International Journal of Clinical and Diagnostic Pathology

ISSN (P): 2617-7226
ISSN (E): 2617-7234
www.patholjournal.com
2025; 8(3): 01-04
Received: 05-05-2025
Accepted: 07-06-2025

Ayushee Ganatra
3rd Year Resident, Department of Pathology, Smt.B.K.Shah Medical Institute & Research Centre, Sumandeep Vidhyapeeth, Vadodara, Gujarat, India

Shweta Mehta
3rd Year Resident, Department of Pathology, Smt.B.K.Shah Medical Institute & Research Centre, Sumandeep Vidhyapeeth, Vadodara, Gujarat, India

Devanshi Shah
3rd Year Resident, Department of Pathology, Smt.B.K.Shah Medical Institute & Research Centre, Sumandeep Vidhyapeeth, Vadodara, Gujarat, India

Manan Bhensadadiya
Assistant Professor, Department of Pathology, Smt.B.K.Shah Medical Institute & Research Centre, Sumandeep Vidhyapeeth, Vadodara, Gujarat, India

Corresponding Author:
Ayushee Ganatra
3rd Year Resident, Department of Pathology, Smt.B.K.Shah Medical Institute & Research Centre, Sumandeep Vidhyapeeth, Vadodara, Gujarat, India

Characteristics of bone marrow cell dysplasia and its effectiveness in diagnosing myelodysplastic syndrome

Ayushee Ganatra, Shweta Mehta, Devanshi Shah and Manan Bhensadadiya

DOI: https://www.doi.org/10.33545/pathol.2025.v8.i3a.2085

Abstract
Aim: The aim is to identify the distinctive morphological abnormalities in bone marrow cells and evaluate their accuracy and usefulness in diagnosing myelodysplastic syndrome.
Materials and methods: This retrospective study analyzed 50 patients with dysplasia. Out of these, 20 patients were diagnosed with Myelodysplastic Syndromes (MDS) and 30 with non-clonal anemia. The MDS group had a median age of 42, while the non-clonal anemia group had a median age of 44, with no significant age difference ($P > 0.05$). MDS subtypes included MDS-SLD, MDS-MLD, MDS-RS, MDS-EB, MDS with isolated del(5q), and MDS-U. Data analysis was done using SSPS software.
Results: The study included 50 participants, with 20 diagnosed with myelodysplastic syndromes (MDS) and 30 with non-clonal anemia. The groups were comparable in age and gender distribution, showing no significant differences. Among the MDS patients, the most common subtype was MDS with excess blasts (MDS-EB), followed by MDS with ring sideroblasts (MDS-RS), multi-lineage dysplasia (MDS-MLD), and single lineage dysplasia (MDS-SLD), with fewer cases of isolated del(5q) and unclassifiable MDS. Cytogenetic abnormalities were observed in 9 MDS cases, with trisomy 8 being the most frequent, followed by del(5q), −Y, and del(20q), indicating the cytogenetic diversity in MDS. In contrast, the non-clonal anemia group showed a varied distribution of subtypes, including immune thrombocytopenia (ITP), megaloblastic anemia, iron deficiency anemia, hemolytic anemia, and anemia of chronic disease. Significantly higher rates of dysplastic features—dyserythropoiesis, dysgranulopoiesis, and dysmegakaryopoiesis—were found in the MDS group compared to the non-clonal anemia group ($P< 0.05$), underlining their diagnostic relevance in distinguishing MDS.
Conclusion: This study demonstrates that the presence of significant dysplastic features and specific cytogenetic abnormalities plays a crucial role in distinguishing myelodysplastic syndromes (MDS) from non-clonal anemia, supporting the importance of comprehensive bone marrow evaluation in the diagnostic process.

Keywords: Myelodysplastic syndromes, anemia, hematopoiesis

Introduction

Myelodysplastic syndrome (MDS) is a diverse group of hematologic disorders characterized by ineffective hematopoiesis due to clonal abnormalities in hematopoietic stem cells, often resulting in cytopenias—low levels of red cells, white cells, and platelets. Most commonly diagnosed in individuals over 65, MDS may be asymptomatic initially, requiring treatment only in symptomatic or high-risk cases. The clinical course varies, and some cases progress to acute myeloid leukemia (AML). Prognosis depends on factors such as cytopenia severity, blast percentage, and cytogenetic findings. While genetic mutations like TP53, RUNX1, and SF3B1 influence clinical behavior and outcomes, they are not formally included in traditional prognostic scoring systems [1, 2, 3, 4].

