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Bone Marrow Examination: An Audit from Tertiary Care Oncology Institute

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

Introduction: Bone marrow aspiration and biopsy forms the foundation of diagnostic hematopathology. These outpatient procedures were performed under local anaesthesia yielding accurate and timely diagnosis.
Aim: To evaluate the utility of bone marrow biopsy in the diagnosis and follow up of haematological neoplasms.
Type of Study: A simple observational retrospective study design.
Period of Study: 1st January 2021 to 12th September 2021
Results: A total of 111 bone marrow examinations were performed during the current year till 12.09.2022. The M:F ratio is 2.08:1. Age range is from 17 to 79 years with a mean of 49.67, Median of 53. Out of 111 bone marrow examinations, 71 procedures were performed for the diagnostic purpose. Whereas 40 procedures were for follow up after initial diagnosis, the majority are for response assessment. Of the 71 diagnostic bone marrow procedures 53 cases had a neoplastic condition, whereas 18 cases were diagnosed with benign conditions.

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Keywords: Bone marrow; diagnosis; haematological disorders; chemotherapy.

1. INTRODUCTION

Bone marrow aspiration and biopsies form the foundation of diagnostic hematopathology. These outpatient procedures were performed under local anaesthesia. The ease of doing these procedures make them an important tool in hematopathology. These procedures are easy to perform can yield accurate as well as timely diagnosis [1,2].

Bone marrow examination is not only an integral tool, for diagnosis of haematological disorders, but also crucial and definitive in evaluation of response assessment, effect of chemotherapy & unexplained cytopenia in solid organ neoplasms. Bone marrow procedures are performed as an outpatient and inpatient basis [3]. Most common site used is the posterior superior iliac spine, though other sites can be used such as sternum or anterior superior iliac spine in relevant scenarios.

Indications for definitive diagnosis of Suspected leukaemia, plasma cell dyscrasias, chronic myeloproliferative or lymphoproliferative neoplasms & MDS. It is also a very important tool in response assessment in acute leukaemia and plasma cell dyscrasias. In a tertiary care oncology hospital, it can also help to solve the riddles of unexplained cytopenia's in solid organ neoplasms [4,5].

There are very few absolute contraindications for procedures such as bleeding diatheses, skeletal abnormalities, and local site infection. Thrombocytopenia is not an absolute contraindication for the procedure.

Post-operative bleeding is rare but the most common complication. Rarely, internal haemorrhage can occur due to injury to the internal iliac or superior gluteal artery, when the site is the posterior superior iliac spine. Sternal aspiration is more prone to serious and life-threatening complications. Sternal punctures must not be performed in children below 12 years of age [6,7]. Haemorrhage, cardiac tamponade, or death can occur if the needle is misplaced during sternal puncture. Lastly infection of the procedural site can occur if proper sterile technique is not used.

Aim: To evaluate the utility of bone marrow biopsy in the diagnosis and follow up of haematological neoplasms.

Type of study: A simple observational retrospective study design.

Period of study: 1st January 2021 to 12th September 2021

2. RESULTS

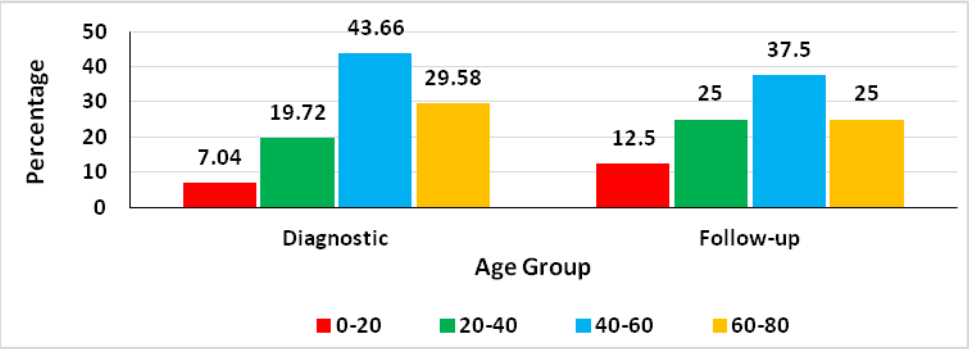
A total of 111 bone marrow examinations were performed during the current year till 12.09.2022. The M:F ratio is 2.08:1. Age range is from 17 to 79 years with a mean of 49.67, Median of 53. Out of 111 bone marrow examinations, 71 procedures were performed for the diagnostic purpose. Whereas 40 procedures are for follow-up, the majority are for response assessment. Of the 71 diagnostic bone marrow procedures 53 cases had a neoplastic condition, whereas 18 cases were diagnosed with benign conditions.

