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Hematological Profile of Patients with Type 2 Diabetic Mellitus in El-Beida, Libya

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Abstract

Objectives: The objective of this study is to help identify the hematological profile of patients with diabetes **Settings:** The study was conducted at El-Beida Hospital, El-Beida City, Libya. **Subjects and Methods:** The study subjects selected for this study consist of 103 Libyan type 2 diabetic patients (79 males + 24 females) and 39 healthy non-diabetic subjects (29 males and 10 females) acted as controls. They were matched for age (56.1 ± 7.8 years vs. 55.0 ± 6.3 years. The hematocrit value (HCT), hemoglobin content, red blood cells count (RBCs) and mean corpuscular volume (MCV) concentration with increased white blood cells counts (WBCs), mean erythrocyte hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), lymphocytes and neutrophils levels were performed. **Results:** Hematological studies in the diabetic patients showed significantly lower HCT values, hemoglobin content, RBCs count and MCV concentration than in the controls. Greater total WBC counts, MCHC concentrations, MCH, lymphocytes and neutrophils counts were observed in the patients than in the controls. No differences were found between platelets counts in the diabetic patients and the control. **Conclusions:** Significant aberrations in some hematological parameters associated with carbohydrate, protein and lipid metabolisms was identified in this selected group of people with diabetes.

Keywords: El-Beida, Diabetes Mellitus, Hematological markers, Libya.

Introduction

Diabetes mellitus (DM) is one of the most common non-communicable diseases affecting people around the world (1). The Middle East and North Africa (MENA) region has a high prevalence of type 2 diabetes (T2DM) (2). A high prevalence of diabetes (16.4%; mostly due to T2DM) was demonstrated in the recent Libyan national non-communicable diseases survey of 2009 (3).

Hematological parameters are routinely measured in diabetic patients. Some of these, such as white blood cell (WBCs) count and hematocrit (HCT) level, have been shown to be associated with insulin resistance and incident T2DM (4). Hematocrit is positively correlated with hyperinsulinemia and other risk factors associated with insulin resistance such as high blood pressure, elevated serum triglycerides, low HDL cholesterol, and

central obesity and could therefore be related to insulin resistance (5,6). In addition, chronic inflammation is also involved in the pathogenesis of T2DM. Evidence from epidemiological studies suggests an association between total WBCs or leukocyte count, a non-specific marker of inflammation, and diabetes risk (5,6). However, only a few prior studies investigated whether selected hematological parameters are related to pre-diabetic states. This may be of particular relevance in regions having surge in the prevalence of diabetes such as our own region.

To the best of our knowledge, there are no population-based studies which investigated the association between various routinely measured hematological parameters and pre-diabetes status. Therefore, we wished to investigate the status and associations of commonly-measured hematological parameters in a group of diabetic patients in Libya.

Subjects and Methods

Study population

The study population included a convenience sample of males and females with T2DM, aged 40-60 years from patients seeking medical care at the District General Hospital of El-beida, Libya. 103 patients with T2DM and 39 healthy subjects were included. They were matched for age, gender and socio-economic conditions and they had no concurrent acute illnesses (Table 1). Controls had no known history of diabetes and their fasting blood glucose (BG) levels were lower than 120 mg/dl.

Data collection

A structured interview was conducted to collect data using a specially prepared questionnaire. All interviews were conducted face to face by the primary investigator who would explain the questions that participants may find difficult. Most questions were dichotomus questions consisting of a yes/no answers. All participants gave an informed consent prior to participation. All subjects were anonymized and a numerical system was used to identify both the patients and the corresponding samples obtained. Subjects fasted overnight for 8 hours overnight during which no treatment (insulin or hypoglycemic drugs) were taken. Lifestyle habits and medical history were documented. HCT, whole blood hemoglobin concentration, WBCs, MCHC, MCH, RBCs, MCV, lymphocytes, neutrophils and PLT analyses of blood samples collected into test tubes with anticoagulant were performed on fully-automatic analyzer hematological analyzer (Selectra E, Hungary). It was calibrated by standardized commercially available calibrated kit. Blood samples for hematological analyses were delivered to the laboratory within 2 h of collection and promptly assayed.

