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Original Research Paper

Hematological Biomarkers in Acute Myeloid Leukemia: A Comparative Study of New and Relapsed Iraqi Cases

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Abstract: The hematopoietic cell cancer known as acute myeloid leukemia (AML) starts in the bone marrow and quickly spreads to the blood. Despite recent advancements in treatment, the prognosis for people with acute myeloid leukemia (AML) remains poor . **Aim:** This study aims to evaluate changes in hematological parameters in Iraqi patients with acute myeloid leukemia (AML), by comparing several hematological parameters (such as white blood cell (WBC) count, hemoglobin (Hb) concentration, platelet count (PLT), and blast count) between newly diagnosed and relapsed patients, as well as a healthy control group. **Methods**: The study was conducted from September 2023 to March 2024 and included 70 patients diagnosed with AML (50 new cases and 20 relapsed cases), in addition to 38 healthy individuals as a control group. Children under the age of 18, patients with AML-M3, and patients with chronic diseases or other malignancies were excluded.Peripheral blood samples were collected from all participants, and a complete blood count (CBC) was performed using automated hematology analyzers. The percentage of blast cells was assessed using Giemsa-stained blood smears, and cytological and immunological tests were performed to confirm the diagnosis. **Results**: The results showed significant differences between AML patients (new and relapsed) and the control group. The mean white blood cell (WBC) count in new patients was $26.69\times10^3/\mu L$, and in relapsed patients, $22.05\times10^3/\mu L$, compared to $7.32\times10^3/\mu L$ in healthy controls ($P=0.0061$). Hemoglobin (Hb) concentration also decreased significantly in patients, reaching 8.27 g/dL in new cases and 9.01 g/dL in relapsed cases, compared to 13.53 g/dL in controls ($P\leq0.0001$). The platelet count (PLT) was $82.88\times10^3/\mu L$ in new patients and $48.39\times10^3/\mu L$ in relapsers, compared to $217.47\times10^3/\mu L$ in healthy controls ($P\leq0.0001$). Regarding the percentage of blast cells, the study did not record significant differences between new patients (39.66% in the blood and 47.92% in the marrow) and relapsers (42.05% in the blood and 39.85% in the marrow), with P values > 0.05 in both cases **Conclusions**: The study concludes that acute myeloid leukemia (AML) causes a marked disturbance in hematologic function, leading to significant changes in hematologic parameters that can be used as supportive tools in diagnosis and clinical assessment. The results also confirm similarities in the hematologic pattern between new and relapsed cases, highlighting the importance of continuing research into immunological and molecular factors to explain this similarity and assess the likelihood of treatment response and relapse.

Keywords: Acute myeloid leukemia , Relapse , New diagnosis ,WBC, HB .

1. Introduction

Hematopoiesis is the process by which self-renewing cells develop into mature blood cells, while abnormal hematopoiesis is characterized by the accumulation of immature cells in the bone marrow [1]. Leukemia is a heterogeneous hematological malignancy marked by uncontrolled blood cell proliferation and elevated white blood cell counts in both bone marrow and peripheral blood [2,3]. Its development is influenced by various genetic and environmental factors [2]. Leukemia is classified into lymphoid and myeloid types based on the origin of the proliferating cells [4], and into acute and chronic forms depending on the rate of disease progression [5]. In lymphoid leukemia, the malignancy affects lymphocyte-producing cells, whereas in myeloid leukemia, it affects cells responsible for producing erythrocytes, platelets, and some leukocytes [6]. AML accounts for about one-third of all leukemias and nearly 80% of adult acute leukemia cases, often presenting with leukocytosis, elevated blast counts, and extramedullary involvement [7,8]. Despite advances in treatment, AML still has a poor prognosis [9]. Cytogenetic and molecular abnormalities play a crucial role in disease classification, prognosis, and treatment decisions in the era of precision medicine [10,11]. AML leads to decreased production of normal blood cells, causing anemia, thrombocytopenia, neutropenia, and accumulation of abnormal blasts in the bone marrow, blood, and sometimes the spleen and liver due to impaired apoptosis and maturation arrest [12,13]. Consequently, immature hematopoietic precursors replace normal red blood cells (RBCs), white blood cells (WBCs), and platelets (PLTs) [13,14]. The transformation of hematopoietic stem cells (HSCs) into leukemic stem cells (LSCs) due to mutations is a key mechanism in AML pathogenesis. These LSCs proliferate rapidly, producing blast cells instead of mature ones, leading to a shortage of normal blood cells and an excess of blasts [15]. This study aims to compare hematological parameters in newly diagnosed and relapsed Iraqi AML patients and evaluate differences in these parameters with healthy individuals.

