

A study of clinicopathological Correlation of Complete Blood Count and Peripheral Smear Findings with Bone Marrow Diagnosis: A Cross-Sectional Study from a Tertiary Centre in a Tribal Region¹Dr. Pallavi Reddy, Department of Pathology, K.M.S.K. Government Medical College, Chandrapur, Maharashtra, India.²Dr. Bhushan Namdeorao Naitam, Associate Professor, Department of Pathology, K.M.S.K. Government Medical College, Chandrapur, Maharashtra, India.³Dr. Devishri Atram, Associate Professor, Department of Community medicine, K.M.S.K. Government Medical College, Chandrapur, Maharashtra, India.⁴Dr. Pranay Gandhi, Assistant Professor, Department of Community medicine, K.M.S.K. Government Medical College, Chandrapur, Maharashtra, India.**Corresponding Author:** Dr. Bhushan Namdeorao Naitam, Associate Professor, Department of Pathology, K.M.S.K. Government Medical College, Chandrapur, Maharashtra, India.**How to citation this article:** Dr. Pallavi Reddy, Dr. Bhushan Namdeorao Naitam, Dr. Devishri Atram, Dr. Pranay Gandhi, “A study of clinicopathological Correlation of Complete Blood Count and Peripheral Smear Findings with Bone Marrow Diagnosis: A Cross-Sectional Study from a Tertiary Centre in a Tribal Region”, IJMACR– October– 2026, Volume – 9, Issue – 5, P. No. 294 – 301.**Open Access Article:** © 2026 Dr. Pallavi Reddy, et al. This is an open access journal and article distributed under the terms of the creative common's attribution license (<http://creativecommons.org/licenses/by/4.0>). Which allows others to remix, tweak, and build upon the work non - commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.**Type of Publication:** Original Research Article**Conflicts of Interest:** Nil**Abstract**

Background: Complete blood count and peripheral smear examination are the first-line hematological investigations in many patients referred for bone marrow examination. Their diagnostic value depends on the underlying disorder, and non-specific cytopenic patterns may not accurately predict marrow pathology. This study assessed the relationship of clinical findings, CBC abnormalities and peripheral smear impressions with bone marrow diagnoses.

Methods: This cross-sectional observational study included 100 patients undergoing bone marrow

examination at a tertiary health-care centre in a tribal region over 24 months (July 2023–July 2025). Clinical findings, CBC categories and peripheral smear impressions were compared with integrated bone marrow aspiration/biopsy diagnoses. Associations were assessed using chi-square tests, and agreement between peripheral smear and bone marrow diagnosis was summarized using Cohen's kappa.

Results: Pallor was present in 98% of patients, fever in 39%, hepatomegaly in 23% and splenomegaly in 23%. CBC abnormalities included pancytopenia in 60%, bicytopenia in 23%, anemia in 16% and normal counts

in 1%. Pancytopenia was most frequently associated with megaloblastic anemia (23/60), mixed deficiency anemia (14/60) and MDS (8/60). Leukocytosis occurred in 14%, while thrombocytosis occurred in 5%. The association between CBC pattern and marrow diagnosis was statistically significant ($\chi^2=212.7$, $df=57$, $p<0.001$). Peripheral smear showed good concordance for several leukemia categories and characteristic nutritional anemias, but poor agreement in non-specific cytopenic presentations; overall Cohen's kappa was 0.086. In 27% of cases, the dissertation reported either non-specific/reactive marrow findings (6%) or the need for ancillary investigations (21%).

Conclusion: CBC and peripheral smear remain valuable for directing the indication and initial diagnostic suspicion for bone marrow examination, but non-specific cytopenic patterns have limited ability to establish the final marrow diagnosis. Integrated marrow morphology with ancillary testing is particularly important in MDS and acute leukemias.

Keywords: Bone Marrow, Peripheral Smear, Pancytopenia, Bicytopenia, CBC, Cohen Kappa, Hematological Disorders, Diagnostic Correlation.

Introduction

Complete blood count and peripheral blood smear examination constitute the first-line hematological investigations in patients presenting with cytopenias, abnormal leukocyte counts, thrombocytopenia or suspected hematological malignancy. These investigations frequently provide the initial indication for bone marrow aspiration and biopsy. However, many peripheral blood patterns are non-specific, and identical CBC abnormalities may arise from nutritional deficiencies, marrow failure, immune destruction, hypersplenism, myelodysplasia or leukemia.^{1,2}

Bone marrow examination allows direct assessment of hematopoietic cellularity and maturation and can demonstrate abnormal blasts, dysplasia, storage cells, infiltrative processes and other pathological changes that may not be apparent in peripheral blood. It therefore serves as an important confirmatory investigation when the clinical and peripheral blood findings do not provide a definitive diagnosis. The examination also provides material for ancillary studies including flow cytometry, cytogenetics and molecular testing, which are increasingly integrated into the classification of hematological neoplasms^{1,5}.

