Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

# Relationship between bone marrow and leukemia

**Yasmin T. Aboud[1], Muna B. Aldeen [2],Dima G.Aldhanimy[3],Zuhair Abdulkareem Dawah[4]**

Email : yasmin.taha1202a@csw.uobaghdad.edu.iq [1]

[1,4]College of Veterinary medicine, University of Baghdad, Baghdad, Iraq.

[2.] College of Science, Al-Nahrain University, Baghdad, Iraq.

[3].Ibn Sina University for Medical and Pharmaceutical Sciences, Baghdad, Iraq.

Abstract

Background:Leukemia is a malignant condition of the hematological system is defined by the abnormal growth of immature white blood cells in the bone marrow, leading to anemia, thrombocytopenia, and immune suppression. These overlapping hematological patterns may complicate diagnosis in endemic regions.Objective:The present study aimed to the study sought to identify similarities in bone marrow suppression and immune response between leukemia.Methods:50 blood samples were collected from patients diagnosed with leukemia (25 males, 25 females) and 25 healthy controls. Complete blood count (CBC) parameters were analyzed using an automated hematology analyzer.Results:Leukemia patients showed a significant increase in lymphocyte count and a decrease in hemoglobin and platelet levels compared with the control group. Similar hematological abnormalities. Conclusion The study demonstrated a clear link between leukemia and changes in bone marrow and blood parameters, underscoring the importance of bone marrow examinations in diagnosis and follow-up treatment, while highlighting the need for further research to improve diagnostic and treatment methods

Keywords : **Bone marrow, leukemia, blood, blood cells**

**الملخص**

تعدّ اللوكيميا (ابيضاض الدم) من الأمراض الخبيثة التي تصيب الجهاز الدموي، ويعود أصل تسميتها إلى المصطلح اليوناني الذي يعني "الدم الأبيض". تتميز هذه الحالة بتكاثر غير طبيعي وغير منضبط لخلايا الدم البيضاء في نخاع العظم، مما يؤدي إلى اضطراب في التوازن الطبيعي لتكوين مكونات الدم. وتختلف اللوكيميا عن معظم أنواع السرطان الأخرى في كونها لا تُشكّل كتلة ورمية صلبة، بل تتجلى بزيادة إنتاج خلايا دموية غير طبيعية، لا سيما خلايا الدم البيضاء. هذه الخلايا تكون غير مكتملة النضج، مما يفقدها القدرة الوظيفية على أداء دورها الأساسي في الدفاع المناعي ومكافحة العدوى ومع استمرار تكاثر هذه الخلايا غير الطبيعية، فإنها تحتل حيزًا كبيرًا من نخاع العظم، مما يعيق عملية إنتاج الخلايا الدموية السليمة. ونتيجة لذلك، يحدث انخفاض في عدد خلايا الدم الحمراء، مما يؤدي إلى فقر الدم، بالإضافة إلى نقص الصفائح الدموية، الأمر الذي يزيد من قابلية النزف، فضلًا عن التأثير السلبي على الخلايا البيضاء الطبيعية. وقد استهدف هذا البحث جمع وتحليل عينات دم من مرضى من كلا الجنسين، واستخدامها كمجموعة دراسية مقارنة وأظهرت النتائج وجود ارتفاع ملحوظ في عدد خلايا الدم البيضاء نتيجة الاستجابة المرضية، مع وجود نمو غير طبيعي في الخلايا اللمفاوية، إلى جانب انخفاض في مستويات خلايا الدم الحمراء، مما يعكس التأثيرات المرضية المتعددة لابيضاض الدم على مكونات الدم المختلفة.

**الكلمات المفتاحية : نخاع العظم , اللوكيميا, الدم , خلايا الدم**

## Introduction

Leukemia is a malignant hematological disorder characterized by the abnormal proliferation of white blood cells within the bone marrow and peripheral blood. It is considered one of the most common types of blood cancer worldwide and is associated with significant alterations in normal hematopoietic function[1].Leukemia, Lymphoma and multiple myeloma are two different types of blood cancer, each with its own specific symptoms. However, many types of blood cancer share some common symptoms [2][3].

