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CYTOMORPHOLOGICAL CHARACTERISTICS OF THE BONE MARROW IN PATIENTS WITH CHRONIC LEUKEMIA

Madasheva Anazhan Gazkhanovna, PhD,
Senior Lecturer, Department of Hematology, SamSMU
Esanova Mukhlisa Eldorzhon kizi,
student 402 gr, Faculty of Medical Biology, SamSMU
Ravshanova Parviza Ulmas kizi,
student 402 gr, Faculty of Medical Biology, SamSMU
Abdullaeva Gavkhar Aziz kizi
student 402 gr., Faculty of Medical Biology, SamSMU

Abstract: Chronic leukemia involves the abnormal accumulation of mature blood cells in the bone marrow. This study examines the cytomorphological features of bone marrow in chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML). CLL is characterized by small lymphocytes, while CML shows granulocytic hyperplasia with increased eosinophils and basophils. Accurate cytomorphological analysis is crucial for diagnosis, disease monitoring, and treatment decisions in chronic leukemia.

Keywords: Chronic leukemia, bone marrow, cytomorphology, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), hypercellularity, granulocytic hyperplasia, diagnosis, hematological malignancies.

Introduction

Chronic leukemia is a group of hematological disorders characterized by the progressive accumulation of mature or maturing blood cells in the bone marrow and peripheral blood. Unlike acute leukemia, which involves rapid proliferation of immature cells (blasts), chronic leukemias typically show a slower progression and an overproduction of relatively mature cells. Chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML) are the most common subtypes of chronic leukemia, with each displaying distinct clinical and cytomorphological features. The evaluation of bone marrow cytomorphology is a key diagnostic tool in the management of chronic leukemia, providing essential insights into the nature and stage of the disease. CLL primarily involves the proliferation of small, mature lymphocytes, whereas CML is a myeloproliferative disorder that leads to excessive production of granulocytes. Analyzing the morphological characteristics of bone marrow in these conditions not only aids in diagnosis but also plays a critical role in monitoring disease progression and treatment response.

This article aims to explore the cytomorphological characteristics of the bone marrow in patients with CLL and CML, highlighting the diagnostic significance and differences between these two chronic leukemias. Understanding these features is essential for clinicians to make informed decisions regarding patient care and management.

Materials and Methods

Study Design**:** This study was conducted to evaluate the cytomorphological characteristics of bone marrow in patients diagnosed with chronic leukemia, focusing on chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML). The study included patients with confirmed diagnoses based on clinical, cytogenetic, and molecular findings.

Sample Collection: Bone marrow aspirates and biopsies were collected from 50 patients, 25 with CLL and 25 with CML, attending hematology clinics. Samples were taken from the iliac crest using a standard aspiration technique under local anesthesia. Peripheral blood samples were also collected for comparison.

Cytomorphological Analysis: Bone marrow aspirates were stained using the Wright-Giemsa method to assess cell morphology. Bone marrow biopsies were processed and stained with hematoxylin and eosin for histological evaluation. Cytomorphological features such as cellularity, cell type, maturation stage, and presence of abnormal cells were examined under light microscopy by experienced hematopathologists.

Diagnostic Criteria: Patients with CLL were diagnosed based on the presence of small, mature lymphocytes with clumped chromatin and scant cytoplasm. For CML, diagnosis was confirmed by the presence of hypercellular marrow with a predominance of granulocytic precursors and increased eosinophils and basophils. Cytogenetic analysis for the Philadelphia chromosome (BCR-ABL1 fusion gene) was performed for all CML patients.

Statistical Analysis: Data were analyzed using descriptive statistics to summarize the cytomorphological characteristics of the bone marrow in each group. Comparisons between CLL and CML groups were made using chi-square tests for categorical variables and t-tests for continuous variables. Statistical significance was set at $p < 0.05$.

Ethical Considerations: The study was approved by the institutional ethics committee, and informed consent was obtained from all participants before sample collection.

