

Comparative analysis of hematological parameters in Type-2 Diabetes Mellitus patients and Healthy residents of Lahore, Pakistan

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Author's Contribution

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Background: Type-2 Diabetes Mellitus (T2DM) is a one of the most widespread metabolic disorder which involves blood and cellular level fluctuations. Various studies report the altered hematological parameters in T2DM, but results are conflictive. Therefore, present study was designed to compare the hematological parameters of adult T2DM patients with healthy control residents of Lahore, Pakistan.

Methodology: This comparative cross-sectional study was conducted at the hematology lab of Jinnah Hospital, Lahore, Pakistan. A total of 60 study subjects were enrolled (T2DM=30, Healthy controls=30) who fulfilled the strict inclusion criteria. Blood samples were collected from enrolled participants in sterile EDTA tubes and hematological parameters were noted using the automated hematology analyzer. The medical history of the enrolled participants was collected on the self-administered data collection form.

Results: The results of present study revealed that the mean values of white blood cells (9.92 ± 8.14), lymphocytes (46.76 ± 26.75), and mean corpuscular volume (80.62 ± 9.91) were significantly different in two groups and were found to be high in T2DM group as compared to healthy control group. There were minor changes between hematocrit, mean corpuscular hemoglobin concentration, platelet, platelet distribution width in diabetic patients as compared to healthy control group. The mean values of hemoglobin, red blood cells, platelet, mean platelet volume, mean corpuscular hemoglobin, and neutrophils decreased in T2DM patients as compared to control group.

Conclusion: This study shows statistically significant variations in white blood cells, lymphocyte and mean corpuscular volume in T2DM group as compared to the healthy control group. The results suggest routine hematological parameters evaluation of T2DM patients for effective management of the disease.

Keywords: Hematological parameters, Type II Diabetes Mellitus, Metabolic disorders, Hemoglobin.

ABSTRACT

Introduction

Diabetes Mellitus is one of the most widespread metabolic disorder across the globe especially in Pakistan. Approximately 537 million adults are living with DM worldwide and 90% of the people suffer from T2DM.¹ According to a report published in 2019 the prevalence rate of diabetes in Pakistan has been amplified by 70% and 33 million people were expected to live with diabetes in 2021 and causes 40,000 death in Pakistan. After India and China, Pakistan is on the third highest place with people living with diabetes in the world.² T2DM has become a

major public health alarm worldwide, as a result of rapid economic growth, significant lifestyle changes, and an aging population.³ It is a metabolic disorder which is characterized by glycosuria, hyperglycemia, hyperlipidemia and defects in insulin secretion and metabolism of carbohydrates, lipids, and proteins.^{4,5} Chronic hyperglycaemic conditions cause perturbations in blood cells and their parameters which leads to several microvascular complications.⁶⁻⁸ The affected people experience increased thirst, frequent urination, weight loss,

sometimes consuming food in excess amount and blurred vision.^{5,8}

According to American Diabetes Association, all people with higher body mass index (BMI) (greater than 25kg/m²) should screen for diabetes.⁹ The pathologic hallmark of DM involves both microvascular and macrovascular complications.¹⁰ Chronic hyperglycemia is also linked with these complications and various organ damage mainly (eyes, nerves, kidneys, and the heart).¹¹ Increased in the formation of ROS and AGEs because of long term hyperglycemia which indirectly related to changes in hematological indices and endothelial dysfunction. The excessive ROS results in oxidative stress, which leads to RBC dysfunction and platelet destruction. Function of blood cells is compromised and tissue injury is also affected which may lead to many other complications.⁵

DM patients show a significant change in few hematological parameters. 12 RBCs, WBCs, PLT and coagulation systems all underwent alterations in function, structure, and metabolism in T2DM patients. When compared to non-diabetic persons, these alterations may show up as immunological and coagulation issues as well as anemia. Anemia is a condition in which RBC count, Hgb, and HCT levels are lowered.¹³ Patients with T2DM frequently experience anemia, and its prevalence rate vary greatly.¹⁴ Many studies have shown the significant independent association of hematological parameters, including hematocrit (HCT) and white blood cells count (WBC) with Type-II Diabetes Mellitus.¹⁵ Various studies have also shown that white blood cells (WBCs) such as basophil, eosinophil and neutrophil are raised and there is no change in monocyte count in patients with T2DM.¹⁶