2.1 Haematological Characteristics

Diagnostic procedures: A total of 71 procedures performed, and of those 49 cases were diagnosed with malignant conditions, whereas 22 cases were of non-malignant pathology. Majority of these cases in which some types of malignant pathological conditions were suspected, 14 cases labelled as morphologically normal marrow. Four cases were diagnosed as Aplastic anaemia on bone marrow biopsy. One case was diagnosed as Mixed deficiency anaemia which presented with bicytopenia and was a case of carcinoma breast. Now, from the diagnosed malignant (49) – pathological cases, most common diagnosis was of multiple myeloma (16), followed by Acute leukaemia (13), CML (8), Involvement of bone marrow by metastatic neoplasms (3), myeloproliferative neoplasms (3), chronic lymphoproliferative neoplasms (3), and 1 case of Myelodysplastic syndrome. Acute leukaemia cases are less, probably because in many cases with high presenting Total leucocyte count, bone marrow procedure is not required, as ancillary test like flowcytometry, cytogenetics and molecular testing can be performed from peripheral blood.

Table 1. Age distribution

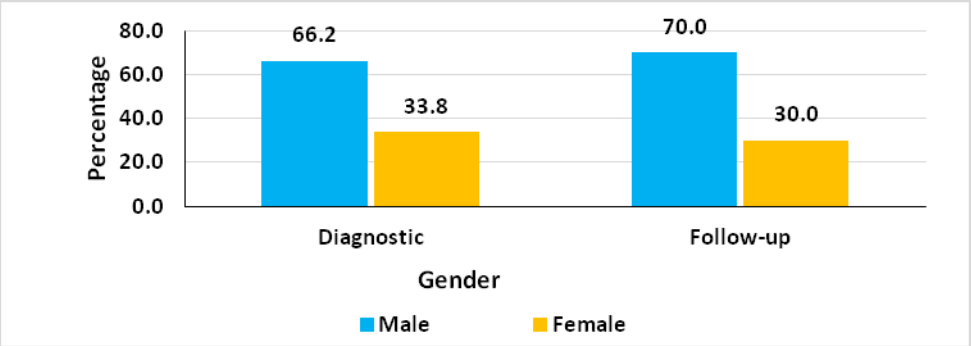
Sr. No.	Age Group	Diagnostic	%	Follow-up	%	Grand Total	%
1	0-20	5	7.04	5	12.5	10	9.01
2	20-40	14	19.72	10	25	24	21.62
3	40-60	31	43.66	15	37.5	46	41.44
4	60-80	21	29.58	10	25	31	27.93
	Grand Total	71	100.00	40	100	111	100.00



Graph 1. Age distribution

Table 2. Gender distribution

Sr. No.	Gender	Diagnostic	%	Follow-up	%	Grand Total	%
1	Male	47	66.20	28	70.00	75	67.57
2	Female	24	33.80	12	30.00	36	32.43
	Grand Total	71	100.00	40	100.00	111	100.00



Graph 2. Gender distribution

Table 3. Diagnostic Details

Sr. No.	Final diagnosis in diagnostic bone marrow procedures	No. of Cases	%
1	Multiple Myeloma	16	22.54
2	Morphologically Normal Marrow	14	19.72
3	AML	9	12.68
4	CML	8	11.27
5	Hypoplastic Marrow	4	5.63
6	CLPD	3	4.23
7	Myeloproliferative Neoplasm	3	4.23

Sr. No.	Final diagnosis in diagnostic bone marrow procedures	No. of Cases	%
8	APML	2	2.82
9	T-ALL	2	2.82
10	DLBCL-ABC Type	1	1.41
11	B ALL	1	1.41
12	Mixed dficiency Anemia	1	1.41
13	Myelodysplastic Syndrome	1	1.41
14	Myeloid Hyperplasia	1	1.41
15	No Opinion	1	1.41
16	Reactive Plasmacytosis	1	1.41
17	Relapse from Complete Response in K/C/O Multiple Myeloma	1	1.41
18	T Cell NHL	1	1.41
19	Thymic Carcinoma	1	1.41
	Grand Total	71	100.00

Follow-up/ Response assessment procedures: A total of 40 procedures performed, of which 20 procedures were done for the response assessment of acute leukaemia's (viz AML, B & T ALL, and APML), followed by response assessment of multiple myeloma (15).

