Journal of Blood & Lymph
ISSN: 2165-7831

Uko et al., J Blood Lymph 2013, 3:1
DOI: 10.4172/2165-7831.1000110

Research Article Open Access

Some Haematological Parameters in Patients with Type-1 Diabetes in Sokoto, North Western Nigeria

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Abstract

Problem statement: Diabetes mellitus is a global public health problem with increasing prevalence. The purpose of this study was to investigate changes in some haematological parameters in patients with type 1 diabetes (T1D) in Sokoto, North Western Nigeria and to compare the results with non-diabetics.

Material and methods: A total of 100 consecutively recruited confirmed T1D patients constituted the subjects for this case-control study. Subjects included 52 males (52%) and 48 females (48%). The age range and mean range was 25-60 years and 42.45 years ± 12.23 years respectively. Forty age and gender-matched non-diabetics were monitored as controls. The packed cell volume, platelet and total white cell count and blood glucose level was determined using standard methods and results were compared statistically with values obtained from non-diabetic controls.

Results: The mean PCV was significantly lower among subjects with (T1D) (36.93 ± 2.19) compared to the non-diabetic controls (39.80 ± 2.24), p=0.003. Diabetics with poor glycaemic control had lower packed cell volume compared to those with lower blood sugar level. The mean platelet and total white cell count was significantly higher among diabetics compared to non-diabetic controls (464.76 ± 158.66 and 8.48 ± 3.27) compared to (297.13 ± 94.25 and 6.48 ± 2.12) p=0.0001 and 0.001 respectively. Platelet and total white cell count increased with increasing hyperglycaemia (t=7.66 and 6.33, p-value=0.001). We observed a significant positive correlation between high platelet and total white cell count count and raised blood sugar level among the diabetic subjects studied (r=0.52 and 0.45) respectively. There were no statistically significant differences between haematological values based on the gender of diabetic subjects.

Conclusion: The packed cell volume is lower among diabetic patients compared to non-diabetics. Platelet and total white cell count are significantly higher among diabetic subjects compared to non-diabetic controls. Anaemia, thrombocytosis and leucocytosis were associated with raised blood sugar levels among patients with type 1 diabetes. We recommend the routine haematological monitoring of patients with type 1 diabetes to prevent complications associated with deranged haematological values in this patient group.

Keywords: Haematological parameters; Type- 1 Diabetes; Sokoto; Nigeria

Introduction

It is predicted that about 366 million people worldwide will be diabetic by the year 2030 [1]. There are 2 types of diabetes; T1D and Type2 Diabetes (T2D). T1D is a heterogeneous disorder associated with the destruction of pancreatic beta cells, with the resultant effect of absolute insulin deficiency. Type2 diabetes on the other hand is characterized by resistance to insulin action and suboptimal insulin secretory response. Causes of diabetes ranges from autoimmune-mediated destruction of beta cells and idiopathic destruction or failure of beta cells [2,3]. About 5-10% of the total cases of diabetes worldwide are due to T1D. T1D is the most common type of diabetes in children and adolescents while Type2 Diabetes (T2D) is common among young adults [4-6]. Type1 Diabetes (T1D) has been increasing by 2% to 5% worldwide. Approximately 1 in 300 persons in the United States are diabetic at the age of 18 years. Epidemiologic patterns show that several factors play a role in distribution of T1D; demographic, geographic, biologic, cultural, and other factors (the role of infections, early childhood diet, vitamin D exposure, environmental pollutants, increased height velocity, obesity, and insulin resistance) [7]. Patients with diabetes mellitus show a significant derangement in various haematological parameters [8]. A high prevalence of anaemia was identified in this group of Type2 Diabetic patients [9]. About 27% of diabetics' patients are anaemic [10]. The mean values of TRBC, Hb, PCV and MCHC for the diabetic patients were found to be lower than the values of control group [11].

