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Original Article

Hematological profile associated with type 2 diabetes mellitus

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ABSTRACT

Background: Hematological changes affecting blood cells and the coagulation factors are shown to be associated with diabetes mellitus. We investigated some of the hematological risk factors implicated in the development of type 2 diabetes mellitus.
Methods: The study conducted in western Algeria on a sample of 1852 subjects, 1059 with type 2 diabetes and 793 witnesses, were evaluated for peripheral blood parameters using hematology analyzer. All the informations related to the disease were collected from the patients and recorded using predesigned questionnaire.
Results: The logistic model retained, the mean corpuscular hemoglobin concentration reveals that subjects with concentration over the normal ratio (>36 g/dl) have an exposure risk six and half times higher than subjects with normal concentration (OR = 6.59; 95% CI = 2.51–17.31, P = 0.000). As regards to the platelets blood ratio, subjects with a ratio lower are five times more exposed to type 2 diabetes compared to subjects with a normal ratio (OR = 5.01; 95% CI = 1.78–14.13, $P < 0.002$). Our logistic model also retained basophils ratio (OR = 2.18; 95% CI = 1.35–3.53, $P < 0.001$) and sedimentation rate at one hour (OR = 7.83; 95% CI = 3.39–18.06, P = 0.000).
Conclusions: Hematological profile associated with type 2 diabetes mellitus retained the mean corpuscular hemoglobin concentration over the normal ratio, lower platelets blood ratio, basophils ratio and sedimentation rate at one hour.

1. Introduction

Several hematological changes affecting the red blood cells (RBCs), white blood cells (WBCs), and the coagulation factors are shown to be directly associated with DM [1]. Other hematological abnormalities reported in the DM patients include RBCs, WBCs, and platelet dysfunction [2].

The mean corpuscular hemoglobin concentration (MCHC) was higher in diabetics. However, mean corpuscular volume (MCV) of diabetics was lower.

The quantitative and qualitative analysis of red cell parameters as measured by the red blood cell count, Hematocrit, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) gives the indication of red cell deformability and the hemorheological state. The red blood cell distribution width (RDW) is a measurement of the size variation among circulating red cells and is calculated as part of the routine complete blood count. The RDW, along with mean cell volume, is useful in the differential diagnosis of the causes of anemia [3].

Hemoglobin concentration is closely associated with diabetic profiles. It is widely accepted that patients with diabetes are more vulnerable to the effects of anemia [4]. Al-Khoury and al. demonstratiod that for each chronic kidney disease (CKD) stage, hemoglobin is 1 g/dL lower in patients with diabetes than in the non-diabetic population [5].

Several prospective studies have shown that a high hematocrit (or hemoglobin) predicts type 2 diabetes [6]. However, the reasons for this association have not been fully explored.

Hematocrit has been positively correlated with hyperinsulinemia and conditions associated with insulin resistance such as high blood pressure, elevated serum triglycerides, low HDL cholesterol, and central obesity and could therefore be associated with insulin

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resistance [7]. On the other hand, hematocrit is also a major determinant of blood viscosity [8].

Blood platelets play a pivotal role in the blood clotting process by mediating the primary phase of hemostasis. Their involvement in atherogenesis and thrombotic complications has been previously well documented [9,10]. Platelets taken from diabetic patients, particularly those with vascular instability and angiopathy, have been found to have increased baseline activation levels as well as enhanced stimuli-induced activation and aggregation responses (platelet hyper-reactivity) [11]. Altered platelet morphology and function have been reported in patients with diabetes [12].

Evidence from epidemiological studies suggests an association between total peripheral WBC or leukocyte count, a non-specific marker of inflammation, and diabetes risk [13,14]. Although a number of studies have been published, they have not been systematically reviewed or meta-analysed. Granulocytes themselves are comprised of neutrophils, basophils and eosinophils [13]. Little is known about the association of each of the subfractions with type 2 diabetes mellitus.

Inflammation is hypothesized to play a role in development of type 2 diabetes mellitus; however, clinical data addressing these issues are limited [15].

Some epidemiologic data, mostly from cross-sectional studies, have shown that diabetes and its precursor states are associated with leukocyte count or leukocyte populations and diabetes incidence [13].

2. Methods

Subjects in this study were participants in a case-control study of the pathogenesis of type 2 diabetes that was initiated in April 2015. All participants were recruited from extreme western Algeria. Subjects selected for analysis were ≥30 years old. After taking the Institutional Ethics Committee clearance, the study was conducted on patients diagnosed with diabetes mellitus.

