RESEARCH ARTICLE

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Received: 22.12.2020
Acceptance: 18.11.2021
DOI: 10.18521/ktd.843666

Konuralp Medical Journal
e-ISSN1309–3878
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Could Hemogram Parameters Be Useful Biomarkers for The Diagnosis of Impaired Glucose Tolerance?

ABSTRACT

Objective: Elevated blood glucose may be affect complete blood count parameters. In this study, we compared the hemogram parameters of healthy individuals and cases with impaired glucose tolerance.

Methods: We examineted 134 patients with impaired glucose tolerance and 30 healthy cases. Patients files were evaluated retrospectively and the levels of hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, red blood cell, red cell distribution wide, mean platelet volume, platelet distribution wide, leukocycte, neutrophil, lymphocycte, platelet, and hemoglobin A1c were recorded. Control and patient groups were compared in terms of these parameters with student T test.

Results: There was no significantly difference between study and control groups in terms of hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, red blood cell count, red cell distrubition wide, leukocycte, neutrophil, lymphocycte, platelet levels. The mean platelet volume and platelet distribution wide values were significantly higher in the patient group than the control group (p value: 0.002, p value: 0.04 respectively).

Conclusions: Complete blood count is an easy, inexpensive test that can be performed in most hospitals. If our study results are supported by other studies, some hemogram parameters may be used to diagnose of impaired glucose tolerance.

Keywords: Complete Blood Count, Hyperglycemia, Impaired Glucose Tolerance.

Bozulmuş Glukoz Toleransının Tanısında Hemogram Parametreleri Biyobelirteç Olarak Kullanılabilir mi?

ÖZET

Amaç: Yüksek kan şekeri, tam kan sayımı parametrelerini etkileyebilir. Biz bu çalışmada sağlıklı bireylerin ve bozulmuş glukoz toleranslı olguların hemogram parametrelerini karşılaştırdık.

Gereç ve Yöntem: Biz bozulmuş glukoz toleranslı 134 hasta ve 30 sağlıklı bireyi inceledik. Hasta dosyaları retrospektif olarak değerlendirildi ve hemoglobin, hematokrit, ortalama eritrosit hacmi, ortalama eritrosit hemoglobini, kırmızı kan hücresi, eritrosit dağılım genişliği, ortalama trombosit hacmi, trombosit dağılım genişliği, lökosit, nötrofil, lenfosit, trombosit ve hemoglobin A1c düzeyleri kaydedildi . Kontrol ve hasta grupları bu parametreler açısından student T testi ile karşılaştırıldı.

Bulgular: Çalışma ve kontrol grupları arasında hemoglobin, hematokrit, ortalama eritrosit hacmi, ortalama eritrosit hemoglobini, kırmızı kan hücresi sayısı, eritrosit dağılım genişliği, lökosit, nötrofil, lenfosit, trombosit düzeyleri açısından anlamlı fark yoktu. Hasta grubunda ortalama trombosit hacmi ve trombosit dağılım genişliği değerleri kontrol grubuna göre anlamlı olarak yüksekti (sırasıyla p değeri: 0.002, p değeri: 0.04).

Sonuç: Tam kan sayımı, çoğu hastanede yapılabilen kolay ve ucuz bir testtir. Çalışma sonuçlarımız başka çalışmalarla desteklenirse, bozulmuş glukoz toleransını teşhis etmek için bazı hemogram parametreleri kullanılabilir.

Anahtar Kelimeler: Tam Kan Sayımı, Hiperglisemi, Bozulmuş Glukoz Toleransı.

INTRODUCTION

Impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) are prediabetic conditions. Diabetes mellitus develops in approximately 25% over three to five years in prediabetic people (1). Prediabetic conditions are associated with cardiovascular disease (2,3). Also stroke, large-vessel occlusive disease, retinopathy, renal disease and polyneuropathy are more common in prediabetic patients (4). If prediabetes is diagnosed early, patients can be protected from these complications by regulating their diet and lifestyle change. Parameters that showing glycemic control are the levels of blood glucose, fructosamine and hemoglobin A1c (HbA1c). HbA1c level is affected by presence of variant hemoglobin, hemolytic and renal anemia and shows the last 3 months blood glucose status of the patients. But it is an expensive test and cannot be performed in all hospitals. Fructosamine is a glycolyzed protein and shows glycemic status in the last 2-3 weeks. It is affected that serum protein concentration and the levels of plasma bilirubin, hemoglobin, uric acid.