The relationship between peripheral smear and marrow diagnosis is not uniform across diseases. Characteristic circulating blasts or mature leukemic patterns may show relatively high concordance with marrow findings, whereas broad impressions such as pancytopenia, bicytopenia or dimorphic anemia are inherently less specific. The diagnostic value of a peripheral smear therefore depends not only on the observer's interpretation but also on the biological characteristics of the underlying disease.

Pancytopenia is a particularly important indication for marrow examination because it represents a syndrome rather than a single disease. Nutritional deficiencies, aplastic anemia, myelodysplastic syndromes, acute leukemia, hypersplenism and other disorders may all present with reductions in multiple cell lines. Published studies from India and neighbouring regions have therefore emphasized the value of integrating clinical examination, CBC, peripheral smear and bone marrow morphology when investigating pancytopenia^{3,4}.

Similarly, bicytopenia and isolated anemia may have multiple etiologies. The presence of leukocytosis or thrombocytosis can narrow the differential diagnosis but

remains dependent on clinical context. A structured comparison of CBC abnormalities with final marrow diagnoses can therefore help clarify which peripheral blood patterns are most strongly associated with specific marrow disorders in a particular referral population.

Peripheral smear examination remains particularly useful when it demonstrates disease-specific morphology. The dissertation literature review cites Thiyagarajan et al., who reported that all seven patients suspected of leukemia on peripheral smear were confirmed on marrow examination, including cases of CML, CLL and AML. Conversely, non-specific cytopenic impressions may not identify the underlying marrow disease. This distinction is clinically relevant in deciding when marrow examination should be pursued despite a non-diagnostic peripheral smear⁶.

The present study was undertaken in a tertiary health-care centre in a tribal region and included patients undergoing both CBC/peripheral smear evaluation and bone marrow examination. It was designed to examine the relationship between clinical presentation, CBC abnormalities, peripheral smear impressions and the final marrow diagnosis. Particular emphasis was placed on pancytopenia and bicytopenia, disease-specific leukocytosis and the degree of agreement between peripheral smear and marrow diagnosis.

The study also evaluated limitations encountered during marrow diagnosis. In modern hematopathology, some cases cannot be fully classified on morphology alone. MDS and acute leukemias frequently require immunophenotyping, cytogenetic or molecular investigations, while plasmacytosis may require studies of clonality. Assessing these limitations is important in understanding the practical diagnostic role of bone marrow examination in a resource-constrained tertiary setting.

Materials and Methods

The study was a cross-sectional observational study conducted in the Department of Pathology over 24 months from July 2023 to July 2025. One hundred patients for whom clinicians advised bone marrow examination were included after written informed consent. Clinical data included fever, bleeding, pallor, lymphadenopathy, hepatomegaly, splenomegaly and other relevant history. CBC was performed using automated hematology analyzers. Peripheral blood and marrow aspirate smears were stained with Leishman/Romanowsky stain; biopsy sections were stained with hematoxylin and eosin. Final marrow diagnosis was based on integrated aspiration and biopsy findings. The dissertation reports statistical analysis using STATA version 12, with $p < 0.05$ considered significant.

Results

Table 1: Clinical features among patients undergoing bone marrow examination (n=100).

Clinical feature	n	%
Pallor	98	98
Fever	39	39
Hepatomegaly	23	23
Splenomegaly	23	23
Bleeding manifestations	8	8

Lymphadenopathy	3	3
Other significant history	4	4

The dissertation reported a statistically significant association between clinical features and bone marrow diagnosis ($\chi^2=297.19$, $df=114$, $p=2.8 \times 10^{-18}$). Pallor was widespread across nutritional anemias, leukemias, marrow failure syndromes and other disorders. Bleeding was particularly represented among ITP and aplastic anemia, while hepatosplenomegaly was frequently recorded with leukemias, hypersplenism and Gaucher disease.

Table 2: Distribution of CBC patterns and their principal marrow diagnoses.

CBC pattern	n	%	Examples of frequent marrow diagnoses
Pancytopenia	60	60	Megaloblastic anemia 23; mixed deficiency anemia 14; MDS 8
Bicytopenia	23	23	ITP 5; ALL 3; erythroid hyperplasia 3
Anemia	16	16	CML 4; IDA 2; ACD 2
Normal counts	1	1	Normocellular marrow 1
Total	100	100	—

The overall association between CBC pattern and marrow diagnosis was statistically significant ($\chi^2=212.7$, $df=57$, $p<0.001$). Leukocytosis was observed in 14 patients, predominantly in CML and acute leukemias, while thrombocytosis occurred in five patients and was most frequent in iron deficiency anemia.