Leukemia and bone marrow are directly and causally linked, as the bone marrow is the primary site of origin and development for most types of leukemia [4]. Bone marrow contains hematopoietic stem cells, which are pluripotent cells responsible for producing all blood components through a complex series of cell division and differentiation processes regulated by various growth factors and cytokines[5]. Under normal conditions, these processes are

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

subject to precise genetic control that ensures a balance between blood cell production and programmed cell death[6]. Leukemia begins when a stem cell or progenitor cell within the bone marrow undergoes genetic mutations or chromosomal abnormalities that lead to a loss of control over the cell cycle[7]. Among the most prominent of these changes are mutations affecting genes that regulate cell division, cell survival, and differentiation, giving the affected cells a high capacity for proliferation and resistance to programmed cell death[8]. As a result, a leukemic clone forms and gradually grows within the bone marrow. As the disease progresses, leukemic cells begin to accumulate within the bone marrow spaces, competing with normal cells for space, nutrients, and growth factors necessary for blood cell formation[9]. These cells also secrete inflammatory molecules and cytokines that alter the bone marrow microenvironment, inhibiting the activity of healthy stem cells and reducing their ability to produce normal blood cells[10]. This process is known as bone marrow failure and is one of the most significant pathological features of leukemia[11]. This imbalance affects the various components of the blood. A decrease in red blood cell production leads to anemia, accompanied by paleness, fatigue, and shortness of breath[12]. A deficiency in platelets causes increased bleeding and bruising. A decrease in normal immune cells weakens the immune system and increases the risk of recurrent infections[13]. Conversely, the number of white blood cells in the peripheral blood may be significantly elevated, but most of these cells are immature and lack functional competence[14].

Recent epidemiological studies indicate a rise in leukemia rates in Iraq in recent years, particularly among children[15]. Statistics based on data from the Iraqi Cancer Registry and specialized hematology centers show a gradual increase in the number of registered cases, with acute lymphoblastic leukemia (ALL) being the most prevalent type. Studies also suggest that this increase may be linked to several environmental, genetic, and health factors, necessitating the strengthening of early detection programs and continuous epidemiological surveillance to reduce the disease burden and improve treatment outcomes in Iraq[16].

Leukemia is the third most commonly diagnosed cancer in Australia after breast and colorectal cancer, and accounts for approximately 10% of all cancer cases globally [17].Epidemiological data indicate a steady increase in incidence rates, primarily due to rising life expectancy and improved diagnostic techniques. Australian statistics show that the disease affects males more frequently than females, with an age-standardized incidence of approximately 75 cases per 100,000 males compared to 48 cases per 100,000 females[18]. Although leukemia can occur at any age, the highest incidence rates are recorded in individuals in their seventh and eighth decades of life. It is one of the leading causes of unpreventable cancer deaths in Australia. Five-year survival rates have also increased to approximately 68%, compared to around 52% in the early 1990s, an improvement linked to significant advancements in treatment methods[1].

Blood cancer patients frequently receive a late diagnosis and visit their primary care physician several times prior to receiving a diagnosis [19]. Hospital emergency presentations are frequently used for diagnosis and are linked to worse outcomes, such as a higher chance of advanced disease and a lower survival rate [20]. Low knowledge of cancer has been proposed as a factor in the postponement of seeking medical care and the subsequent postponements in diagnosis[22]. Given the high frequency of symptoms such as fatigue, body aches and pains, weakness, nausea, and weight loss, this can be a particularly significant problem for leukemia.[23], leading to a dearth of

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

understanding about disease-specific symptoms, such as leukemia's bleeding and bruises and lymphoma's night sweats [24]. The disregard for nonspecific symptoms exacerbates this delay, which are frequently mistaken for self-limiting illnesses and lead to several consultations before a diagnosis is made.