Complete blood count (CBC) is a test performed using an automated instrument. CBC measures the amounts and sizes of leukocyte, platelet and erythrocyte. In some studies, it has been reported that CBC parameters may be used as a biomarker that shows glycemic status. Insulin is an anabolic hormone (5). Therefore, hyperinsulinemia may trigger hematopoiesis in bone marrow in patients with hyperglycemia. As a result, the numbers of erythrocyte and leukocyte increase. However, there are contradictory results in the literature about this topic. Emilia et al. showed that erythrocyte half-life was shortened due to impaired erythrocyte shape and function by increasing erythrocyte caspase 3 activity in diabetic patients (6). Diabetes mellitus affects the number and function of platelets and triggers atherosclerosis and atherothrombosis. Platelet hyperactivity has been demonstrated in diabetic patients in some studies (7,8). Some authors reported that the MPV value was an indicator of the platelet activity. In this study, we aimed to compare the hemogram parameters of healthy cases and patients with impair red glucose tolerance.

MATERIAL AND METHODS

We determined 134 patients with IGT and 30 healthy cases who were admitted to the Internal Medicine Outpatient Clinic of University of Health Sciences, Erzurum Regional Education and Research Hospital in Turkey. Local ethical committee approval was obtained before starting this study (date:01.07.2019, number: 2019/10-115). This study was in accordance with the Helsinki Declaration of 1964. Informed consent was obtained from all individual participants included in the study. We excluded cases with hematological disease, diabetes mellitus, cardiac failure, chronic renal and hepatic diseases, pregnancy, autoimmune and infectious diseases from this study. The diagnosis of impaired glucose tolerance was made by performing a 75 gram oral glucose tolerance test (OGTT) that was applied to patients in the morning after 12 hours of night hunger. Venous blood sample was drawn for measurement of glucose at fasting and at 120-min after ingestion of the glucose load. In the OGTT test, cases with a glucose level of 140 to 199 mg/dl (7.8 to 11.0 mmol/l) at the second hour were considered impaired glucose tolerance, according to American Diabetes Association Guideline. CBC was performed using a hematology analyzer (model XN-1000; Sysmex) in all cases. We retrospectively examined the patients' files and recorded age, gender, hbA1c, fasting blood glucose, hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), red blood cell (RBC), red cell distribution wide (RDW), leukocyte, neutrophil, lymphocyte, platelet, mean platelet volume (MPV), platelet distribution wide (PDW) levels of all cases.

Statistical evaluations were made by SPSS-21 windows software. Categorical values were specified as numbers and percentages (%). The Student t-test was used to compare differences between two independent groups. Categorical variables were compared by the Chi-square test or Fisher exact test. Statistical significance was defined as a $p < 0.05$.

RESULTS

We evaluated 134 IGT patients and 30 control cases. Seventy-one (53%) of the patient group were women and 63 (47%) were men, while the number of men and women in the control group was equal (men: 15 cases, women:15 cases). The mean age was 48.89 ± 13.47 years in patients with IGT and 40.2 ± 15.32 years in control group. There was no statistically significant difference between the study and control groups in terms of erythrocyte indices such as hemoglobin, hematocrit, MCV, MCH, RDW, RBC levels (Table 1).

Table 1. Erythrocyte indices in control and patient groups.

Variables	Patient group	Control group	P value
Hemoglobin (g/dL)	15.09 ± 1.31	15.09 ± 1.20	0.90
Hematocrit (%)	45.57 ± 3.79	44.55 ± 3.56	0.18
RBC (10^6/µL)	5.25 ± 0.45	5.11 ± 0.47	0.12
RDW-CV	12.69 ± 0.99	12.78 ± 0.83	0.64
MCV (fl)	85.99 ± 7.80	84.72 ± 14.56	0.50
MCH (pg)	28.51 ± 2.37	28.83 ± 3.69	0.54

RBC: Red blood cell, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, RDW: Red cell distribution wide

We did not find significant difference between the study and control groups in terms of leukocyte, lymphocyte and neutrophil counts (Table 2). Platelet count was not significantly different in the study and control groups (p value: 0.28).

