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Original Article

# A Comparative Study of Modified Bauermeister Grading System and Semiquantitative Bone Marrow Fibrosis Grading System by WHO (2016)

**Amandeep Kaur[1], Sarita Nibhoria[2], Shaminder Kaur[3]**

[1]Senior Resident, Department of Pathology, Guru Gobind Singh Medical College, Faridkot, Punjab, India, [2]Professor and Head, Department of Pathology, Guru Gobind Singh Medical College, Faridkot, Punjab, India, [3]Associate Professor, Department of Medicine, Guru Gobind Singh Medical College, Faridkot, Punjab, India

## Abstract

**Introduction:** Bone marrow (BM) fibrosis is defined as an increase in BM stromal fiber content resulting from an abnormal and excessive deposition of collagen and reticulin fibers. In BM biopsies, stromal structural fibers are detected by special stains such as reticulin and masson's trichrome stains. Increased reticulin staining is associated with many benign and malignant conditions while increased masson's trichrome staining is prominent in late stages of severe myeloproliferative diseases or following tumor metastasis to BM.

**Objectives:** This study was done to study BM fibrosis by Modified Bauermeister Grading System and Semiquantitative BM Fibrosis Grading System by WHO (2016).

**Materials and Methods:** This study was conducted over a period of 1 year and included all the patients coming to the Department of Pathology, GGS Medical College, Faridkot for BM examination. BM biopsies were subjected to routine H&E staining along with reticulin and masson's trichrome staining to assess the grade of BM fibrosis. The completed proforma was compiled and data obtained were presented and statistically analyzed.

**Results:** (1) The study comprised 300 cases of hematological disorders. (2) Majority of the cases were of erythroid hyperplasia, followed by myeloproliferative neoplasms (MPN) and lymphoproliferative disorders. (3) Significant fibrosis was seen in 107 cases (35.6%).

**Conclusion:** High Grades of fibrosis (Modified Bauermeister Grade 3 and 4, WHO Grade 2 and 3) were seen in Metastatic deposits (5 out of 6 cases) and MPN (28 out of 77 cases). Our results obtained for grading of fibrosis in BM were almost similar by Modified Bauermeister Grading System as well as by Semiquantitative BM Fibrosis Grading System by the WHO. Modified Bauermeister Grading System is complex and time-consuming in contrast to the WHO Grading system which is much simpler. Therefore, we conclude that WHO Grading System should be widely used in grading BM Fibrosis.

**Key words:** Bone marrow, Bone marrow fibrosis, Myelofibrosis, Reticulin, Collagen

## INTRODUCTION

Bone marrow (BM) fibrosis is defined as an increase in BM stromal fiber content resulting from an abnormal and excessive deposition of collagen and reticulin fibers derived from marrow fibroblasts.[1-3] BM fibrosis is a common morphological finding in trephine biopsies that carries diagnostic and prognostic significance in various hematological and non-hematological disorders. Elevation of cytokines such as IL-6, IL-2, IL-8, tumor necrosis factor-α, γ-interferon, and profibrogenic growth factors such as transforming growth factor β, basic fibroblast growth factor,and vascular endothelial growth factor are thought to mediate BM fibrosis.[4-7]

In BM biopsies, stromal structural fibers are not well appreciated on routine hematoxylin and eosin stain and are detected by special stains such as Reticulin and Masson's trichrome stains. BM biopsy sections can be stained for reticulin using a silver impregnation

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**Corresponding Author:** Dr. Sarita Nibhoria, Department of Pathology, Guru Gobind Singh Medical College, Faridkot, Punjab, India,

technique.[8] Masson's trichrome stain can be used to identify collagen.[9,10]

Increased reticulin staining (reticulin fibrosis) is associated with many benign and malignant conditions while increased masson's trichrome staining (collagen fibrosis) is prominent in late stages of severe myeloproliferative diseases or following tumor metastasis to BM.[11]

The clinical significance of reticulin fibrosis is well established in primary myelofibrosis (PMF).[12] BM fibrosis has also been evaluated in other myeloproliferative neoplasms (MPN), in particular chronic myeloid leukemia.[13,14] Moderate to marked reticulin fibrosis, which correlates with increased numbers of megakaryocytes and may be associated with an enlarged spleen has been reported in 30–40% cases of CML at diagnosis.[15,16]

