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Original Article

The effects of Hyperglycemia and Hyperlipidemia on blood indices

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ABSTRACT

Background: Cell Blood Count (CBC) are performed with automatic analyzers in laboratories, despite the speed and accuracy of cell counting devices in the analysis of blood samples, several confounding factors may influence their outcomes. This study was performed to assess the effect of hyperlipidemia and hyperglycemia patterns on the results of complete blood cell count (CBC). **Materials and Methods**: This analytical study (case-control) was performed among 270 non-anemic patients, who were divided into five groups: 1) cholesterol above 200 mg/dl, 2) triglycerides above 150 mg/dl, 3) cholesterol above 200 mg/dl and low-density lipoprotein (LDL) over 130 mg/dl and triglycerides above 150 mg/dl, 4) FBS above 100 mg/dl, and 5) cholesterol above 200 mg/dl and triglycerides above 150 mg/dl. The blood cell indices were compared with the control group. After obtaining samples from the participants, the level of FBS, blood lipids and complete blood cell count were measured. Finally, statistical analysis and comparison between the two groups were performed with SPSS, (version24). **Result**s: Comparison between the case and control groups separately in each of the groups showed the following results: 1- WBC in the group with high cholesterol level were significantly higher than the control group ($P<0.05$). 2- RBC, PLT, MCV, and MCH in the group with high triglycerides were significantly higher than the control group ($P<0.05$). 3- RBC, WBC, and PLT in patients with high cholesterol and triglyceride levels were higher than the control group ($P<0.05$). 4- MCV in the group with high FBS were significantly higher than the control group ($P<0.05$) 5- MCV in the group with high FBS, cholesterol and triglyceride levels were significantly higher than the control group ($P<0.05$). **Conclusion**: Our study showed that hyperglycemia and hyperlipidemia patterns clearly increased blood cell indices. Therefore, these patterns should be considered as a confounding factor in the interpretation of complete blood cell count.

Keywords: Hyperlipidemia, Hyperglycemia, Blood indices.

Introduction

Complete blood count (CBC) is a test for basic evaluation of blood cells. This test determines quantitation measures about erythrocytes such as Red blood cell count (RBC count), density of hemoglobin (HB), Hematocrit percentage (HCT), Mean cellular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Red blood cell distribution width (RDW) and also white blood cell and platelets count. Now a days, in clinical laboratories in order to reach to more accurate results, automatic counters machine (cell counter) has takeover analog and hand methods. The basic method of working of this devices is electrical impedance, Radiofrequency conductivity, light scattering and cytochemistry [1, 2]. Endogenous interfering factors include hemolysis, increase blood fat (Hyperlipidemia), hyper bilirubinemia, para-proteinemia, hyperosmolar conditions (such as hyperglycemia) and exogenous interfering factors include the effect of drugs and chemicals used in cell counters [3, 11]. High levels of fat due to their insolubility in the solutions used in the counters and Plasma

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opacity causes false value of some erythrocyte indices [4]. On the other hand, an increase in blood lipids due to the formation of fat particles results in a false increase in white blood cells and platelets [3, 5]. Hyperglycemia may increase the false-positive MCV. In fact, hyperglycemia increases osmotic pressure and, as a result, red blood cells (hypertonic) in isotonic solution (hypotonic) in the counter are absorbed this solution and increased in volume [6].The purpose of this study was to evaluate the effect of hyperglycemia and hyperlipidemia on erythrocyte indices and counting white blood cell and platelets.

Material and Methods

In this case-control analytical study, 270 university staff aged 32-65 years with no previous history of illness who referred to Buali hospital in Tehran for outpatient checkups. 220 patients were evaluated for: age, sex, hypertriglyceridemia (TG > 150), Hypercholesterolemia (CHOL>200), hyperglycemia (FBS> 100) and compared with control group without lipid and glucose abnormalities. The patients were divided into the following groups; (1) a group that had only hyperglycemia, (2) a group that had only high Triglyceride, (3) a group had only high cholesterol and LDL, (4) a group with high cholesterol, triglyceride, and LDL concurrently without the intervention of other interfering factors, and (5) a group that had both hyperlipidemia and hyperglycemia simultaneously. Complete cell counts and blood counts were performed by ADVIA 2120 hematologic analyzer, which works on the indices studied based on the principle of light scattering. Comparison of the two groups performed using SPSS (version 24) with One –Way Anova, Chi-square test and Independent sample t test.