MPV and PDW values were higher in patients with impaired glucose tolerance than the control group (p value:0.002, p value: 0.04, respectively) (Table 3).

Table 2. Leukocyte, lymphocyte and neutrophil counts in patient and control groups.

Variables	Patient Group	Control Group	p value
Leukocyte count (10^3/µL)	7.54 ± 1.6	7.08 ± 1.34	0.14
Lymphocyte count (10^3/µL)	2.47 ± 0.71	2.46 ± 0.66	0.93
Neutrophil count (10^3/µL)	4.28 ± 1.32	3.86 ± 1.23	0.11

Table 3. Platelet parameters in patient and control groups.

Variables	Patient Group	Control Group	P value
Platelet Count (10^3/µL)	290.33 ± 69.89	275.66 ± 58.52	0.28
MPV (fl)	10.23 ± 0.93	9.22 ± 1.70	0.002
PDW	14.78 ± 4.07	12 ± 1.96	0.04

MPV: Mean platelet volume, PDW: Platelet distrubition wide

DISCUSSION

The results of studies on the effects of high blood glucose on RBC, hemoglobin and hematocrit levels are contradictory. Increased blood glucose causes to reduce of red blood cell lifespan, reduction in erythrocyte production due to low erythropoietin level in patients with nephropathy (9). Therefore RBC, hemoglobin and hematocrit levels are also low in patients with diabetic nephropathy. It reported that the levels of hemoglobin, hematocrit and RBC in T2DM patients are lower than in the control group (10). This condition was explained by the erythrocyte aging triggered with nonenzymatic glycation due to hyperglycemia. In a study, it wasn't found difference between diabetic patients and the control group in terms of hemoglobin value (11). On the contrary, in some studies reported that high blood glucose causes incresased red blood cell count due to hyperinsulinemia and insulin resistance positively affecting erythropoiesis (12, 13). We did not find statistically significant difference between the impaired glucose tolerance and the control groups in terms of hemoglobin and hematocrit levels.

MCV, MCH levels increase due to nonenzymatic glycolisation of cell membrane proteins in patients with elevated glucose. Alamri et al examinated 1000 type 2 Saudi diabetic patients and they reported RBC, MCV, MCHC levels were high in patients with hyperglisemia and RDW was negatively correlated with poor glycemic control (14). Nada et al reported RDW was high in diabetic patients (15). In contrary, Cakır et al determined that no significant correlation RDW level and diabetes mellitus (16). We did not find difference between the study group and the control group in terms of RBC, MCV,MCH, RDW. This may be due to ethnic and cultural differences.

Nada et al. found that leukocyte count was higher in patients with uncontrolled hyperglycemia (HbA1c > 7%) than in patients with good glycemic control (HbA1c ≤ 7%) (15). Nagareddy et al. declared that high blood glucose level causes leukocytosis by triggering myelopoesis due to oxidative stress (17, 18). Leukocytosis may contribute acute and chronic ischemic vascular diseases that cause to nephropathy, coronary artery disease. It reported that WBC level was positively associated with fasting plasma glucose in female patients with impaired glucose tolerance. In our study, the numbers of leukocyte, lymphocyte and neutrophil were not significantly different in the study and control groups.

High MPV and PDW values are associated with increased platelet activation and function. MPV was higher in patients with diabetes mellitus than in normoglycemic patients (19). Chen et al reported that platelet count and platelet distribution wide (PDW) were not increased in T2DM patients (20). But Zuberi et al. detected that MPV was high in patients with impaired glucose tolerance (7). In addition, Hekimsoy et al. examineted 145 diabetic and 100 nondiabetic patients. They found MPV value was significantly higher in patients with diabetes than non-diabetic patients (8). In our study; we detected MPV and PDW values were higher in the study group compared to the control group.

CONCLUSION

Complete blood count is a cheap test that can be done in most hospital. CBC parameters can be used to determine blood glucose status if our study results are supported by larger and randomized studies. MPV and PDW were higher in patients with impaired glucose tolerance than in the control group in our study. This may be a cause of complications in impaired glucose tolerant patients. Reference ranges can be determined for MPV and PDW values and cases with high MPV and PDW values can be followed up more closely for the devolepment of IGT.

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