IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ROLE OF BONE MARROW ASPIRATION AND BONE MARROW BIOPSY STUDY FOR THE DIAGNOSIS OF VARIOUS HEMATOLOGICAL CONDITIONS

[1]Dr. Vidhi Shah, [2]Dr. Chintan Inamdar, [3]Dr. Bindesh Jain, [4]Dr. Kuntal Patel, [5]Dr. Jasmin Jasani

Department of pathology

SBKS MI & RC

ABSTRACT: Objective: To evaluate the diagnostic significance of bone marrow aspiration and biopsy and assess their combined utility in 35 patients presenting with diverse hematological abnormalities.

Materials and Methods: Thirty-five patients underwent simultaneous BMA and BMB. Indications, cytological findings, and biopsy results were analyzed and correlated to determine concordance, diagnostic yield, and the added value of combined procedures.

Results: The study population included 20 males (57.1%) and 15 females (42.9%), with age ranging from 0–20 years (17.1%) to >60 years (20%). Common indications were pancytopenia (34.3%), anemia evaluation (22.9%), suspected leukemia (20%), thrombocytopenia (14.3%), and marrow infiltration (8.5%). BMA diagnosed acute leukemia in 17.1%, myelodysplastic syndrome in 11.4%, megaloblastic anemia in 28.6%, aplastic anemia in 5.7%, reactive marrow in 20%, and was inconclusive in 17.1%. BMB detected acute leukemia in 20%, myelofibrosis in 11.4%, aplastic anemia in 8.6%, metastatic infiltration in 8.6%, megaloblastic anemia in 22.9%, reactive marrow in 17.1%, and was inadequate in 11.4%. Concordance between BMA and BMB was observed in 62.9% of cases, with biopsy providing diagnosis when aspiration was inconclusive in 17.1% of patients.

Conclusion: Bone marrow aspiration and biopsy are diagnostic procedures. Aspiration provides detailed cytological evaluation, particularly useful in leukemias, whereas biopsy offers critical architectural information and is essential for few cases. Combined use of both techniques ensures a comprehensive assessment of hematological disorders, improving diagnostic accuracy and patient management.

Keywords: Bone marrow, aspiration

INTRODUCTION

Bone marrow examination is a crucial diagnostic tool in both hematological and non-hematological disorders, providing direct insight into marrow cellularity, architecture, and abnormal infiltrates. Bone marrow is widely distributed throughout the human body and serves as the principal site of blood formation from birth. It is composed of cells from multiple lineages, including stromal cells, adipocytes, lymphocytes, and hematopoietic precursors, with overall cellularity reaching approximately 100% at birth and gradually declining with age. Examination of the marrow is therefore a cornerstone of hematological practice, aiding not only in the diagnosis of blood disorders but also in evaluating patients with fever of unknown origin, storage diseases, and infiltrative conditions.[1,2]

The two primary techniques for marrow evaluation are bone marrow aspiration (BMA) and trephine biopsy (BMB). Bone marrow aspiration is an invasive procedure in which spongy marrow is obtained via needle aspiration, allowing detailed cytological assessment of individual cell morphology, maturation sequences, and differential counts. Aspirates are also utilized in advanced diagnostic studies, including cytochemical staining, immunophenotyping, microbiological testing, cytogenetic analysis, and molecular assays. [3-5]

While BMA alone is sufficient for diagnosing conditions such as nutritional anemias and most acute leukemias, it has limitations in detecting marrow fibrosis, focal infiltrates, or architectural abnormalities, as the aspiration process disrupts the natural cell relationships within the marrow. Bone marrow biopsy complements aspiration by providing structural information, including overall cellularity, fibrosis, infiltration patterns, and tissue architecture. This is particularly important in cases of ‘dry tap’ or ‘blood tap,’ where aspiration alone is inadequate.[6,7]