Significant degrees of myelofibrosis (corresponding to grade 2 or 3 of the WHO grading scheme) are observed in 10-15% of MDS cases and these cases have been referred to as MDS with fibrosis.[17]

An increase in BM stromal fibers has also been reported in children and adults with acute lymphoblastic leukemia and in adults with acute myeloid leukemia.[18,19]

Lymphoid myelofibrosis represents a particular and rare entity in which medullary fibrosis associated with abnormal lymphoproliferation replaces normal hematopoiesis. Hairy cell leukemia is one of the most known lymphoma in which MF is frequently encountered and often results in a so-called dry tap (i.e. failure to obtain aspirate on attempted BM aspiration); however, the association with other lymphoproliferation is rarely described. Rare cases have been reported in multiple myeloma, T-cell lymphoma, marginal cell, and lymphoplasmacytic lymphoma.[20-23] In very few cases of chronic lymphocytic leukemia (CLL), there may be associated marrow fibrosis.

Several grading systems have been developed over the years to evaluate the severity of BMF. The two most widely used systems include the Bauermeister system, subsequently modified by Manoharan *et al.* and Bain *et al.*, which assesses fibrosis on a scale of 0–4, and the revised European Consensus system, which uses a 0–3 scale to provide a semiquantitative assessment of BMF.[9,19,24,25] Revised European consensus system proposed by Thiele *et al.* has been accepted in the WHO classification of tumors of hematopoietic and lymphoid tissues.

### Modified Bauermeister Grading System[9]

- Grade 0 - No reticulin fibers demonstrable
- Grade 1 - Occasional fine individual fibers and foci of a fine fibre network
- Grade 2 - Fine fiber network throughout most of the section; no coarse fibers
- Grade 3 - Diffuse fiber network with scattered, thick, coarse fibers but no mature collagen (negative trichrome staining)
- Grade 4 - Diffuse, often coarse fiber network with areas of collagenization (positive trichrome staining).

### Semiquantitative BM Fibrosis Grading System by the WHO[26]

- Grade 0 (MF-0) - Scattered linear reticulin with no intersections (cross-overs), corresponding to normal BM
- Grade 1 (MF-1) - Loose network of reticulin with many intersections, especially in perivascular areas
- Grade 2 (MF-2) - Diffuse and dense increase in reticulin with extensive intersections, occasionally with focal bundles of thick fibers mostly consistent with collagen and/or associated with focal osteosclerosis
- Grade 3 (MF-3) - Diffuse and dense increase in reticulin with extensive intersections and coarse bundles of thick fibers consistent with collagen usually associated with osteosclerosis.

Accurate assessment of the fibrous BM matrix is clinically important for staging of MPN and MDS.[27-30] Convincing evidence has been produced by several groups that the degree of BM fibrosis is linked to overall survival in patients with MPN.[31,32]

The present study was done to study BM fibrosis by Modified Bauermeister Grading System and Semiquantitative BM Fibrosis Grading System by the WHO (2016).

## MATERIALS AND METHODS

This present study was conducted over a period of 1 year from Nov 2019 to Nov 2020 in the Department of Pathology, GGS Medical College, Faridkot (Punjab) with the aim to study BM fibrosis pattern in various hematological disorders.

### Study Design

Prospective study.

### Inclusion Criterion

All patients were referred to the Department of Pathology for BM studies during the study period.

### Sample Size

In this study, 300 cases were taken.

### Methodology

All patients who were referred to the Department of Pathology in Guru Gobind Singh Medical College for BM studies were included in the study.

The data of the patients were obtained from the patient's case sheets, BM report forms, and histopathology forms. They were clinically examined for any positive clinical signs such as organomegaly and lymphadenopathy.

The patient's details were recorded with respect to age, gender, occupation, presenting features, or clinical features. In this study, investigations done were blood counts, peripheral blood smear findings, BM studies along with special stains. Initially, complete blood counts and PBF examination were done on each and every patient followed by BM studies (aspiration as well as biopsy).

