Hematological parameters in diabetic patients-an institutional study

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Abstract- **Type 2 Diabetes mellitus is a metabolic disease characterized by impaired glucose tolerance and insulin resistance. WHO has predicted that the prevalence of DM worldwide will be 592 million by the year 2035.**

The hematological changes in Diabetes Mellitus are linked to inflammation and endothelial dysfunction. Alteration in size, morphology and functions of RBCs, WBCs and platelets are assumed to be responsible for the metabolic effects of hyperglycemia.

Previous studies have implicated a rise in WBC count as a prognostic factor for development of cardiovascular complications in DM. Elevated MPV, PDW, Platelet count and RDW in patients with poor glycemic control has been shown to be predictors of endothelial dysfunction.

Aim-This study aims to find the variation in CBC indices and compare it to a non-diabetic population to evaluate its statistical significance.

Method- A cross –sectional study was carried out among patients who were known cases of diabetes mellitus, attending a tertiary care hospital during the month of January 2023. Total of 276 subjects were included in this study, with 138 diabetic patients and 138 non-diabetic subjects.

Result- The current study shows that there is significant decrease in RBC values while RDW-SD is elevated in diabetic patients. Total WBC count, ANC and NLR are drastically increased in th diabetic population.

Conclusion- In concordance with previous studies, it shows the need for monitoring these values for predicting the outcome or occurrence of micro and macro vascular complications.

Keywords- **Type 2 Diabetes Mellitus, Complete Blood Count, vascular complications.**

I. INTRODUCTION

Type 2 Diabetes mellitus is a metabolic disease that is characterized by impaired glucose tolerance and insulin resistance. It is a public health issue that has been increasing in incidence all over the world. WHO has predicted that the prevalence of Diabetes Mellitus(DM) worldwide will be 592 million by the year 2035.[1]Uncontrolled diabetes is the most common factor for development of micro vascular and macro vascular complications.[2]

Type 2 Diabetes Mellitus (T2DM) is a part of the metabolic syndrome that includes hypertension, obesity, dyslipidemia and altered hematological parameters. The hematological changes in Diabetes Mellitus are linked to inflammation and endothelial dysfunction. Alteration in size, morphology and functions of RBCs, WBCs and platelets are assumed to be responsible for the metabolic effects of hyperglycemia. [3]

Few studies have been conducted to evaluate the changes in Complete Blood Count (CBC) indices in diabetic patients. Previous studies have implicated a rise in White Blood Cell (WBC) count as a prognostic factor for development of cardiovascular complications in DM. Elevated Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), Platelet count and Red cell Distribution Width (RDW) in patients with poor glycemic control has been shown to be predictors of endothelial dysfunction.[4,5]

This study aims to find the variation in CBC indices and compare it to a non-diabetic population to evaluate its statistical significance.

II. MATERIALS AND METHOD

Study area: The study was conducted in a tertiary care hospital in Kerala, India.

Study design and study period: A cross –sectional study was carried out among patients who were known cases of diabetes mellitus, attending a tertiary care hospital during the month of January 2023.

Sample size:
Sample size was calculated using the following formula:

$$N= \frac{(Z_{\alpha/2}+2\beta)^2 \times 2\sigma^2}{d^2}$$

Where $Z\alpha/2$=Critical value at 5% level of significance (1.96)
2β=critical value at 80% power (0.84)
σ=pooled standard deviation (2.26)

d=mean difference (1.77)

Total of 276 subjects were included in this study. 138 diabetic patients were evaluated and CBC findings were tabulated. 138 subjects were selected from the non-diabetic population .76 females and 62 males were included in both groups and were age adjusted.

Inclusion criteria: Patients who were known cases of diabetes mellitus were included in the study

Exclusion criteria: Patients with coexisting co morbidities like hypertension and liver diseases were excluded from the study.

Study protocol: Blood samples were sent to be processed and evaluated by Auriba ABX Penta xlr hematology analyser. CBC findings were obtained and peripheral smears were prepared and evaluated.
Data analysis: Data was entered and tabulated in Microsoft Excel and analyisis was carried out by SPSS software (version 16.0).