Findings

In the present study the mean age of people with hyperglycemia and hyperlipidemia (49٪ male, 51٪ female) and control group (48٪ male, 52٪ female) were 43/62. It should be noted that there was no significant difference in age and sex between the two patient and control groups. The mean glucose, triglyceride and cholesterol levels in the patient group were 213,344,231 and 85, 101, 155 in the control group, respectively. The statistical results are shown in the tables below. So that Hyperglycemia Increases MCV(p=0/003), (table4), Hyperlipidemia and Hyperglycemia Both Increase MCV(p=0/003), (table5). Hypertriglyceridemia Increase MCV, RBC MCH, PLT (P=0/004, P=0/040, P=0/045, P=0/020), (table2). Hypercholesterolemia Increase white blood Cell(P=0/002), (table3) and also Hyperlipidemia Increase in PLT, WBC, RBC. (P=0/007, P=0/002, P=0/020), (table1).

Table 1: comparison of blood indices in hyperlipidemia and control group.

	Group	Mean	P Value
WBC	HLP	7330.00	.002
	Control	7020.00	
RBC	HLP	5338000	.020
	Control	5088000	
Platelet	HLP	245600.0	.007
	Control	212800.0	
Hb	HLP	15.51	.300
	Control	14.81	
Hct	HLP	45.96	.400
	Control	44.82	
MCV	HLP	83.26	.080
	Control	81.62	
MCH	HLP	30.70	.060
	Control	30.32	
MCHC	HLP	34.90	.240
	Control	34.98	

Table2: comparison of blood indices in hypertriglyceridemia and control group.

	Group	Mean	P Value
WBC	HyperTG	7412.00	.186
	Control	7320.00	
RBC	HyperTG	5518000	.040
	Control	5188000	
Platelet	HyperTG	253600.0	.020
	Control	212800.0	
Hb	HyperTG	16.02	.212
	Control	15.81	
Hct	HyperTG	45.96	.121
	Control	44.82	
MCV	HyperTG	88.26	.004
	Control	79.62	
MCH	HyperTG	30.70	.045
	Control	28.32	
MCHC	HyperTG	34.90	.097
	Control	34.98	

Table3: comparison of blood indices in hypercholesterolemia and control group.

	Group	Mean	P Value
WBC	HyperChl	7450.00	.002
	Control	7120.00	
RBC	HyperChl	5338000	.100
	Control	5288000	
Platelet	HyperChl	205600.0	.106
	Control	212800.0	
Hb	HyperChl	15.51	.294
	Control	14.81	
Hct	HyperChl	45.96	.080
	Control	44.82	
MCV	HyperChl	89.26	.088
	Control	86.62	
MCH	HyperChl	30.70	.076
	Control	30.32	
MCHC	HyperChl	34.93	.681
	Control	34.98	

Table4: comparison of blood indices in hyperglycemia and control group.

	Group	Mean	P Value
WBC	HyperGlycemia	7270.00	.067
	Control	7320.00	
RBC	HyperGlycemia	5238000	.090
	Control	5288000	
Platelet	HyperGlycemia	245600.0	.120
	Control	242800.0	
Hb	HyperGlycemia	14.51	.294
	Control	14.81	
Hct	HyperGlycemia	45.96	.070
	Control	45.82	
MCV	HyperGlycemia	87.26	.003
	Control	79.62	
MCH	HyperGlycemia	30.70	.110
	Control	30.32	
MCHC	HyperGlycemia	34.90	.383
	Control	34.98	

Table5: comparison of blood indices in hyperlipidemia + hyperglycemia and control group.

