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Original Research Article

Evaluation of Hematological, Biochemical and Inflammatory Markers in Patients with Acute Leukemia

Taghreed Mustafa Zaean[1]*

[1]Aldour Technical, Northern Technical University Institute, Salahaddin, Iraq

***Corresponding Author:** Taghreed Mustafa Zaean
Aldour Technical, Northern Technical University Institute, Salahaddin, Iraq

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Abstract: ***Background*:** White blood cell malignancy classified by an overabundance of lymphoblasts is known as acute lymphoblastic leukaemia (ALL). The current study aimed to investigate the alteration in mean level of some biochemical, hematological and inflammatory markers in patients with acute lymphoblastic Leukemia. ***Methods*:** The study included forty ALL patients (20 newly diagnosed with ALL patients and 20 under treatment ALL patients) with 20 healthy control persons from February to May 2026 from ages 2-70 years of both genders. Lipid profile (Cholesterol, Triglyceride, High Density lipoprotein and low Density lipoprotein), Liver function test (Aspartate aminotransferase and Alanine aminotransferase), Hematological profile, C-reactive protein, Interleukein-6 (IL-6) and Tumer necrosis factor- alpha (TNF-α) was measured in serum of studied groups. ***Results*:** Results of the study revealed noteworthy alterations in hematological, chemical and inflammatory markers in Acute Lymphoblastic Leukemia (ALL) patients compared to control. Patients in treatment had higher cholesterol, HDL and LDL levels than newly diagnosed and control patients, with triglyceride levels being elevated in newly diagnosed patients. It was also found that liver enzymes increased significantly. Patients under treatment with HIV had higher levels of ALT and patients with newly diagnosed had higher levels of AST than the patients under treatment and the control group. The study demonstrated a significantly lower level of Hb and PLT and higher WBC count in ALL patients in comparison with control. Hb and platelet level improved and the number of WBC decreased in patients under treatment as compared to newly diagnosed patients showing relative improvement in some of the blood parameters in the treated patient. As for inflammatory indicators, levels of CRP, IL-6, and TNF-α showed an increase in newly diagnosed patients compared to patients under treatment and the control group. These indicators decreased more in patients being treated, reflecting the inflammatory response with the course of the disease and reduction with treatments. ***Conclusion*:** The results confirm the potential of these biomarkers to be used as adjunctive indicators in assessing physiological and inflammatory changes in ALL and treatment related changes.

Keywords: Acute Lymphoblastic Leukemia, IL-6, Inflammatory Markers, Malignancy.

INTRODUCTION

Hematologic cancer, also referred to as blood cancer, is a neoplasm that arises from tissues responsible for blood formation, such as bone marrow and immune system cells (Sochacka-Ćwikła *et al*., 2021). Hematologic malignancies include a range of cancers such as leukaemia, lymphoma, and multiple myeloma. In leukaemia, the bone marrow produces abnormal white blood cells known as leukaemia cells (Fardin and Akter, 2021).

White blood cell malignancy classified by an overabundance of lymphoblasts is known as acute lymphoblastic leukaemia (ALL) (Agustin *et al*., 2021). The pathophysiology of this haematological malignancy that is frequently linked to childhood leukaemia has been linked to both hereditary and environmental risk factors (Cobaleda *et al*., 2024).

Leukaemia usually commences in white blood cells, the potent cells responsible for combating infections. It is postulated that leukaemia develops when blood cells experience modifications (mutations) in their genetic framework, or DNA. DNA harbours guidelines that dictate cellular activities. Generally, DNA directs a cell to develop at a particular

speed and to terminate at a specific period through a controlled process referred to as apoptosis (Eldeeb,2023). In leukaemia, genetic alterations, which arise from hereditary or environmental factors, instruct blood cells to persist in their growth and division. This causes the over production of irregular white blood cells originating from stem cells in the bone marrow (Choi *et al*., 2024). Consequently, the proliferation of unregulated cells within the bone marrow intensifies. Thus, neoplastic cells obstruct the development of nascent immune cells and curtail the synthesis of lymphoid and myeloid stem cells (Bayik *et al*., 2021).

Leukaemia cells can ultimately traverse from the regulated bone marrow into the circulatory system and potentially invade and spread to other organs, including the liver, spleen, and neurological system, while also negatively impacting the blood and bone marrow itself. Significant advancements in the prognosis of paediatric ALL have been realised in recent decades, although such enhancements have not been observed to the same degree in adult cases (Trendowski *et al*., 2015). The survival rates in the former exceeded 80%, whilst those in the latter did not surpass 40%. Such pronounced disparities may be ascribed to various elements, including the implementation of more rigorous treatment protocols and more advantageous genetic predispositions in paediatric acute lymphoblastic leukaemia (Mohammed *et al*., 2021; Al-Mahayri *et al*., 2021). The current study aimed to investigate the alteration in mean level of some biochemical, hematological and inflammatory markers in patients with acute lymphoblastic Leukemia.