III. RESULTS
138 diabetic patients and 138 non-diabetic subjects were included in the study. Both groups had 76 females and 62 males. (Figure 1)
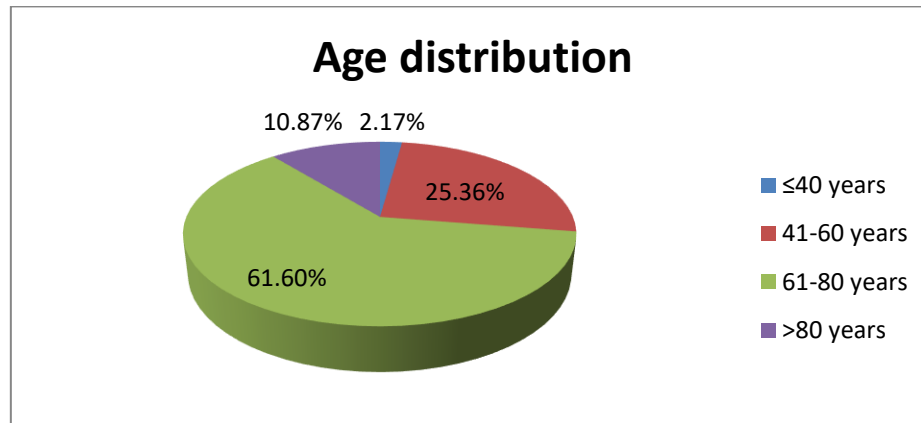
Figure 1: Sex distribution of the study population
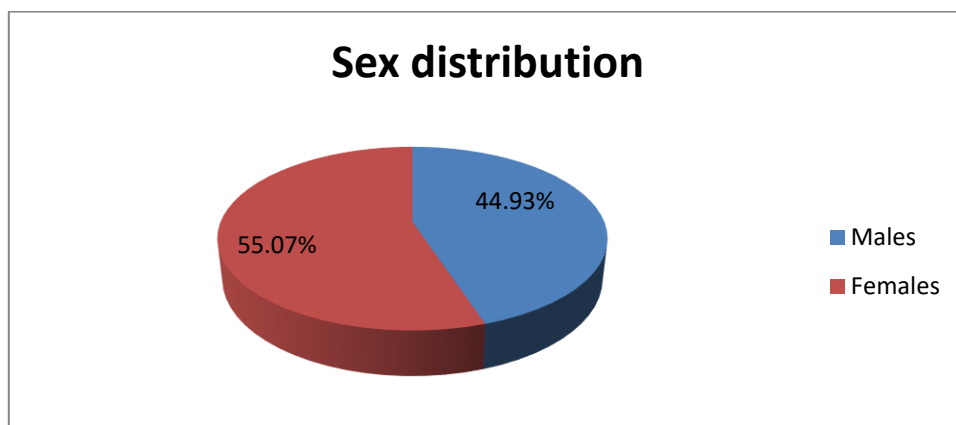
Ages of the study population ranged from 39 to 91 years and the age distribution of the study population are shown in Table 1 and Figure 2.

Age group	Number of subjects
≤40 years	3
41-60 years	35
61-80 years	85
>80 years	15
Total	138

Figure 2: Age distribution of the study population

Majority of patients were from the age group 61-80 years, constituting 61.6 % of the study population.
The non-diabetic group selected was age and sex- adjusted according to the diabetic population.

RBC parameters:
RBC parameters of the study population are entered in Table 2.