Diabetes is a common community based disease among Nigerians [12,13]. Nigeria has the highest prevalence of diabetes in Africa [14]. There is paucity of data on the effect of T1D on the haematological parameters in Nigerians with T1D diabetes. The aim of this study was to investigate changes in some haematological parameters in patients with T1D in Sokoto, North Western Nigeria and to compare the results with non-diabetics.

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Received September 10, 2013; **Accepted** October 31, 2013; **Published** November 04, 2013

Citation: Uko EK, Erhabor O, Isaac IZ, Abdulrahaman Y, Adias TC, et al. (2013) Some Haematological Parameters in Patients with Type-1 Diabetes in Sokoto, North Western Nigeria. J Blood Lymph 3: 110. doi:10.4172/2165-7831.1000110

Materials and Methods

Subjects and study design

This case-control study was designed to investigate some haematological parameters among diabetics' patients in Sokoto, North Western Nigeria. We monitored the Packed Cell Volume (PCV), Total White Cell Count (TWBC), Platelet (PLT) COUNT and blood glucose level of 100 consecutively recruited confirmed T1D subjects made up of 52 males (52%) and 48 females (48%). The age range and mean range was 25–60 years and 42.45 years ± 12.23 years respectively. Forty age and gender-matched non-exposed individuals were monitored as controls. Haematological values obtained from subjects were compared with that of controls and the difference analysed statistically. The effects of socio-demographic factors were also being compared statistically.

Eligibility criteria, informed consent and ethical clearance

One hundred consecutively recruited and consenting adults >18 years with confirmed T1D constituted the subjects for this case-control study. Exclusion criteria included; age <18 years, non-diabetics and failure to give written informed consent after counselling. The mean duration of T1D was 8.9 years ± 6.5 years. Socio-demographic information; age, gender and duration of diabetes mellitus was collected from each subjects. Written informed consent was obtained from all participants recruited into this study (controls and subjects). Ethical clearance was obtained from the ethical review board in the Faculty of Medical Laboratory Science of Usmanu Danfodiyo University in Sokoto, Nigeria.

Study area

This present research work was carried out at the Department of Haematology Faculty of Medical Laboratory Science in Usmanu Danfodiyo University Sokoto State, Nigeria in collaboration with the Department of Haematology in Usmanu Danfodiyo University Teaching Hospital in Sokoto State, Nigeria. The faculty is a centre of excellence in the undergraduate and post graduate training of Medical Laboratory Scientist in Nigeria. Usmanu Danfodiyo University Teaching Hospital is a tertiary health hospital in the Northwest geopolitical zone of Nigeria offering quality care services to residents of Sokoto metropolis and neighbouring states of Zamfara and Kebbi. Sokoto State is located in the extreme North Western part of Nigeria near to the confluence of the Sokoto River and the Rima River. With an annual average temperature of 28.3°C (82.9°F), Sokoto is, on the whole, a very hot area. However, maximum daytime temperatures are for most of the year generally under 40°C (104.0°F). The warmest months are February to April when daytime temperatures can exceed 45°C (113.0°F). The rainy season is from June to October during which showers are a daily occurrence. There are two major seasons, wet and dry which are distinct and are characterized by high and low malarial transmission respectively. Report from the 2007 National Population Commission indicated that the state had a population of 3.6 million [15].

Methods

Six millilitres of blood was collected from each participant. Three millilitres of blood were collected into 3 tubes containing EDTA and fluoride oxalate respectively. EDTA anticoagulated sample was used for determination of haematological parameters while the fluoride oxalate sample was used for the determination of blood glucose level. PCV was estimated according to standard method described by Dacie and Lewis [16]. The percentage Packed Cell Volume (PCV) was determined according to the microhematocrit method [17] using Hawksley microhematocrit centrifuge (Hawksley and Sons, UK). WBC and PLT count was done using the haemocytometry method using the improved Neubauer's counting chamber.

Statistical analysis

Data were entered and analysed using statistical package SPSS version 9 (SPSS Inc., Chicago, IL). Statistical analysis included descriptive analysis of mean, standard deviation, student's t-test and chi-square analysis. A p-value of <0.05 was considered to be statistically significant in all statistical analyses. Correlation was compared using a version of linear regression analysis. Student's t-test was used to compare the differences between mean haematological values of diabetic subjects and non-diabetic controls.

