Original Research Article

SIGNIFICANCE OF SOME HEMATOLOGICAL PARAMETERS IN TYPE 2 DIABETIC PATIENTS IN THE ENUGU STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY TEACHING HOSPITAL, ENUGU STATE, NIGERIA

ABSTRACT

Diabetes mellitus has over the years become a public health challenge and a complex disease which is characterized by chronic hyperglycemia that results in microvascular and macrovascular complications. The present study was designed to determine the hematological profile of type 2 diabetic(T2DM) patients in Enugu State University of Science and Technology Teaching Hospital, Enugu State, Nigeria. A total of 240 subjects comprising 120 T2DM (60 males and 60 females) aged 20-55 years and 120 apparently healthy age and gender-matched controls were recruited for the study. Blood sample (5.0ml) was collected from each subject for the analyses of the hematological parameters using Mindray 530 BC automated analyzer, Mindray Japan. The data was analysed using T-test and level of significance set at $p<0.05$. The result revealed significantly decreased Mean Cell Volume (MCV) (86.54 ± 0.85) in the T2DM subjects compared to the controls (89.88 ± 1.09) and significantly increased Basophil count (0.93 ± 0.09) in the T2DM subjects compared to the controls (0.22 ± 0.03). These findings supports the claim for alterations in hematological profile of T2DM patients.

Key words: Type 2 diabetes mellitus, Hematological parameters, Enugu State.

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by abnormal carbohydrate metabolism resulting in chronic hyperglycemia caused by defective insulin production, action or both (1, 2). Type 2 diabetes mellitus (T2DM) is the most prevalent type of diabetes and accounts for about 90-95% of diabetes cases (3, 4, 5). It's global prevalence has increased from 4.7% (108 million) in 1980 to 9.3% (463 million) in 2019,postulated to increase to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045 (6,7). It is also estimated that 15.5% (9.8-27.8million) people has type 2 diabetes mellitus in the sub-Saharan Africa with Nigeria having the highest burden of cases (8). Patients present with microvascular and macrovascular complications. The microvascular complications include neuropathy, retinopathy and nephropathy while the macrovascular complications manifest as accelerated atherosclerosis and cardiovascular disorders. Some metabolic products such as reactive oxygen species produced in T2DM patients due to long term hyperglycemia has been postulated to cause some changes in the hematological parameters leading to development of complications (2, 4).The aim of the present study is to investigate the levels of hematological parameters in the type 2 diabetic patients and control.

JUSTIFICATION

Although, it has been documented that changes in hematological parameters is a common factor underlying the development of complications in T2DM, there is currently a paucity of scientific data on the hematological parameters of patients with T2DM accessing clinical care in the Enugu State University of Science and Technology Teaching Hospital. An effective follow-up monitoring of hematological parameters in these patients can help reduce the risk of development of complications.

MATERIALS AND METHODS

Study Area

The study was conducted with blood samples from patients attending the diabetic clinic of the Enugu State University of Science and Technology (ESUT) Teaching Hospital, Enugu State in the South eastern geopolitical zone of Nigeria. The State takes its name from its capital and largest city, Enugu. It has an area of 7,161km^2 with a population of 3,267,837 comprising mainly the Igbo tribe of the South eastern Nigeria. It lies between longitudes 6^o 30 'E and 6^o 55 'E and latitudes 5^o IS 'N and 7^o 15' N. It consists of three senatorial divisions namely Enugu East, Enugu North and Enugu West (9). The ESUT Teaching Hospital is the major tertiary health facility for the State and s located at the heart of the Enugu metropolis (Parklane) for easy accessibility to Enugu residents (9).

Study Design

This is a cross-sectional case-controlled survey in which patients with type 2 diabetes mellitus serve as the cases while age-matched healthy non-diabetics served as the controls.

Ethical Considerations

Ethical clearance was gotten from the Ethical Review Committee of the ESUT Teaching Hospital (ESUT NP/C-MAC/RA/034/Vol. I/290) as well as informed consent from subjects.

