

SPECTRUM OF HEMATOLOGICAL DISORDERS IN BONE MARROW EXAMINATION

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ABSTRACT

Objective: To study the bone marrow aspiration (BMA) trends and to observe and analyze the various patterns of hematological disorders in bone marrow examinations of patients attending a tertiary care teaching hospital.

Methods: A 2-year study was done retrospectively in the department of pathology at the tertiary care teaching hospital. Relevant demographics, clinical details, intraprocedural details, and results were obtained through records and case files.

Results: A total of 48 cases were studied. The most common diagnoses recorded were erythroid hyperplasia, nutritional anemia, megaloblastic anemia, acute leukemias, etc.

Conclusion: Bone marrow cytology is a highly informative and diagnostic test procedure performed in evaluating blood and blood-related diseases. Some hematological conditions can be diagnosed with serological studies, and the need for an invasive test like BMA can be avoided.

Keywords: Bone marrow, Pancytopenia, Anemia, Erythroid hyperplasia, Leukemia.

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INTRODUCTION

All age groups are prone to hematological problems, and the majority of them start off as anemia [1]. In the majority of instances, a comprehensive clinical evaluation, in addition to standard laboratory tests, aids in the diagnosis. The diagnosis and treatment of numerous blood and bone marrow illnesses depend on the results of the bone marrow examination [2]. Under some circumstances, a diagnosis cannot be made purely based on the evaluation of peripheral blood samples; in these cases, a bone marrow examination is required. An invasive procedure known as bone marrow aspiration (BMA) involves obtaining a representative sample of spongy bone marrow using a needle aspiration for diagnostic evaluations, including cytology and stem cell harvest [3]. The diagnosis of leukemias and the explanation of cytopenias both rely significantly on BMA. The diagnosis and staging of neoplasms and storage disorders are both accomplished through the examination of the bone marrow. Although some hematological disorders now require a molecular diagnosis, cytomorphological diagnosis still plays a significant role in diagnosis, especially in remote places where access to modern diagnostic services is limited. The main objectives of the present study were to determine the BMA trends and to observe and analyze the various patterns of hematological disorders in bone marrow examinations of patients attending a tertiary care teaching hospital.

METHODS

Study place

The study was conducted in the pathology department of the GITAM Institute of Medical Sciences and Research, Visakhapatnam.

Study design and study period

It is a retrospective study conducted for a period of 2 years, from January 2021 to December 2022.

Study population

A total of 48 cases admitted during the period of 2 years from January 2021 to December 2022 were reviewed in this study.

Inclusion criteria

All the bone marrow cases, both aspirations and biopsies done during the study period, were included in the study.

Exclusion criteria

Patients with bleeding tendencies or any coagulation disorders are excluded from the study.

Methodology

Relevant demographics, clinical details, intraprocedural details, and results were obtained through records and case files. The data thus retrieved were analyzed statistically. The BMA procedure was done under local anesthesia (2% xylocaine) and general anesthesia in the cases of pediatric subjects. The peripheral blood sample as well as the BMA smears are stained with Leishman stain and special stains like Perl's stain, etc. Bone marrow smears are assessed for hematopoiesis as well as iron stores, abnormal cells, granulomas, storage disorders, etc. A bone marrow biopsy was done only when the bone marrow aspiration showed a dry or bloody tap. Bone marrow biopsy samples underwent a decalcification process for 24 h. After regular tissue processing, the slides are stained with hematoxylin and eosin.

RESULTS

A total of 48 cases of bone marrow were included in this study. Only two cases of bone marrow biopsy were done, where the aspirations were dry tap and bloody tap. In the present study, there was a slight male preponderance with 25 (52%) patients compared to 23 (48%) female patients, with a male-to-female ratio of 1.08:1. The age groups ranged from 4 to 78 years was included. Most of the cases were in the age group of 60–80 years (33.3%). Table 1 shows the age-wise distribution of bone marrow cases. The posterior superior iliac spine is the most common site for BMA as well as biopsy in the majority of the cases in the present study. 39 cases (81%) were done at the posterior superior iliac spine, and 9 cases (18%) at the sternum. Bone marrow procedures were done under general anesthesia for