Result

This case -control study included 100 consecutively recruited subjects with T1D diabetes aged 25-60 years with mean age 42.45 years ± 12.23 years. The mean PCV was significantly lower among subjects with T1D compared to the non-diabetic controls (p=0.003). Table 1 show the mean PCV, PLT and TWBC count of diabetic subjects and non-diabetic controls. We observed that patients with poor glycaemic control defined as higher blood sugar had lower PCV compared to those with lower blood sugar level. The mean platelet and TWBC was significantly higher among compared to non-diabetic controls (p=0.0001 and 0.001) respectively. We observed that PLT and TWBC count increased with increasing hyperglycaemia (t=7.66 and 6.33, p-value=0.001). Table 2 show the mean PCV, PLT and TWBC count of diabetic subjects based of their blood sugar levels. We observed a significant positive correlation between high PLT and TWBC count and raised blood sugar level among the diabetic subjects studied (r=0. 52 and 0.45) respectively.

Discussion

A wide range of haematology laboratory values change significantly in patients with diabetes [18,19]. In this present study, we observed that the PCV as an index of anaemia was significantly lower among diabetic subjects compared to non-diabetic controls. Anaemia is prevalent

Participant Groups	Number	Mean PLT count ($x10^9$/l)	Mean TWBC count ($x10^9$/l)	PCV (%)
Diabetic Subjects	100	464.76 ± 158.66	8.48 ± 3.27	36.93 ± 2.19
Non- Diabetic Controls	40	297.13 ± 94.25	6.48 ± 2.12	39.80 ± 2.24
t-value		7.70	4.27	3.10
p-value		0.0001	0.001	0.003

Table 1: The mean ± SD of platelet count, white blood cell count and packed cell volume of diabetic patients and control subjects.

Random sugar level (mmol/l) among Diabetics	PLT ($x10^9$/l)	WBC ($x10^9$/l)
3.5-5.8	368.38 ± 140.51	4.20 ± 0.00
5.9-7.0	390.00 ± 0.00	6.59 ± 1.84
7.1-9.0	447.75 ± 99.68	8.30 ± 2.65
9.1-11.0	511.70 ± 109.47	9.44 ± 2.45
11.1-13.0	584.25 ± 163.24	10.96 ± 5.08
>13.1	626.72 ± 84.76	11.16 ± 4.47
t-value	7.66	6.33
p-value	0.001	0.001

Table 2: Mean PCV, PLT and TWBC count of diabetic subjects based of their blood sugar levels.

among diabetic's patients and may also be significant in determining the outcome of heart failure and hypoxia-induced organ damage in patients with diabetes [20,21]. Anaemia is a common finding in patients with diabetes, particularly in those with overt nephropathy or renal impairment [22]. Anaemia is associated with an increased risk of diabetic complications including nephropathy, retinopathy and macrovascular disease. Similarly, a previous study observed that the mean values of TRBC, Hb, PCV and MCHC for the diabetic patients are lower than the values of control group, indicating the presence of anemia in the former group [11]. Anaemia has been shown to be a risk factor for cardiovascular disease in diabetic patients particularly those with chronic kidney disorder. There is advocacy to monitor and manage the development of anaemia in patients with Type1 Diabetes as its presence may predate an abnormality in renal function. Anaemia may also be significant in determining the outcome of heart failure and hypoxia-induced organ damage in diabetes. While several factors contribute to the increased prevalence of anaemia in diabetes, the failure of the kidney to increase erythropoietin in response to falling haemoglobin appears to be the dominant factor. Previous report indicated that the occurrence of anaemia in diabetes mellitus is due to the increased non-enzymatic glycosylation of RBC membrane proteins, which correlates with hyperglycemia [22,23]. Previous reports have suggested that recombinant human erythropoietin treatment is effective in correcting erythropoietin-deficiency anaemia in patients with diabetes [24]. About 50% of patients with diabetic nephropathy were at CKD stages 4 and 5. Anaemia is common and predicted mortality and there is increasing advocacy that all diabetic patients from CKD stage 3 should be screened for anaemia [25,26]. PCV may be decreased in patients with T1D because of higher levels of blood glucose which can potentially cause intracellular dehydration. This finding does indicates that PVC may not be a good marker for the monitoring of anaemia among patients with T1D. It may be better to use haemoglobin level in the monitoring of anaemia among patients with T1D.