There were three diagnosed cases of Chronic myeloid leukaemia, routinely we don't perform marrow examinations for response assessment in CML but these cases presented with pancytopenia, while on treatment with tyrosine kinase inhibitors. Two of them diagnosed with Aplastic anaemia on bone marrow biopsy and one case showed marked fibrosis with marked megakaryocytic hyperplasia. There was one case of primary myelofibrosis on Tab. Thalidomide, presented with pancytopenia, marrow was fibrotic with bone marrow lymphocytosis. A case of low-grade lymphoproliferative disorder presented with unexplained cytopenia's after receiving 4# of Inj. Rituximab. This patient was diagnosed as Aplastic anaemia on bone marrow biopsy.

Table 4. Response Assessment in Follow-Up Marrow Examination

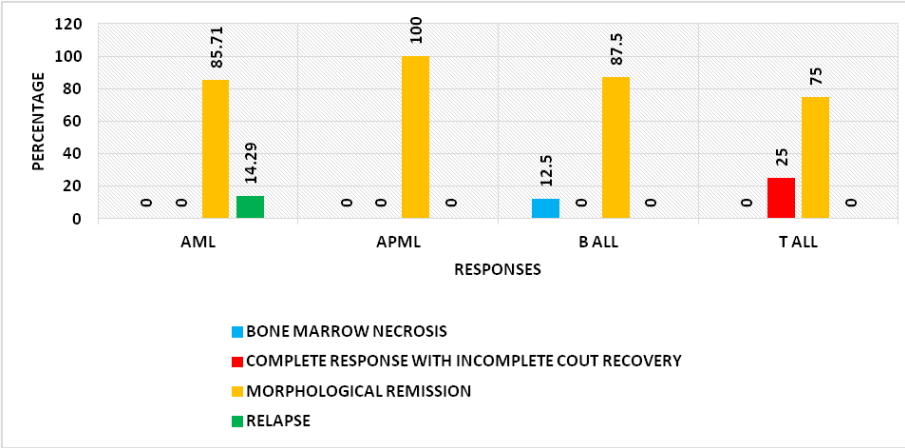
Sr. No.	Response Assessment in Follow-Up Marrow Examination	No. of cases	%
1	Morphological Remission (AL)	17	42.50
2	Very Good Partial Response (MM)	9	22.50
3	Hypoplasticc Marrow	4	10.00
4	Partial Response (MM)	3	7.50
5	Relapse	2	5.00
6	Bone Marrow Lymphocytosis	1	2.50
7	Bone Marrow Necrosis	1	2.50
8	Complete Response (MM)	1	2.50
9	Complete Response With Incomplete Count Recovery (AL)	1	2.50
10	Progression To Myelofibrosis	1	2.50
	Grand Total	40	100.00

Table 5. Response assessment in Multiple Myeloma

Sr. No.	Response in Multiple Myeloma	No. of cases	%
1	Very Good Partial Response	9	60.00
2	Partial Response	3	20.00
3	Complete Repsone	1	6.67
4	Hypoplastic Marrow	1	6.67
5	Relapse	1	6.67
	Grand Total	15	100.00

Table 6. Response assessment in Acute leukemias

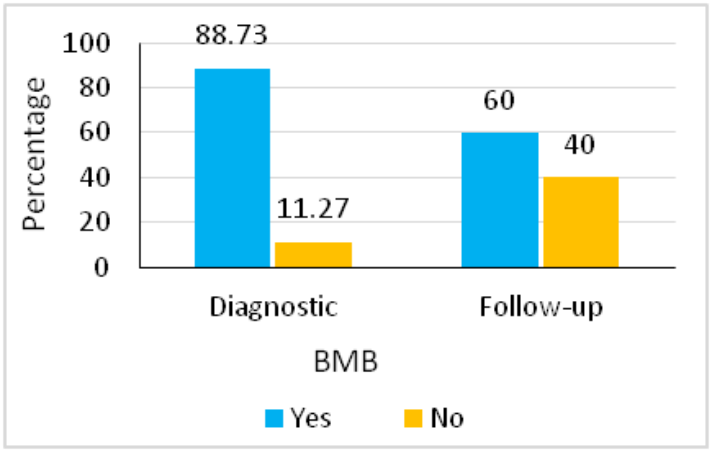
Sr. No.	Response Assessment in Acute Leukemia	AML	%	APML	%	B ALL	%	T ALL	%	Grand Total	%
1	Bone Marrow Necrosis	-	0	-	0.00	1	12.50	-	0.00	1	5.00
2	Complete Response With Incomplete Count Recovery	-	0	-	0.00	-	0.00	1	25.00	1	5.00
3	Morphological Remission	6	85.71	1	100.00	7	87.50	3	75.00	17	85.00
4	Relapse	1	14.29	-	0.00	-	0.00	-	0.00	1	5.00
5	Grand Total	7	100	1	100.00	8	100.00	4	100.00	20	100.00