According to a study if structure and function of platelet is changed it can be a risk factor for both microvascular and macro vascular illnesses, and elevated platelet activity may increase vascular problems in DM patients.^{17,18} Greater platelet reactivation in diabetic patients may result in poorer cardiovascular protection from antiplatelet medication, especially aspirin.^{19,20} The activation and elevation of levels inflammatory markers have already been shown to be related to insulin resistance.²¹

There are many hematological changes observed in the T2DM patients. Although various studies are conducting on diabetic patients regarding the hematological parameters in different areas. Many studies showed that there is no significant changes in the mean red blood cell indices in diabetic patient group and control group²²⁻²⁴, WBCs, and PLT.^{22,25} Various other studies showed that significant values of red and white blood cells and platelet indices are higher in T2DM patients.²⁶ Various other studies reported that RDW are lower, whereas

WBC and platelet indices are higher in diabetic group as contrast to the healthy controls group.^{27,28} The results obtained from CBC analyzers showed that changes occur in hematological parameters. Evaluation of these hematological parameters may help in monitoring the emergence of diabetic complications.⁶ Therefore, the main aim of our study is to compare hematological parameters of T2DM patients with healthy control group,

Methodology

This cross-sectional study was conducted at the hematology lab of Jinnah Hospital, Lahore from March 2023 to July 2023. The participants for this study were enrolled from outpatient door of Jinnah Hospital, Lahore, Pakistan after getting the written informed consent of all subjects and were selected by using non-probability random sampling technique. A total of 60 subjects were recruited in this study after selection by strict inclusion-exclusion criteria. The patients of both genders, already diagnosed with T2DM from last one year, aged 18-60 years were included. Patients with history of cardiac, renal, liver diseases or with HIV/AIDS and pregnant women were excluded from the study. 3cc blood sample was collected from all enrolled subjects in sterile EDTA vacutainers and were tested for hematological parameters within 1 hour of collection using an automated CBC analyzer.

Clinical and demographic characteristics of the enrolled study subjects were collected using a self-administered data collection form. Clinical characteristics including duration of disease, fasting blood glucose level, type of anti-diabetic drug therapy was collected from the diabetic patient's medical records review. Blood pressure (BP) was noted by trained paramedical staff. After that blood sample was collected from the study participants for evaluation of hematological parameters.

5cc of venous blood sample was collected from all enrolled T2DM patients in two separate sterile vacutainers i.e., one in serum separator tube for fasting blood glucose measurement and second in EDTA tube for evaluation of hematological parameters. Similarly, samples were collected from healthy controls at the time of blood donation. The Glucose oxidase method was used to measure the fasting blood glucose levels by an automated chemistry analyzer (using Biosystems A25) according to the standard guidelines. Complete blood cell count (CBC) was performed using automated hematology analyzer (Mindray BC-20s) at hematology lab of Jinnah Hospital, Lahore. Hematological parameters evaluated included RBC, Hb, HCT, MCV, MCH, MCHC, RDW, WBCs, absolute lymphocytes, monocyte, basophil, eosinophil, neutrophils, platelet count and MPV.

All collected data was recorded in a spreadsheet at Microsoft excel and was thoroughly checked for completeness and accuracy. Study subjects with incomplete data/information were excluded from the study. For statistical analysis data was exported to SPSS version 27.0. Kolmogorov-Smirnov test was performed to check the normality of the data. Categorical variables were reported as frequency and percentage while mean $\pm$ SD for normally distributed continuous variable and median with interquartile range (IQR) for continuous variables with skewed distribution. Chi-square test was performed to find out the statistical differences between the groups for categorical variables while independent t-test/Mann-Whitney U test was used to compare the hematological parameters in T2DM and healthy control groups. In any condition, P-value <0.05 was considered as statistically significant.

