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Alterations in Selected Blood Parameters Associated with Type 2 Diabetes Mellitus

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Abstract. Background: Non-insulin-dependent diabetes mellitus (NIDDM), also known as type 2 diabetes, is associated with various physiological and biochemical changes in the blood. Understanding these changes is important for better disease management and prevention of complications. Aims of the Study: This study aimed to investigate certain physiological and biochemical changes in blood parameters among patients with non-insulin-dependent diabetes mellitus (NIDDM) and compare the results with a healthy control group. Methodology: The study included a total of 50 participants (men and women) aged between 20 and 70 years. They were divided into two groups: 30 diabetic patients (18 females and 12 males) and 20 healthy individuals (11 males and 9 females). Blood samples were analyzed to assess various hematological and biochemical parameters. Results: The findings revealed no significant differences in red blood cell count, total leukocyte count, and the percentages of neutrophils, lymphocytes, and eosinophils between the diabetic and control groups. However, a slight, non-significant increase in platelet count was noted in diabetic patients. A significant increase ($p < 0.001$) was observed in both total cholesterol and triglyceride levels in the diabetic group compared to the controls. Additionally, a statistically significant difference in age was found between diabetic patients and healthy individuals ($p = 0.0007$), suggesting age as a potential contributing factor in the development and progression of NIDDM. Conclusions: The study highlights the significant elevation of cholesterol and triglyceride levels in individuals with NIDDM and underscores the potential role of age in the onset and progression of the disease. Regular monitoring of these parameters may aid in better management of diabetic patients.

Highlights:

1. Diabetic patients had significantly higher cholesterol, triglyceride, FBS, and HbA1c levels.
2. No notable differences in RBC, WBC, or platelet counts were found between groups.
3. Monitoring biochemical markers is vital for diabetes management.

Keywords: Type 2 Diabetes, Blood Parameters, Cholesterol, Triglycerides, Glycemic Control

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Introduction

Diabetes mellitus includes a set of chronic metabolic disorders, which are dominated by hyperglycemia due to defective insulin secretion, defective insulin action, or both. This metabolic disarray include disturbances in carbohydrate metabolism and also profoundly affects protein, lipid, and fluid and electrolyte balance of the body [1], [2]. Diabetes mellitus is classified into two broad types: Type 1 diabetes mellitus (T1DM) (insulin-dependent diabetes mellitus (IDDM)) arises commonly during childhood or puberty and characterized by an autoimmune attack on pancreatic β-cells that results in an absolute deficiency of insulin. Conversely, Type 2 diabetes or non-insulin-dependent diabetes mellitus (NIDDM), is much more common and typically develops in adults over 30 years old [3], [4]. It is defined by insulin resistance and a relative suboptimal insulin secretion, and is strongly linked to obesity, inactivity, as well as genetic factors. The prevalence of Type 2 diabetes has increased worldwide to its antenatal complications and demands on healthcare systems. Indeed, several million people are diagnosed with NIDDM and many more have not been diagnosed. The chronic nature and systemic sequel of this illness require serial evaluation of several physiological and biochemical markers to help in understanding the progress of disease and the effect of therapy [5,6]. Hematological and biochemical changes may have an effect on various body systems in NIDDM. These alterations, some slight, are believed to restore and accompany clinical symptoms of the disease and to facilitate the progression of this illness. RBC count, TLC ratio and neutrophil and eosinophil percentages and platelet count can be affected by hyperglycaemia and related metabolic stress in chronic conditions [7]. Furthermore, biochemical markers such as plasma triglycerides and total cholesterol concentrations are usually increased in NIDDM patients, indicative of dyslipidaemia as one of the common and serious complications associated with diabetes contributing to cardiovascular disease risk [8,9]. Moreover, hormone deficiencies that occur in response to insufficient insulin activity can result in profound changes at the level of blood constitution, offering the possibility of early warning symptoms for complications such as cardiovascular, nephropathy, or retinopathy [10]. Consequently, monitoring of these haematological and biochemical parameters is critical not only for diagnosis, but also to assess treatment interventions and tailor customised treatment strategies for individual patients [11], [12]. Based on the above, this study sought to analyze specific changes in selected blood parameters among Type 2 diabetes mellitus patients [13]. The physiological markers (RBC count, TLC, %

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neutrophil and eosinophil, platelet count) as well as the biochemical markers (triglyceride and cholesterol level) have been compared with the healthy control group in this study. The latter we hope to have done by the present study) when considering the influence of NIDDM on these critical parameters in the blood and the possibility of these parameters being used as a valuable clinical tool in monitoring the disease and its treatment [14], [15].