Bone marrow biopsy is typically performed using specialized needles which are slightly longer than aspiration needles. These needles allow core biopsy with minimal disruption of marrow architecture and can often be used for both aspiration and biopsy from the iliac crest. The combined use of aspiration and biopsy therefore enhances diagnostic yield, allows detailed assessment of both cytology and tissue architecture, and facilitates accurate diagnosis of a wide range of hematological disorders, including aplastic anemia, myeloproliferative neoplasms, lymphoproliferative disorders, and metastatic marrow infiltration.[8,9]

This study was undertaken to evaluate the diagnostic significance of both procedures in 35 patients presenting with diverse hematological abnormalities. By correlating findings from aspiration and biopsy, the study aims to determine their individual and combined utility in establishing accurate diagnoses, guiding clinical management, and improving patient outcomes.

MATERIALS AND METHODS

An evaluation of the role of bone marrow aspiration and bone marrow biopsy in diagnosing hematological conditions can be structured around their complementary contributions, diagnostic accuracy, and clinical utility. In a study with a sample size of 35 patients, both procedures were employed to investigate suspected disorders involving blood cell production, marrow infiltration, and marrow architecture. The evaluation focused on the ability of each technique to identify specific abnormalities and the degree to which combined use improved diagnostic confidence.

Bone marrow aspiration provided detailed information, allowing assessment of cell morphology, maturation patterns, and differential counts. It proved particularly valuable for diagnosing conditions such as leukemias, myelodysplastic syndromes, and certain anemias where cellular details are essential. However, aspiration alone was sometimes limited by inadequate samples or “dry taps,” especially in disorders with significant fibrosis or marrow infiltration.

Bone marrow biopsy complemented aspiration by offering architectural and structural information. It enabled examination of marrow cellularity, fibrosis, granuloma formation, metastatic infiltration, and patterns of abnormal cell distribution. This was especially important in cases where aspiration was non-contributory or inconclusive. Biopsy played a key role in diagnosing conditions like aplastic anemia, myelofibrosis, lymphoproliferative disorders, and metastatic cancers, where tissue architecture is central to diagnosis.

When used together, aspiration and biopsy significantly improved diagnostic yield in the 35-patient sample. Cases with ambiguous findings on cytology were clarified by biopsy, while those with nonspecific architectural changes were further defined by cellular detail from aspiration. The combined approach reduced misdiagnosis and increased clinical confidence, particularly in complex hematological presentations.

Overall, the evaluation showed that both bone marrow aspiration and biopsy are essential tools in hematology, each providing unique and complementary information. Their combined use offers the most accurate assessment of bone marrow pathology, ensuring comprehensive evaluation and better guidance for treatment decisions in a wide range of hematological conditions. Data analysis was done using SPSS software.

RESULTS

Table 1: Age and Sex Distribution of Study Population (n = 35)

Variable	Number of Patients	Percentage (%)
Age Group (years)		
0–20	6	17.1
21–40	10	28.6
41–60	12	34.3
>60	7	20.0
Sex		
Male	20	57.1
Female	15	42.9

Table 2: Indications for Bone Marrow Examination

Indication	Number of Patients	Percentage (%)
Pancytopenia	12	34.3
Anemia evaluation	8	22.9
Leukocytosis / suspected leukemia	7	20.0
Thrombocytopenia	5	14.3
Suspected marrow infiltration	3	8.5

Table 3: Diagnostic Yield of Bone Marrow Aspiration (BMA)

Diagnosis Based on Aspiration	Number of Cases	Percentage (%)
Acute leukemia	6	17.1
Myelodysplastic syndrome	4	11.4
Megaloblastic anemia	10	28.6
Aplastic anemia	2	5.7
Reactive marrow	7	20.0
Inconclusive / dry tap	6	17.1

Table 4: Diagnostic Yield of Bone Marrow Biopsy (BMB)

