Spectrum Of Diseases On Bone Marrow Aspiration In Cases Of Pancytopenia In A Tertiary Care Centre

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Abstract

Background: Pancytopenia is a hematological condition characterized by a reduction in all three blood cell lines—erythrocytes, leukocytes, and platelets. It is a manifestation of various underlying pathologies affecting the bone marrow and peripheral blood.

Objectives: To determine the spectrum of diseases diagnosed on bone marrow aspiration in cases of pancytopenia in a tertiary care setting.

Methods: This prospective study was conducted over 18 months on 100 pancytopenic patients. Bone marrow aspiration and relevant hematological investigations were performed, and data were statistically analyzed.

Results: Megaloblastic anemia (47%) was the most common cause, followed by aplastic anemia (19%) and acute leukemia (13%). Hypercellular marrow was observed in 52% of cases. Peripheral smear findings correlated well with bone marrow diagnoses.

Conclusion: Bone marrow aspiration remains a crucial diagnostic tool in evaluating pancytopenia and helps in guiding appropriate patient management.

Introduction

Pancytopenia is a hematological condition characterized by a concurrent decrease in erythrocytes, leukocytes, and platelets in the peripheral blood. It is not a diagnosis but a manifestation of diverse underlying disorders that suppress or replace the bone marrow or increase peripheral destruction of blood cells.[1,2] The etiological spectrum includes nutritional deficiencies, bone marrow failure syndromes, infiltrative disorders, autoimmune diseases, and infections, each requiring distinct diagnostic and therapeutic approaches.[3]

In India, megaloblastic anemia is frequently identified as the most common cause of pancytopenia, accounting for up to 45% of cases, followed by infections, aplastic anemia, hematological malignancies, and autoimmune conditions like systemic lupus erythematosus.[4] The marrow response varies—from hypocellular marrow in aplastic anemia to hypercellular patterns in megaloblastic and leukemic conditions, highlighting the necessity of marrow assessment in these cases.[5]

Bone marrow aspiration is a minimally invasive and widely utilized diagnostic tool to evaluate the morphological and cellular composition of bone marrow. It is essential in identifying the exact cause of pancytopenia and provides valuable guidance for further investigations and treatment planning.[6] Given

its diagnostic utility, especially in tertiary care centers where complex and advanced cases are referred, bone marrow examination remains pivotal in the diagnostic algorithm of pancytopenia.

The purpose of the study is to identify the spectrum of diseases diagnosed through bone marrow aspiration in patients with pancytopenia at a tertiary care centre, aiding accurate diagnosis and improving patient management.

Materials and Methods

This prospective clinico-hematological study was conducted in the Department of Pathology at Venkateshwara Institute of Medical Sciences, Gajraula, Uttar Pradesh, over a total duration of 18 months, including 12 months for data collection and 6 months for data analysis. The study aimed to determine the spectrum of diseases identified on bone marrow aspiration in patients presenting with pancytopenia. Patients were selected through simple random sampling. Inclusion criteria comprised individuals with hemoglobin levels less than 10 g/dL, total leukocyte counts below 4000 cells per cubic millimeter, and platelet counts less than 1,50,000 per cubic millimeter, who provided informed written consent. Patients were excluded if they had known bleeding disorders such as hemophilia, were undergoing chemotherapy or radiotherapy, were pregnant, or declined consent. The minimum sample size was calculated 100 cases. Each patient underwent clinical evaluation followed by hematological investigations including complete blood count and peripheral blood smear examination. Bone marrow aspiration was performed using standard procedures under aseptic conditions. The smears were evaluated for cellularity, hematopoietic lineage development, dysplasia, abnormal infiltrates, and other morphological features. All relevant findings, along with clinical and laboratory data, were documented using a structured proforma. Ethical clearance for the study was applied for from the Institutional Ethics Committee, and informed written consent was obtained from all participants prior to their inclusion. Data collection was carried out prospectively, and entries were maintained in a secured Microsoft Excel spreadsheet. For statistical analysis, SPSS software version 22.0 was used. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were applied. Associations between categorical variables were evaluated using the chi-square test, and a p-value less than 0.05 was considered statistically significant.

Results

In our study, the majority of pancytopenia cases were observed in the 31–50 year age group, accounting for 46% of the study population, suggesting that this hematological condition predominantly affects individuals in their most active years of life, as shown in Table 1. A male predominance was noted, with 58% of the cases being male and 42% female, which may reflect differential exposure to etiological factors or healthcare-seeking behavior between genders, as shown in Table 2. The most frequently identified cause of pancytopenia was megaloblastic anemia (47%), followed by aplastic anemia (19%) and acute leukemia (13%), highlighting the predominance of nutritional and bone marrow failure disorders in our patient population, as shown in Table 3. Bone marrow cellularity assessment revealed that 52% of cases were hypercellular, 26% normocellular, and 22% hypocellular. This distribution aligns with the predominance of hyperproliferative conditions such as megaloblastic anemia and hematological malignancies, as shown in Table 4. Peripheral blood smear findings showed significant diagnostic correlation with marrow results: macrocytic red cells were linked with megaloblastic anemia, normocytic smears with aplastic anemia, and blast cells with acute leukemia, emphasizing the clinical utility of peripheral smears in narrowing diagnostic possibilities prior to marrow examination, as shown in Table 5.

