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Morphological Changes in Peripheral Blood Film of Iron Deficiency Anemia Suspected Patients in Muzaffarabad

Lahraseb Khan*, Usman Khurshid, Dr. Usman Munir, Dr. Junaid Ahmed Mir, Mahnoor Tasadaq, Rimsha Akram and Rabia Mehmood

Institute of Allied Health & Medical Sciences, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan

Abstract

Iron deficiency anemia (IDA) remains one of the most frequent hematological disorders in low-resource settings and continues to affect women and children disproportionately. This study was undertaken to describe the peripheral blood film changes seen in patients with suspected IDA in Muzaffarabad and to relate those findings to the corresponding complete blood count profile. A descriptive cross-sectional study was conducted over three months at Abbas Institute of Medical Sciences and Combined Military Hospital, Muzaffarabad. A total of 180 patients aged 1–40 years with laboratory evidence suggestive of IDA were included. Demographic data and hematological indices, including hemoglobin, red blood cell count, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and red cell distribution width, were recorded. Peripheral blood smears were reviewed for microcytosis, hypochromia, anisocytosis, poikilocytosis, and specific red cell forms. Female patients accounted for 72.2% of cases, and the 21–30 year age group represented the largest proportion of the sample (44.4%). The mean hemoglobin level was 7.84 ± 1.50 g/dL, mean MCV was 66.35 ± 5.51 fL, mean MCH was 20.30 ± 3.09 pg, mean MCHC was 28.0 ± 3.01 g/dL, and mean RDW was 17.74%. Microcytosis and hypochromia were observed in virtually all smears. Anisocytosis was present in 74.4% of patients, poikilocytosis in 65.0%, and pencil cells or elliptocytes in 85.0%. A few smears also showed target cells, rare tear-drop cells, and occasional schistocytes. These findings indicate that IDA in this patient population is characterized by marked microcytic hypochromic morphology with frequent anisopoikilocytosis. Peripheral smear examination, interpreted alongside CBC indices, remains a practical and highly informative tool for the diagnosis of iron deficiency anemia in routine clinical settings.

Keywords: Iron deficiency anemia; peripheral blood film; microcytosis; hypochromia; anisocytosis; poikilocytosis; pencil cells; Muzaffarabad.

Introduction

Iron deficiency anemia is the most common nutritional anemia worldwide and remains a major cause of reduced physical capacity, impaired cognitive performance, and adverse maternal and child health outcomes. In clinical practice, it is identified by reduced hemoglobin concentration together with evidence of impaired hemoglobinization of red blood cells. The classic hematological pattern is microcytic hypochromic anemia, in which erythrocytes are smaller than normal and show increased central pallor because of reduced intracellular hemoglobin [1-5]. The burden of iron deficiency is particularly high in women of reproductive age, pregnant women, and children. In Pakistan, nutritional deficiencies, repeated pregnancies, menstrual blood loss, parasitic disease, and limited dietary diversity all contribute to the persistence of IDA as a public health problem. In Azad Jammu & Kashmir, geographical constraints, uneven access to nutrient-dense foods, and delayed care-seeking may further intensify this burden. Yet, despite the frequency with which anemia is encountered in hospital laboratories, locally generated evidence on the peripheral smear patterns of suspected IDA remains limited [1,2,6].

Peripheral blood film review still has major diagnostic value, especially in settings where iron studies are not immediately available. Microcytosis, hypochromia, anisocytosis, poikilocytosis, and the presence of pencil cells can provide rapid morphological support for the diagnosis and can help distinguish iron deficiency from other causes of microcytic anemia, particularly thalassemia trait. The present study therefore aimed to describe the principal morphological changes in peripheral blood films of suspected IDA patients in Muzaffarabad and to summarize the corresponding hematological profile observed in routine hospital practice [3-5,7,8].

Research Methodology

This work was designed as a descriptive cross-sectional study carried out in Muzaffarabad, Azad Jammu & Kashmir, Pakistan. Data were collected from the hematology records of Abbas Institute of Medical Sciences and Combined Military Hospital over an approximately three-month period in 2025. These institutions serve a broad catchment population and routinely perform complete blood counts and peripheral smear examinations for patients presenting with anemia-related complaints. The study included 180 patients aged 1–40 years who had been classified as suspected iron deficiency anemia on the basis of clinical impression together with laboratory findings consistent with microcytic hypochromic anemia. Patients with clearly documented alternate causes of anemia, such as macrocytic anemia or other major hematological disorders, were excluded as far as the record review allowed. Because the study was hospital-based and relied on available laboratory files, the sample represents consecutive accessible cases rather than a community prevalence estimate.

For each case, demographic variables and CBC indices were extracted from laboratory records, including hemoglobin, red blood cell count, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and red cell distribution width. Peripheral blood smear slides or their recorded morphology reports were then reviewed for microcytosis, hypochromia, anisocytosis, poikilocytosis, pencil cells or elliptocytes, target cells,

***Corresponding Author:** *Lahraseb Khan, Lecturer Institute of Allied Health and Medical Sciences University of Azad Jammu & Kashmir

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tear-drop cells, schistocytes, and other relevant abnormalities. Data were compiled in a structured proforma and analyzed descriptively. Continuous variables were summarized as means, standard deviations, and ranges where available, while categorical variables were reported as frequencies and percentages. The study relied on de-identified hospital laboratory data and was described in the source thesis as having been conducted with institutional ethical oversight.