BM biopsies were subjected to routine H&E staining along with reticulin and masson's trichrome staining to assess the grade of BM fibrosis.

The completed proforma was compiled and data obtained were presented and statistically analyzed and valid conclusions were drawn. Appropriate statistical methods were applied as per requirement.

### Statistics

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean ± standard deviation were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square test was used for the association between two categorical variables and McNemar's Test for exploring the difference across paired observations.

## RESULTS

1. The study comprised of 300 cases of hematological disorders. The majority of the patients were in the age group of 51–60 years
2. The majority of the patients were males constituting 58.7% of the total with M: F ratio of 1.42:1
3. Fever was the chief clinical feature in majority of cases (58%) followed by splenomegaly (42.3%). Splenomegaly (61.7%) was significantly more common in patients presenting with bone marrow fibrosis ($P < 0.001$)
4. Of 300 cases, 100 cases (33.3%) were of erythroid hyperplasia, 77 cases (25.7%) of MPN, 63 cases (21%) of lymphoproliferative disorders, 16 cases (5.3%) of ITP, 12 cases (4%) of acute leukemia, 11 cases (3.7%) of aplastic anemia, 6 cases (2%) of metastatic deposits, 4 cases (1.3%) of storage disorder, and 4 cases (1.3%) of MDS, 3 cases (1%) of granulomatous pathology, 2 cases (0.7%) of idiopathic hypereosinophilia, 1 case (0.3%) each of haemophagocytic lymphohistiocytosis and leukemoid reaction
5. Peripheral blood analysis showed mean Hb of 9.2 g/dl, mean TLC of 51900/mm$^3$, and mean Platelets of 229786.7/mm$^3$
6. Out of 300 cases, Modified Bauermeister Grade 0 was seen in 103 cases (34.3%), Grade 1 in 90 cases (30%), Grade 2 in 59 cases (19.7%), Grade 3 in 16 cases (5.3%), and Grade 4 in 32 cases (10.7%). Significant fibrosis (more than or equal to Grade 2) was seen in 107 cases (35.6%) [Table 1 and Figures 1 and 2].
7. Out of 300 cases, the WHO Grade 0 was seen in 193 cases (64.3), Grade 1 in 61 cases (20.3%), Grade 2 in 34 cases (11.3%), and Grade 3 in 12 cases (4%). According to WHO grading, bone marrow fibrosis (more than or equal to Grade 1) was seen in 107 cases constituting upto 35.6% of total cases [Table 2 and Figures 1 and 2].
8. High grades of fibrosis (MB Grade 3 and 4, WHO Grade 2 and 3) were seen in Metastatic deposits (5 out of 6 cases) and MPN (28 out of 77 cases) [Figure 3]
9. The early and late stages of bone marrow fibrosis graded by Modified Bauermeister and WHO grading systems yielded a statistically non-significant ($P = 0.48$) difference in the bone marrow biopsy specimens [Table 3].

## DISCUSSION

The present study was conducted over a period of 1 year on 300 patients referred to the Department of Pathology, Guru Gobind Singh Medical College, Faridkot for bone marrow studies.

In our study, the patients belonged to all age groups with the majority of patients in the age group of 51–60 years. The mean age was 42.4 years. Mean age of the patients presenting with bone marrow fibrosis was 46.5 years. Similar findings were reported in a study conducted by Kazi *et al.* on 160 cases where the patients belonged to all age groups with a mean age of 43.5 years.[33]

In the present study, the majority of the patients were males constituting 58.7% of the total with M: F ratio of 1.42:1. Out of 107 patients presenting with bone marrow fibrosis, 67 were male (62.6%) and 40 were female (37.4%), and M: F ratio was 1.7:1. Kazi *et al.* in their study reported a slightly higher male: female ratio of 4.5:1.[33] M: F ratio was 4:5 in a study conducted by Priyathersini *et al.* in contrast to our study.[34]

The majority of patients in our study presented with fever (58%) followed by splenomegaly (42.3%). Splenomegaly (61.7%) was significantly more common in patients presenting with bone marrow fibrosis ($P < 0.001$) as