the pediatric subjects. In the present study, pancytopenia was the most common indication, followed by anemia. The distribution of indications of bone marrow study is shown in Table 2. Other indications include bone pain, organomegaly, chronic kidney disease, etc. Erythroid hyperplasia was the most reported diagnosis in the present study, with 28 cases (58%). Of the 28 cases of erythroid hyperplasia, 11 cases had shown micronormoblastic maturation (Fig. 1), and 12 cases had shown megaloblastic maturation (Fig. 1), while the rest 5 cases had normoblastic maturation (Table 3). Serum iron studies and vitamin B12 were done in cases with micro- and megaloblastic maturation. Perl's stain (Fig. 2a and b) was done for the detection of iron stores. There were three cases of sickle cell anemia, which were reported as micro-normoblastic maturation on BMA. Table 3 shows the spectrum of results in the present study. Our present study encountered a total of 9 cases of hematological malignancies, of which acute myeloid leukemia (AML) was the most common finding with 4 cases. The other findings were acute lymphoblastic leukemia (ALL), chronic myeloid leukemia (CML), plasma cell myeloma, etc. (Figs. 3-6). Table 4 shows the distribution of the hematological malignancies encountered in the present study. Our present study has encountered 3 cases of dilute, inadequate, or bloody tap smears on BMA. Out of these 3 cases, bone marrow biopsy was done in two cases, which were reported as inconclusive. These cases constitute 6% of all the cases.

Table 1: Age-wise distribution of cases

Age group	Number of cases (%)
0–20 years	7 (14)
20–40 years	10 (20)
40–60 years	15 (31)
60–80 years	16 (33)
Total cases	48 cases

Table 2: Distribution of indications of bone marrow

Indication	Number of cases (%)
Pancytopenia	18 (37.5)
Anemia	14 (29)
Fever	6 (12)
Thrombocytopenia	5 (10)
Others	5 (10)
Total cases	48

Table 3: Bone marrow diagnosis

Bone marrow diagnosis	Number of cases (%)
Erythroid hyperplasia with megaloblastic maturation	12 (25)
Erythroid hyperplasia with micronormoblastic maturation	11 (23)
Erythroid hyperplasia with normoblastic maturation	5 (10)
Normal bone marrow study	4 (8)
Hypoplastic bone marrow	4 (8)
Hematological malignancies	9 (18)
Inadequate smears	3 (6)

Table 4: Distribution of the hematological malignancies

Malignancy	Number of cases (%)
AML	4 (44)
ALL	2 (22)
CML	2 (22)
Plasma cell myeloma	1 (11)

AML: Acute myeloid leukemia, ALL: Acute Lymphoblastic Leukemia, CML: Chronic myeloid leukemia

DISCUSSION

An essential and effective diagnostic technique for identifying a variety of hematological diseases is a bone marrow examination. The diagnosis is established as accurately as feasible with the aid of clinical examination, peripheral smear findings, and bone marrow investigation. A bone marrow examination aids in the staging of various hematological and non-hematological cancers and the development of successful treatment plans. Our present study included a total of 48 cases. In these cases, there is a slight male preponderance, with a male-to-female ratio of 1.08:1. These findings are similar to the age distribution of the study done by Atchuta *et al.* [4], where the male-to-female ratio is 1.1:1. Clinico-epidemiologic studies revealed a milder increase in hematological disorders among females of the same age [5]. The gender distribution in the present study shows a similar male preponderance. The age distribution of the present study ranges from 4 years to 78 years. A similar study conducted by Kibria *et al.* [6]