Results

Among the 180 suspected IDA cases, 130 patients (72.2%) were female and 50 (27.8%) were male, giving a female-to-male ratio of approximately 2.6:1. The age distribution showed a clear concentration in young adults: 15 patients (8.3%) were aged 1–10 years, 37 (20.6%) were aged 11–20 years, 80 (44.4%) were aged 21–30 years, and 49 (27.2%) were aged 31–40 years. The mean age was approximately 24.5 years. The hematological profile reflected moderate to severe microcytic hypochromic anemia. Mean hemoglobin was 7.84 ± 1.50 g/dL, with values ranging from 3.6 to 10.6 g/dL. Mean RBC count was 3.78 × 10^12/L, mean hematocrit was 26.35%, mean MCV was 66.35 ± 5.51 fL, mean MCH was 20.30 ± 3.09 pg, mean MCHC was 28.0 ± 3.01 g/dL, and mean RDW was 17.74%. These values are strongly consistent with iron-deficient erythropoiesis.

Morphological review demonstrated a highly characteristic pattern. Microcytosis and hypochromia were seen in virtually all cases (179/180, 99.4% each). Anisocytosis was documented in 134 patients (74.4%), while poikilocytosis was observed in 117 (65.0%). Pencil cells or elliptocytes were the most prominent specific abnormality and were present in 153 cases (85.0%). Target cells were noted in a small minority of smears, tear-drop cells were rare, and occasional schistocytes were seen in 6 cases (3.3%). No meaningful evidence of nucleated red cells, major polychromasia, or spherocytosis was described.

Table 1: *Age-wise distribution of suspected iron deficiency anemia cases (N = 180).*

Age group (years)	Number of cases	Percentage
1–10	15	8.3%
11–20	37	20.6%
21–30	80	44.4%
31–40	49	27.2%
Total	180	100%

Table 2: Summary of hematological parameters in suspected iron deficiency anemia cases.

Parameter	Mean ± SD	Range	Interpretation
Hemoglobin (g/dL)	7.84 ± 1.50	3.6–10.6	Moderate to severe anemia
RBC count (×10^12/L)	3.78	2.0–5.8	Generally reduced
Hematocrit (%)	26.35	14.3–39.0	Consistent with anemia
MCV (fL)	66.35 ± 5.51	48.8–79.7	Marked microcytosis
MCH (pg)	20.30 ± 3.09	11.6–26.7	Reduced hemoglobin per cell
MCHC (g/dL)	28.0 ± 3.01	19.4–36.2	Hypochromia
RDW (%)	17.74	—	Anisocytosis likely present

Table 3: Frequency of key morphological findings on peripheral blood film.

Morphological feature	Number of cases	Percentage
Microcytosis	179	99.4%
Hypochromia	179	99.4%
Anisocytosis	134	74.4%
Poikilocytosis	117	65.0%
Pencil cells / elliptocytes	153	85.0%
Target cells	Approx. 18	Approx. 10%
Schistocytes	6	3.3%
Ovalocytes	3	1.7%

Discussion

The findings demonstrate that suspected iron deficiency anemia in this Muzaffarabad hospital cohort was concentrated primarily among young and middle-aged females, which is in keeping with the known epidemiology of iron deficiency. Menstrual blood loss, pregnancy-related demand, nutritional insufficiency, and delayed presentation probably contributed to this pattern. The predominance of patients in the 21–30 year age group further supports the importance of reproductive-age vulnerability in this setting. The CBC profile was typical of established microcytic hypochromic anemia. Mean hemoglobin and hematocrit values showed that many patients were already substantially anemic at presentation, while the marked depression of MCV, MCH, and MCHC confirmed reduced hemoglobinization of red cells. The elevated RDW indicated significant heterogeneity in cell size, a pattern that supports iron deficiency and helps distinguish it from more uniform microcytosis, such as thalassemia trait.

The peripheral smear findings strengthen this interpretation. Nearly universal microcytosis and hypochromia, together with frequent anisocytosis and poikilocytosis, reflect progressive disruption of erythropoiesis under iron-restricted conditions. The very high frequency of pencil cells is particularly noteworthy, as these elongated erythrocytes are widely regarded as a useful morphological clue in iron deficiency. Their prominence in this cohort suggests that many patients had moderate or advanced deficiency by the time of testing. This study also reinforces the continuing value of peripheral smear examination in routine hematology practice. Automated analyzers quantify abnormality, but direct visualization of cell size, color, and shape provides interpretive depth that remains important in resource-limited settings. The study is nevertheless limited by its hospital-based design, its dependence on existing laboratory records, and the absence of consistently tabulated iron studies for every patient. Accordingly, the data are best interpreted as a detailed morphological and hematological description of suspected IDA in a clinical sample rather than a population prevalence survey.

Conclusion

Iron deficiency anemia in this Muzaffarabad cohort was characterized by moderate to severe microcytic hypochromic anemia with a clear predominance among females and young adults. CBC findings showed reduced hemoglobin, low hematocrit, marked microcytosis, reduced hemoglobin content, and increased red cell size variability. On peripheral blood film, microcytosis and hypochromia were almost universal, anisopoikilocytosis was common, and pencil cells emerged as the most distinctive specific morphological feature. Taken together, these observations confirm that peripheral smear examination remains a valuable diagnostic companion to automated blood counts in the recognition of iron deficiency anemia. Earlier screening and nutritional intervention in high-risk groups may help reduce the fre-

quency of patients reaching the hospital with advanced morphological disease.

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