziz F, Wasti AZ. Hyperglycemic induced variations in hematological indices in Type 2 diabetics. IJAR 2013;1(8):322–34.
13. Khandekar MM, Khurana AS, Deshmukh SD, et al. Platelet volume indices in patients with coronary artery disease and acute myocardial infarction: an Indian scena. J ClinPathol 2006;59(2):146–49.
14. Yenigün EC, Gülay Okyay GU, Pirpir A, et al. Increased mean platelet volume in Type 2 diabetes mellitus. Dicle Medical Journal 2014;41(1):17–22.
15. Zuberi B F, Akhtar N, Afsar S. Comparison of mean platelet volume in patients with diabetes mellitus, impaired fasting glucose and nondiabetic subjects. Singapore Med J 2008;49(2):114–6.
16. NC Marius, Cratoiu S, Avramescu ET, et al. The prevalence of the red cell morphology changes in patients with Type 2 Diabetes Mellitus. Rom J Morphol Embryol 2015;56(1):183–9.