The etiology of MDS can be de novo or secondary to exposures such as chemotherapy (notably alkylating agents), radiation, or environmental toxins like benzene. Treatment-related MDS (t-MDS) generally has a worse prognosis and higher AML transformation rates. Cytogenetic abnormalities, particularly 5q deletion and complex karyotypes, play a crucial role in classification and risk stratification. The 2016 WHO classification outlines several MDS subtypes based on dysplasia extent, blast percentage, and genetic features. More than 100 recurrent somatic mutations have been identified, affecting genes involved in RNA splicing, epigenetic regulation, and transcription. These genetic insights continue to evolve the understanding and management of MDS [5, 6].

Patients with Myelodysplastic Syndromes (MDS) may remain asymptomatic for years, with incidental findings of cytopenias during routine evaluations. When symptoms do develop, they are typically related to bone marrow failure, most commonly presenting as anemia—manifested by fatigue, shortness of breath, or dizziness. Less frequently, patients may experience infections due to neutropenia or bleeding due to thrombocytopenia. The physical examination may only show subtle signs like pallor or petechiae, and organ enlargement is rare. MDS is suspected based on persistent cytopenias, and diagnosis requires exclusion of other causes and confirmation through bone marrow biopsy, cytogenetics, and molecular testing for mutations such as SF3B1, TET2, or TP53 [7-9].

Diagnosis of MDS hinges on identifying cytopenias, evidence of dysplasia in hematopoietic lineages, and specific genetic abnormalities. Bone marrow analysis typically shows hypercellularity and dysplastic features in one or more lineages, with blast counts below 20%. Genetic evaluation through karyotyping and FISH helps detect common chromosomal abnormalities like del(5q), monosomy 7, or trisomy 8, which influence prognosis and guide treatment. Mutational analysis plays a crucial role, with TP53 mutations indicating a poor prognosis. Differentiation from similar conditions, such as nutritional deficiencies or drug-induced cytopenias, is critical in establishing an accurate diagnosis [10, 11].

Management of MDS is highly individualized and guided by risk stratification systems like IPSS or R-IPSS, which factor in blast percentage, cytopenias, and cytogenetics. Low-risk patients may only require supportive care, including transfusions or erythropoiesis-stimulating agents. High-risk patients may benefit from hypomethylating agents like azacitidine or decitabine and may be considered for potentially curative allogeneic stem cell transplantation, especially if they are younger and fit. Prognosis varies widely; patients with favorable cytogenetics, like isolated del(5q), generally have better outcomes, while those with complex cytogenetic abnormalities or TP53 mutations face a poorer prognosis. A multidisciplinary team approach is essential to optimize outcomes and manage complications effectively [12].

Materials and Methods

This retrospective study analyzed 50 patients with dysplasia. Out of these, 20 patients were diagnosed with Myelodysplastic Syndromes (MDS) and 30 with non-clonal anemia. The MDS group had a median age of 42, while the non-clonal anemia group had a median age of 44, with no significant age difference ($P > 0.05$). MDS subtypes included MDS-SLD, MDS-MLD, MDS-RS, MDS-EB, MDS with isolated del(5q), and MDS-U.

All patients underwent comprehensive diagnostic procedures at their first visit, including bone marrow aspiration, peripheral blood smear, Wright-Giemsa staining, various cytochemical stainings, cytogenetic analyses (G-banding and FISH), and flow cytometry. Diagnoses were first made by morphology and pathology specialists and later confirmed by clinical hematologists, strictly following the 2016 WHO classification for myeloid neoplasms and acute leukemia. Cases with alternative diagnoses or insufficient data were excluded from the study.

Morphological assessment involved evaluating nucleated cells per case, including detailed reviews of neutrophils, erythroblasts, and megakaryocytes. Two key parameters were used: PSDC (Percentage of Specific Dysplastic Cells) and ISD (Incidence of Specific Dysplasia).Data analysis was done using SSPS software.

Results

Table 1: Baseline Characteristics and Diagnosis Distribution of Study Participants (N = 50)

Parameter	MDS Group (n = 20)	Non-clonal Anemia Group (n = 30)
Median Age (range)	42 years (28-66)	44 years (25-70)
Sex (Male / Female)	12 / 8	17 / 13
Statistical Age Difference (P-value)	P > 0.05	

Table 1 presents the baseline characteristics of the study participants, comprising 20 patients in the MDS group and 30 in the non-clonal anemia group. The median age was 42 years (range 28-66) in the MDS group and 44 years (range 25-70) in the non-clonal anemia group, with no statistically significant difference in age between the groups ($P > 0.05$). The gender distribution was relatively balanced, with 12 males and 8 females in the MDS group, and 17 males and 13 females in the non-clonal anemia group.