2. Methodology

Samples collection

The investigation was conducted from September 2023 to March 2024. The samples were taken from the National Center of Hematology and the hematology unit at the Baghdad Teaching Hospital, spanning both sexes and age categories .AML-positive samples from 70 individual individuals,(50 New AML and 20 Relapse AML) ages 18–84, 31 females and 39 males , were included in the study. Patients' exclusion criteria : AML-M3 type patients and children under the age of eighteen. AML-diagnosed patients who are at least 18 years old meet the inclusion criteria. No other severe illnesses or cancer. For this study, forty (38) healthy volunteers were gathered, of which 18 were men and 20 were women. None of the fit participants had ever experienced leukemia. Using CBC analyzers Hematology Sysmex XS-500i and XT-1800, Hb, WBC, RBC, and platelet count were measured. Giemsa-stained blood smears were used to assess the blast cell percentage. WBC differential count using peripheral blood smear (blood film examination). Diagnosis of AML was established according to the morphology, cytochemistry, and immunophenotype (cluster of differentiation or CD profile) measured by flow cytometry of both PB and BM aspiration as well as studying biopsy reports. All the study experiments were performed at Mustansiriyah University, College of Science, Department of Biology and accepted by the committee on scientific ethics. Ethical approval number BCSMU/0923/0038Z Collected information was kept confidential.

Statistical analysis

To find out how different groups and types of study parameters affected the results, the Statistical Packages of Social Sciences-SPSS (2019) program was utilized. To compare means significantly, the T-test and the least significant difference (LSD) were employed. A meaningful comparison between percentages (0.05 and 0.01 probability) was made using the chi-square test. Calculate the estimated correlation between the variables. The study's estimate of the odds ratio, or OR [16].

3. Results and discussion

108 volunteers were recruited for this study and divided into three age groups. In the first age group (less than 40 years), there were 18 (36.00%) new AML patients, 10 (50.00%) relapsed AML patients, and 22 (57.89%) control persons. Ten (20.00%) people in the second age group (40–50 years) were new AML patients, three (15.00%) were relapsed AML patients, and eight (21.05%) were control persons. The third age group (over 50) consisted of 22 (44.00%) new AML patients, 7

(35.00%) relapsed AML patients, and 8 (21.05%) control individuals.

For every age group, the P-value was Highly Significant (P≤0.01). The control group's mean ± SE was 42.15± 18.96, while the groups of new AML patients and relapsed AML patients had mean ± SEs of 45.28 ± 17.73 and 41.3 ± 18.07, respectively. The accompanying table (1) indicates that there are statistical disparities between ages. Indicating that the differences across the age groups (less than 40, 40-50, and beyond 50) are statistically significant at the P ≤ 0.01 level, the table's P-value = 0.0074 makes this clear.

The three categories of study participants—new AML patients, relapsed AML patients, and the control group—were analyzed according to their gender. According to the findings, 48.00% (24 out of 50) of new AML patients were female, whereas 52.00% (26 out of 50) were male. Males made up 65.00% (13 out of 20) of the relapsed AML group, while females made up 35.00% (7 out of 20). Males made up 47.37% (18 out of 38) of the control group, while females made up 52.63% (20 out of 38). The gender distribution in the various groups differed statistically significantly, as indicated by the P-value (P-value = 0.0492), which may suggest that gender influences the course of the disease. according to table (1).

Table 1: Distribution of sample study according difference Gender and Age in difference groups.

Factors		New AML No (%)	Relapse AML No (%)	Control No (%)	P-value
Gender	Male	26 (52.00%)	13 (65.00%)	18 (47.37%)	0.0492 *
	Female	24 (48.00)	7 (35.00%)	20 (52.63%)	
Age (year)	<40 yr.	18 (36.00%)	10 (50.00%)	22 (57.89%)	0.0074 **
	40-50 yr.	10 (20.00%)	3 (15.00%)	8 (21.05%)	
	>50 yr.	22 (44.00%)	7 (35.00%)	8 (21.05%)	
Total		50	20	38	---
* (P≤0.05), ** (P≤0.01).					

The median hemoglobin levels for the new and relapsed AML patients and the control group were 8.27 g/dl, 9.01 g/dl, and 13.53 g/dl, respectively. Table 2 indicates that there was a significant difference (P ≤0.0001) in hemoglobin levels between the patient and control groups.

The platelets count $\times 10^3/\mu L$ in the control group and both new and relapsed AML patients was 217.47 $\times 10^3$, 48.39 $\times 10^3$, and 82.88 $\times 10^3$, respectively, with a significant difference (P ≤0.0001), as indicated in table (2).

Table 2: Comparison between difference groups/Type in Parameters study.

Group/ Type	Mean ±SE		
	WBC ($x10^3$)	Hb (g/dl)	PLT ($x10^3$)
Patients/New AML	26.69 ±7.04 a	8.27 ±0.17 b	82.88 ±19.65 b
Patients/Relapse AML	22.05 ±9.63 a	9.01 ±0.06 b	48.39 ±10.29 b
Control	7.32 ±0.24 b	13.53 ±0.13 a	217.47 ±6.68 a
L.S.D.	9.439 **	0.752 **	50.241 **
P-value	0.0061	0.0001	0.0001
Means having with the different letters in same column differed significantly. ** (P≤0.01).			

The current study's CBC parameter levels revealed large significant discrepancies between the patients and control individuals, respectively, but no significant differences between the patients' fresh and recurrent AML.

