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IMMUNOPHENOTYPING IN THE DIAGNOSIS OF LEUKEMIAS IN ADULTS

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ABSTRACT

Immunophenotyping was performed in 48 patients aged 18 to 62 years diagnosed with acute leukemia (AL). Based on the results, the disease variants were specified as follows: acute lymphoblastic leukemia (ALL) was identified in 17% of patients, including T-cell subtype in 9% and B-cell subtype in 27%; acute undifferentiated leukemia was diagnosed in 6%, and acute myeloblastic leukemia (AML) in 50% of cases. The obtained data on AL subtypes confirm the diagnostic value of immunophenotyping and support its implementation in clinical practice to optimize therapeutic strategies, including selective intensification of chemotherapy and the application of program-based treatment protocols.

Key words: leukemia, immunophenotype, diagnostics, adults.

ИММУНОФЕНОТИПИРОВАНИЕ В ДИАГНОСТИКЕ ЛЕЙКОЗОВ У ВЗРОСЛЫХ

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АННОТАЦИЯ

Иммунофенотипирование было проведено у 48 пациентов в возрасте от 18 до 62 лет с диагнозом острый лейкоз (ОЛ). Исходя из результатов, варианты заболевания были уточнены следующим образом: острый лимфобластный лейкоз (ОЛЛ) был выявлен у 17% пациентов, в том числе Т-клеточный подтип у 9% и В-клеточный подтип у 27%; острый недифференцированный лейкоз был диагностирован у 6% и острый миелобластный лейкоз (ОМЛ) у 50% пациентов. Полученные данные по подтипам АЛ подтверждают диагностическую ценность иммунофенотипирования и поддерживают его внедрение в клиническую практику для оптимизации терапевтических стратегий, включая селективную интенсификацию химиотерапии и применение программных протоколов лечения.

Ключевые слова: лейкоз, иммунофенотип, диагностика, взрослые.

Relevance

Leukemias (leukemias) are malignant neoplasms of the hematopoietic system, primarily originating in the bone marrow and subsequently disseminating to the peripheral blood, spleen, lymph nodes, and other tissues. The development of leukemia in humans appears to be multifactorial, involving the interaction of external influences—such as radiation exposure and viral infections—with constitutional or genetic predispositions.

Leukemias are among the most common oncological diseases in childhood, accounting for approximately one-third of newly diagnosed malignancies each year in adults. Acute lymphoblastic leukemia (ALL) represents 76–82% of all leukemia cases, while acute non-lymphoblastic leukemia (ANLL) accounts for 17–21%, and chronic myelocytic leukemia for about 3% [1,4].

Based on the concept that the phenotype of malignant cells corresponds to that of their normal counterparts at specific stages of differentiation, several immunological variants of leukemia have been identified. These variants reflect the cellular origin of the leukemic clone and the level of differentiation arrest within the leukemic population. Although no truly leukemia-specific markers have been identified to date, the immunophenotypes of leukemic blasts often mirror those of normal hematopoietic cells at similar differentiation stages. In both ALL and acute myeloblastic leukemia (AML), the blasts are considered malignant analogs of normal progenitor cells in the early stages of lymphoid and myeloid development.

Thus, a single marker cannot reliably distinguish neoplastic from normal cells, as malignant cells frequently express the same differentiation antigens found on their physiological counterparts. However, studies have shown that malignant cells may express combinations of normal differentiation antigens that are rarely or never detected in normal bone marrow—typically occurring in less than 0.1% of cases.

Given the heterogeneity of therapeutic responses and clinical outcomes, immunophenotyping of leukemic cells—together with other diagnostic parameters—plays a crucial role in assessing tumor aggressiveness and determining the prognostic relevance of immunological characteristics.

In the 1970s, long-term remissions (over five years) were achieved in only about 5% of patients with acute leukemias. Advances in hematology over the past few decades have dramatically improved outcomes for these once uniformly fatal diseases [4,6]. Currently, remission rates reach 95% in ALL and 90% in AML. Approximately 70–75% of patients with ALL achieve durable remissions considered curative, while 40–50% of AML patients survive for more than 3–6 years. These outcomes have become possible due to improved diagnostic precision, risk-adapted intensification of chemotherapy, structured treatment protocols, and the widespread implementation of bone marrow transplantation in clinical practice [4,7].