Table 2: Distribution of Subtypes in Each Group

MDS Subtype	Number of Cases (n = 20)
MDS with single lineage dysplasia (MDS-SLD)	2
MDS with multi-lineage dysplasia (MDS-MLD)	3
MDS with ring sideroblasts (MDS-RS)	5
MDS with excess blasts (MDS-EB)	8
MDS with isolated del(5q)	1
MDS unclassifiable (MDS-U)	1

Table 2 outlines the distribution of MDS subtypes among the 20 patients diagnosed with myelodysplastic syndromes. The most common subtype was MDS with excess blasts (MDS-EB), observed in 8 cases, followed by MDS with ring sideroblasts (MDS-RS) in 5 cases. MDS with multi-lineage dysplasia (MDS-MLD) and MDS with single lineage dysplasia (MDS-SLD) were seen in 3 and 2 cases, respectively. Less frequent subtypes included MDS with isolated del(5q) and MDS unclassifiable (MDS-U), each reported in one case.

Table 3: Cytogenetic Abnormalities in MDS Patients (n = 9/20)

Abnormality	Number of patients
+8	3
del(5q)	2
−Y	2
del(20q)	2

Table 3 summarizes the cytogenetic abnormalities identified in 9 out of 20 MDS patients. The most common abnormality was trisomy 8 (+8), observed in 3 patients, followed by deletion of the long arm of chromosome 5 \[del(5q)] and loss of the Y chromosome (−Y), each found in 2 patients. Deletion of the long arm of chromosome 20 \[del(20q)] was

also detected in 2 patients. These findings highlight the cytogenetic diversity commonly seen in MDS cases.

Table 4: Non-clonal Anemia Subtypes (n = 30)

Subtype	Number of Cases
Immune thrombocytopenia (ITP)	7
Megaloblastic anemia (MA)	5
Iron deficiency anemia (IDA)	6
Hemolytic anemia (HA)	6
Anemia of chronic disease (ACD)	6

Table 4 details the distribution of non-clonal anemia subtypes among the 30 patients in the control group. Immune thrombocytopenia (ITP) was the most frequent subtype, seen in 7 cases. Megaloblastic anemia (MA) was observed in 5 patients, while iron deficiency anemia (IDA), hemolytic anemia (HA), and anemia of chronic disease (ACD) were each identified in 6 cases. This distribution reflects the varied etiologies of non-clonal anemias included in the study.

Table 5: Frequency and Proportion of Lineage Dysplastic Rate ≥10% in MDS and Non-Clonal Anemia Patients

Dysplastic Lineage	MDS (n = 20)		Non-Clonal Anemia (n = 30)	
	Case Number	Proportion (%)	Case Number	Proportion (%)
Dyserythropoiesis ≥10%	7	35.00% *	1	3.33%
Dysgranulopoiesis ≥10%	2	10.00% *	0	0.00%
Dysmegakaryopoiesis ≥10%	3	15.00% *	0	0.00%
*Indicates statistically significant difference ($P< 0.05$) between MDS and non-clonal anemia groups.				

The data show a significantly higher incidence of dysplastic features in the MDS group compared to the non-clonal anemia group. Dyserythropoiesis ≥10% was present in 35% (7 out of 20) of MDS patients, compared to only 3.33% (1 out of 30) in the non-clonal anemia group. Dysgranulopoiesis ≥10% and dysmegakaryopoiesis ≥10% were observed in 10% (2 patients) and 15% (3 patients) of the MDS group, respectively, but were absent in the non-clonal anemia group. These differences were statistically significant ($P< 0.05$), emphasizing the diagnostic value of dysplastic features in distinguishing MDS from non-clonal anemia.

Discussion

Myelodysplastic syndromes (MDS) are a group of heterogeneous hematopoietic stem cell disorders characterized by ineffective hematopoiesis, resulting in blood cytopenias and a risk of progression to acute myeloid leukemia (AML). One of the hallmark features of MDS is bone marrow cell dysplasia, which reflects abnormal development and maturation of blood cell precursors within the bone marrow [13].

