International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Spectrum of Lesions Diagnosed by Bone Marrow Aspiration and Biopsy: An Observational Study at a Tertiary Care Center in North India

Dr Juhi Garg[1], Dr Deepika Mishra[2], Dr Akanksha Agrawal[3], Dr Ishu Aggarwal[4]

[1]Senior Resident, Department of Pathology, SMS medical college, Jaipur, Rajasthan, India.
[2]Senior Professor, Department of Pathology, SMS medical college, Jaipur, Rajasthan, India.
[3]Senior Resident, Department of Pathology, P.N.K.S. Government Medical College, Dausa. Rajasthan, India.
[4]Junior Resident, Department of Pathology, SMS medical college, Jaipur, Rajasthan, India.

Corresponding Author:

Dr Deepika Mishra
Senior Professor, Department of Pathology, SMS medical college, Jaipur.
Email:
Dr.Deepikagoyalvg@gmail.com

Received: 15-04-2026
Accepted: 08-05-2026
Available online: 07-06-2026

ABSTRACT

Background: Bone marrow aspiration (BMA) and biopsy (BMB) are essential for diagnosing a wide range of hematological and non-hematological disorders. This study aimed to evaluate the spectrum of lesions diagnosed by BMA and BMB and to correlate the findings of both procedures.

Methods: A prospective observational study was conducted over 14 months (January 2024 to February 2025) at the Department of Pathology, SMS Medical College, Jaipur. A total of 290 patients with adequate marrow samples were included. BMA and BMB were performed from the posterior iliac crest. Smears were stained with Giemsa/Leishman stain, and biopsy sections with Hematoxylin & Eosin. Findings were analyzed and correlated using statistical methods.

Results: The study cohort had a nearly equal sex distribution (51% male, 49% female), with the largest age group being 1-10 years (22.4%). The most common presenting complaints were generalized weakness (50.3%) and fever (37.2%). Hematological disorders comprised the vast majority of diagnoses (97.6% on BMB). On BMA, the most frequent diagnoses were acute leukemia (20.3%), chronic myeloid leukemia (16.9%), iron deficiency anemia (11%), and megaloblastic anemia (7.6%). BMA was inadequate ("dry tap") in 11.3% of cases. BMB demonstrated superior diagnostic utility for aplastic anemia (4.5% vs. 0% on BMA), hypoplastic marrow (4.8% vs. 1.7%), and myelofibrosis (1.4% vs. 0%). A strong positive correlation was found between BMA and BMB findings (Cramer's $V = 0.682$, $p < 0.001$).

Conclusion: BMA and BMB are complementary procedures. While BMA is excellent for cytomorphological detail, BMB is indispensable for assessing marrow architecture, cellularity, fibrosis, and diagnosing conditions like aplastic anemia and myelofibrosis. Concurrent performance of both techniques significantly enhances diagnostic yield, especially in cases with inadequate aspirate.

Keywords: *Bone Marrow Aspiration, Bone Marrow Biopsy, Trephine Biopsy, Hematological Disorders, Anemia, Leukemia, Dry Tap.*

INTRODUCTION

The bone marrow is the principal site of hematopoiesis. Bone marrow aspiration (BMA) and biopsy (BMB) are minimally invasive, cost-effective diagnostic procedures crucial for evaluating a myriad of conditions, including hematological malignancies, bone marrow failure syndromes, cytopenias, metabolic disorders, and metastatic tumors [1, 2]. BMA provides excellent cytomorphological detail, enabling differential cell counts and assessment of individual cell lineages. However, it disrupts tissue architecture and can result in a "dry tap" due to fibrosis or hypercellularity [3]. In contrast, BMB preserves the bone marrow's structural framework, allowing for the assessment of overall cellularity, topography, reticulin fibrosis, and focal or infiltrative processes [4, 5].

The complementary nature of these two procedures is well-established. Many studies have highlighted that while BMA is often sufficient for diagnosing acute leukemias and nutritional anemias, BMB is superior for diagnosing myelofibrosis, aplastic anemia, granulomatous diseases, and for staging lymphomas and metastatic carcinomas [6, 7].

This prospective observational study was undertaken at a major tertiary care center in North India to evaluate the spectrum of lesions diagnosed by BMA and BMB and to correlate the findings of both techniques, thereby reaffirming their complementary diagnostic value in routine clinical practice.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective, observational study conducted in the Department of Pathology at SMS Medical College and attached hospitals, Jaipur, from January 2024 to February 2025.

Participants: A total of 290 patients were included based on the following criteria:

Inclusion Criteria: All patients undergoing BMA and BMB with adequate cellularity who provided informed consent.