**Table 1: Distribution of Haematological disorders according to Modified Bauermeister grading system**

| Haematological disorders | Total cases | MB Grade | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grade 0 | | Grade 1 | | Grade 2 | | Grade 3 | | Grade 4 | |
| | | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % |
| Erythroid hyperplasia | 100 | 51 | 51.0 | 37 | 37.0 | 10 | 10.0 | 2 | 2.0 | 0 | 0.0 |
| Myeloproliferative neoplasms | 77 | 10 | 13.0 | 16 | 20.8 | 23 | 29.9 | 8 | 10.4 | 20 | 26.0 |
| Lymphoproliferative disorders | 63 | 17 | 27.0 | 20 | 31.7 | 16 | 25.4 | 4 | 6.3 | 6 | 9.5 |
| ITP | 16 | 11 | 68.8 | 4 | 25.0 | 1 | 6.3 | 0 | 0.0 | 0 | 0.0 |
| Acute leukemia | 12 | 2 | 16.7 | 4 | 33.3 | 3 | 25.0 | 2 | 16.7 | 1 | 8.3 |
| Aplastic anaemia | 11 | 6 | 54.5 | 3 | 27.3 | 2 | 18.2 | 0 | 0.0 | 0 | 0.0 |
| Metastatic deposits | 6 | 0 | 0.0 | 1 | 16.7 | 0 | 0.0 | 0 | 0.0 | 5 | 83.3 |
| Storage disorder | 4 | 1 | 25.0 | 0 | 0.0 | 3 | 75.0 | 0 | 0.0 | 0 | 0.0 |
| Granulomatous pathology | 3 | 0 | 0.0 | 2 | 66.7 | 1 | 33.3 | 0 | 0.0 | 0 | 0.0 |
| MDS | 4 | 3 | 75.0 | 1 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Idiopathic hypereosinophilia | 2 | 1 | 50.0 | 1 | 50.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Haemophagocytic lympho-histiocytosis | 1 | 1 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Leukemoid reaction | 1 | 0 | 0.0 | 1 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Total | 300 | 103 | 34.3 | 90 | 30.0 | 59 | 19.7 | 16 | 5.3 | 32 | 10.7 |

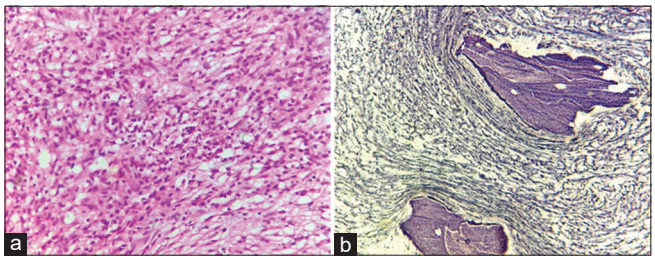


**Figure 1: (a) Bone marrow biopsy section of hairy cell leukemia demonstrating fried egg appearance. (H&E stain: ×400). (b) Bone marrow biopsy section of hairy cell leukemia demonstrating MB Grade 3 and WHO Grade 2 (Reticulin stain: ×400)**

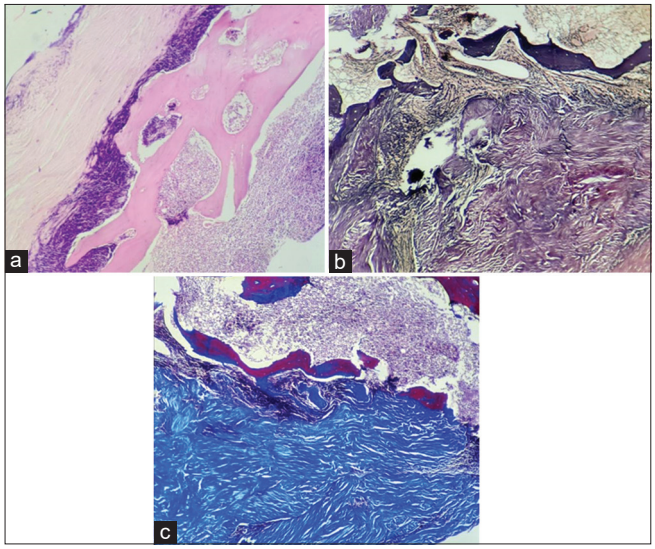


**Figure 2: (a) Bone marrow biopsy section of CLL with myelofibrosis. (H&E stain: ×100). (b) Bone marrow biopsy section of CLL with Myelofibrosis demonstrating MB Grade 4 and WHO Grade 3 (Reticulin stain: ×100). (c) Bone marrow biopsy section of CLL with myelofibrosis demonstrating Collagen Grade 3 and Osteosclerosis Grade 2 (Masson's Trichrome stain: ×100)**