Results

This study recruited 60 study participants that comprised 30 patients of T2DM and 30 healthy controls. Mean age of enrolled T2DM patients was 54.36 (± 12.11) years and mean age of healthy controls were 50.43 (± 12.40) years. There was equal proportion of male and female patients in T2DM group while healthy control group contained slightly variable proportion (17 males and 13 females). Demographic and clinical characteristics of the enrolled participants are given in the table. I.

The mean values of Hb, RBC, MPV, MCH, neutrophils decreased in patients of T2DM as compared to healthy control group the respective values of patients were (12.44 $\pm$ 2.19), (4.62 $\pm$ 0.98), (11.34 $\pm$ 2.33) (27.32 $\pm$ 3.71) (11.51 $\pm$ 9.25) (36.55 $\pm$ 25.06) compared to healthy control group (13.6 $\pm$ 2.93) (6.52 $\pm$ 6.0) (15.79 $\pm$ 20.07) (28.76 $\pm$ 9.09) (12.19 $\pm$ 9.90) (51.07 $\pm$ 22.17) respectively. The mean values of these parameters were not statistically significant. The mean value of

WBC, lymphocytes, MCV were high (9.92 $\pm$ 8.14) (46.76 $\pm$ 26.75) (80.62 $\pm$ 9.91) as compared to healthy control group (8.25 $\pm$ 5.86) (35.65 $\pm$ 21.42) (74.53 $\pm$ 15.71) respectively. The mean values of lymphocytes were statistically significant but other parameters were insignificant. These parameters showed no significant changes in their mean values HCT, MCHC, PLT, PDW and PCT in diabetic patients (36.92 $\pm$ 7.261), (33.93 $\pm$ 3.39), (196.7 $\pm$ 119) (16.09 $\pm$ 2.18) (1.56 $\pm$ 1.44) as compared to healthy control group (36.96 $\pm$ 9.08), (33.48 $\pm$ 5.50), (197 $\pm$ 109) (16.4 $\pm$ 2.60) (1.98 $\pm$ 1.39).

Table I: Demographic details and clinical characteristics of study subjects.

Variables	T2DM	Healthy control	Total
No. of study Participants (n)	30	30	60
Mean Age	54.36 (± 12.11)	50.43 (± 12.40)	
Gender			
Male	15	17	30
Female	15	13	30
Medicine			
Dexiva	7	0	7
Glucophage	3	0	3
Getryl 2	2	0	2
Metformin	2	0	2
Insulin	16	0	16
Duration of illness			
>10	22	0	20
<10	8	0	8

Discussion

Diabetes Mellitus has high mortality rate worldwide. In developing countries DM is one of the major public health concerns.²⁹ DM is caused by chronic hyperglycemia which can leads to various long-term complications.³⁰ Uncontrolled DM may cause oxidative stress because of the development of various abnormal metabolic processes. Diabetes also cause

Table II: Comparison of hematological parameters of T2DM group with healthy control group.

Hematological Parameters	Unit	Normal values	T2DM group Mean ($\pm$ SD)	Control group Mean ($\pm$ SD)	P-values
WBC	10 ⁹ /L	4-11	9.921(± 8.145)	8.2566(± 5.866)	0.50087
lymph	10 ⁹ /L	1000-4800	46.76(± 26.75)	35.65(± 21.42)	0.00637
Neutrophils	10 ⁹ /L		36.55(± 25.06)	51.07(± 22.17)	0.0359
RBC	10 ¹² /L	4-5.2	4.624(± 0.988)	6.52(± 6.000)	0.11538
HB	g/dl	11.5-16	12.43(± 2.19)	13.6(± 2.93)	0.14314
HCT	%	35-45	36.96(± 7.26)	40.096(± 9.08)	0.06672
MCV	fl	79-95	80.67(± 9.919)	74.53(± 15.71)	0.22532
MCH	pg	26-32	27.28(± 3.71)	28.76(± 9.091)	0.8766
MCHC	g/dl	32-36	33.87(± 3.397)	33.84(± 5.503)	0.9941
PLT	10 ⁹ /L	160-400	196.7(± 119.43)	197.47(± 109.143)	0.72264
MPV	fL	7.2-13	11.34(± 2.33)	15.79(± 20.07)	0.22235
PDW	Fl	25-65	16.093(± 2.18)	16.40(± 2.60)	--
PCT	mL/L	Less than 0.05	1.56(± 1.44)	1.98(± 1.39)	--