	Group	Mean	P Value
WBC	HLP+HyperGlycemia	7230.00	.087
	Control	7170.00	
RBC	HLP+HyperGlycemia	5138000	.210
	Control	5198000	
Platelet	HLP+HyperGlycemia	245600.0	.065
	Control	240800.0	
Hb	HLP+HyperGlycemia	14.51	.294
	Control	14.31	
Hct	HLP+HyperGlycemia	45.96	.053
	Control	45.82	
MCV	HLP+HyperGlycemia	87.72	.003
	Control	79.62	
MCH	HLP+HyperGlycemia	30.70	.110
	Control	30.32	
MCHC	HLP+HyperGlycemia	34.90	.383
	Control	34.98	

Discussion

The present study investigated the effect of hyperglycemia and hyperlipidemia on blood indices in Advia 2120 cell counting machine. The WBC,RBC,PLT are obtained directly by the light scattering method and the HB by the cyan methemoglobin method and other indices as a calculation are obtained. Despite the high accuracy and precision of cell counters, there are always errors that lead to false results in these devices. It is noteworthy that the reason for choosing these person for the study was that we had complete information about these patients and that the study group had no specific disease (including cancer, anemia, etc…) and did not use any particular drug. Many studies have been conducted on the effects of interfering factors on the results of automated counters, in these researches the cell counter has been different. Our study results showed that hyperglycemia significantly increased MCV level compared to the control group ($P<0.05$), while MCH ($P>0.05$) were not significantly different from the control group, which is similar to the Plannas study about effect of glucose [4]. In this study the cholesterol level in the case group and control group was not different but hypercholesterolemia increased WBC in this study however the present study was shown in the group that had high cholesterol, WBC were significantly higher than the control group. In this regard; Cantero and his associates Found that patient with hyperlipidemia, fatty droplet in circulating are shown false high HB, PLT, WBC, RBC counts, this is in line with the result of the present study [7] except that hyperlipidemia patterns in the present study had no significant effect on HB, which may be related to accuracy of the device used. On the other hand, in the study of Zandaki and his associates [8]; effect of hyperlipidemia on hematologic indices is limited to increase MCH and MCHC, but not significantly correlated with changes in MCV, whereas; the present study showed that triglyceride elevation was significantly associated with increased MCH and MCV in the control group. The results of a study by Sadeghian and his associates [9]; which investigated the effect of hyperlipidemia on blood indices in electrical resistance-based cell counts, showed that hypertriglyceridemia significantly increased MCHC but had no effect on MCV and MCH, which is not consistent with the present study. The results of their study showed that hypercholesterolemia has no significant effect on blood indices. In the study of Hosseini and his associate [10], which compared the confounding factors on blood indices in electrical resistance-based cell counts, comparison of case and control groups showed that hyperlipidemia increased the levels of white blood cells, platelets, hemoglobin, hematocrit, MCHC, and MCV; this finding was similar to the effect of triglyceride on blood indices in the present study in terms of the effect of hyperlipidemia. It should be noted that the effect of high triglycerides on blood indices is important in anemic patients because, if high levels of TG are available, to determine the type of anemia (micro, normo, and macro-cystic or hypo, normo and hyperchromic), the increased effect of TG on blood indices should be considered. And the present study shows that the effects of hyperlipidemia and hyperglycemia on blood counts and blood indices were similar to those of the present study, although the present study did not show any significant effect of HGB, HCT and MCHC pattern in any of the case groups. This is probably due to the higher accuracy of the device.

Result

The present study showed that white blood cells increased with lipid profile and later on platelets and red blood cells falsely high.

Among the patterns of hyperlipidemia just effect of hypertriglyceridemia on MCH and MCV was significant, but about MCHC; there was no significant change and also increased triglyceride; increased red blood cell and platelet count. Cholesterol in keeping with the high LDL; increased white blood cell count. Hyperlipidemia also increased PLT, WBC, RBC and hyperglycemia increase MCV. Hyperlipidemia and concomitant hyperglycemia both increased

MCV. Based on the results of this study and similar studies interfering factors affect cell count results. Therefore, it is necessary in clinical laboratories consider the effect of these interfering factors on the results of the experiments. It is important to note that in order to determine quantitative effect

of hyperglycemia and hyperlipidemia additives on counting test whole blood cells need to have a proper correction procedure. ($p<0/05$).

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