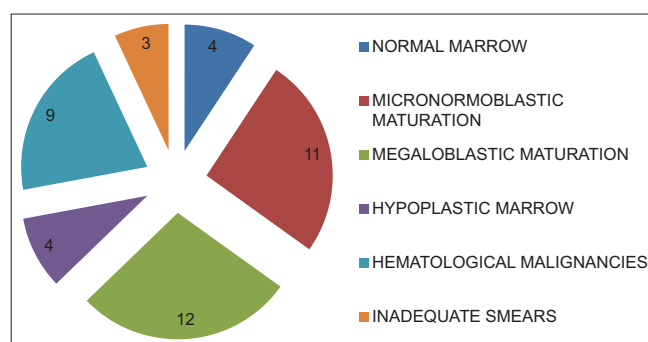


Fig. 1: Spectrum of results

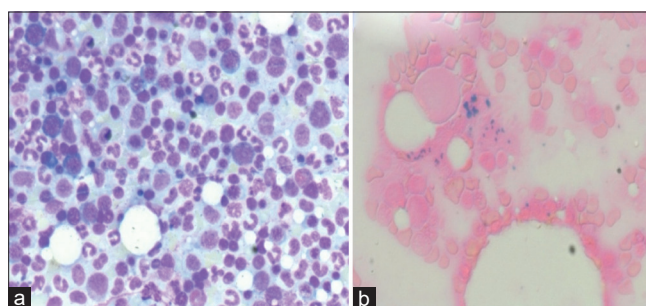


Fig. 2: (a) Bone marrow aspirate showing erythroid hyperplasia with micronormoblastic maturation (leishman stain, ×40). (b) Bone marrow aspirate smears showing very few iron stores (Perl's stain, ×40)

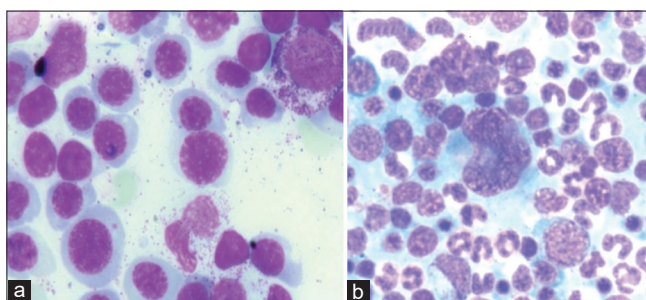


Fig. 3: (a) Bone marrow aspirate smears showing erythroid hyperplasia with megaloblastic maturation with enlarged size and nuclear features like open sieve like chromatin (leishman stain, ×100). (b) Bone marrow aspirate smears showing a giant megakaryocyte in megaloblastic anaemia (leishman stain, ×40)

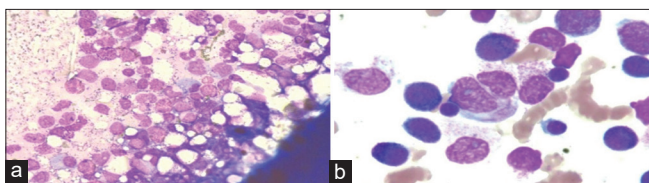


Fig. 4: (a) Bone marrow aspirate smears showing hyper cellular marrow with a predominant population of homogenous myeloblasts (leishman stain, ×40). (b) Bone marrow aspirate smears showing a myeloblast with condensed azurophilic granules called auer rods (leishman stain, ×100)

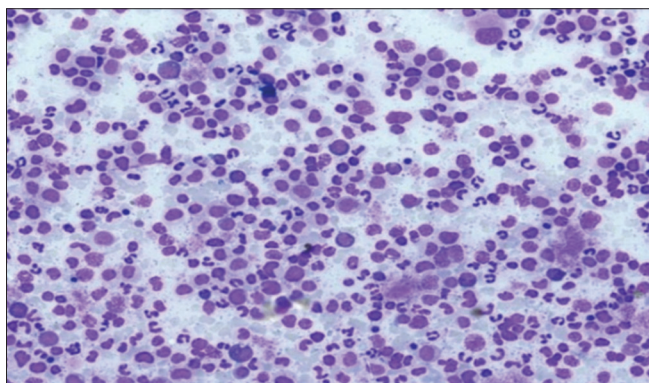


Fig. 5: Bone marrow aspirate smears showing hypercellular marrow with features of chronic myelogenous leukemia (leishman stain, ×10)

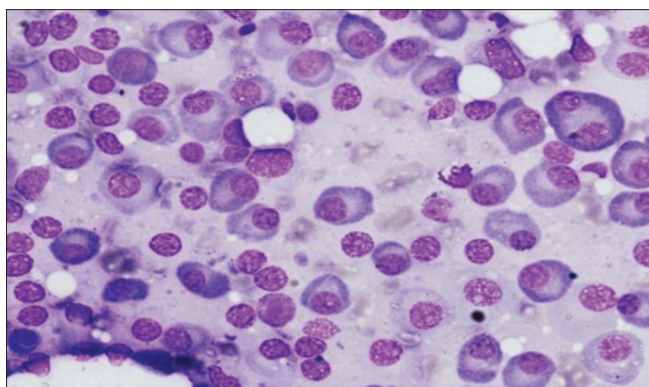


Fig. 6: Bone marrow aspirate smears of plasma cell myeloma, showing crowding of bone marrow with malignant plasma cell (leishman stain, ×40)