Table 3: Peripheral smear impressions in relation to final bone marrow diagnosis.

Bone marrow diagnosis	Peripheral smear impression reported	n
Megaloblastic anemia	Pancytopenia (20), megaloblastic anemia (4), bicytopenia (1)	25
Mixed deficiency anemia	Pancytopenia (14), bicytopenia (6), dimorphic anemia (2), mixed deficiency anemia (1)	23
MDS	Pancytopenia (8), dimorphic anemia (1)	9
Hypersplenism	Pancytopenia (8)	8
ALL	ALL (6)	6
ITP	Bicytopenia (5)	5
CML	CML (4)	4
Erythroid hyperplasia	Bicytopenia (3), microcytic hypochromic anemia with leukocytosis (1)	4
Aplastic anemia	Pancytopenia (2)	2
ACD	Microcytic hypochromic anemia (2)	2
AML-M5	Acute leukemia (1), AML (1)	2
IDA	Microcytic hypochromic anemia (2)	2
Other diagnoses	Various non-specific or disease-specific impressions	8

The dissertation reported exact or close agreement for several characteristic diagnoses, including ALL, AML subtypes, CML, megaloblastic anemia and mixed deficiency anemia. Conversely, non-specific impressions such as pancytopenia

and bicytopenia often encompassed multiple marrow diagnoses. Rare entities such as Gaucher disease, reactive plasmacytosis and normocellular marrow were not reliably identified on peripheral smear.

Table 4: Reported limitations of bone marrow examination (n=100).

Bone marrow examination limitation	Specific findings	n	%
Non-specific/reactive marrow changes	Erythroid hyperplasia (4), myeloid hyperplasia with dysmyelopoiesis (1), myeloid hyperplasia (1)	6	6
Ancillary studies required	MDS (9), ALL (6), AML-M5 (2), acute leukemia (1), CML-blast crisis (1), AML-M2 (1), reactive plasmacytosis (1)	21	21
Total with reported limitation	—	27	27

The requirement for ancillary studies was reported as significantly greater than the non-specific/reactive category ($\chi^2=8.33$, $p=0.0039$). The dissertation emphasized the importance of flow cytometry, cytogenetics and molecular studies, particularly for MDS and acute leukemias.

Discussion

In the present cohort of 100 patients, pancytopenia was the most frequent CBC pattern, occurring in 60%, followed by bicytopenia in 23%, anemia in 16% and normal counts in 1%. The predominance of pancytopenia reflects the referral nature of the study and the clinical indications for marrow examination. The dissertation comparison showed that the 60% frequency was higher than the 50% reported by Pudasaini et al. and 44.92% reported by Nigam et al., whereas bicytopenia and anemia were less frequent than in those series^{4,7}. Biswas et al. also emphasized the etiological heterogeneity underlying pancytopenia in patients evaluated by bone marrow examination⁸. Such differences may arise from differences in inclusion criteria, age distribution, clinical indications and referral patterns.

Among patients with pancytopenia, megaloblastic anemia accounted for 23 of 60 cases (38.3%), mixed

deficiency anemia for 14 (23.3%) and MDS for 8 (13.3%). This distribution illustrates the non-specific nature of pancytopenia: the same peripheral CBC pattern encompassed nutritional, dysplastic and other marrow disorders. Bicytopenia was most frequently associated with ITP, ALL and erythroid hyperplasia, while isolated anemia was observed particularly in CML, IDA and ACD. Thus, the CBC was strongly associated with marrow diagnosis statistically ($\chi^2=212.7$, $df=57$, $p<0.001$), but individual CBC categories could not be regarded as disease-specific.

Leukocytosis occurred in 14% of patients and was concentrated in CML and acute leukemias. The dissertation comparison with published marrow series, including the central Indian study by Nigam et al., similarly demonstrates that leukocytosis is disproportionately represented among proliferative and leukemic disorders⁴. The present observation therefore supports the usefulness of marked leukocytosis as a clinical trigger for consideration of proliferative or leukemic disease, while recognizing that the absolute frequency varies substantially between study populations.

Peripheral smear–marrow correlation showed a more complex pattern. Disease-specific impressions

demonstrated relatively good concordance: ALL, CML, AML subtypes, megaloblastic anemia and mixed deficiency anemia were often identified correctly. In contrast, pancytopenia, bicytopenia and dimorphic anemia on smear were frequently followed by multiple possible marrow diagnoses. Rare conditions such as Gaucher disease, reactive plasmacytosis and normocellular marrow were not reliably predicted by peripheral smear. The overall Cohen's kappa was 0.086, indicating poor agreement beyond chance in the categorical comparison used in this study.