METHODS

Study Design

The study included fourty ALL patients (20 newly diagnosed with ALL patients and 20 under treatment ALL patients) with 20 healthy control persons from February to May 2026 from ages 2-70 years of both genders. Information was collected from participating patients after obtaining their ethical consent and compiled in a questionnaire form specific to each of them.

Sample Collection

About five milliliters of blood were obtained from each participant, two ml of blood were placed in EDTA tubes for hematological tests and three ml of Blood was placed in gel tubes and left to clot for ten minutes at room temperature. It was then centrifuged at 3000 rpm for five minutes to obtain serum. The serum was stored in Eppendorf tubes at – 8° C until used in tests for patients and healthy individuals.

Biochemical Tests

Lipid profile (Cholesterol, Triglyceride, HDL and LDL), Liver function test (AST and ALT), C-reactive protein was measured in serum of studied groups by COBAS C111 ROCHE (Germany) according to manufacturer instructions.

Hematological Profile Analysis

The study assessed hematological profile in studied groups by using Swelab Automated hematology analyzer from Boule Diagnostics AB (Sweden).

Inflammatory Markers

Mean level of Interleukien-6 and Tumer necrosis factor- α were measured by ELISA device using SUNLONG biotech kit / China according to manufacturer instructions.

Statistical Analysis

The data's statistical evaluation was conducted utilising the pre-existing statistical software SPSS 21 to ascertain the mean and the standard deviation of the mean. The outcomes were subjected to statistical analysis employing one-way ANOVA to compare multiple groups.

RESULTS

Mean Levels of Lipid Profile in Studied Groups

The results in table (1) showed a significant difference in mean levels of lipid profile in acute lymphocytic leukemia compared with control. Mean levels of cholesterol, HDL and LDL were high in ALL patients under treatments (166.41± 11.4, 45.37± 10.66, 90.50± 5.9 mg/dl) respectively compared with new diagnosed patients (151.29±12.5,40.32± 11.76, 85.44±3.1) respectively and control group (130.11± 19.5, 55.80±4.98,65.89±15.1 mg/dl), respectively. While triglyceride level were high in new diagnosed patients (110.50± 14.25 mg/dl) compared with ALL patients under treatments and control group (99.21±9.8, 64.41± 9.9 mg/dl) respectively.

Table 1: Mean levels of lipid profile in studied groups

Lipid profile	New diagnosed ALL Mean ± SD	Under treatment ALL Mean ± SD	Control group Mean ± SD	P value
Cholesterol (mg/dl)	151.29±12.5	166.41± 11.4	130.11± 19.5	0.05
Triglyceride (mg/dl)	110.50± 14.25	99.21±9.8	64.41± 9.9	0.007
HDL (mg/dl)	40.32± 11.76	45.37± 10.66	55.80±4.98	0.04
LDL (mg/dl)	85.44±3.1	90.50± 5.9	65.89±15.1	0.007

Mean Levels of Liver Function Enzymes in Studied Groups

The results in table (2) showed a significant difference in mean levels of Liver function enzymes in acute lymphocytic leukemia compared with control. Mean levels of ALT were high in ALL patients under treatments (45.40± 3.41 U/L) compared with new diagnosed patients (25.19± 1.4U/L) and control group (12.55±1.5 U/L). While AST level were high in new diagnosed patients (30.21±2.19U/L) compared with ALL patients under treatments and control group (23.52±3.31, 16.45±5.5 U/L).

Table 2: Mean levels of Liver function enzymes in studied groups

Liver enzyme	New diagnosed ALL Mean ± SD	Under treatment ALL Mean ± SD	Control group Mean ± SD	P value
ALT (U/L)	25.19± 1.4	45.40± 3.41	12.55±1.5	0.002
AST (U/L)	30.21±2.19	23.52±3.31	16.45±5.5	0.001

Mean Levels of Hematological Parameters in Studied Groups

The results in table (3) showed a significant difference in mean levels of Hematological parameters in acute lymphocytic leukemia compared with control. Mean levels of hemoglobin and platelets were high in ALL patients under treatments (8.65± 1.67 g/dl,80.78± 55.76 x 10^9/L) respectively compared with new diagnosed patients (7.55±2.81 g/dl,54.13± 44.38 x 10^9/L) respectively and control group (12.54± 1.26 g/dl, 277.46± 59.98 x 10^9/L), respectively. While White blood cells level were high in new diagnosed patients (37.13±4.11 x 10^9/L) compared with ALL patients under treatments and control group (22.45± 4.98, 7.50± 2.98 x 10^9/L) respectively.