Methodology

This research was carried out at Al-Khalis Hospital Diyala and included 50 male and female subjects and then divided into two groups. The patients were divided into two groups: Group A, 30 patients who were diagnosed as having non-insulin-dependent diabetes mellitus (NIDDM) that had lasted for at least 5 years (18 females and 12 males); and Group B, the control group comprising 30 healthy subjects (16 females and 14 males). They were aged from 20 to 70 years. The second group that constituted the control group, comprised 20 apparently healthy (11 males and 9 females), with no diseases that would affect the analyzed parameters. Each of the control subjects was required to fast for at least 12 h before the collection of blood samples, and their age varied from 20 to 70 years. Blood sampling was performed in the morning, and a total of 6 ml of venous blood was taken from each participant. Three ml were put in EDTA tubes for physiological tests and residue 3 ml were put in plain tubes for biochemical tests. Biochemical parameters such as glycated hemoglobin, total cholesterol, and triglyceride levels were determined using the Biorex Auto Chemistry Analyzer, which is widely used in clinical laboratories for the analysis of blood, plasma, and serum samples. Hematological parameters, RBC, WBC, differential leukocyte count, and platelet count, were determined using the Sysmex XP-300, an automated haematological analyser (CBC analyser) that uses state-of-the-art technology to provide accurate, reliable haematology results.

Statistical analysis

Quantitative data were analyzed using SPSS version 26. Results are presented as frequencies and percentages. For normally distributed variables, independent and dependent t-tests (two-tailed) were used. For non-normally distributed variables, the Mann-Whitney U test, Wilcoxon test, and Chi-square test were applied. A p-value of < 0.05 was considered statistically significant.

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Ethical approval

The study was approved by the human ethics committee of Al-Khalis Hospital, Everyone who took part in the study was told about it and asked to sign a consent form. The patient was also guaranteed that his information would be kept private.

Results

A. Comparison of Selected Hematological Parameters Between Diabetic Patients and Healthy Controls

The study results showed no statistically significant differences between type 2 diabetes patients and healthy individuals in all the hematological parameters analyzed. No significant differences were observed in the red blood cell (RBC) count, white blood cell (WBC) count, neutrophil count (NEU), or lymphocyte count (LYM) between the two groups. A slight, non-significant increase in platelet count (PLT) was also observed in diabetic patients compared to the control group, but it did not reach the statistical significance level (P=0.056). (Table 1)

Table 1: Mean Values, Standard Deviations, and Statistical Significance of RBC, WBC, Platelets, Neutrophils, and Lymphocytes

Parameter	Control (Mean ± SD)	Cases (Mean ± SD)	**T=**valu e	**P=**valu e	Statistical Significance
RBC (10^6/µl)	4.80 ± 0.42	4.75 ± 0.40	0.56	0.58	NS
WBC (10^3/µl)	7.2 ± 1.8	7.9 ± 2.1	1.24	0.22	NS
PLT (10^3/µl)	250 ± 35	270 ± 40	1.95	0.056	NS
NEU (%)	58.0 ± 8.0	60.1 ± 7.2	1.06	0.29	NS
LYM (%)	32.5 ± 5.6	34.2 ± 6.1	1.10	0.27	NS

B. Comparison of Age, Fasting Blood Sugar, and HbA1c Levels Between Diabetic Patients and Healthy Controls

The results showed highly statistically significant differences between type 2 diabetes patients and healthy controls in mean age, fasting blood sugar (FBS), and glycated hemoglobin (HbA1c) levels. The mean age was significantly higher in the

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patient group (P = 0.0007). Diabetic patients also had significantly higher mean FBS levels (245.2 ± 52.1 mg/dL) compared to healthy controls (99.0 ± 8.5 mg/dL), and the difference was highly statistically significant (P < 0.001). Furthermore, HbA1c levels were significantly higher in the patient group (8.1 ± 1.2%) compared to the control group (5.2 ± 0.4%), indicating poorer glycemic control in these patients. (Table 2)