compared to patients without bone marrow fibrosis. Splenomegaly (59%) was also the most common clinical presentation in a study conducted by Kazi *et al.*[33]

### Distribution of Haematological Disorders

On stratification of the hematological disorders in the current study, it was found that out of 300 cases, 100 cases (33.3%) were of erythroid hyperplasia, 77 cases (25.7%) of MPN, 63 cases (21%) of lymphoproliferative disorders, 16 cases (5.3%) of ITP, 12 cases (4%) of acute leukemia, 11 cases (3.7%) of aplastic anemia, 6 cases (2%) of metastatic deposits, 4 cases (1.3%) of storage disorder, 4 cases (1.3%) of MDS, 3 cases(1%) of granulomatous pathology, 2 cases (0.7%) of idiopathic hypereosinophilia, 1 case (0.3%) each of haemophagocytic lymphohistiocytosis and leukemoid reaction. In accordance with our results, maximum cases were of erythroid hyperplasia (18.75%) in a study conducted by Kazi *et al.*[33] Shehata *et al.* in their study on 50 BM biopsy samples included maximum of 22 cases (44%) of reactive bone marrow, 14 cases of lymphoproliferative disorders (24%), 7 cases (14%) of MPN, 4 cases of metastasis (8%), and 3 cases (6%) of acute leukemia.[35]

### Modified Bauermeister Grading in Haematological Disorders

In the present study, Grade 0 was seen in 103/300 cases (34.3%), Grade 1 in 90/300 cases (30%), Grade 2 in 59/300 cases (19.7%), Grade 3 in 16/300 cases (5.3%), and Grade 4 in 32/300 cases (10.7%). Significant fibrosis was seen in 107 cases constituting 35.6% (MB grade more than or equal to 2). In a study conducted by Shehata *et al.*, grade 0 was noted in 56% of cases, Grade 1 in 6% of cases, Grade 2 in 18% of cases, and Grade 3 in 12% cases, and Grade 4 in 8% cases. Significant fibrosis was noted in 38% of cases.[35] These findings were nearly parallel to the observations in our study.

**Table 2: Distribution of haematological disorders according to semiquantitative bone marrow fibrosis grading system by WHO (2016)**

| Haematological disorders | Total cases | WHO Grade | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Grade 0 | | Grade 1 | | Grade 2 | | Grade 3 | |
| | | *n* | % | *n* | % | *n* | % | *n* | % |
| Erythroid hyperplasia | 100 | 88 | 88.0 | 12 | 12.0 | 0 | 0.0 | 0 | 0.0 |
| Myeloproliferative neoplasms | 77 | 26 | 33.8 | 23 | 29.9 | 24 | 31.2 | 4 | 5.2 |
| Lymphoproliferative disorders | 63 | 37 | 58.7 | 16 | 25.4 | 7 | 11.1 | 3 | 4.8 |
| ITP | 16 | 15 | 93.8 | 1 | 6.3 | 0 | 0.0 | 0 | 0.0 |
| Acute leukemia | 12 | 6 | 50.0 | 3 | 25.0 | 3 | 25.0 | 0 | 0.0 |
| Aplastic anaemia | 11 | 9 | 81.8 | 2 | 18.2 | 0 | 0.0 | 0 | 0.0 |
| Metastatic deposits | 6 | 1 | 16.7 | 0 | 0.0 | 0 | 0.0 | 5 | 83.3 |
| Storage disorder | 4 | 1 | 25.0 | 3 | 75.0 | 0 | 0.0 | 0 | 0.0 |
| Granulomatous pathology | 3 | 2 | 66.7 | 1 | 33.3 | 0 | 0.0 | 0 | 0.0 |
| MDS | 4 | 4 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Idiopathic hypereosinophilia | 2 | 2 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Haemophagocytic lympho-histiocytosis | 1 | 1 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Leukemoid reaction | 1 | 1 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Total | 300 | 193 | 64.3 | 61 | 20.3 | 34 | 11.3 | 12 | 4.0 |