A disturbance in the physiological activity of the bone marrow occurs when immature white blood cells proliferate excessively, displacing healthy cells within the marrow. This displacement results in a significant decrease in platelet production, which negatively impacts the efficiency of the blood clotting process. As a result of this deficiency, individuals with leukemia are more prone to easy bruising, excessive bleeding, and the appearance of tiny petechial (small, pinpoint hemorrhages)[25].

**Material & Methods**

**Study design**

The study design includes obtained approval from the Ministry of Health to take samples from patients for the purpose of conducting research. 75 samples were collected, divided as follows: 50 Patient's(25 females',25 males) , 25 controls, during a period of 3For approximately .

several months, with the help of the Medical City Complex (teaching laboratories and the Centre for Hematology and Bone Marrow Diseases). All these were in the 20 to 45 age range, and then the patient's information was sent, with enough of it, to a statistician to compare the blood types.

5 ml of whole blood samples were collected from leukemia patients and divided into EDTA tube then performed a CBC analysis for each patient.

**Methods:**

**Collection of blood samples:**

A disposable syringe was used to collect 5 milliliters of peripheral blood by vein puncture, from each subject. The peripheral blood was used to prepare blood by flow the blood in EDTA tubes which used in the CBC study.

After the patients were diagnosed with leukemia, the patients' blood analyzed to detect the percentage of red blood cells, white blood cells, and platelets[26]. After that, The T Test was used in the statistical analysis to ascertain whether the percentage of blood cells in patients and healthy individuals differed significantly[27]

**Results &Dissection**

**Table (1): Comparison between control and patients according to Age**

| Parameters | Controls, N=25 (mean ± SD) | Patients N=50 (mean ± SD) | *P* value |
|---|---|---|---|
| **Age (years)** | 30.51 ± 9.78 | 32.2 ± 6.96 | 0.428 |

The statistical shows there are no significant differences between patients with leukemia and control based on age

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

**Table (2): Comparison between females and male patients according to Age**

| Parameters | female, N=25 (mean ± SD) | male N=25 (mean ± SD) | *P* value |
|---|---|---|---|
| **Age (years)** | 31.56 ± 6.42 | 32.88 ± 7.53 | 0.50 |

The statistical T test shows there are no significant differences between Female patients and male patients with leukemia based on age.

**Table (3): Comparison of WBC, Lymphocyte Levels Between Patients and Control Groups**

| Parameters | Controls, N=25 (mean ± SD) | Patients N=50 (mean ± SD) | *P* value |
|---|---|---|---|
| **WBC** | 7.17 ± 1.3 | 8.45 ± 4.65 | 0.315 |
| **Lymphocyte** | **2.17 0.62** | **22.95 ± 15.6*** | **< 0.001** |

The statistical T test shows there are no significant differences between the control and patients in WBC, but there are significant differences between the control and patients in lymphocyte

The blood contains either B or T lymphocytes, As a component of the immune system, they aid the body in combating infections. They are present in the lymphatic glands, which are made of lymph tissue. One kind of blood cancer that affects the lymph nodes is lymphoma. The outcome is that the lymphocytes start acting strangely [28]

.

**Table (4): Comparison of WBC, Lymphocyte Levels Between Female and Male Groups.**

| Parameters | female, N=25 (mean ± SD) | male N=25 (mean ± SD) | *P* value |
|---|---|---|---|
| **WBC** | **8.26 ± 3.49** | **6.44 ± 2.49** | **0.05** |
| **Lymphocyte** | 19.12 ± 12.8 | 26.78 ± 15.47* | 0.084 |

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

The statistical T test shows there are significant differences between females and male patients in WBC, but there are no significant differences between the control and patients in lymphocyte. They aid the body in fending against diseases. When a person has leukemia, their cells' DNA changes in a way that causes the body to produce a lot of immature white blood cells[29].