Bone marrow cell dysplasia manifests as morphological abnormalities in one or more of the major hematopoietic lineages: erythroid, myeloid (granulocytic), and megakaryocytic cells. These dysplastic changes include nuclear irregularities, abnormal cytoplasmic features, and impaired cell differentiation, which collectively contribute to defective blood cell production [14].

The evaluation of bone marrow dysplasia is critical in diagnosing MDS, as it helps distinguish MDS from other causes of cytopenias such as reactive or secondary conditions. The World Health Organization (WHO) diagnostic criteria for MDS include the presence of dysplasia in at least 10% of cells in one or more myeloid lineages. However, recognizing and quantifying dysplasia can be challenging due to inter-observer variability and the overlap of dysplastic features with other hematologic disorders [15].

Despite these challenges, bone marrow dysplasia remains a cornerstone in the diagnostic workup of MDS. Morphological assessment combined with clinical findings, cytogenetic analysis, and molecular studies enhances diagnostic accuracy and guides prognosis and treatment strategies. Thus, understanding the characteristic dysplastic changes in bone marrow cells and their diagnostic significance is essential for early and accurate identification of myelodysplastic syndromes.

Our study included 50 participants, with 20 diagnosed with myelodysplastic syndromes (MDS) and 30 with non-clonal anemia. The groups were comparable in age and gender distribution, showing no significant differences. Among the MDS patients, the most common subtype was MDS with excess blasts (MDS-EB), followed by MDS with ring sideroblasts (MDS-RS), multi-lineage dysplasia (MDS-MLD), and single lineage dysplasia (MDS-SLD), with fewer cases of isolated del(5q) and unclassifiable MDS. Cytogenetic abnormalities were observed in 9 MDS cases, with trisomy 8 being the most frequent, followed by del(5q), −Y, and del (20q), indicating the cytogenetic diversity in MDS. In contrast, the non-clonal anemia group showed a varied distribution of subtypes, including immune thrombocytopenia (ITP), megaloblastic anemia, iron deficiency anemia, hemolytic anemia, and anemia of chronic disease. Significantly higher rates of dysplastic features—dyserythropoiesis, dysgranulopoiesis, and dysmegakaryopoiesis—were found in the MDS group compared to the non-clonal anemia group ($P< 0.05$), underlining their diagnostic relevance in distinguishing MDS.

In the study by Liang C *et al*., [16] the diagnostic value of dysplasia in myelodysplastic syndromes (MDS) was evaluated despite its morphologic variability posing clinical challenges. Bone marrow smears from MDS and non-clonal anemia patients were analyzed microscopically to assess the percentage of specific dysplastic cells (PSDC) and incidence of specific dysplasia (ISD) across erythroid, granulocytic, and megakaryocytic lineages. Four dysplastic features—petal-shaped nuclei and internuclear bridging in erythroid cells, pseudo-Pelger-Huet anomaly in granulocytes, and small lymphoid-like megakaryocytes—were significantly more frequent in MDS. Their diagnostic accuracy was reflected in area under the curve (AUC) values exceeding 0.600, and false positive rates (FPRs) remained very low when dysplasia exceeded certain thresholds. Notably, a dysplastic rate above 10% in any lineage yielded FPRs below 0.033, and even lower at specific thresholds in all three lineages. The study suggests that these four dysplastic markers have strong diagnostic potential for MDS and proposes that lowering the diagnostic threshold could be justified when high-efficacy dysplastic features are present.

The study by Oster HS *et al.* [17] highlights that myelodysplastic syndromes (MDS) are a heterogeneous group of clonal myeloid neoplasms originating from bone marrow stem cells, typically marked by bone marrow dysplasia, macrocytic anemia, or cytopenia, with a risk of progression to leukemia. Diagnosis is primarily based on bone marrow examination, assessing for uni- or multi-lineage dysplasia and blast count, while also ruling out other causes. Although clinical features and lab results may raise suspicion, cytogenetic analysis plays a vital role, with flow cytometry and molecular genetics providing supportive, though not essential, diagnostic data. The review also discusses emerging non-invasive diagnostic methods, including digital tools and peripheral blood genetic testing, which may in the future supplement or even replace invasive bone marrow biopsies. A key drawback of the study is its limited sample size, which may restrict the generalizability of the findings and reduce the statistical power of the conclusions. Additionally, the results may vary due to individual patient differences and the heterogeneity of MDS, potentially impacting the consistency and reliability of the observed diagnostic patterns.