Table 3: Mean levels of Hematological parameters in studied groups

Hematological profile	New diagnosed ALL Mean ± SD	Under treatment ALL Mean ± SD	Control group Mean ± SD	P value
Hb (g/dl)	7.55±2.81	8.65± 1.67	12.54± 1.26	0.002
WBC (x 10^9/L)	37.13±4.11	22.45± 4.98	7.50± 2.98	0.001
PLT (x 10^9/L)	54.13± 44.38	80.78± 55.76	277.46± 59.98	<0.001

Mean Levels of Inflammatory Biomarkers in Studied Groups

The results in table (4) showed a significant difference in mean levels of inflammatory biomarkers in acute lymphocytic leukemia compared with control. Mean levels of CRP, IL-6 and TNF-a were high in newly diagnosed ALL patients (25.77± 5.88 mg/L,39.33±9.11 pg/ml, 59.67±22.45 pg/ml) respectively compared with patients with treatments (19.22± 3.62 mg/L,13.56±4.22 pg/ml, 30.86±3.11 pg/ml) respectively and control group (4.14±1.77 mg/l, 5.37±7.81 pg/ml, 25.70± 5.90 pg/ml), respectively.

Table 4: Mean levels of inflammatory biomarkers in studied groups

Inflammatory biomarker	New diagnosed ALL Mean ± SD	Under treatment ALL Mean ± SD	Control group Mean ± SD	P value
CRP (mg/L)	25.77± 5.88	19.22± 3.62	4.14±1.77	0.001
IL-6 (pg/ml)	39.33±9.11	13.56±4.22	5.37±7.81	0.03
TNF-α (pg/ml)	59.67±22.45	30.86±3.11	25.70± 5.90	0.008

DISCUSSION

The present study indicated a significant alteration in lipid, hepatic, hematological and inflammatory biomarkers among patients with ALL with detectable differences between new diagnosed and receiving treatment patients compared with healthy persons. The reason for these findings is largely due to the replacement of normal bone marrow cells with proliferating lymphoblasts which lead to a decrease in erythropoiesis and megakaryopoiesis.

Improvements in several haematological indices in treated patients could be due to a decrease in the number of leukaemic cells and partial restoration of normal bone marrow function. This is a similar to previous observations in

children with ALL, who had haematological abnormalities at presentation and responded to the effective treatment (Méndez-Ferrer *et al*., 2020; Duarte *et al*., 2019).

Disparities were also seen in lipid profile with elevated triglycerides and decreased HDL in newly diagnosed patients while elevated cholesterol and LDL levels were noted during treatment. These results were similar to the study of Dyslipidemia at diagnosis of childhood ALL; the main lipid disorders at initial diagnosis were low HDL and high triglycerides (Mogensen *et al*., 2020). Similarly, a recent study of children with ALL during the use of L-asparaginase showed that there was significant change in HDL, triglycerides and cholesterol levels throughout this therapy. These changes can be due to the increased or decreased lipid metabolism that can occur with the presence of malignancy or the changes that can occur due to treatment (corticosteroids and L-asparaginase) (Ioannidou *et al*., 2023).

The present study also demonstrated significant difference in liver enzymes levels, increased level of ALT enzyme during treatment and increased level of AST enzyme at diagnosis. These changes can be a representation of hepatic involvement with the disease and/or treatment-induced hepatotoxicity (Mason *et al*., 2026). Previously, raised transaminases activity has been reported in ALL patients even prior to chemotherapy and more recent studies highlighted the role of treatment-related hepatic injury in the course of ALL treatment (Fettiplace *et al*., 2023). Therefore, it is possible that the rise in ALT during treatment is due to some chemotherapy effects on the liver.

The extent of inflammation significantly influences the advancement of leukaemia and its reaction to therapy. Elevated levels of CRP, TNF-α, and IL-6 in leukemic patients are associated with a deteriorated disease prognosis, indicating more advanced stages of incurable leukaemia (Flaherty *et al*., 2019; Hu *et al*., 2024). Chemotherapy may enhance outcomes by alleviating the inflammatory load, as seen by the notable reduction in several markers following treatment (Sharma *et al*., 2024). In the case of active disease, this finding suggests activation of systemic inflammatory pathways. IL-6 and TNF-α are involved in inflammatory signaling and leukemic cell-bone marrow microenvironment interactions, and can induce hepatic acute-phase reactions and thus raise CRP (Abdullah *et al*., 2026). These findings are consistent with previous findings indicating higher levels of IL-6 and TNF-α in children with ALL at diagnosis and significant decrease in levels during remission (Jaime-Pérez *et al*., 2017; Paganini *et al*., 2025). Likewise, a prospective study of ALL found elevated IL-6 and TNF-α levels at diagnosis, which was evidence of inflammatory activation during the active disease (Florescu *et al*., 2023).

CONCLUSION

The findings of the study reveal that ALL is linked to marked alterations in hematologic, lipid, liver function and inflammatory markers. The most significant changes were a reduction in Hb and platelets, and an elevation in WBC, as well as some abnormalities in the lipid profile and the liver enzymes, particularly in those receiving treatment.

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