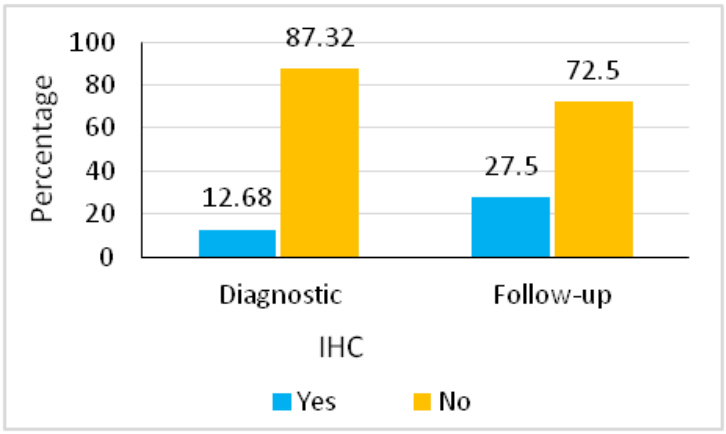
Graph 3. Response assessment in Acute leukemias

Table 7. Bone marrow biopsy procedure data

Sr. No.	BMB	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	63	88.73	24	60.00	87	78.38
2	**No**	8	11.27	16	40.00	24	21.62
	Grand Total	71	100.00	40	100.00	111	100.00



Graph 4. Bone marrow biopsy procedure data



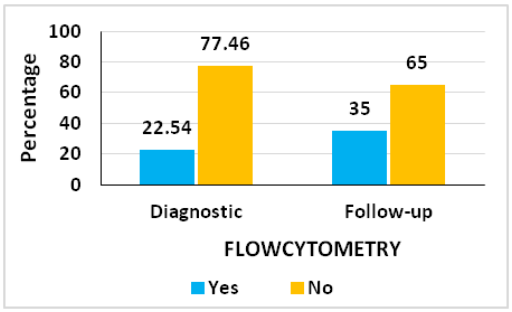
Graph 5. Immunohistochemistry (IHC) Data

Table 8. Immunohistochemistry (IHC) Data

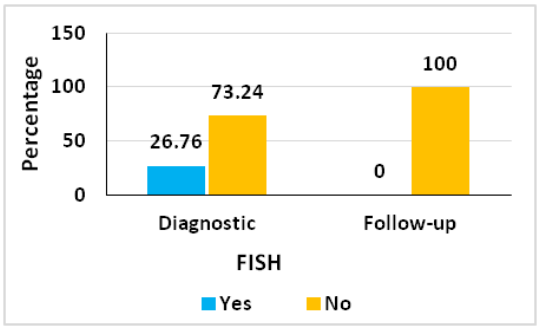
Sr. No.	IHC	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	9	12.68	11	27.50	20	18.02
2	**No**	62	87.32	29	72.50	91	81.98
	Grand Total	71	100.00	40	100.00	111	100.00

Table 9. Flowcytometry (FCM) Data

Sr. No.	Flowcytometry	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	16	22.54	14	35.00	30	27.03
2	**No**	55	77.46	26	65.00	81	72.97
	Grand Total	71	100.00	40	100.00	111	100.00



Graph 6. Flow cytometry Data



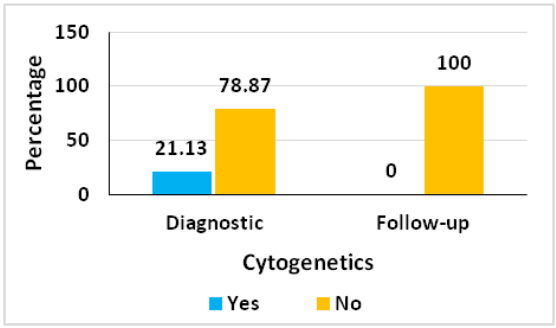
Graph 7. Fluorescent in Situ hybridization data