Sample Size

The sample size for the study was calculated using the Leslie Kish formular (10).

$$n = \frac{Z^{\alpha 2} PQ}{D^2}$$

Where n = minimum required sample size

$Z\alpha$ = the α level of the coefficient interval or the standard normal deviate set at 1.96 corresponding to the 95% confidence interval.

P = the proportion in the target population estimated to have diabetes mellitus 8.0%.(11)

D = the width of the confidence internal set at 0.05

Q = (1-p); the proportion of non-occurrence.

Substituting into the formular

$$n = \frac{1.96 \times 1.96 \times 0.08(1-0.08)}{(0.05)^2}$$

$$= 120$$

Subject Recruitment

Subject's selection was based on a simple random sampling procedure from a population of diabetic patients who gave their consent to participate in the study.

Inclusion Criteria

1. All consenting non-insulin-dependent diabetic mellitus (Type 1DM) patients on treatment were chosen as cases.
2. All consenting non-diabetic healthy adults were chosen as controls.

Exclusion Criteria

1. Nutritional anemia can be a cause of reactive thrombocytosis, therefore male and female patients having mean hemoglobin (Hb) <12g/dl and <11g/dl respectively was excluded from the study.
2. Non diabetic individuals with any diagnosed malignancy, thrombocytopenia, thrombocytosis or any systemic disease was also excluded.

Blood Sample Collection

Blood was collected by venipuncture (12).Subjects were made comfortable in a sitting position. A tourniquet was gently applied 2-5cm just above the antecubital fossa. The antecubital fossa was cleaned using a 70% alcohol in cotton wool. A hypodermic Syringe and 21G needle was inserted into the lumen of the antecubital vein and five milliliters(5ml) of blood was drawn quickly by a free flowing non-traumatic pull. The blood was dispensed into EDTA bottle.

Determination of Hematological Parameters

The parameters were measured using the Mindray 530 BC autoanalyzer Japan. Sample was aspirated by letting the machine sample probe into the blood sample bottle and then pressing the probe button. Approximately 20ul of blood was aspirated by the autoanalyzer. The result of the Full Blood Count were displayed in the screen after about 30secs and a printout copy of results is released on the thermal printing paper(13).

Data Analysis

Data was analysed using SPSS version 23 (SPSS Inc. Chicago). Statistical significance was defined as $p < 0.05$. Differences in the hematological parameters between the cases and controls was tested using T-test.

RESULTS

The hematological parameters of type 2 diabetic mellitus patients revealed a significant decrease in the mean cell volume (MCV) and a significant increase in the basophil count compared to the control subjects(Table.1).There were no significant differences in the hematological parameters involving the Red blood cell count, hemoglobin concentration, packed cell volume, mean cell hemoglobin concentration, mean cell hemoglobin value, platelet count, total white blood cell count, neutrophil count, eosinophil count and monocyte count between the type 2 diabetic cases and the controls(Table.1).

Table 1: Mean hematological parameters of type 2 diabetic mellitus cases and controls

Hematological Parameter	Reference Range	Type 2 Diabetic Subjects (n = 120)	Controls (n = 120)	T-test (P-Value)
RBC (x 10^6 cells/ul)	3.0 – 6.2	4.60 ± 0.07	4.54 ± 0.11	0.66484
HB (g/Dl0	11.5 – 18	12.46 ± 0.21	12.56 ± 0.28	0.7637
PCV	35 – 54	39.62 ± 0.64	40.2 ± 0.92	0.5970
MCHC (g/dL)	30 – 32	31.12 ± 0.16	32.51 ± 2.01	0.4622
MCV (FL)	74 – 98	86.56 ± 0.85	89.88 ± 1.09	0.0164*
MCH (Pg)	26 – 30	27.25 ± 0.32	31.94 ± 4.30	0.2483
PLT (x 10^3 cells/ul)	130 – 400	216.90 ± 12.92	208.60 ± 9.43	0.6170
WBC (x 10^3 cells/ul)	4 – 11	5.97 ± 0.22	6.37 ± 0.31	0.2796
Neutrophil (%)	40 – 75	53.20 ± 1.47	54.55 ± 1.67	0.5440
Eosinophil (%)	1 – 6	2.75 ± 0.28	2.70 ± 0.36	0.9040
Basophil (%)	0 – 1	0.93 ± 0.09	0.22 ± 0.03	0.0001*
Lymphocyte (%)	32 – 48	40.92 ± 1.24	40.81 ± 1.58	0.9536
Monocyte (%)	2 – 10	2.39 ± 0.70	1.48 ± 0.12	0.2338
FBS (mmol/l)	3.6-5.6	9.6 ± 1.21	3.6 ± 0.35	0.021
HbA1C (%)	< 7.0	9.54 ± 2.02	3.86 ± 1.12	0.007