Statistical analysis

All the data from patients and controls were analyzed and compared using Student's t-test. The results were expressed as mean ± SD. The percentage difference was calculated according to the formula: [100 X [(mean patients-mean controls)/(mean patients + mean controls)]. Differences were considered significant at $p < 0.05$.

Table 1. Demographic and metabolic characteristics of patients and controls.

Characteristic	Patients	Controls
Number	103	39
Age (years)	56 ± 8 (42-67)	55 ± 6 (39-61)
Gender (male/female)	79/24	29/10
Fasting glucose (mg/dl)	210 ± 49 (148-387)	99 ± 9 (79-119)
Duration of diabetes (year):		
< 5	60 (58%)	-
5-10	27 (26%)	-
> 10	16 (16%)	-

Data are shown as numbers, mean ± standard deviation (range: min- maximal).

Results

The general characteristics of the study population are summarized in table 1. Patients and controls were well matched for age and gender distribution. The number of patients from were balanced between different areas of the district as the number and geographical distribution of diabetic patient in El-Beida is not available. Over half of the patients had diabetes for 5 years.

Measurements of RBCs and its related indices of healthy controls and T2DM patients are presented in table 2. In T2DM patient's HCT, whole blood hemoglobin concentration, RBCs and MCV values are significantly lower than in controls with percent differences of 27.7, 19.2, 23.5 and 5.4%, respectively. The mean values for MCHC and MCH were also significantly greater in diabetic patients than healthy controls (Table 2).

Table 2. The hematological cell counts parameters and related indices of diabetic patients and healthy controls

Parameters	Diabetic patients	Healthy controls	Percent difference (%)
RBCs (x106/µl)	4.24 ± 1.69 (2.32-4.88)	5.37 ± 0.10 (5.07-5.49)	23.5*
Hemoglobin (g/dl)	12.37 ± 4.82 (7.26-13.87)	15.01 ± 0.49 (14.82-15.90)	19.2*
HCT (%)	34.49 ± 9.68 (19.16-37.81)	45.57 ± 2.16 (39.97-47.01)	27.7*
MCV (fL)	81.33 ± 19.82 (64.12-84.98)	84.85 ± 3.48 (83.10-86.13)	5.4*
MCH (pg)	29.16 ± 12.47 (28.81-38.62)	27.94 ± 1.38 (26.39-28.81)	4.2*
MCHC (%)	35.81 ± 11.91 (32.42- 44.57)	32.89 ± 1.08 (30.56-33.61)	8.5*
WBCs (million/mm3)	9.13 ± 3.02 (6.67- 11.14)	6.86 ± 0.63 (5.93-6.96)	28.4*
Lymphocytes (%)	32.95 ± 10.96 (29.01- 45.24)	26.17 ± 1.83 (25.21-28.16)	22.9*
Neutrophils (%)	55.15 ± 13.97 (49.34- 66.71)	46.29 ± 4.32 (44.12- 48.01)	17.4*
Platelets (x103/µl)	241.82 ± 32.10 (213-301)	238.22 ± 28.67 (199-291)	1

All results are expressed as mean ± SD (range as min-max),
**p < 0.05 for diabetic compared to control group.*

Total white blood cell count, lymphocytes and neutrophils counts were significantly higher in the diabetic patients than in the controls. However, no significant differences were observed in platelet counts between patients and controls.

Discussion

In El-Beida city, available data on DM are limited to the annual reports from the Libyan Ministry of Health. Biochemical tests of the disease are limited to monitoring of diabetes mellitus when the patients visit the clinic. The present study is the first to demonstrate abnormalities in hematological markers among T2DM patients in this specific population. The present study demonstrated that the total and differential leukocyte counts were significantly altered in patients with hyperglycemia.