Table 2: RBC parameters of the study population

Parameters	Mean	Standard deviation	p-value
Hb of diabetic patients(g/dl)	9.033582	2.31828119	<0.001
Hb of normal population(g/dl)	12.23134	2.122752431	
RBC count of diabetic patients(x10^6/mm^3)	3.28403	0.752742474	<0.001
RBC count of normal population(x10^6/mm^3)	4.172836	0.6613868	
HCT of diabetic patients (%)	27.22239	6.542511552	<0.001
HCT of normal population (%)	35.50597	5.529045128	
MCV of diabetic patients(μm^3)	83.1194	8.015065491	<0.05
MCV of normal population(μm^3)	85.47015	7.616454584	
MCH of diabetic patients(pg)	27.56791	3.381875636	<0.001
MCH of normal population(pg)	29.3709	3.070911908	
MCHC of diabetic patients(g/dl)	33.09478	2.100530444	<0.001
MCHC of normal population(g/dl)	34.3791	2.179745264	
RDW-CV of diabetic patients (%)	13.3306	1.878378264	<0.001
RDW-CV of normal population (%)	12.72537	1.311527065	
RDW-SD of diabetic patients(μm^3)	39.40299	4.382328497	>0.05
RDW-SD of normal population(μm^3)	38.88806	3.607970391	

Abbreviations: Hb:hemoglobin; RBC:Red Blood Cell; HCT:Hematocrit; MCV:Mean Corpuscular Volume; MCH: Mean Corpuscular Hemoglobin; MCHC: Mean Corpuscular Hemoglobin Concentration; RDW-CV: Red cell Distribution Width-coefficient of variation ; RDW-SD:Red cell Distribution Width- Standard Deviation

Hemoglobin(Hb) values of the diabetic subjects varied from 3.8 g/dl to 15.9 g/dl with a mean value of 9.03 g/dl. Hemoglobin values of the non-diabetic population ranged from 5.9 g/dl to 16.4g/dl with a mean value of 12.23 g/dl.RBC counts of the diabetic subjects varied from 1.45 x10^6/mm³ to 5.29 x10^6/mm³with a mean value of 3.28 x10^6/mm³.RBC counts of the non-diabetic population ranged from 2.34 x10^6/mm³ to 6.3 x10^6/mm³ with a mean value of 4.17 x10^6/mm³. Hematocrit (HCT) of the diabetic subjects varied from 10.5% to 45.9% with a mean value of 27.2%.HCT of the non-diabetic population ranged from 19.3% to 47.3% with a mean value of 35.5%. Mean corpuscular volume (MCV) of the diabetic subjects varied from 51 µm³ to 97 µm³ with a mean value of 83.1 µm³.MCV of the non-diabetic population ranged from 61 µm³ to 105 µm³ with a mean value of 85.4µm³. Mean Corpuscular Hemoglobin (MCH) of the diabetic subjects varied from 13.2pg to 33.5pg with a mean value of 27.5pg. MCH of the non-diabetic population ranged from 19.4pg to 38.1pg with a mean value of 29.3pg. Mean Corpuscular Hemoglobin Concentration (MCHC) of the diabetic subjects varied from 25.8g/dl to 42.3g/dl with a mean value of 33.09g/dl. MCHC of the non-diabetic population ranged from 29.5g/dl to 46.6g/dl with a mean value of 34.3g/dl. Red cell Distribution Width-coefficient of variation (RDW-CV) of the diabetic subjects varied from 10.6% to 20.6% with a mean value of 13.3%.RDW-CV of the non-diabetic population ranged from 10.5% to 17.7% with a mean value of 12.7%. Red cell Distribution Width- Standard Deviation (RDW-SD) of the diabetic subjects varied from 29 µm³ to 52 µm³ with a mean value of 39.4 µm³.RDW-SD of the non-diabetic population ranged from 30 µm³ to 51 µm³ with a mean value of 38.8 µm³.

RBC parameters of all diabetic patients showed significantly lower values compared to non-diabetic population, except for RDW-SD which was slightly increased in the diabetic population.

All values, except RDW-SD showed a p-value of less than 0.01 proving it to be highly significant. MCV showed a p-value less than 0.05, proving it to be statistically significant

Platelet parameters:
Platelet parameters of the study population are entered in Table 3.