**Table 3: Association of modified Bauermeister grading system with semiquantitative bone marrow fibrosis grading system by WHO (2016)**

| MB Grade | WHO Grade | | |
|---|---|---|---|
| | Early Fibrosis (Grade 0, 1) | Late Fibrosis (Grade 2, 3) | Total |
| Early Fibrosis (Grade 0, 1, 2) | 252 | 0 | 252 |
| Late Fibrosis (Grade 3, 4) | 2 | 46 | 48 |
| Total | 254 | 46 | 300 |

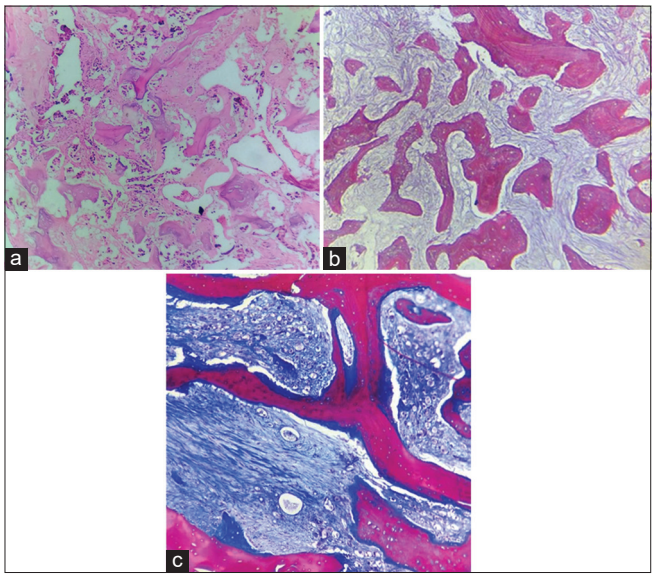


**Figure 3: (a) Bone marrow biopsy section of Metastatic Deposits. (H&E stain: ×100). (b) Bone marrow biopsy section of metastatic deposits demonstrating MB Grade 4 and WHO Grade 3 (Reticulin stain: ×100). (c) Bone marrow biopsy section of Metastatic Deposits demonstrating Collagen Grade 3 and Osteosclerosis Grade 3 (Masson's Trichrome stain: ×100)**

MPN constituted 77 cases (25.7%) out of 300 cases. On further stratification, 69 cases (89.6%) were of CML, 3 cases (3.9%) of PMF-overt fibrotic stage, 2 cases (2.6%) each of essential thrombocythemia and polycythemia vera, and 1 case (1.3%) of PMF-Pre fibrotic stage. MB Grade 0 was seen in 10 cases (13%), Grade 1 in 16 cases (20.8%), Grade 2 in 23 cases (29.9%), Grade 3 in 8 cases (10.4%) and Grade 4 in 20 cases (26%). In accordance with our study showing 66.3% of cases with significant fibrosis, Shehata *et al.* also found that significant fibrosis was present in 71.4% of cases. Grade 2, 3 and 4 were given in 14.3%, 42.8% and 14.3% of cases, respectively.[35] Our study reported significant fibrosis (Grade 2, 3, and 4) in 43/69 cases (62.3%) of CML. Grade 2 and Grade 4 were the most evident grades present in 26.08% and 24.63% of cases, respectively. Similar results were reported in a study conducted by Jesus *et al.* in 22 patients with CML, who reported significant fibrosis in 59.09% of samples.[36]