The TWBC count was significantly higher among diabetics compared to non-diabetics. We observed a positive correlation between raised TWBC and platelet and hyperglycaemia. Previous report indicates that diabetic foot ulcer and associated amputations are common among diabetics particularly those with high random blood sugars. Baseline levels of acute phase reactants (white blood cell count, polymorphonuclear leukocyte count, platelet count, Erythrocyte Sedimentation Rate (ESR), serum C-Reactive Protein (CRP) and albumin) and decreased haemoglobin levels were associated with foot ulcer-associated amputation risk [27,28]. Previous report indicates that the total microbial load was positively correlated with the number of isolates on tissue cultures, White Blood Cell count (WBC) and Platelet count (PLT) [29].

In this present study, we observed that the PLT count was significantly higher among diabetics compared to non-diabetics. We observed a positive correlation between platelet count and poor glycaemic control defined as raised blood sugar level. Our finding is in agreement with previous reports which suggest that platelet counts are higher and contribute to vascular events in patients with insulin resistance [30]. Diabetes mellitus is a metabolic syndrome. Previous report show that PLT and TWBC counts are higher in patients with T1D than without the metabolic syndrome and that the rise is in a "dose-dependent" fashion. Increase in PLT and TWBC with increasing blood glucose in patients with T1D could be a result of a stress response. WBC counts correlated positively with platelet counts, which may suggest that a shared mechanism drives both the elevated platelet and WBC counts in patients with this syndrome [31]. Clinically elevated platelet counts are frequently seen in diabetics with a long duration of disease. Elevated platelet levels as well as platelet dysfunction could be injurious to the microcirculation and enhance the risk for vascular complications. Previous report seems to suggest the possibility that elevated platelet count could be used as a prognostic indicator of future diabetic complications [32]. Similarly previous report has shown that raised PLT values are commonly seen in inflammatory and infectious diseases [33]. Reactive thrombocytosis has also been reported among diabetic patients particularly those with poor diabetic control associated with raised blood sugar level [34,35]. Reactive thrombocytosis is defined as an abnormally high platelet count in the absence of a chronic myeloproliferative disease and is associated with many medical illnesses, including infection. Previous report among a cohort of patients with T1D in Japan showed that reactive thrombocytosis was common during the recovery phase of this critical illness [36]. Similarly, a pprevious report among Japanese patient with Type2 Diabetes which estimated insulin by the insulin resistance index of Homeostasis Model Assessment (HOMA-IR) observed that HOMA-IR was positively correlated to platelet count and white blood cell count [30].

There were no statistically significant differences between haematological values based on the gender of subjects. Our finding is consistent with previous report which indicated that the RBC and hematocrit concentrations were similar in male and female diabetic patients [9]. However a previous report showed that there also seems to be a connection between raised platelet number and female gender [32].

Conclusion

The mean values of PCV are lower among diabetic patients compared to non-diabetic controls. PLT and TWBC are significantly higher among diabetic subjects compared to non-diabetic controls. Anaemia, thrombocytosis and leucocytosis were associated with raised blood sugar levels among T1D subjects. The findings from this present study have implications for the effective management of diabetes patients in Nigeria. There is the urgent need to include routine full blood counts in the management of patients with T1D in Nigeria.

Acknowledgements

The authors would like to thank all subjects and control participants for their collaboration. We are also grateful to staff of the Faculty of Medical Laboratory Science of Usmanu Danfodiyo University, Sokoto (UDUS) and the Department of Haematology and Blood Transfusion of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, Nigeria for their support with laboratory testing and data collection.

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