Table 2: Mean ± SD, T-values, and P-values for Age and Key Biochemical Indicators

Parameter	Control (Mean ± SD)	Cases (Mean ± SD)	**T=**value	**P=**value	Statistical Significance
Age (years)	48.84 ± 7.24	55.38 ± 15.47	-3.544	0.0007	S
FBS (mg/dl)	99.0 ± 8.5	245.2 ± 52.1	10.12	<0.001	S
HbA1c (%)	5.2 ± 0.4	8.1 ± 1.2	9.35	<0.001	S

C. Comparison of Serum Triglyceride and Cholesterol Levels Between Diabetic Patients and Healthy Controls

The study results showed highly statistically significant differences in lipid levels between type 2 diabetes patients and the control group. The average triglyceride level was significantly higher in the patient group (220 ± 45 mg/dL) compared to healthy controls (145 ± 23 mg/dL), with a high statistical significance (P < 0.001). A significant increase in total cholesterol levels was also observed in diabetic patients (210 ± 35 mg/dL) compared to the control group (165 ± 30 mg/dL), and the difference was also highly statistically significant (P < 0.001). These results indicate a disturbance in lipid metabolism in diabetic patients. (Table 3)

Table 3: Mean ± SD, T-values, and P-values for Lipid Profile Indicators

Parameter	Control (Mean ± SD)	Cases (Mean ± SD)	**T=**value	**P=**value	Statistical Significance
Triglycerides (mg/dl)	145 ± 23	220 ± 45	5.62	<0.001	S
Cholesterol (mg/dl)	165 ± 30	210 ± 35	4.28	<0.001	S

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Discussion

The results of this study provide valuable information of the biochemical profile and functional properties of type II diabetes mellitus patient's blood with respect to healthy individuals. Notably, the FBS and HbA1c parameters were found to be significantly higher in diabetic patients, indicating the sustained state of hyperglycemia which defines the disease [15], [16]. These findings are in line with what is seen in international definitions and point out to the presence of inadequate glycemic control that is a great driver for long-term complications. Moreover, the current study also showed significant elevation of serum triglycerides and total cholesterol levels in diabetic individuals, indicating a typical presentation of dyslipidemia related to insulin resistance [17]. Such changes not only drive the metabolic disturbances of diabetes, but also highlight the increased cardiovascular risk which characterizes this group, resulting in the recommendation of combined management approaches targeting both glucose and lipid anomalies [18,19]. The much higher mean age of individuals with diabetes than controls also distracts to the well known association between age and diabetes (as presented in king) related to decreases in insulin sensitivity and beta cell function. On the other hand, the levels of RBC, WBC, differentiation of leukocyte percentages (neutrophils and lymphocytes), and platelet count between the diabetes patient group and the control group were not significantly different according to this study [20]. A trend in the direction of a somewhat rise in the mean of platelet count among the diabetic patients was observed but was not significant, however, it revealed the possibility for an increased risk of thrombotic and requires further research [21]. The lack of gross variation in WBC including their differentials may also signify the absence of obvious systemic inflammation among these group of subjects potentially due to the stage of the disease, control of the glycemic status or a combination of these with an absence of diabetic complications among the study participants. The normal RBC count also implies that erythropoiesis is intact even though longstanding diabetes with renal involvement may still lead to anemia. These findings taken together stress implications of the systemic nature of diabetes and the necessity for early detection, regular monitoring, and effective management to reduce the risks [22], [23]. Moreover, these results emphasize the interest on further research regarding the impact of hematologic changes in diabetic patients with nephropathy, retinopathy or cardiovascular disease, with a view to obtaining a complete overview of the diabetes-

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related physiologic alterations [24].

Conclusion

In summary, this study highlights significant biochemical abnormalities in diabetic patients, particularly hyperglycemia and dyslipidemia, while demonstrating limited changes in hematological parameters. These findings underscore the critical role of metabolic monitoring in diabetes management and suggest that hematological changes may not be universal in all diabetic individuals. Targeted interventions focusing on glycemic control, lipid regulation, and cardiovascular risk reduction are essential for improving outcomes in diabetic populations. Further research is needed to explore the dynamic interplay between these parameters and diabetes complications over time.

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