Table 3: Platelet parameters of the study population

Parameters	Mean	Standard deviation	p-value
Platelet count of diabetic patients(x10^5/mm³)	2.774851	1.356484696	>0.05
Platelet count of normal population(x10^5/mm³)	2.538284	1.018641677	
MPV of diabetic patients (µm³)	8.028358	0.894394569	>0.05
MPV of normal population (µm³)	8.088806	0.983675817	
PCT of diabetic patients (%)	0.218843	0.099224501	>0.05
PCT of normal population (%)	0.199515	0.071195456	
PDW of diabetic patients (%)	13.62214	3.052925207	>0.05
PDW of normal population (%)	13.5203	3.123293701	

Abbreviations: MPV- Mean Platelet Volume; PCT- Plateletcrit; PDW- Platelet Distribution Width

Platelet counts of the diabetic subjects varied from 14 x10^5/mm³ to 7.3 x10^5/mm³with a mean value of 2.77 x10^5/mm³.Platelet counts of the non-diabetic population ranged from 5 x10^5/mm³ to 6.9 x10^5/mm³ with a mean value of 2.5 x10^5/mm³. Plateletcrit (PCT) of the diabetic subjects varied from 0.014% to 0.583% with a mean value of 0.21%.PCT of the non-diabetic population ranged from 0.044% to 0.476% with a mean value of 0.19%. MPV of the diabetic subjects varied from 6.1 µm³ to 10.1 µm³ with a mean value of 8.02 µm³.MPV of the non-diabetic population ranged from 6.1 µm³ to 10.9 µm³ with a mean value of 8.08 µm³. PDW of the diabetic subjects varied from 8% to 26.5% with a mean value of 13.6%.PDW of the non-diabetic population ranged from 8% to 23.3% with a mean value of 13.5%.
Platelet parameters showed no significant difference in the diabetic population as compared to the non-diabetic population.

WBC parameters:
WBC parameters of the study population are entered in Table 4.

Table 4: WBC parameters of the study population

Parameters	Mean	Standard deviation	p-value
Total WBC count of diabetic patients(x10³/mm³)	11.2806	6.352070027	<0.001
Total WBC count of normal population(x10³/mm³)	7.886567	3.060192904	
ANC of diabetic patients(/mm³)	880.2873	611.8994775	<0.001
ANC of normal population(/mm³)	526.0612	283.2638253	
ALC of diabetic patients(/mm³)	195.9799	104.2387844	>0.05
ALC of normal population(/mm³)	218.7388	95.44505872	
NLR of diabetic patients	6.032516	5.92501887	<0.001
NLR of normal population	3.157232	2.979583286	

Abbreviations: WBC: White Blood Cell; ANC: Absolute Neutrophil Count; ALC: Absolute Lymphocyte count; NLR : Neutrophil-Lymphocyte Ratio

WBC counts of the diabetic subjects varied from 14 x10³/mm³ to 7.3 x10³/mm³with a mean value of 11.2 x10³/mm³.WBC counts of the non-diabetic population ranged from 5 x10³/mm³ to 6.9 x10³/mm³ with a mean value of 7.8 x10³/mm³. Absolute Neutrophil Count (ANC) of the diabetic subjects varied from 123.2/mm³ to 2706.3/mm³ with a mean value of 880.2/mm³.ANC of the non-diabetic population ranged from 187.2/mm³ to 1428.7/mm³ with a mean value of 526.06/mm³. Absolute Lymphocyte Count (ALC) of the diabetic subjects varied from 47.2 /mm³ to 592.8 /mm³ with a mean value of 195.9 /mm³.ALC of the non-diabetic population ranged from 30.4 /mm³ to 589 /mm³ with a mean value of 218.7 /mm³. Neutrophil- Lymphocytes Ratio (NLR) of the diabetic subjects varied from 0.46 to 32 with a mean value of 6.03.NLR of the non-diabetic population ranged from 0.75 to 15.6 with a mean value of 3.15.

Total WBC count, Absolute Neutrophil count and Neutrophil-Lymphocyte ratio of diabetic patients showed significant statistical difference compared to normal population, whereas absolute lymphocyte count showed no significant difference.

Peripheral smear:

Peripheral smears showed considerable anisopoikilocytosis.66 cases were reported a normocytic normochromic anemia. 5 cases showed presence of occasional microcytes out of which one showed presence of occasional schistocytes and polychromatophils. 4 cases showed presence of macrocytes along with normocytes.29 cases of microcytic hypochromic anemia and 8 cases of dimorphic anemia with moth normocytes and microcytes were reported.One cases of hemolytic anemia was reported.All other cases were reported as peripheral smear within normal limits.