Our case-control study included 1059 patients, with confirmed diagnoses of type 2 diabetes. These cases were all diagnosed according to criteria recommended by the World Health Organization (WHO) [16]. Altogether, we included 793 controls who did not have impaired fasting glucose or type 2 diabetes following a glucose tolerance test.

Information concerning age, gender, family history of diabetes, level of education, occupational, marital status, and consanguineous levels was collected by questionnaire. All study subjects were asked to fill out the questionnaire.

The following data was collected from the patients: Fasting Blood Glucose, Red blood cell count, Hemoglobin level, Hematocrit, MCV, MCH, and MCHC. The blood parameters were analyzed using by Automated Hematology Analyzer Beckmon Coulter 750 using impedance method.

2.1. Statistical analysis

Analysis of data was performed using Minitab 16 for Windows. A binary logistic regression study was performed to determine a predictive model of type 2 diabetes using the measured factors (the response variable is here denoted Y, which counts diabetic subjects (D) and the controls (T), (D) being the reference value). And the ROC curve was plotted to estimate the predictive capacity of our logistic model. P-value less than 0.05 was considered statistically significant.

3. Results

From our results in Table 1, we conclude that Level 0 shows a hypoglycemia (< 0.80 g/l), whereas, Level 1 shows a normal glycemia (0.80 to 1.26 g/l). Indeed, a subject with normal blood glucose has a risk of exposure to type 2 diabetes of eight out of a hundred (OR = 0.08; 95% CI = 0.00-1.27, $P < 0.073$) compared to an subject who has an hypoglycemia. On the other hand, Level 2 shows a hyperglycemia (>1.26 g/l), the risk of exposure in subjects with hyperglycemia is multiplied by 226.37 compared with normal one (OR = 226.37; 95% CI = 95.26-537.93, P = 0.000).

In our model we retained the age group between 50 years and 61 years, in which subjects aged between 50 and 61 years are most exposed to the risk of type 2 diabetes compared to those aged less than 50 years (OR = 2.17; 95% CI = 1.24-3.81, $P < 0.01$). However, the risk of exposure to type 2 diabetes in subjects older than 61 years (OR = 2.04; 95% CI = 1.17-3.55, $P < 0.05$) is two times than subjects with an age between 50 and 61 years.

The logistic model also retained basophils ratio (OR = 2.18; 95% CI = 1.35-3.53, $P < 0.001$), subjects with a basophils ratio higher than 0.1 * 10^9/l are two times more exposed to type 2 diabetes compared to those with normal basophils ratio.

In addition, taking in to account the terms of the MCV, results shows that, subjects with a MCV lower than normal ratio (80fl) present weak probability to have type 2 diabetes than those with normal levels (OR = 0.64; 95% CI = 0.39-1.05, $P < 0.079$). We have retained this factor even if it is not significant in the previsionel

Table 1
Logistic regression results.

predictors	Coeffients	Z (Wald)	P-value	OR	CI Min (95%)	CI Max (95%)
Constant	−1,33743	−0,94	0,345			
Glycemia 1	−2,53302	−1,79	0,073	0,08	0,00	1,27
Glycemia 2	5,42216	12,28	0,000	226,37	95,26	537,93
Age (50–61 years)	0,774525	2,7	0,007	2,17	1,24	3,81
Age (>61 years)	0,713275	2,52	0,012	2,04	1,17	3,55
Basophils ratio ($\times 10^9$/l)	0,78122	3,2	0,001	2,18	1,35	3,53
MCV (fl)	−0,450255	−1,75	0,079	0,64	0,39	1,05
MCHC (g/dl)						
1	0,0629506	0,24	0,813	1,06	0,63	1,79
2	1,88494	3,82	0,000	6,59	2,51	17,31
Platelets ratio ($\times 10^9$/l)						
1	1,61134	3,05	0,002	5,01	1,78	14,13
2	−0,572405	−1,58	0,113	0,56	0,28	1,15
Sedimentation rate (1 h/mm)	2,05765	4,82	0,000	7,83	3,39	18,06

Key: OR: odds ratio, **CI:** confidence interval, **10^9/l:** Giga per liter, **fl:** femtolitre, **g/dl:** Gram per deciliter, **1 h/mm:** millimeter at one hour.

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