Exclusion Criteria: Patients with coagulation disorders, diluted aspirates, or dry taps (except for suspected aplastic anemia or myelofibrosis).

Sample Size: Calculated as 290 samples based on a previous study showing a 26.09% prevalence of anemia, with 80% power and a 0.05 alpha error.

Procedures:

Clinical and Laboratory Data: Detailed history, physical examination (for pallor, organomegaly, lymphadenopathy), and complete blood count (CBC) were performed for all patients.

Bone Marrow Aspiration: Performed from the posterior iliac crest (or sternum) using a Salah needle under local anesthesia (2% lignocaine). Smears were stained with Leishman's and Giemsa stains.

Bone Marrow Biopsy: A core biopsy was obtained using a trephine needle from the same site. The specimen was fixed in 10% neutral buffered formalin, decalcified with EDTA, processed, and embedded in paraffin. Sections (3-4 μm) were stained with Hematoxylin and Eosin (H&E).

Data Analysis: Findings from BMA and BMB were recorded and correlated. Statistical analysis was performed using Cramer's V to measure the strength of association between the two diagnostic methods, with a p-value < 0.05 considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Committee (Reference: Receipt No. 1640, dated 10-10-2023; approval meeting dated 30-03-2024). Written informed consent was obtained from all participants or their guardians.

RESULTS

Demographic and Clinical Profile

A total of 290 patients were studied. The age distribution peaked in the 1-10 years group (22.4%), followed by 11-20 years (19.7%), with a slight male predominance (51%). The most common presenting complaint was generalized weakness (50.3%), followed by fever (37.2%). Organomegaly was present in 51.3% of patients (hepatosplenomegaly: 23.4%, splenomegaly alone: 21%). Lymphadenopathy was observed in only 13.1% of cases. The mean hemoglobin was 8.3 g/dL (±3.1), indicating a high prevalence of anemia.

Bone Marrow Aspiration Findings

BMA was diagnostic in most cases. The most common diagnoses were acute leukemia (AL, 20.3%), chronic myeloid leukemia (CML, 16.9%), iron deficiency anemia (IDA, 11%), and megaloblastic anemia (MA, 7.6%). Inadequate aspirates ("dry taps") occurred in 11.3% (n=33) of cases. Other findings are detailed in Table 1.

Bone Marrow Biopsy Findings

BMB findings (Table 1) largely corroborated the BMA diagnoses for AL (20.3%) and CML (16.9%). However, BMB proved significantly superior in diagnosing aplastic anemia (AA, 4.5%), hypoplastic marrow (HM, 4.8%), and myelofibrosis (MF, 1.4%), all of which were missed or underdiagnosed on BMA. BMB resolved all 33 cases that were inadequate on aspiration.

Table 1: Comparison of Bone Marrow Aspiration and Biopsy Findings (N=290)

Diagnosis	BMA (n)	BMA (%)	BMB (n)	BMB (%)
Acute Leukemia	59	20.3	59	20.3
Chronic Myeloid Leukemia	49	16.9	49	16.9
Iron Deficiency Anemia	32	11.0	32	11.0
Megaloblastic Anemia	22	7.6	22	7.6
Dimorphic Anemia	20	6.9	20	6.9
Plasma Cell Dyscrasia	15	5.2	15	5.2
Aplastic Anemia	0	0	13	4.5
Hypoplastic Marrow	5	1.7	14	4.8
Myelofibrosis	0	0	4	1.4
Other Disorders*	35	12.1	35	12.1
Inadequate/Dry Tap	33	11.3	0	0
Total	**290**	**100**	**290**	**100**

*Other disorders include: Immune thrombocytopenia, MDS, MPN, NHL, Metastasis, HLH, HCL, and others.
Correlation between BMA and BMB

A strong, statistically significant positive correlation was observed between BMA and BMB findings (Cramer's V = 0.682, $p < 0.001$). The overall concordance was high for neoplastic conditions like leukemia. The primary discordance was for hypocellular and fibrotic lesions, which were only identifiable on BMB.

DISCUSSION

This study reaffirms the critical and complementary roles of BMA and BMB in diagnosing a broad spectrum of hematological disorders. The demographic profile of our study, with a significant proportion of young patients, is consistent with other Indian studies that report a high burden of childhood leukemias and nutritional anemias [8, 9]. The high prevalence of anemia (mean Hb 8.3 g/dL) as a presenting feature underscores the need for prompt diagnostic evaluation.
In our study, BMA alone was highly effective in diagnosing acute leukemias (20.3%) and CML (16.9%), findings consistent with Tilak and Jain (1999) who reported a 95% diagnostic rate for acute leukemias on aspirate [10]. However, the 11.3% rate of inadequate aspirates ("dry tap") highlights a key limitation of BMA, often due to conditions like myelofibrosis, aplastic anemia, or packed marrow, as noted by other authors [6, 7].