Key: RBC = Red blood cell count, HB = hemoglobin concentration, PCV = parked cell volume, MCH = mean cell hemoglobin, MCHC = mean cell hemoglobin concentration, MCV = mean cell volume, PLT = platelet count, WBC = White blood cell count, FBS=fasting blood sugar, HbA1C= glycated haemoglobin * = significant at p-value < 0.05.

DISCUSSION

Hematological parameters are useful indices for the early diagnosis and prognosis of diabetic complications (I4). There are currently some controversies in reports of hematological parameters on type 2 diabetic patients. Some studies reported significantly lower hematological parameters, some reported significant increase while others failed to record significant changes in these parameters among the diabetic subjects and controls. The present study recorded a significant reduction in the mean cell volume (MCV) of type 2 diabetic subjects compared to the normal controls. The Mean Cell Volume refers to the volume of individual red blood cells determined by their size. Red blood cells with normal sizes are referred to normocytes, those with larger sized are referred to as macrocytes while those with smaller sizes are termed microcytes. When the Mean Cell Volume is high, the RBCs are predominantly macrocytes while when the Mean Cell Volume is lower RBCs are predominantly microcytes. The reduced Mean Cell Volume recorded in the type 2 diabetic patients could be attributed to some factors such as increased production of reactive oxygen species and the formation of advanced glycation end products as a result of long-term hypercycemia. This is similar to the findings of Al-Salhen et al (15) who recorded significant reduction in the Mean Cell Volume in diabetic subjects compared to non-diabetic controls.

The present study recorded a significantly increased basophil counts in the type 2 diabetic subjects compared to the controls. This can be attributed to the presence of low grade chronic inflammation in the type 2 diabetic patients resulting from persistent hyperglycemia (15). This is similar to the findings of Arkew et al (2) who recorded significantly increased basophil counts in type 2 diabetic patients compared to the controls. However, there was no significant differences in the hematological parameters involving the RBC, HB, MCHC, MCH, PLT, WBC, Neutrophil, Eosinophil, Lymphocyte and monocyte counts between the type 2 diabetic patients and the controls. This disagrees with the findings of Kizilgul et al (16),Adane et al (1) and Umeji et al (17), who recorded significant increase in PLT,WBC and Lymphocyte counts in type 2 diabetic patients compared to controls. Arkew et al(2) and Al-Salhen et al (15) also recorded significant decrease in the RBC,HB and HCT as well as significant increase in the MCH and MCHC which was not observed in our present study. The observed differences in the present study when compared to these previous studies could be ascribed to some differences in study design, duration, sample size of study and genetic differences in the various populations.

CONCLUSION

The findings of the present study reveals that T2DM causes alterations in hematological parameters of affected patients. This could be a major underlying factor to the development of complications in patients. Therefore there is need for constant monitoring of the levels of hematological parameters to enhance patient management.

REFERENCES

1. Adane T, Arise F, Getaneh Z, Getawa T. (2002) White blood cells and platelet profile of diabetic patients at University of Gondar specialised referral hospital: A comparative cross-sectional study. Journal of Clinical Laboratory Analysis 35(e23808): 1-7.

2. Arkew M, Yemane T, Mengistu Y, Gemechu K, Tesfaye G. (2021) Hematological parameters of type 2 diabetic adult patients at DebreBerhan Referral Hospital, Northeast Ethiopia: A comparative cross-sectional study. Public Library of Science One 16(6): e0253286.