The present study concluded 63 cases (21%) of lymphoproliferative disorders out of 300 cases. On further stratification, 38 cases were of CLL constituting 60.3%, followed by 14 cases (22.2%) of Multiple myeloma, 8 cases (12.7%) of NHL, 2 cases (3.2%) of Hairy cell leukemia, and 1 case (1.6%) of Plasma cell leukemia. MB Grade 0 and Grade 1 were seen in majority of cases (37/63) constituting upto 58.7%, Grade 2 in 16 cases (25.4%), Grade 3 in 4 cases (6.3%), and Grade 4 in 6 cases (9.5%). Concordant results were obtained by Shehata *et al.*, who assessed BM fibrosis in 14 cases with LPDs, Grade 0 was reported as the most evident grade in 71.5% of cases, and Grade 3 and 4 were seen only in 14.3% of cases.[35] The present study reported significant fibrosis in 11 out

of 38 cases of CLL constituting 28.94%. Our results are discordant with Kazi *et al.*, who found fibrosis in all the 7 cases (100%) of CLL.[33]

In our study, out of 6 cases of metastatic deposits, MB Grade 1 was seen in 1 case (16.7%) and Grade 4 in 5 cases (83.3%). In accordance with our results, many studies documented the presence of high grades of fibrosis in BM metastasis. Boman *et al.* reported reticulin and/or collagen fibrosis in 32/35 BM biopsies of patients with neuroblastoma.[37] Another study performed by Kaur *et al.* on nine patients with BM metastasis found BM fibrosis in 66.6% of cases and osteosclerosis in 22.2% of cases, as detected by reticulin and trichrome staining.[38]

### Semiquantitative Bone Marrow Fibrosis Grading by WHO in Haematological Disorders

The current study showed Grade 0 fibrosis in 193 cases (64.3), Grade 1 in 61 cases (20.3%), Grade 2 in 34 cases (11.3%) and Grade 3 in 12 cases (4%). Bone Marrow Fibrosis was seen in 107 cases constituting upto 35.6% of total cases.

In present study, out of 77 cases of MPN, WHO Grade 0 was seen in 26 cases (33.8%), Grade 1 in 23 cases (29.9%), Grade 2 in 24 cases (31.2%) and Grade 3 in 4 cases (5.2%). Pozdnyakova *et al.* evaluated a total of 728 bone marrow biopsies with MPN and graded bone marrow fibrosis. Grade 0 was seen in 3.2%, Grade 1 in 13.5%, grade 2 in 35.2% and grade 3 in 48.1% of cases, in contrast to our study.[39] The maximum number of cases were of PMF, while in our study majority of the cases comprised of CML. WHO Grade 0 was seen in 26 cases (37.68%) out of 69 cases of CML in our study. Grade 1 in 18 cases (26.08%), Grade 2 in 23 cases (33.33%) and Grade 3 in 2 cases (2.89%). Similar observations were reported by Hamid *et al.* in their study on 82 patients with CML. Advanced fibrosis (Grade 2 and 3) was seen in 35% of cases which in our study constituted upto 36.22%.[40]

The present study concluded 63 cases of lymphoproliferative disorders, WHO Grade 0 was seen in 37 cases (58.7%), Grade 1 in 16 cases (25.4%), Grade 2 in 7 cases (11.1%) and Grade 3 in 3 cases (4.8%). In our study, out of 38 cases of CLL, WHO Grade 0 and 1 were seen in 35/38 cases constituting upto 92.1%. Similar results were seen in a study conducted by Tadmor *et al.*, who studied BM fibrosis in 173 cases diagnosed as CLL and reported that a total of 129/173 cases (74.56%) had WHO Grade 0 and 1.[41]

Our study recorded significant marrow fibrosis in 83.3% cases (5/6) of metastatic deposits. WHO Grade 0 was seen in 1 case (16.7%) and Grade 3 in 5 cases (83.3%).

## CONCLUSION

Our results obtained for grading of fibrosis in bone marrow were almost similar by modified Bauermeister grading system as well as by Semiquantitative bone marrow fibrosis grading system by WHO. Modified Bauermeister grading system is complex and time consuming in contrast to WHO grading system which is much simpler. Therefore, we conclude that WHO grading system should be widely used in grading Bone Marrow Fibrosis. The study of bone marrow fibrosis is important in evaluation of diagnosis as well as prognosis. Advanced fibrosis is associated with disease progression and poor prognosis.

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