The low overall kappa should be interpreted carefully. It does not imply that peripheral smear examination lacks clinical value. Rather, it demonstrates that broad, non-specific smear impressions cannot reliably substitute for marrow examination when the clinical indication persists. The smear remains important for identifying blasts, abnormal leukocyte populations and characteristic red-cell morphology, while marrow examination provides direct information about cellularity, maturation and pathological infiltration. The two investigations are therefore complementary rather than interchangeable.

The findings can be compared with the study by Thiagarajan et al. cited in the dissertation. In their series, all seven cases suspected of leukemia on peripheral smear were confirmed on bone marrow examination, comprising CML, CLL and AML. This high disease-specific agreement contrasts with the lower overall agreement in the present study because the current analysis included the entire spectrum of marrow diagnoses, including many non-specific cytopenic presentations⁶.

Clinical findings provided additional diagnostic context. Pallor was present in 98% of patients, fever in 39%, hepatomegaly in 23% and splenomegaly in 23%. The

dissertation found a statistically significant relationship between clinical features and marrow diagnosis ($\chi^2=297.19$, $df=114$, $p=2.8 \times 10^{-18}$). In particular, splenomegaly was present in all patients with hypersplenism, while hepatosplenomegaly and fever were frequent among acute leukemias. These findings reinforce the importance of integrating physical examination with laboratory morphology rather than interpreting CBC or smear findings in isolation.

The study also demonstrated an important limitation of marrow morphology itself. Overall, 27% of cases were categorized as having either non-specific/reactive marrow changes (6%) or a requirement for ancillary investigations (21%). The latter group was dominated by MDS and acute leukemias, in which immunophenotyping, cytogenetic and molecular findings can be essential for precise classification. Bain has similarly emphasized the continuing central role of morphology while recognizing the increasing importance of ancillary techniques in contemporary bone marrow pathology¹⁰.

The single case of reactive plasmacytosis illustrates another diagnostic limitation. The dissertation notes that the patient had 15% plasma cells and was assessed morphologically without clonality studies. Gupta et al., in a series of 114 cases of plasmacytosis, reported that most cases were non-neoplastic but that a proportion were neoplastic, demonstrating the morphological overlap between reactive and clonal plasmacytosis⁹. This supports the need for appropriate ancillary investigations when the morphology is not definitive.

From a practical perspective, the findings indicate that the diagnostic pathway should be sequential but integrated: clinical assessment identifies the indication, CBC defines the cytopenic or proliferative pattern,

peripheral smear may identify characteristic morphology, and bone marrow examination establishes the marrow phenotype. Where morphology remains indeterminate or where disease classification requires additional information, flow cytometry, cytogenetics and molecular studies become necessary.

The study has limitations that affect interpretation of the correlation measures. It was conducted at a single centre, included only 100 patients, and was cross-sectional without outcome follow-up. Referral bias may have enriched the cohort for patients with more severe or diagnostically difficult disease. Access to ancillary investigations was also limited, particularly for precise classification of leukemias and MDS. Therefore, the kappa estimate and distribution of diagnoses should be interpreted as findings from this selected cohort rather than as universal estimates of peripheral smear performance.

Overall, the study supports the continuing diagnostic value of CBC and peripheral smear while demonstrating their limitations as stand-alone tools. The statistically significant CBC–marrow association and the disease-specific smear concordance indicate that routine hematology remains highly informative, but the low overall kappa and the 27% rate of reported marrow limitations emphasize that definitive diagnosis frequently requires integrated marrow assessment and ancillary testing.

Strengths and Limitations

The study provides simultaneous clinical, CBC, peripheral smear and marrow data from a tertiary centre in a tribal region. However, the sample size was modest, the study was single-centre and cross-sectional, and access to ancillary tests was not uniform. Referral bias may have increased the representation of severe or

diagnostically difficult cases. In addition, the overall kappa estimate is based on the categories recorded in the dissertation and should not be generalized to all laboratories or patient populations.

Conclusion

CBC and peripheral smear findings remain essential components of the diagnostic pathway leading to bone marrow examination. Pancytopenia and bicytopenia were common but non-specific, whereas characteristic leukemic or nutritional morphology showed closer correlation with marrow diagnoses. Because 21% of cases required ancillary studies and overall smear-marrow agreement was low, definitive diagnosis—particularly of MDS and acute leukemias—should rely on integrated morphology with appropriate immunophenotypic, cytogenetic and molecular investigations.

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