Results and Discussion

Results

The cytomorphological analysis of bone marrow in 50 patients with chronic leukemia (25 CLL, 25 CML) revealed distinct differences between the two groups.

Chronic Lymphocytic Leukemia

- Cellularity: Bone marrow in CLL patients showed mild to moderate hypercellularity, with lymphoid infiltration observed in all samples.
- Lymphocyte Morphology: Small, mature lymphocytes with clumped chromatin and scant cytoplasm were predominant. The average percentage of lymphocytes in the bone marrow aspirates was 75%, with nodular, interstitial, or diffuse infiltration patterns observed in different cases.
- Fibrosis: Minimal or absent fibrosis was noted in most CLL patients.
- Peripheral Blood: Peripheral blood smears showed an increased number of small lymphocytes, with occasional “smudge cells,” typical of CLL.

Chronic Myeloid Leukemia

- Cellularity: Bone marrow in CML patients was markedly hypercellular, with a predominance of granulocytic precursors, ranging from myeloblasts to segmented neutrophils.
- Granulocytic Hyperplasia: The myeloid-to-erythroid ratio was significantly increased, averaging 10:1. Basophilia and eosinophilia were common findings, with an average basophil percentage of 8%.
- Megakaryocytes: Small, hypolobulated megakaryocytes were observed in the majority of cases.
- Fibrosis: Some patients, particularly those in the accelerated or blast phase, showed evidence of increased marrow fibrosis.
- Peripheral Blood: Peripheral blood showed elevated white blood cell counts, with a significant increase in granulocytes at all stages of maturation.

Statistical Comparisons

- The difference in bone marrow cellularity between CLL and CML was statistically significant ($p < 0.01$).
- The percentage of lymphocytes in CLL patients was significantly higher than in CML patients ($p < 0.01$), while the percentage of granulocytes was significantly higher in CML patients ($p < 0.01$).

Discussion

The findings of this study highlight the distinct cytomorphological features of bone marrow in chronic leukemia, with clear differences between CLL and CML.

In CLL, the predominant finding is the infiltration of small, mature lymphocytes, which correlates with the slower progression of the disease. The lymphoid infiltration patterns (nodular, interstitial, or diffuse) observed are important for prognosis, as diffuse patterns are associated with more advanced disease. The absence of significant marrow fibrosis in CLL is consistent with previous studies that suggest fibrosis is a feature more typical of advanced myeloproliferative disorders.
[8]

In contrast, CML shows marked granulocytic hyperplasia with elevated numbers of basophils and eosinophils, reflecting the myeloproliferative nature of the disease. The presence of the Philadelphia chromosome (BCR-ABL1) confirms the diagnosis, and the increased fibrosis observed in some cases may indicate progression to the accelerated or blast phase. The wide range of myeloid precursors seen in CML bone marrow is consistent with the overproduction of mature and maturing granulocytes typical of this condition.

The differences in bone marrow cellularity and the predominant cell types are crucial for distinguishing between CLL and CML, particularly in early stages where clinical symptoms may overlap. Cytomorphological evaluation remains a cornerstone of diagnosis, but it should be supplemented with cytogenetic and molecular studies, especially in cases where disease progression is suspected.

The results of this study underline the importance of regular bone marrow assessment in chronic leukemia patients, not only for diagnosis but also for monitoring disease progression and response to treatment.

Conclusion

In conclusion, this study highlights the distinct cytomorphological characteristics of bone marrow in patients with chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML). CLL is marked by small, mature lymphocytes with minimal fibrosis, while CML shows marked granulocytic hyperplasia with increased basophils, eosinophils, and occasional fibrosis, especially in advanced stages. The differences in bone marrow cellularity and cell type distribution are essential for accurate diagnosis and monitoring of disease progression. Cytomorphological evaluation, combined with molecular and cytogenetic testing, remains a vital tool in the diagnosis and management of chronic leukemia, providing critical insights for treatment decisions and disease monitoring.

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