Conclusion

This study demonstrates that the presence of significant dysplastic features and specific cytogenetic abnormalities plays a crucial role in distinguishing myelodysplastic syndromes (MDS) from non-clonal anemia, supporting the importance of comprehensive bone marrow evaluation in the diagnostic process.

Acknowledgement

Not available

Author's Contribution

Not available

References

1. Arber DA, Orazi A, Hasserjian R, Thiele J, Borowitz MJ, Le Beau MM, *et al*. The 2016 revision to the World Health Organization classification of myeloid neoplasms and acute leukemia. Blood. 2016 May 19;127(20):2391-2405.
2. Bejar R, Stevenson K, Abdel-Wahab O, Galili N, Nilsson B, Garcia-Manero G, *et al*. Clinical effect of point mutations in myelodysplastic syndromes. The New England Journal of Medicine. 2011 Jun 30;364(26):2496-2506.
3. Kantarjian HM, Keating MJ, Walters RS, Smith TL, Cork A, McCredie KB, *et al*. Therapy-related leukemia and myelodysplastic syndrome: clinical, cytogenetic, and prognostic features. Journal of Clinical Oncology. 1986 Dec;4(12):1748-1757.
4. Goldberg SL, Chen E, Corral M, Guo A, Mody-Patel N, Pecora AL, *et al*. Incidence and clinical complications of myelodysplastic syndromes among United States Medicare beneficiaries. Journal of Clinical Oncology. 2010 Jun 10;28(17):2847-2852.
5. Greenberg PL, Stone RM, Al-Kali A, Barta SK, Bejar R, Bennett JM, *et al*. Myelodysplastic syndromes, version 2.2017, NCCN clinical practice guidelines in oncology. Journal of the National Comprehensive Cancer Network. 2017 Jan;15(1):60-87.
6. Kuendgen A, Lauseker M, List AF, Fenaux P, Giagounidis AA, Brandenburg NA, *et al*. International Working Group on MDS with del(5q). Lenalidomide does not increase AML progression risk in RBC transfusion-dependent patients with low- or intermediate-1-risk MDS with del(5q): a comparative analysis. Leukemia. 2013 Apr;27(5):1072-1079.
7. Nomdedeu M, Pereira A, Ramos F, *et al*. Excess mortality in the myelodysplastic syndromes. American Journal of Hematology. 2017 Feb;92(2):149-154.
8. Arber DA, Orazi A, Hasserjian R, *et al*. The 2016 revision to the World Health Organization classification of myeloid neoplasms and acute leukemia. Blood. 2016;127(20):2391-2405.
9. Liu D, Chen Z, Xue Y, *et al*. The significance of bone marrow cell morphology and its correlation with cytogenetic features in the diagnosis of MDS-RA patients. Leukemia Research. 2009;33(8):1029-1038.
10. Schemenau J, Baldus S, Anlauf M, *et al*. Cellularity, characteristics of hematopoietic parameters and prognosis in myelodysplastic syndromes. European Journal of Haematology. 2015;95(3):181-189.
11. Ganguly BB, Dolai TK, De R, *et al*. Spectrum of complex chromosomal aberrations in a myelodysplastic syndrome and a brief review. Journal of Cancer Research and Therapeutics. 2016;12(3):1203-1206.
12. Pedersen-Bjergaard J, Andersen MK, Andersen MT, Christiansen DH. Genetics of therapy-related myelodysplasia and acute myeloid leukemia. Leukemia. 2008 Feb;22(2):240-248.
13. Mittelman M. The myelodysplastic syndromes—1990. Israel Journal of Medical Sciences. 1990;26(8):468-478.
14. Tefferi A, Vardiman JW. Myelodysplastic syndromes. The New England Journal of Medicine. 2009 Nov 5;361(19):1872-1885.
15. Liang C, Li J, Cheng J, Chen S, Ye Z, Zhang F, *et al*. Characteristics of bone marrow cell dysplasia and its effectiveness in diagnosing myelodysplastic syndrome. Hematology. 2018 Feb 7;23(2):65-76.
16. Oster HS, Van de Loosdrecht AA, Mittelman M. Diagnosis of myelodysplastic syndromes: the classic and the novel. Haematologica. 2024 Oct 24;110(2):300.

How to Cite This Article

Ganatra A, Mehta S, Shah D, Bhensadadiya M. Characteristics of bone marrow cell dysplasia and its effectiveness in diagnosing myelodysplastic syndrome. International Journal of Clinical and Diagnostic Pathology. 2025; 8(3):01-04.