Table 1: Age-wise Distribution of Pancytopenia Patients

Age Group (years)	Number of Patients (n)	Percentage (%)
<20	5	5.0%
21–30	18	18.0%

31–40	24	24.0%
41–50	22	22.0%
51–60	17	17.0%
>60	14	14.0%
Total	**100**	**100.0%**

Table 2: Gender-wise Distribution of Pancytopenia Patients

Gender	Number of Patients (n)	Percentage (%)
Male	58	58.0%
Female	42	42.0%
Total	**100**	**100.0%**

Table 3: Spectrum of Diseases Diagnosed on Bone Marrow Aspiration

Bone Marrow Diagnosis	Number of Patients (n)	Percentage (%)
Megaloblastic Anemia	47	47.0%
Aplastic Anemia	19	19.0%
Acute Leukemia	13	13.0%
Myelodysplastic Syndrome	7	7.0%
Lymphoma Infiltration	5	5.0%
Kala Azar	3	3.0%
Others	6	6.0%
Total	**100**	**100.0%**

Table 4: Bone Marrow Cellularity in Pancytopenia Cases

Marrow Cellularity	Number of Cases (n)	Percentage (%)
Hypocellular	22	22.0%
Normocellular	26	26.0%
Hypercellular	52	52.0%
Total	**100**	**100.0%**

Table 5: Correlation Between Peripheral Smear and Bone Marrow Findings

Peripheral Smear Finding	Most Likely Bone Marrow Diagnosis	Number of Cases (n)	Percentage (%)
Macrocytic RBCs	Megaloblastic Anemia	45	54.2%
Normocytic Normochromic	Aplastic Anemia	19	22.9%
Presence of Blast Cells	Acute Leukemia	13	15.7%
Microcytic Hypochromic / Others	Miscellaneous (MDS, Infections, etc.)	6	7.2%

Discussion

In our study, pancytopenia was most prevalent in the 31–40 year age group (24%), followed by 41–50 years (22%), indicating that it primarily affects adults in their productive years. This pattern is consistent with findings by TN Dubey et al[7] and Chandan R.H et al[8], who also reported higher incidence in the 21–50 year age range, while M Desalphine et al[9] noted a slight shift toward younger patients. Male predominance was seen in our study (58%), which aligns with reports by TN Dubey et al[7], Nath S et al[10], and B Mansuri et al[11], though Charusheela R. Gore et al[12] observed a more balanced gender distribution. Etiologically, megaloblastic anemia was the most common diagnosis (47%) in our series, similar to TN Dubey et al[7] (41.4%), Chandan R.H et al[8] (37%), and Mansuri et al[11] (56%). Charusheela R. Gore et al[12] reported dimorphic anemia as the leading cause (49.3%) and megaloblastic anemia in 35% of cases, while M Desalphine et al[9] found aplastic anemia as most frequent, highlighting some variation across populations. Leukemia accounted for 13% in our study, comparable to TN Dubey et al[7] (14.2%), but lower than the 24.5% subleukemic leukemia rate reported by Nath S et al[10]. Bone marrow cellularity showed hypercellularity in 52% of cases, followed by normocellularity in 26% and hypocellularity in 22%, reflecting the predominance of megaloblastic anemia and leukemia. Similar patterns were seen in studies by TN Dubey et al[7] and Chandan R.H et al[8], where hyperproliferative conditions like megaloblastic anemia and leukemia were common. Nath S et al[10] also reported a majority of hyperplastic marrows, with micro-normoblastic erythroid hyperplasia in 31.5% and subleukemic leukemia in 24.5%. In contrast, M Desalphine et al[9] documented a higher frequency of aplastic anemia, suggesting a greater proportion of hypocellular marrow in their cohort, differing from the predominance of hypercellular cases in the present series. Peripheral smear findings demonstrated macrocytic RBCs in 54.2% of cases, correlating with megaloblastic anemia, normocytic normochromic patterns in 22.9% correlating with aplastic anemia, and blast cells in 15.7% pointing to acute leukemia. These findings are consistent with observations by TN Dubey et al[7], and B Mansuri et al[11] both reporting macrocytic changes in megaloblastic anemia and normocytic smears in marrow failure. Chandan R.H et al[8] similarly emphasized the diagnostic value of peripheral smears in nutritional anemia and leukemia. Nath S et al[10] supported this correlation in leukemic presentations. Charusheela R. Gore et al[12], however, found a predominance of dimorphic and microcytic features due to mixed anemia, diverging from the macrocytic predominance seen in our study.

Conclusion

We concluded that megaloblastic anemia is the most common cause of pancytopenia, followed by aplastic anemia and leukemia. Bone marrow aspiration remains essential for accurate diagnosis and guiding appropriate management in pancytopenic patients.

Strengths of the study

The strengths of the study include a well-defined diagnostic protocol, use of bone marrow examination for definitive etiological classification, and inclusion of a representative sample from a tertiary care population over a sufficient study duration.

Limitations of the study

The limitations of the study include being a single-centre study, lacking long-term follow-up, and not using bone marrow biopsy in all cases, which may underestimate certain marrow pathologies such as fibrosis or focal infiltrates.

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