showed a similar demographic distribution, with ages ranging from 3.5 years to 80 years. In the present study, pancytopenia is the most common indication for bone marrow examination, with 37.5% of all indications. A study done by Ojha *et al.* [7] also showed a similar finding, where pancytopenia shows 27.8% of indications. The present study encountered a majority of 28 cases of erythroid hyperplasia, which include erythroid hyperplasia of normoblastic, micro-normoblastic, and megaloblastic maturation. Megaloblastic anemia constitutes about 12 cases (25%), in concordance with the studies done by Pudasaini *et al.* [1] showed 12.5% of megaloblastic anemia cases. A similar study done by Dapus and Damen [8] showed similar results with 33% of megaloblastic anemia cases. The diagnosis of megaloblastic anemia is made with clinical features, biochemical correlation, peripheral smear studies, red cell indices, in addition to the bone marrow examination. Our present study revealed megaloblastic anemia as the most common diagnosis, and the most common presentation is pancytopenia. These results are in concordance with the studies done by Khodke *et al.* [9],

which reported 44% of megaloblastic anemia cases, and Khunger *et al.* [10], which reported 72% of megaloblastic anemia cases. Hematological malignancies constitute about 18% of the 9 cases in the present study. And the results are in concordance with the studies done by Tahlan *et al.* [11] and Nigam *et al.* [12], reported as 18% and 20.3%, respectively. Of all the hematological malignancies, acute leukemia is the most common in our present study, with 66% of all malignancies and 12% of overall cases. In a study done by Atchuta *et al.* [4], chronic leukemia is more common than acute leukemia, with a share of 10% and 6% of overall cases, respectively. This variation is due to the differences in the population studied. In acute leukemia, AML is more common than ALL, with 8.3% and 4.1% of overall cases, respectively. Studies done by Kibria *et al.* [6] reported similar findings, stating acute leukemias are the most common hematological malignancies and AML is more common than ALL. Of all 4 AML cases, AML-M2 is reported in 2 cases, and the others are AML-M3 and AML-M4. Pudasaini *et al.* reported 6 cases of AML, of which AML-M3 is the most common, with 3 cases followed by AML-M2 and AML-M1. Two cases of CMLs are reported in the present study, and both cases are in the age group of 70–80 years. They constitute about 22% of the malignancies and 4% of overall cases. The present study encountered only one case of plasma cell myeloma in a 74-year-old male patient who presented with bone pains. This constitutes about 11% of hematological malignancies and 2% of all bone marrow cases. In the study done by Atchuta *et al.* [4], there were 5% of myeloma cases, and the studies done by Laishram *et al.* [13] and Jha *et al.* [14] reported an incidence of 20% and 0.94%, respectively. Two cases of dry tap were reported in the present study, for which a bone marrow biopsy was done and reported as hypoplastic marrow. The hypoplastic bone marrow cases account for 4 cases (8.3% of all the cases). These cases are not confined to one age group, and the youngest patient with hypoplastic marrow is 10 years old and the oldest is 72 years old. Studies conducted by Atchuta *et al.* [4] and Pudasaini *et al.* [1] reported an incidence of 3.2% and 5.3%, respectively. Dry tap indicates repeated aspiration failure and is one of the most common indications for bone marrow biopsy. A few past studies done by Humphries [15] and Hyun [16] postulated that the dry tap could be due to bone marrow hypercellularity or extensive fibrosis. Faulty techniques should be ruled out after reviewing bone marrow biopsy slides. A normal bone marrow study was recorded in 4 cases, constituting 8% of all cases. These results are in concordance with the findings reported by Dhanalakshmi *et al.* [17], where they reported an incidence of 9.6% with 17 cases.

CONCLUSION

The BMA study remains an important diagnostic tool for many hematological disorders. A complete clinical examination, patient history, and investigations like peripheral blood examination along with bone marrow examination complete the diagnostic workup for many hematological conditions. Anemia, especially nutritional anemia, remains the most common cause for the bone marrow examination. Erythroid hyperplasia is the most common diagnosis in BMA studies. Though most of the non-invasive investigations are diagnostic, megaloblastic anemia, which commonly presents as pancytopenia, requires a bone marrow examination for the diagnosis, as the clinical presentation and the blood picture are often misleading. Though WHO has revolutionized the classification of hematological disorders based on molecular genetics, cytoarchitectural examination of bone marrow remains the first line and very informative in diagnosis.

