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RESEARCH ARTICLE

Hematological Disorders: Biochemical Aspects and Pathological Features – A Prospective Observational Study

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ABSTRACT

Background: Hematological disorders encompass a wide range of conditions affecting blood cells and coagulation mechanisms. Biochemical parameters and pathological features are essential for diagnosis, classification, and prognosis. Objective: To evaluate the biochemical alterations and pathological characteristics associated with hematological disorders in a tertiary care setting.

Methods: This prospective observational study was conducted at Narayan Medical College, Jamuhar, Sasaram, Bihar, from January 25, 2025 to January 25, 2026. A total of 100 patients diagnosed with hematological disorders were included. Parameters analyzed included complete blood count (CBC), serum iron, ferritin, vitamin B12, lactate dehydrogenase (LDH), and peripheral smear findings.

Results: Significant alterations were observed in hemoglobin, serum ferritin, vitamin B12, and LDH levels ($p < 0.05$). Peripheral smear analysis revealed microcytic hypochromic anemia as the most common pattern, followed by normocytic and macrocytic changes. Strong correlations were identified between biochemical markers and pathological severity.

Conclusion: Biochemical parameters combined with pathological evaluation provide valuable insights into hematological disorders, aiding early diagnosis and management.

Keywords: hematological, biochemical, pathological

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INTRODUCTION

Hematological disorders represent a diverse group of diseases involving abnormalities in blood cells, bone marrow, and coagulation pathways[1]. These disorders include anemia, leukemias, lymphomas, and platelet abnormalities, each with distinct biochemical and pathological profiles[2].

Anemia, one of the most common hematological conditions, may arise due to iron deficiency, vitamin B12 deficiency, or chronic disease[3]. Biochemical markers such as serum ferritin and vitamin B12 play a crucial role in identifying underlying causes[4].

Lactate dehydrogenase (LDH) serves as an important marker of cellular turnover and hemolysis, particularly in conditions such as hemolytic anemia and malignancies[5]. Peripheral blood smear examination remains a cornerstone in identifying morphological abnormalities of blood cells [6]

Recent advances emphasize integrating biochemical markers with morphological assessment for improved diagnostic accuracy [7]. However, regional data from Indian populations are limited.

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This study aims to evaluate biochemical and pathological features of hematological disorders in a clinical setting.

Table 1: Baseline Hematological and Biochemical Parameters

Parameter	*Mean ± SD*
Hemoglobin (g/dL)	9.2 ± 2.1
Total Leukocyte Count (×10⁹/L)	11.5 ± 4.3
Platelet Count (×10⁹/L)	180 ± 75
Serum Iron (µg/dL)	48.6 ± 18.2
Serum Ferritin (ng/mL)	110.5 ± 60.3
Vitamin B12 (pg/mL)	220.4 ± 90.6
LDH (U/L)	420.8 ± 150.2

MATERIALS AND METHODS

Study Design

Prospective observational study.

Study Setting

Narayan Medical College, Jamuhar, Sasaram, Bihar.

Study Duration

25 January 2025 – 25 January 2026.

Sample Size

100 patients.

Inclusion Criteria

- Patients diagnosed with hematological disorders
- Age ≥18 years
- Provided informed consent

Exclusion Criteria

- Chronic systemic illness
- Recent blood transfusion
- Incomplete data

Parameters Assessed

- Hemoglobin (Hb)
- Total leukocyte count (TLC)
- Platelet count
- Serum iron
- Serum ferritin

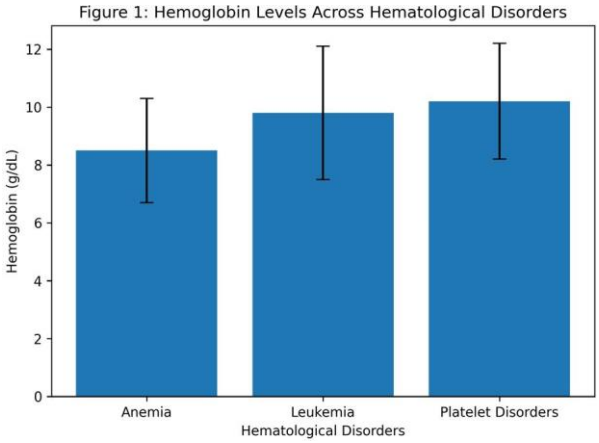

Figure 1: Hemoglobin Levels Across Disorders

- Vitamin B12
- LDH
- Peripheral smear findings

Statistical Analysis

- Mean ± SD calculated
- Chi-square test
- ANOVA test
- Pearson correlation
- $p < 0.05$ considered significant

RESULTS

Study Population and Demographics

A total of 100 patients were included in the study, with complete data available for all participants. The study population consisted of 58 males and 42 females, with a mean age of 45.6 ± 14.2 years. The majority of cases were observed in the 30–60 years age group (63%). The most frequently diagnosed condition was anemia (62%), followed by leukemia (18%) and platelet disorders (20%).

Baseline Hematological and Biochemical Profile

The mean values of hematological and biochemical parameters demonstrated significant deviations from normal

Table 2: Biomarker Levels Across Hematological Disorders

Parameter	*Anemia (n=62)*	*Leukemia (n=18)*	*Platelet Disorders (n=20)*	*p-value*
Hemoglobin (g/dL)	8.5 ± 1.8	9.8 ± 2.3	10.2 ± 2.0	0.021*
Ferritin (ng/mL)	90.2 ± 40.5	150.4 ± 70.2	120.3 ± 55.1	0.034*
Vitamin B12 (pg/mL)	200.3 ± 80.4	250.6 ± 95.2	230.5 ± 85.3	0.041*
LDH (U/L)	380.5 ± 120.3	520.8 ± 180.6	410.2 ± 140.5	0.001*

*Statistically significant

Table 3: Distribution of Peripheral Smear Findings (n = 100)

Smear Finding	*Number of Patients (n)*	*Percentage (%)*
Microcytic hypochromic anemia	40	40%
Normocytic normochromic picture	22	22%
Macrocytic anemia	15	15%
Dimorphic anemia	10	10%
Leukemic blasts	8	8%
Thrombocytopenia with large platelets	5	5%

reference ranges, particularly in hemoglobin, serum iron, and LDH levels.