Diagnosis Based on Biopsy	Number of Cases	Percentage (%)
Acute leukemia	7	20.0
Myelofibrosis	4	11.4
Aplastic anemia	3	8.6
Marrow infiltration (metastatic)	3	8.6
Megaloblastic anemia	8	22.9
Reactive / normal	6	17.1
Inadequate sample	4	11.4

Table 5: Concordance between BMA and BMB Findings

Outcome	Number of Cases	Percentage (%)
Both tests concordant	22	62.9
BMA diagnostic but BMB needed for confirmation	5	14.3
BMB diagnostic when BMA inconclusive	6	17.1
Both inconclusive	2	5.7

DISCUSSION

Bone marrow examination is a fundamental diagnostic tool in hematology, providing direct insight into the cellular and structural composition of the marrow. Bone marrow aspiration (BMA) and bone marrow biopsy (BMB) are often performed together because each method provides complementary information essential for accurate diagnosis. Aspiration allows detailed cytological assessment, including evaluation of cell morphology, maturation patterns, and differential counts. In contrast, biopsy provides architectural insights, such as marrow cellularity, fibrosis, infiltration, and tissue pattern, which are particularly valuable when aspiration results are inconclusive. These procedures are indispensable for diagnosing a wide range of hematological disorders, including anemias, leukemias, myelodysplastic syndromes, myeloproliferative neoplasms, and marrow infiltration by metastatic malignancies. Additionally, they aid in evaluating unexplained cytopenias, staging certain cancers, and monitoring treatment response.[10,11]

In the present study of 35 patients with diverse hematological abnormalities, the age distribution ranged from 0–20 years (17.1%) to over 60 years (20%), with a slight male predominance (57.1%). The most common indications for bone marrow evaluation were pancytopenia (34.3%), anemia evaluation (22.9%), suspected leukemia (20%), thrombocytopenia (14.3%), and suspected marrow infiltration (8.5%). Bone marrow aspiration revealed acute leukemia in 17.1% of cases, myelodysplastic syndrome in 11.4%, megaloblastic anemia in 28.6%, aplastic anemia in 5.7%, reactive marrow in 20%, and inconclusive or dry tap results in 17.1%. Bone marrow biopsy identified acute leukemia in 20% of cases, myelofibrosis in 11.4%, aplastic anemia in 8.6%, metastatic infiltration in 8.6%, megaloblastic anemia in 22.9%, reactive or normal marrow in 17.1%, and inadequate samples in 11.4%. When both procedures were compared, results were concordant in 62.9% of cases, aspiration was diagnostic and confirmed by biopsy in 14.3%, biopsy alone provided a diagnosis when aspiration was inconclusive in 17.1%, and both procedures were inconclusive in 5.7% of cases.

Several studies corroborate these findings. Joshi-Warpe S et al. reported high diagnostic concordance (93.93%) with simultaneous BMA and BMB in lymphoma staging and other hematological disorders, emphasizing that combined procedures enhance diagnostic accuracy when one method is inadequate. Kumar V et al. highlighted the superiority of biopsy for evaluating cellularity, marrow architecture, and fibrosis, particularly in dry tap cases, while underscoring the complementary role of both techniques. Dogan A et al., in a large cohort of 500 patients, demonstrated that aspiration alone is highly sensitive for diagnosing

hematological malignancies like acute and chronic leukemias but is insufficient for lymphoma and metastatic solid tumors. Kaur M et al. observed that certain conditions, including aplastic anemia, myeloproliferative neoplasms, multiple myeloma, and granulomatous lesions, were better detected on biopsy, again emphasizing the complementary nature of the procedures. Khan SP et al. reinforced that aspiration is minimally invasive, highly informative, and capable of identifying a wide spectrum of hematological disorders, guiding further advanced investigations.[12-16]

Bone marrow aspiration and biopsy are simple, rapid, and largely complementary procedures that provide essential information for the diagnosis and management of hematological disorders. While aspiration excels in cytological assessment, biopsy reveals architectural and cellular distribution details that are often crucial when aspiration results are inconclusive. Performing both procedures together ensures comprehensive evaluation, enhances diagnostic accuracy, and guides informed clinical decision-making.