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none.

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Nil.

REFERENCES

1. Pudasaini S, Prasad KB, Rauniyar SK, Shrestha R, Gautam K, Pathak R, *et al.* Interpretation of bone marrow aspiration in hematological disorder. *J Pathol Nepal* 2012;2:309-12. doi: 10.3126/jpn.v2i4.6885
2. Lee SH, Erber WN, Porwit A, Tomonaga M, Peterson LC, International Council for Standardization in Hematology. ICSH guidelines for the standardization of bone marrow specimens and reports. *Int J Lab Hematol* 2008;30:349-64. doi: 10.1111/j.1751-553X.2008.01100.x, PMID 18822060
3. Adewoyin AS, Ezire ES, Adeyemi O, Idubor NT, Edewor-Okiyo DO. Bone marrow aspiration cytology studies in a tertiary hospital, Nigeria: A serie of 88 cases. *Ann Pathol Lab Med* 2015;2:A107-14.
4. Atchyuta M, Premalatha P, Renuka IV, Krishnamashary PA, Tejeswini V. Spectrum of hematological diseases diagnosed by bone marrow examination in a tertiary care hospital. *Indian J Pathol Oncol* 2019;6:185-9. doi: 10.18231/j.ijpo.2019.036
5. Lakhani A, Mamaniya GH, Lakhani KK, Rathod AM, Gajjar MD. Bone marrow trephine biopsy in hematological disorders. *Int J Sci Res* 2014;3:265-7.
6. Kibria SG, Islam MD, Chowdhury AS, Ali MY, Haque MR, Mustanzid SM, *et al.* Prevalence of hematological disorder: A bone marrow study of 177 cases in a private hospital at Faridpur. *Faridpur Med Coll J* 2010;5:11-3. doi: 10.3329/fmcj.v5i1.6806
7. Ojha S, Haritwal A, Meenai FJ, Gupta S. Bone marrow examination findings in cases of pancytopenia-a study from central India. *Indian J Pathol Oncol* 2016;3:479-84. doi: 10.5958/2394-6792.2016.00089.2
8. Dapus DO, Damen JG. Diagnostic outcome of bone marrow aspiration in a new centre in Nigeria. *Glob Adv Res J Med Med Sci* 2012;1:166-71.
9. Khodke K, Marwah S, Buxi G, Yadav RB, Chaturvedi NK. Bone marrow examination in cases of pancytopenia. *J Indian Acad Clin Med* 2001;2:55-9.
10. Khunger JM, Arculselvi S, Sharma U, Ranga S, Talib VH. Pancytopenia-a clinico-haematological study of 200 cases. *Indian J Pathol Microbiol* 2002;45:375-9.
11. Tahlan A, Bansal C, Palta A, Chauhan S. Spectrum and analysis of bone marrow findings in anemic cases. *Indian J Med Sci* 2008;62:336-9. doi: 10.4103/0019-5359.42484, PMID 18711260
12. Nigam RK, Malik R, Kothari S, Gour D, Shrivastava A, Balani S, *et al.* Spectrum of diseases diagnosed by bone marrow examination in central India. *J Evol Med Dent Sci* 2014;3:326-37. doi: 10.14260/jemds/2014/1829
13. Laishram S, Shimray R, Sharma AB, Pukhrambam G, Singh AM, Sharma LD. Neoplastic lesions in the bone marrow: A 10-year study in a teaching hospital. *J Indian Acad Clin Med* 2008;9:175-8.
14. Jha A, Sayami G, Adhikari RC, Panta AD, Jha R. Bone marrow examination in cases of pancytopenia. *J Nepal Med Assoc* 2008;47:12-7. doi: 10.31729/jnma.209, PMID 18552886
15. Humphries JE. Dry tap bone marrow aspiration: Clinical significance. *Am J Hematol* 1990;35:247-50. doi: 10.1002/ajh.2830350405, PMID 2239919
16. Hyun BH. Bone marrow examination: Adventures in diagnostic hematology. *Yonsei Med J* 1986;27:100-5. doi: 10.3349/ymj.1986.27.2.100, PMID 3751124
17. Dhanalakshmi MN, Sangeetha N, Sheeja J. Study of bone marrow aspiration for a period of two years. *Indian J Pathol Res Pract* 2020;9:9-15.