**Table (5): Comparison of RBC, HB, and PLT Levels Between Patients and Control Groups**

| Parameters | Controls, N=25 (mean ± SD) | Patients N=50 (mean ± SD) | *P* value |
|---|---|---|---|
| **RBC** | 4.35± 0.46 | 4.34 ± 0.88 | 0.966 |
| **HB** | 12.5± 1.74 | 11.96 ± 3.0 | 0.317 |
| **PLT** | 222.74± 58.6 | 201.64± 107.1 | 0.268 |

**Table (6): Comparison of RBC, HB, and PLT Levels Between Female and Male Groups**

| Parameters | female, N=25 (mean ± SD) | male N=25 (mean ± SD) | *P* value |
|---|---|---|---|
| **RBC** | 4.12± 0.51 | 4.56 ± 1.1 | 0.063 |
| **HB** | **10.69± 2.18** | **13.22 ± 3.2** | **0.02** |
| **PLT** | 202.15± 119.5 | 201.13± 95.4 | 0.974 |

There are substantial disparities between female and male patients in HB, but no significant differences between female and male patients in RBC or PLT, according to the statistical T test**.** The study results showed clear differences in blood cell indices between the patient group and the control group, reflecting the direct impact of leukemia on hematopoiesis[30]. These changes can be explained by impaired bone marrow function resulting from the abnormal proliferation of leukemic cells, which affects the production of normal blood cells[31]. Alterations in white blood cell counts were observed due to an increase in leukemic cells or the accumulation of immature cells, while a decrease in red blood cell count and hemoglobin levels was associated with anemia resulting from the inhibition of red blood cell production. Changes in platelet counts reflect impaired bone marrow activity and a disruption in its ability to produce blood cells in a balanced manner. These findings are consistent with numerous studies indicating that blood count abnormalities are among the most prominent laboratory features associated with leukemia and can be relied upon to assess disease severity, monitor its progression, and evaluate response to treatment[32].

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

In leukemia, cancerous cells accumulate in the bone marrow and occupy spaces meant for healthy cells, thus inhibiting the normal process of hematopoiesis (blood cell formation)[33]. As a result, red blood cell production decreases, causing anemia, and platelet count drops, increasing the risk of bleeding. Additionally, immature white blood cells are produced, unable to perform their immune functions efficiently, which increases susceptibility to infections[14].

According to immunophenotyping research, acute leukemias may exhibit unanticipated heterogeneity that cannot be detected by morphological assessment. Numerous investigations have shown that malignant transformation can occasionally produce cellular phenotypes that are both aberrant and unstable. The leukemogenic process causes abnormal gene transcription, which is most likely the cause of such unstable phenotypes. Thus, this malignant transformation of a progenitor cell that can develop along either myeloid or lymphoid routes has been used to explain lineage heterogeneity[34]

Leukemic patients in the current study showed notable changes, such as a considerable increase in lymphocyte count and a drop in hemoglobin and platelet levels when compared to the control group[35].

**Conclusion**

the study results demonstrated a strong correlation between leukemia and changes in the bone marrow, as the bone marrow is the primary site of blood cell formation and is directly affected by cancerous cells. The findings showed that bone marrow disorders significantly contribute to disease progression and the accompanying hematological and immunological changes. The study also underscores the importance of histological and laboratory examinations of bone marrow for early diagnosis, determining disease severity, and monitoring treatment response. The study recommends further research focusing on the molecular and genetic aspects of leukemia to improve diagnostic and treatment methods, increase survival rates, and enhance patients' quality of life**.**

**Reference**

1. L. Boswell, J. Harris, A. Ip, J. Russell, G. B. Black, and K. L. Whitaker, “Assessing awareness of blood cancer symptoms and barriers to symptomatic presentation: measure development and results from a population survey in the UK,” *BMC Cancer*, vol. 23, no. 1, p. 633, 2023.
2. M. F. Fardin and M. Akter, “Review on blood cancer and their types,” *J. Mol. Pharm. Regul. Aff.*, vol. 3, no. 1, pp. 18–26, 2021.
3. A. Rosmarin, “Leukemia, lymphoma, and myeloma,” *Cancer Prev. early Detect. Treat. Recover.*, pp. 299–316, 2019.