The present study showed that patients with T2DM had lower hemoglobin concentrations. Anemia is relatively common in patients with DM, and low hemoglobin concentration may contribute to many clinical aspects of diabetes mellitus or its progression. Low hemoglobin concentration is associated with a more rapid decline in glomerular filtration rate than that of other kidney diseases (8). Hemoglobin concentration is closely associated with diabetic profiles. Anemia in patients with diabetes increases susceptibility of the kidney to nephropathy, although the precise mechanism remains unknown. It is widely accepted that patients with diabetes are more vulnerable to the effects of anemia (9). Al-Khoury et al. demonstrated that for each chronic kidney disease stage, hemoglobin is 1 g/dl lower in patients with diabetes than in the non-diabetic population (10). DM is one of the leading causes of cardiovascular mortality and morbidity, and low hemoglobin concentrations contribute to developing cardiovascular disease in patients with diabetes (11). Low hemoglobin concentration has strong associations with the diabetic profiles mentioned above, but has no demonstrated mechanisms to explain such correlations (12). Physicians should be aware of the potential effect of anemia on the diabetic population. The resulting significant reduction in RBCs levels, MCV and HCT levels in the in diabetic population with significant increases in their MCH and MCHC levels when compared with the control group may be due to hematotoxic effects associated with toxic substances on bone marrow depression caused by damage to multiple classes of hematopoietic cells and a variety of hematopoietic functions (13). This result was similar to that were previously reported by others (14).

The association between anemia and the development and/or progression of diabetic nephropathy has been highlighted previously. The high cardiovascular risk in patients with diabetic nephropathy has a clear association with anemia and abnormal cardiac function (15). In a cross-sectional survey of patients with diabetes in a single clinic, nearly a quarter of all outpatients had anemia and our significantly low values of total RBCs and HCT in our study are in agreement with these data (9). Also, a significant decrease in hemoglobin concentration, RBCs counts, MCHC and MCH value was reported in diabetic patients in comparison with controls in another study (16).

The lifespan of red blood cells might be decreased in patients with DM (17), so RBC's are affected by various disturbances in the hematopoietic milieu, such as chronic hyperglycemia and hyperosmolarity (18). These disturbances lead to elevated internal viscosity and increased membrane rigidity in these blood cells (19), so that the number of red blood cells decreases. The results in our study were in agreement with previously published literature on RBCs deformability and related indices in T2DM (20).

Peripheral WBCs count has been shown to be associated with insulin resistance, T2DM (21). Within the last years, a number of potential risk factors for T2DM have been identified. In this context, one's attention was particularly turned on lifestyle risk factors, inflammatory parameters, metabolic abnormalities, and genetic risk factors, many of which have been found to be independently associated with T2DM (22). The present study confirms prior findings on an association between WBCs counts and diabetes. Our study indicated that total WBCs counts, lymphocytes and neutrophils were jointly associated with development of type II diabetes (23).

The results that more than half of patients had diabetics since less than 5 years do support the notion that T2DM has long asymptomatic pre-clinical phase, which frequently goes undetected. At the time of diagnosis, the patient could have one or more diabetes complications (15). In the current study, the finding were not found any associated with complications (liver disease, cardiovascular disease, kidney disease and recurrent infection) in relation to duration of diabetes. These finding are confirmed by self-report questionnaire. However, this point still needs further investigation. The prevalence of such symptoms was positively associated with the progress of the disease i.e. the longer the duration of diabetes mellitus. Several studies reported similar diabetic complications with increasing rates upon disease progress (16). Hematological parameters, which have been implicated in diabetes mellitus (24). The primary reasons for assessing the RBCs and related indices are to check anemia and to evaluate normal erythropoiesis. Hemoglobin level indicates the amount of intracellular iron, while hematocrit, representing the volume of RBCs in 100ml of blood helps to determine the degree of anemia or polycythemia (24). There was not to be differences in platelet count between diabetic cases and the control group. These results are in general agreement with the several recent studies have emphasized no interaction between DM and platelet function (25).

The findings in the present study have implications for diabetes management in that they appear to indicate a need for routine full blood counts. Early detection and management of anemia in diabetic patients at the primary care setting would be cost effective in so far as it would reduce hospital admissions and maintain optimum health.

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Disclosures
1. The authors has jointly conducted the study, drafted and revised the manuscript.
2. Conflict of interest: None
3. Funding: Omar Al-Mukhtar University
4. Compliance with ethical principles: The study was conducted according to the ethical principles. All participants gave an informed consent prior to participation. As part of an MSc degree, the protocol was approved by the National Authority for Scientific Research (Libya) and Omar Al Muktar University.

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