Purpose of the Study

To evaluate the diagnostic and therapeutic significance of immunophenotyping in hemolysates in order to improve the effectiveness of disease detection and treatment.

Materials and Methods

The study presents data obtained from immunophenotyping of 48 patients aged 18 to 62 years who were treated in the Oncohematology Department of the Bukhara Regional Multidisciplinary Medical Center during 2022–2024. All patients were referred with a diagnosis of acute leukemia (AL).

Immunophenotyping of leukemic cells was performed using the immunocytochemical method with the EnVision+ visualization system and monoclonal antibodies (mAbs) manufactured by DAKO (Denmark). The following antigens were analyzed: CD19, CD20, CD22 (B-lineage); CD3, CD7 (T-lineage); and CD13, CD33 (myeloid). Microscopic examination of stained preparations was conducted using a Mikmed (LOMO) microscope.

Results.

To achieve the study objective, immunophenotyping of blast cells was performed using the immunocytochemical method with the following markers: CD3 and CD7 (T-lineage), CD19, CD20, and CD22 (B-lineage), as well as CD13 and CD33 (myeloid lineage). Table 1 presents the immunophenotypic characteristics of 18 cases of acute leukemia (AL) diagnosed between 2022 and 2024.

According to the European Group for the Immunological Classification of Leukemias, four major types of AL are distinguished:

- acute lymphoblastic leukemias (ALL)
- acute myeloblastic leukemias (AML)
- biphenotypic acute leukemias (BAL)
- undifferentiated acute leukemias

Within the ALL group, T-lineage and B-lineage leukemias are identified, along with cases showing co-expression of myeloid markers. In the AML group, subtypes are classified according to the affected myelopoietic lineage, including poorly differentiated AML and AML with co-expression of lymphoid markers.

Table 1

Distribution of major markers on blast cells in leukemia

	marker	**Detection rate, n = 48**	
		quantity	**%**
T-ALL	*CD3*	4	8%
	CD7	7	14%
B-ALL	*CD19*	4	8%
	CD20	3	6%
	CD22	6	12%
AML	*CD13*	8	16%
	CD33	16	33%

In our study, eight patients initially diagnosed with AL demonstrated expression of T-lineage markers, leading to the final diagnosis of T-cell ALL. Blast cells from 13 patients expressed B-lineage markers, confirming a diagnosis

of B-cell ALL. Among 24 patients, blast cells exhibited expression of myeloid markers, resulting in a diagnosis of AML. In three cases, no expression of the investigated markers was detected, and these patients were diagnosed with undifferentiated AL.

Several patients demonstrated co-expression of unrelated lineage markers. According to the literature, the frequency of such aberrant co-expression in acute leukemias ranges from less than 1% to 50%, depending on diagnostic criteria, the antibody panels used, and differences in antibody specificity. Reports indicate that more than 50% of ALL cases show co-expression of myeloid markers (My+ALL), over 40% of AML cases express lymphoid markers (Ly+AML), while simultaneous expression of both T- and B-cell markers occurs in fewer than 2% of cases.

In our study, co-expression of lymphoid markers in AML (Ly+AML) was observed in 10% of cases, and co-expression of myeloid markers in ALL (My+ALL) in 4% of cases. These findings support the concept that leukemogenesis represents not an absolute block in cell differentiation, but rather a disruption of maturation and proliferation processes, resulting in aberrant antigen expression patterns that are rarely observed in normal hematopoiesis.

Immunophenotypic analysis enabled a more accurate selection of therapeutic protocols, contributing to a personalized approach to treatment, optimization of chemotherapy regimens, and improvement of therapeutic efficacy. Furthermore, the implementation of this method reduces the overall cost of treatment through the rational use of medications and clinical resources.

Conclusion.

The findings support the inclusion of immunophenotyping as an essential component of leukemia diagnostics in clinical practice. Further studies aimed at expanding the panel of immunological markers and deepening the analysis of leukemic cell characteristics are considered promising directions for improving prognostic accuracy and therapeutic outcomes in acute leukemia.

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