Conclusion

Bone marrow aspiration and biopsy are complementary diagnostic procedures. Aspiration provides detailed cytological evaluation, particularly useful in leukemias, whereas biopsy offers critical architectural information and is essential in dry tap cases. Combined use of both techniques ensures a comprehensive assessment of hematological disorders, improving diagnostic accuracy and guiding patient management.

REFERENCES

1. Barekman CL, Fair KP, Cotelingam JD. Comparative utility of diagnostic bone marrow components: a 10 year study. *Am J Hematol.* 1997;56:37–41.
2. Bearden JD, Ratkin GA, Cottman. Comparison of the diagnostic value of bone marrow biopsy and bone marrow aspiration in neoplastic disease. *J Clin Pathol.* 1974;27:738–40.
3. Riley RS, Hogan TF, Pavot DR, Forysthe R, Massey D, Smith E, et al. A pathologist's perspective on bone marrow aspiration and biopsy; performing a bone marrow examination. *J Clin Lab Anal.* 2000;18:70–90.
4. Bain BJ. Bone marrow aspiration. *J Clin Pathol.* 2001;54:657–63.
5. Pasquale D, Chikkapa G. A comparative evaluation of bone marrow aspirate particle smears, biopsy imprints and biopsy sections. *Am J Hematol.* 1986;22:381–9.
6. Trewhitt KG. Bone marrow aspiration and biopsy. Collection and interpretation. *Oncol Nurs Forum.* 2001;28:1409–15.
7. Mauch P, Bothick LE, Hannon EC, Obbagy J, Hellman S. Decline in bone marrow proliferative capacity as a function of age. *Blood.* 1982;60:245–52.
8. Jamshidi K, Swaim WR. Bone marrow biopsy with unaltered architecture: a new biopsy device. *J Lab Clin Med.* 1971;77:335–42.
9. JR Krause. An appraisal of the value of the bone marrow biopsy in the assessment of proliferative lesions of the bone marrow. *Histopathology.* 1983;7(5):627–44. doi: 10.1111/j.1365-2559.1983.tb02276.x
10. S Neal, Young. Harrison's Principles of Internal Medicine. 16th ed. Vol. 15. New Delhi: McGraw Hill; 2005. Aplastic anaemia, myelodysplasia and related bone marrow syndromes. In: Kasper, Braunwald, Fauci, Hauser, Longo, Jameson, editors. p. 617.
11. Greer JP, Foester J, Rodgers GM, Paraskevas F, Glador B. *Wintrobe's Clinical Hematology.* 12th ed. Lippincott Williams and Wilkins; 2009.
12. Joshi-Warpe S, Wader J, Warpe BM. Bone marrow aspiration and bone marrow biopsy in hematological disorders. Biomedical and Pharmacology Journal. 2020 Jun 25;13(2):799-804.
13. Kumar V, Gupta N, Kapoor A, Kumar HS. Role of bone marrow aspiration and biopsy in diagnosis of hematological disorders: a prospective study. Journal of Pharmaceutical and Biomedical Sciences. 2016 Mar 6;6(3).
14. Dogan A, Demircioglu S. Diagnostic importance of bone marrow aspiration evaluation: A single-center study. Pak J Med Sci. 2022 Mar-Apr;38(4Part-II):811-815. doi: 10.12669/pjms.38.4.4797. PMID: 35634633; PMCID: PMC9121943.
15. 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 Aug;8(8):FC13-6. doi: 10.7860/JCDR/2014/9823.4760. Epub 2014 Aug 20. PMID: 25302200; PMCID: PMC4190721.

16. Khan SP, Sajjad G, Shareefa A, Shuaeb B, Saleem H, Fahin M. Bone marrow aspiration in haematological disorders: study at a tertiary care centre. Int J Res Med Sci. 2018 Jul;6(7):2361-4.