4. Brown, G. (2022). Oncogenes and the origins of leukemias. International journal of molecular sciences, 23(4), 2293.

5. Kandarakov, O., Belyavsky, A., & Semenova, E. (2022). Bone marrow niches of hematopoietic stem and progenitor cells. International journal of molecular sciences, 23(8), 4462

6. Green, D. R., Galluzzi, L., & Kroemer, G. (2014). Metabolic control of cell death. Science, 345(6203), 1250256.

7. Shlush, L. I., & Feldman, T. (2021). The evolution of leukaemia from pre-leukaemic and leukaemic stem cells. Journal of Internal Medicine, 289(5), 636-649

8. Enane, F. O., Saunthararajah, Y., & Korc, M. (2018). Differentiation therapy and the mechanisms that terminate cancer cell proliferation without harming normal cells. Cell death & disease, 9(9), 912.

9. Biswas, M. D. (2025). Pediatric Hematopathology: Bone Marrow Disorders, Leukemias, Lymphomas, and Molecular Diagnostics. Birupaksha, Pediatric Hematopathology: Bone Marrow Disorders.

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

10. Liu, J., Gao, J., Liang, Z., Gao, C., Niu, Q., Wu, F., & Zhang, L. (2022). Mesenchymal stem cells and their microenvironment. Stem cell research & therapy, 13(1), 429.

11. Iwafuchi, H. (2018). The histopathology of bone marrow failure in children. Journal of clinical and experimental hematopathology, 58(2), 68-86.

12. Kallen, M. E., Dulau-Florea, A., Wang, W., & Calvo, K. R. (2019, Kallen, M. E., Dulau-Florea, A., Wang, W., & Calvo, K. R. (2019, January). Acquired and germline predisposition to bone marrow failure: diagnostic features and clinical implications. In Seminars in hematology (Vol. 56, No. 1, pp. 69-82). WB Saunders.

13. Wilhelm, G., Mertowska, P., Mertowski, S., Przysucha, A. Strużyna, J., Grywalska, E., & Torres, K. (2023). The crossroads of the coagulation system and the immune system: interactions and connections. International journal of molecular sciences, 24(16), 12563

14. Humphry, E., & Armstrong, C. E. (2022). Physiology of red and white blood cells. Anaesthesia & Intensive Care Medicine, 23(2), 118-122.

15. Al-Hashimi, M. M. (2021). Incidence of childhood leukemia in Iraq, 2000-2019. Asian Pacific journal of cancer prevention APJCP, 22(11), 3663.

16. Mahmoud, S. I. (2025). Incidence and Trends of Acute Lymphoblastic Leukemia, Chronic Myeloid Leukemia, Breast Cancer, and Lung Cancer at Nanakali Hospital in Erbil (2022) (Doctoral dissertation, Polytechnic University).

17. K. B. Laupland, F. Edwards, L. Furuya-Kanamori, D. L. Paterson, and P. N. A. Harris, “Bloodstream infection and colorectal cancer risk in Queensland Australia, 2000-2019,” Am. J. Med., vol. 136, no. 9, pp. 896–901, 2023.

18. R. Joshi, “Gender Disparities: 5 Year Survival Rates of Elderly Colorectal Cancer Patients with Depression,” , Walden University. 2023

19. D. A. Howell, D. McCaughan, A. G. Smith, R. Patmore, and E. Roman, “Incurable but treatable: Understanding, uncertainty and impact in chronic blood cancers—A qualitative study from the UK’s Haematological Malignancy Research Network,” PLoS One, vol. 17, no. 2, p. e0263672, 2022.