86.5% of cases from the non-diabetic population was reported to be normocytic normochromic blood picture.9.7% cases were reported as microcytic hypochromic anemia and the rest as dimorphic anemia

IV. DISCUSSION

RBC parameters:

Our study conducted among a total of 276 subjects, with 138 diabetic subjects and 138 non-diabetic subjects showed significant difference in all the RBC parameters, except for RBC-SD where the difference was not statistically significant. All RBC parameters except RDW-SD showed significantly lower values in the diabetic population as compared to the non-diabetic population. A study conducted by Hussen Ebrahim et al [6] showed that MCV, MCH, HCT and RDW SD values were significantly lower in diabetic patients. The study done by Mesay Arkew et al [7] also showed significantly lower hemoglobin values among diabetic patients

The study conducted by Irace et al [8] showed that hemoglobin and HCT was significantly lower in patients with microvascular complications. This contradicts the study conducted by Abdulaziz A et al[9] that showed no significant difference in MCV, MCH, and MCHC values whereas studies conducted in Ethiopia[10] and Pakistan[11] showed a higher RBC count and hemoglobin concentration in the diabetic population

In the present study, RDW-SD was a bit higher in the diabetic population. This finding is similar to a study conducted by Nada et al[12] showed that diabetic patients have higher RDW, and the values are higher in cases with poor glycemic control.

The study by N Malandrino et al [13] showed that increased RDW in diabetic patients were linked to an increased risk of cardiovascular complication. The study conducted by Mesay Arkew et al showed that RDW values were significantly higher in the diabetic population. [7] Similar to studies conducted in Ethiopia [10], Pakistan [11] and Libya [14] concluded that RDW was significantly related to HbA1c

Platelet parameters:

In the present study, platelet parameters showed no significant difference among the two groups. Buch et al [15] have demonstrated that MPV and platelet distribution width could be a predictor of diabetic vascular complications. Chen et al [16] reported that MPV was increased in diabetics, however, PDW and platelet count were not significantly increased. Study conducted by Sonali et al [17] concluded a higher MPV and PDW values in patients with diabetic retinopathy

Studies conducted by Mesay Arkew et al[7], Malachowska et al[18] , Y Li et al[19] and M Ergelen et al[20] showed a higher mean values of platelet parameters in diabetic patients compared to the normal populationStudies conducted in Nigeria [21] and Ethiopia [22] also found that platelet counts were significantly higher in the diabetic group

Similar to our study,the study conducted by Dragana Milosevic and Violeta Lukic Panin[23], showed that there is no statistically significant difference in MPV values among diabetic and non-diabetic population. This is in concordance with the study conducted by Muhammed Kizilgul et al that showed no significant change in MPV whereas PDW was considerably increased[24]

WBC parameters:

Our current study showed a significant increase in Total WBC count, Absolute Neutrophil count and Neutrophil Lymphocyte ratio with p-values less than 0.001 on comparison with the non diabetic population. Earlier studies have suggested that elevated WBC count is an indicator of poor glucose metabolism. A study done by Nada [12] found higher WBC counts in patients with uncontrolled glycemia compared to the population with good glycemic control. Yilmaz et al showed that NLR was higher in obese individuals and could be utilized as a predictor for development of T2DM [25]

The study conducted by Ozturk et al[26] showed that NLR values could be used as a predictor of micro vascular complications in DM whereas a study conducted by Zhu Y et al showed that total neutrophil percentage was an important prognostic indicator in diabetic macular edema.[27]

CONCLUSION

The current study shows that there is significant decrease in RBC values while RDW-SD is elevated in diabetic patients. Total WBC count, ANC and NLR are drastically increased in th diabetic population. In concordance with previous studies, it shows the need for monitoring these values for predicting the outcome or occurrence of micro and macro vascular complications.

V. CONFLICTS OF INTEREST:

None

VI. FUNDING:

None

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