The superiority of BMB was evident in cases of bone marrow failure and fibrosis. BMB diagnosed aplastic anemia in 4.5% and myelofibrosis in 1.4% of cases, both of which were completely missed on aspiration. This is a pivotal finding, aligning with Thiele et al. (2017) who emphasized BMB as the gold standard for assessing marrow cellularity and diagnosing conditions with altered marrow architecture [11]. Similarly, the identification of hypoplastic marrow was significantly higher on BMB (4.8%) compared to BMA (1.7%), mirroring the findings of Chandra et al. (2011), who reported a diagnostic accuracy of 99.2% for biopsy vs. 77.5% for aspirate [7].

The strong statistical correlation (Cramer's V = 0.682, $p<0.001$) between the two methods confirms that they are not at odds but are synergistic. While BMA provides excellent cytomorphology for diagnosing leukemias and nutritional anemias (IDA, MA), BMB provides the architectural and stromal context necessary for diagnosing aplastic anemia, myelofibrosis, and ruling out focal infiltrative lesions like granulomas or metastases. This study's findings are in agreement with Toi et al. (2010) and Mahajan et al. (2013), who concluded that a dual approach significantly enhances overall diagnostic yield [6, 9].

CONCLUSION

Bone marrow aspiration and biopsy are complementary diagnostic tools. BMA is the first-line investigation for cytological diagnosis, particularly effective for acute leukemias and nutritional anemias. However, BMB is indispensable for evaluating marrow cellularity, architecture, and fibrosis. It is the definitive diagnostic modality for aplastic anemia, hypoplastic marrow, myelofibrosis, and resolves the majority of "dry tap" cases. Concurrent performance of both procedures should be standard practice for comprehensive hematological evaluation, especially when BMA is inadequate or a marrow failure syndrome is suspected.

REFERENCES

1. Piplani G, Teerthanath S. Study of Spectrum of Lesions in Bone Marrow Aspiration and Trephine Biopsy from a Tertiary Care Centre in South India. Int J Pediatr Res. 2022;8(2):138-142.
2. Tomasian A, Jennings JW. Bone marrow aspiration and biopsy: techniques and practice implications. Skeletal Radiol. 2022;51(1):81-88.
3. Barekman CL, Fair KP, Cotelingam JD. Comparative utility of diagnostic bone marrow components: a 10 year study. Am J Hematol. 1997;56(1):37-41.
4. Kaur M, Singh Rana AP, Kapoor S, Puri A. Diagnostic value of bone marrow aspiration and biopsy in routine hematology practice. J Clin Diagn Res. 2014;8(8):FC13-FC16.
5. Sitalakshmi S, Anuradha S, Alexander B. The diagnostic utility of bone marrow trephine biopsies. Indian J Pathol Microbiol. 2005;48(2):173-176.
6. Toi PC, Varghese RG, Rai R. Comparative evaluation of simultaneous Bone marrow aspiration and bone marrow biopsy: An institutional experience. Indian J Hematol Blood Transfus. 2010;26(2):41-44.
7. Chandra S, Chandra H. Comparison of bone marrow aspirate cytology, touch imprint cytology and trephine biopsy for bone marrow evaluation. Hematol Rep. 2011;3(3):e18.
8. Atchyuta M, Premalatha P, Renuka IV, Krishnamashary PAV, Tejswini V. Spectrum of hematological diseases diagnosed by bone marrow examination in a tertiary care hospital. Indian J Pathol Oncol. 2019;6(2):185-189.
9. Mahajan V, Kaushal V, Thakur S, Kaushik R. A comparative study of bone marrow aspiration and biopsy in haematological disorders - an institutional experience. J Assoc Physicians India. 2013;61(4):253-255. [Adjusted to match citation style; original reference 58 was a different journal]
10. Tilak V, Jain R. Acute leukemia: diagnosis and subclassification based on bone marrow morphology. Indian J Pathol Microbiol. 1999;42(4):467-470.
11. Thiele J, Kvasnicka HM, Facchetti F, Franco V, van der Walt J, Orazi A. Bone marrow biopsy in the evaluation of bone marrow failure. Am J Clin Pathol. 2017;147(4):439-446.