3. Narjis M, Noreen M, Safi SZ, Ilahi NE, Alomar SY, Alkhuriji AF (2021) Cross talk between complete blood count and progression of type II diabetes mellitus. Journal of King Saud University Science 23: 10149.

4. Ali MH, Hassan Aj (2019) Assessment of the alteration of blood indices in patients with type 2 diabetes mellitus: A cross-sectional study. Mustansiriya Medical Journal 18:24-29.

5. Kaur R, Kaur M, Singh J. (2018) Endothelial dysfunction and platelet hyperactivity in type 2 diabetes mellitus: Molecular insights and therapeutic strategies. Cardiovascular Diabetology 17(121): 1-17.

6. Park J.M, Leee HS, Park J.Y, Jung D.H, Lee J.W. (2021) White blood cell count as a predictor of incident type 2 diabetes mellitus among non-obese adults: a longitudinal 10-year analysis of the Korean Genome and Epidemiology study. Journal of inflammation Research 1(14): 1235-1242.

7. Wang Y, Yang P, Yan Z, Liu Z, Ma Q, Zhang Z, Wang Y, Su Y. (2021). The relationship between erythrocytes and diabetes mellitus. Journal of Diabetic Research 6656062: 1-9.

8. Zimmermann M, Bumm C, Hazel N, Gray CM, Lwanda J. (2018) Experiences of type 2 diabetes in Sub-Saharan Africa: a scoping review. Global Health and Research Policy 3:25.

9. Ndulue DC, Ayadiuno RU, Mozie AT, Ogbu CK. (2021) Spatial variation in the level of awareness and application of climate change poliies and laws in Enugu State, South East, Nigeria. Psychology and Education 58(2): 6466-64-71.

10. Akpan UO, Bassey IE, Nwatu NN, Offor SJ (2018) A comparative study on ABO blood group and fertility hormones in infertile women in Calabar, Southern Nigeria. Annals of Medical Physiology 2(2): 19-24.

11. Cookey SN, Gomba VE, Wariboko CM.Prevalence of diabetes in rural communities in South South and South East Nigeria, A retrospective cross sectional community based survey.IOSR Journal of Dental and Medical Science, 2022;21(2):26-32.

12. Shonde-Adebola KB,Shokunbi WA, Adebola MB. Prevalence of Von Willebrand Disease among Nigerian youth in Ibadan,South-Western Nigeria. Open Access Library Journal,2021;8(e7789):1-8.

13. Akinsegun A, Olusola DA, Sarah J-O, Olajumoke O, Adewumi A, Majeed O,Anthonia O, Ebele U, Olaitan O, Olanrewaju A,Aile.Mean platelet volume and platelet counts in type 2 diabetes mellitus on treatment and non-diabetic mellitus controls in Lagos, Nigeria.Pan Africa Medical Journal 18(42):1-5

14. Sampathkumar VP, Krishnamurthy P, Balaraman S,Balaiya D,Sivaraman R,Manjunathan R.Correlation of non-clinical parameters with the hematological indices in type 2 diabetic mellitus patients.Heliyon,2021,e07366:1-6

15. Al-Salhen KS, Mahmoud AY. Haematological profile of patients with type 2 diabetic mellitus in El-Beida, Libya. Ibinosa Journal of Medicine and Biomedical Sciences,2017;9(3):76-80

16. Kizilgul M, Sencar E,Ucan B,Beyel S, Ozcelik O,Ozbek M, Cakal E.Components of the complete blood counts in type 2 diabetes mellitus with inadequate glycemic control.Dicle Medical Journal,2018;45(2):113-120.

17. Umeji LC, Abiodun OP, Sanni OF, Umeji CN, Abiodun AF, Okeke NC,Eigege NC, Okolo CS.Haematological profile of diabetes and non diabetes patients in Abuja, Nigeria.International Journal of Research and Scientific Innovation, 2019;6(5):2321-2705