various metabolic and cellular disorders and disturbance in hematological parameters may leads to various microvascular complications. Hyperglycemia may also result in various organ damage.³¹

The study revealed significant alterations in hematological parameters of T2DM patients when compared to healthy controls. Our study revealed that there is a decrease in the mean values of Hb, RBC, MPV, MCH, MID and neutrophils of T2DM patients as compared to the controls. Various other studies showed a decrease in the mean values of Hb, RBC, HCT, MCV, MCH, MCHC in the T2DM patients when compared to the controls.²⁸ Many studies also showed that in diabetic patients there is a several morphological changes in RBCs. These changes may affect function of erythrocytes which may contribute to the various diabetic complications.³²

A study showed that mean values of these parameters RBC, Hb and HCT were lower in T2DM patients.³³ Anemia is more common in diabetic patients because of the chronic kidney disease, several other defects also found in diabetic patient.²⁸ The mean values of both groups' diabetics and non-diabetics of hematological parameters Hb (12.44, 13.6), RBC (4.62, 6.52), MPV, (11.34, 15.79), MCH (27.32, 28.76), and neutrophils (36.55, 51.07). This study also showed that the levels of WBC, lymphocytes, MCV were slightly increased in T2DM patients. Various other studies showed an slight increase in mean values WBC including lymphocytes.²⁸

A study showed that the mean values of MCV were high in diabetic patients as compared to the healthy control group.³⁴ Another study revealed that there is an increase MCV of diabetic patients and this is associated with hyperosmolar state.³⁵ Another study reported that WBC are significantly higher in diabetic patients. There was also a statistically significant difference in lymphocyte count. ³⁶ A study reported that there is a association between WBC and diabetes mellitus because of the increased inflammatory mediators. Active immune system can cause an increase in the WBCs.³⁷ Our study also showed that there is a statistically significant difference in the mean values of lymphocyte count. Mean values of these hematological parameters including WBCs (9.921, 8.256), lymphocyte (46.76, 35.65) and MCV (80.67, 74.53).

Our study showed no significant changes in the platelet indices in both groups. The mean values in diabetic patients of PLT (196.7), PDW (16.093), and PCT (1.56) as compared to controls mean values of PLT (197.47), PDW (16.40), and PCT (1.98). Some studies revealed that in diabetic patients' levels of PLT and PCT were lowered because of the presence of neuropathy in diabetic patients. Which showed that PLT and

PCT might be cause of DPN. ³⁸ A study revealed that patients with lower PLT count are at risk of acute coronary syndrome.³⁹ Some studies showed a difference in the mean values of PLT indices in T2DM patients because of the more reactive and aggregable platelets. Platelet evaluation also play important role in early detection of diabetic complications. ²² The increase is PLT count and PDW is because of platelet activation cause various microvascular dysfunction.⁴⁰

Conclusion

In COVID-19 positive patients, our study observed elevated LDH, CK, and CRP levels, alongside decreased Albumin, Urea, and Sodium levels, with a stronger effect in older individuals (61-80 years). Cardiac markers (CK and LDH) did not correlate significantly with the virus, while liver markers (ALP, ALT, bilirubin) had mostly non-significant correlations, except for albumin. Renal marker creatinine showed a significant correlation, while urea did not. Electrolytes (sodium, potassium) had non-significant correlations, and CRP showed a significant correlation. COVID-19 appeared to affect cardiac and hepatic cells more prominently, based on LDH, CK, and albumin levels.

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