20. McPhail, S., Swann, R., Johnson, S. A., Barclay, M. E., Abd Elkader, H., Alvi, R., ... & You, H. (2022). Risk factors and prognostic implications of diagnosis of cancer within 30 days after an emergency hospital admission (emergency presentation): an International Cancer Benchmarking Partnership (ICBP) population-based study. The lancet oncology, 23(5), 587-600.

21. D. A. Howell et al., “Time-to-diagnosis and symptoms of myeloma, lymphomas and leukaemias: a report from the Haematological Malignancy Research Network,” BMC Blood Disord., vol. 13, no. 1, pp. 9, 2013.

22. de Amorim Póvoa, L. S. D., Souza, D. A., Verner, F. S., Junqueira, R. B., & de Aquino, S. N. (2025). Lack of knowledge, understanding, and delayed attitudes towards health-seeking behavior in oral cancer patients: a qualitative pilot study. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 139(1), 64-72.

23. Davis, A. S., Viera, A. J., & Mead, M. D. (2014). Leukemia: an overview for primary care. American family physician, 89(9), 731-738..

24. Guzman, G. C., & Heltemes, B. (2026). Diseases of the Blood. Brackenridge's Medical Selection of Life Risks, 1-24..

25. Aljamali, N. M., Obaid, A. J., & Naser, M. S. (2021). Chemical Causes of Leukemia. Journal of Modern Chemistry & Chemical Technology, 12(3), 25-36p.

26. Quispe, R. A., Aguiar, E. M., de Oliveira, C. T., Neves, A. C. X., & da Silva Santos, P. S.

Al-Shatrah Veterinary and Biological Sciences Journal
ISSN (Print): 2958-8952
Volume 2 , Issue 3 , June 2026
Page 90 - 97

(2022). Oral manifestations of leukemia as part of early diagnosis. Hematology, Transfusion and Cell Therapy, 44(3), 392-401.
27. Lippi, G., Salvagno, G. L., & Guidi, G. C. (2014). Red blood cell distribution width is significantly associated with aging and gender. Clinical Chemistry and Laboratory Medicine (CCLM), 52(9), e197-e199.
28. Miliauskas, J., Orell, S. R., & Sterrett, G. F. (2011). Lymph nodes.Orell, Orell and Sterrett's Fine Needle Aspiration Cytology E- Book: Expert Consult.
29 Hemalatha, N., Sowjanya, M., & Prapurna Chandra, Y. (2025). A review on leukemia: Advances in diagnosis, treatment and prognosis. Journal of Innovations in Applied Pharmaceutical Science (JIAPS), 1-6.
30. Terwijn, M., Zeijlemaker, W., Kelder, A., Rutten, A. P., Snel, A. N., Scholten, W. J., ... & Schuurhuis, G. J. (2014). Leukemic stem cell frequency: a strong biomarker for clinical outcome in acute myeloid leukemia. PloS one, 9(9), e107587.
31. Méndez-Ferrer, S., Bonnet, D., Steensma, D. P., Hasserjian, R. P., Ghobrial, I. M., Gribben, J. G., ... & Krause, D. S. (2020). Bone marrow niches in haematological malignancies. Nature Reviews Cancer, 20(5), 285-298.
32. Shah, A., Naqvi, S. S., Naveed, K., Salem, N., Khan, M. A., & Alimgeer, K. S. (2021). Automated diagnosis of leukemia: a comprehensive review. IEEE Access, 9, 132097-132124.
33. Fardin, M. F., & Akter, M. (2021). Review on blood cancer and their types. J. Mol. Pharm. Regul. Aff, 3, 18-26.
34. Saleem, M., & Yusoff, N. M. (2016). Fusion genes in malignant neoplastic disorders of haematopoietic system. Hematology, 21(9), 501-512.
35. Zhang, L., Liu, J., Qin, X., & Liu, W. (2022). Platelet–acute leukemia interactions. Clinica Chimica Acta, 536, 29-38.