Acute myeloid leukemia (AML) patients who were newly diagnosed and those who had relapsed had their blood and bone blast ratios evaluated. In new patients, the mean blast ratio in blood was 39.66 ± 3.77, but in relapsed patients, it was 42.05 ± 6.44. Relapsed patients had a bone marrow ratio of 39.85 ± 4.94, whereas new patients had a ratio of 47.92 ± 3.58. There was no statistically significant difference between new and relapsed patients, as indicated by the P values for blasts in blood (0.741) and bone (0.218) in the T-test, which did not reveal any significant differences between the two groups. As a result, the findings show that there was no statistically significant difference between the two groups. According to table (3)

Table 3: `Comparison between difference groups/Type in Blast in blood and in bone.

Group/ Type	Mean ±SE	
	Blast in blood	Blast in bone
Patients/New AML	39.66 ±3.77	47.92 ±3.58
Patients/Relapse AML	42.05 ±6.44	39.85 ±4.94
T-test	11.419 NS	12.940 NS
P-value	0.741	0.218
NS: Non-Significant.		

Acute myeloid leukemia (AML) is a malignant tumor of the bone marrow and blood, characterized by the accumulation of rapidly growing immature myeloblasts that impede the production of healthy blood cells [17]. The results of this study showed that the mean age of newly diagnosed patients was 45.28 ± 17.73 years, while the mean age of relapsed patients was 41.3 ± 18.07 years, with an age range of 18 to 84 years. These results are consistent with previous studies conducted in Iraq in 2020 [18], 2009 [19], and 2017 [20], as well as an Egyptian study in 2016 [21].

Although the risk factors leading to leukemia have been extensively researched, only a few clearly explain the origin of the disease. These factors include genetics, environmental factors (such as benzene, ionizing radiation, and electromagnetic fields), and lifestyle factors such as smoking, obesity, and dietary patterns [22].

The study results showed that the gender distribution of patients indicated a similar prevalence between males and females in new AML cases, with males accounting for 52% and females for 48%. In relapsed patients, the prevalence was 65% for males compared to 35% for females. The higher prevalence among males may be attributed to the nature of their work, hormones, gender-related genetic factors, and environmental exposures [23], findings supported by other studies [24–26].

Complete blood counts (CBCs), the first diagnostic test for leukemia patients, showed significant changes resulting from the infiltration of malignant cells into the bone marrow [27]. The most notable of these changes was a significant increase in the white blood cell count (leukocytosis) [28]. The study results showed that the white blood cell count was significantly higher in both new and relapsed patients, compared to the control group. This has been confirmed in other studies [25, 26, 29, 30]. These studies also showed a significant decrease in platelet and hemoglobin levels in patients compared to healthy controls.

In this study, the white blood cell count was 26.69 ± 7.04 × 10^3/µL in new patients and 22.05 ± 9.63 × 10^3/µL in relapsed patients, compared to 7.32 ± 0.24 × 10^3/µL in the control group. Similar results have been supported by other studies [31–34]. The reason for this increase is attributed to genetic changes that lead to cancerous transformation and clonal proliferation in myeloid progenitor cells, as in other tumors [35].

On the other hand, hemoglobin levels were significantly lower in all patient groups compared to healthy controls, with no significant differences between new and relapsed patients. The mean hemoglobin concentration was 8.27 ± 0.17 g/dL in new patients, compared to 13.53 ± 0.13 g/dL in healthy controls, results consistent with those reported by other studies [26, 36]. Low hemoglobin in AML patients is due to the replacement of normal bone marrow cells by malignant cells, which prevents the formation of new blood cells and the absorption of nutrients needed for their production [37].

When comparing the percentages of blast cells in the blood and bone marrow between new and relapsed patients, no statistically significant difference was observed. This is because the diagnosis of AML is based on the presence of ≥20% blasts in the blood or marrow [38], while relapse is diagnosed when ≥5% of blasts return or reappear in the blood, or extramedullary disease develops [39]. These results were supported by other studies [18,40] that indicated that the surrounding immune environment may contribute to the survival of blasts, and that the clinical and hematological similarities between the two groups reflect the aggressive nature of the disease. Another study [25] also demonstrated the role of response to chemotherapy in changing cytokine levels and blast ratios.

Conclusion

The study clarifies the alterations in the hematological parameters associated with AML. According to the findings, AML alters the patient's hematological parameters, causing them to become abnormal or to rise or fall as the disease progresses. In both fresh and relapsed cases, the WBC, HB, and platelet counts are comparable.

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Author's Contributions

Bassam F. Matti suggested the research idea, Israa H. Hamzah performed the theoreticalsection , and Ghaydaa A .Nabat organized all the results, data , wrote and revised themanuscript. All authors agreed to the final version of this manuscript.

Ethics

The study was approved by ethics committee of the department of biology, college of science, mustansiriyah university , baghdad , iraq, as did the iraqi ministry of health and environment . committee number dated **BCSMU/0923/0038Z** written informed consent was obtained from all patients.

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