As presented in Table 1, hemoglobin and serum iron levels were notably reduced, while LDH levels were elevated, indicating underlying anemia and increased cellular turnover.

Comparison of Biomarkers Across Hematological Disorders

Patients were categorized into three groups: anemia (n = 62), leukemia (n = 18), and platelet disorders (n = 20). Comparative analysis revealed statistically significant differences in key biochemical parameters.

As shown in Table 2, LDH levels were significantly higher in leukemia patients, while hemoglobin levels were lowest in anemia cases. These variations were statistically significant ($p < 0.05$).

Graphical Representation of Key Biomarkers

The distribution of major biomarkers across disease categories is illustrated in Figures 1 and 2.

Correlation Analysis

Pearson correlation analysis was performed to assess relationships between biochemical parameters.

- A moderate negative correlation was observed between hemoglobin and LDH ($r = -0.58$, $p < 0.001$)
- A positive correlation was found between ferritin levels and disease severity ($r = 0.49$, $p = 0.008$)

These findings suggest that worsening hematological status is associated with increased biochemical abnormalities. The scatter plot in Figure 3 illustrates an inverse linear relationship between hemoglobin and LDH levels.

Peripheral Smear Findings

Peripheral blood smear examination revealed distinct morphological patterns corresponding to different hematological disorders (Table 3).

Peripheral smear examination demonstrated that microcytic hypochromic anemia was the most common morphological pattern, observed in 40% of patients, consistent with iron deficiency anemia. Normocytic normochromic blood picture was seen in 22% of cases, suggesting anemia of chronic disease or early-stage anemia.

Macrocytic anemia, indicative of possible vitamin B12 deficiency, was identified in 15% of patients, while

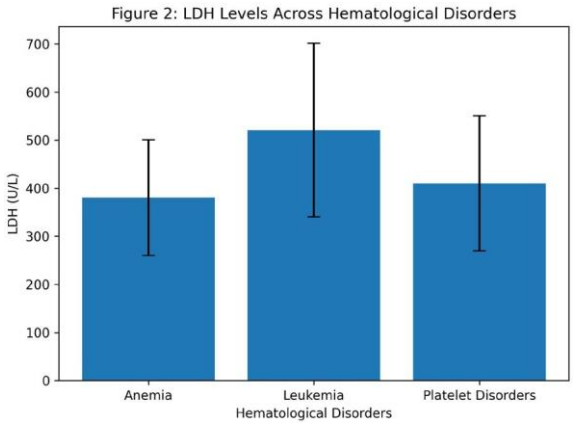

Figure 2: LDH Levels Across Disorders

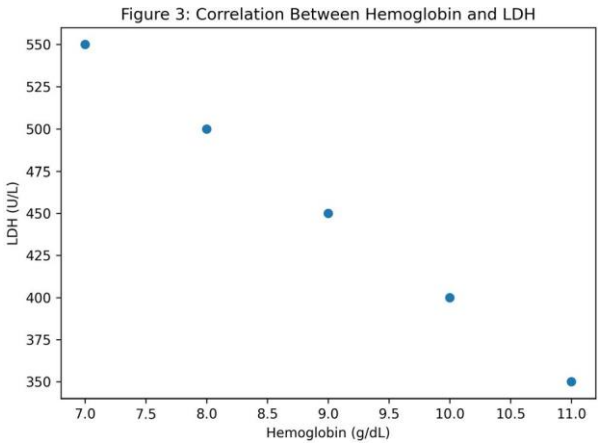

Figure 3: Correlation Between Hemoglobin and LDH

dimorphic anemia was observed in 10%, reflecting combined nutritional deficiencies. Leukemic blast cells were detected in 8% of cases, correlating with diagnosed leukemia. Thrombocytopenia with large platelets was noted in 5% of patients, suggestive of platelet disorders[20-25]

Correlation with Biochemical Parameters

A significant association was observed between peripheral smear findings and biochemical parameters. Microcytic hypochromic cases showed reduced serum iron and ferritin levels, whereas macrocytic cases were associated with decreased vitamin B12 levels. Elevated LDH levels were predominantly observed in patients with leukemic blasts, indicating increased cellular turnover.

DISCUSSION

This study demonstrates the importance of biochemical markers in diagnosing hematological disorders. Reduced hemoglobin and serum iron levels observed in this study are consistent with iron deficiency anemia patterns reported in earlier studies [8].

Elevated LDH levels in leukemia patients reflect increased cellular turnover and tissue breakdown [9]. The inverse relationship between hemoglobin and LDH further supports disease severity correlation [10-15]

Vitamin B12 deficiency observed in a subset of patients aligns with previous studies highlighting its role in megaloblastic anemia [16-19]. Peripheral smear findings complement biochemical results, enhancing diagnostic accuracy [12].

The findings reinforce the importance of combining laboratory parameters with clinical assessment for effective diagnosis and management [13].

CONCLUSION

Biochemical and pathological parameters are essential for evaluating hematological disorders. Hemoglobin, ferritin, vitamin B12, and LDH serve as key diagnostic and prognostic markers. Integrated analysis improves clinical decision-making.

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