Table 10. Fluorescent in Situ hybridization (FISH) data

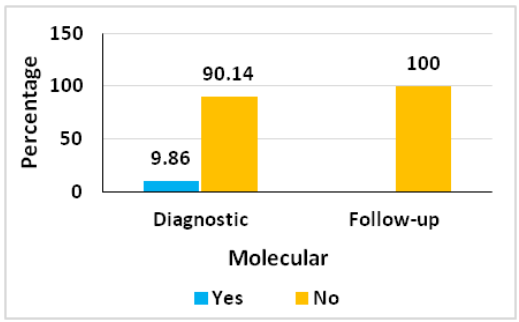
Sr. No.	FISH	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	19	26.76		0.00	19	17.12
2	**No**	52	73.24	40	100.00	92	82.88
	Grand Total	71	100.00	40	100.00	111	100.00

Table 11. Cytogenetics data

Sr. No.	Cytogenetics	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	15	21.13		0.00	15	13.51
2	**No**	56	78.87	40	100.00	96	86.49
	Grand Total	71	100.00	40	100.00	111	100.00



Graph 8. Cytogenetics data



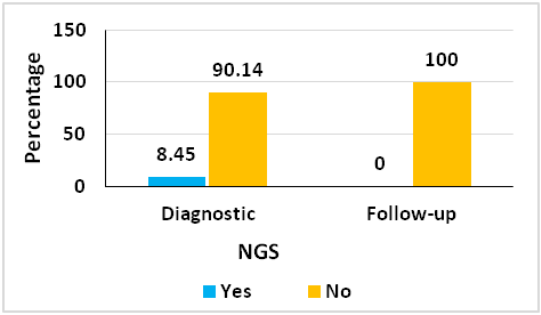
Graph 9. Molecular testing data

Table 12. Molecular testing data

Sr. No.	Molecular	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	7	9.86	-	0.00	7	6.31
2	**No**	64	90.14	40	100.00	104	93.69
	Grand Total	71	100.00	40	100.00	111	100.00

Table 13. Next generation sequencing (NGS) data

Sr. No.	NGS	Diagnostic	%	Follow-up	%	Grand Total	%
1	**Yes**	6	8.45		0.00	6	5.41
2	**No**	64	90.14	40	100.00	104	93.69
	Grand Total	71	100.00	40	100.00	111	100.00



Graph 10. Next generation sequencing data

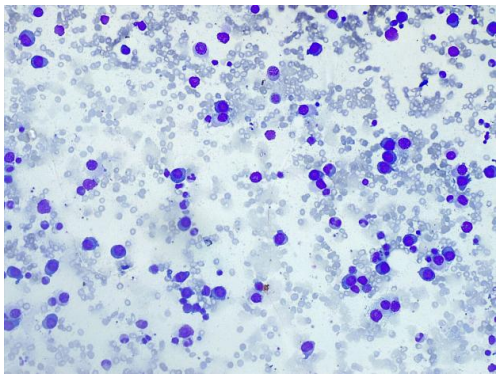


Fig. 1. (Leishman) BMA10x scattered plasma cells

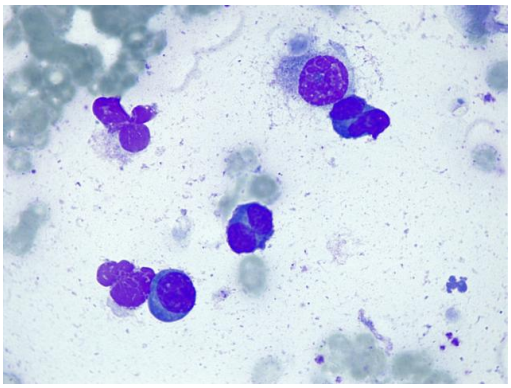


Fig. 2. (Leishman) BMA 40x Binucleate Plasma cells

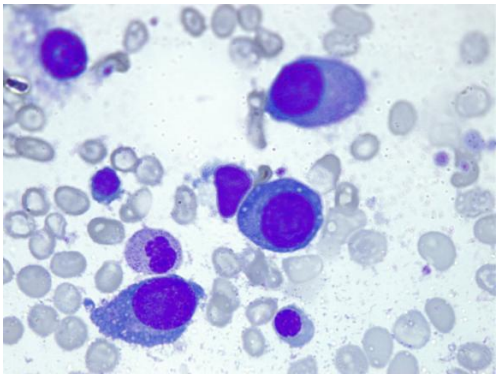


Fig. 3. (Leishman) BMA 100x Plasma cells (MM)

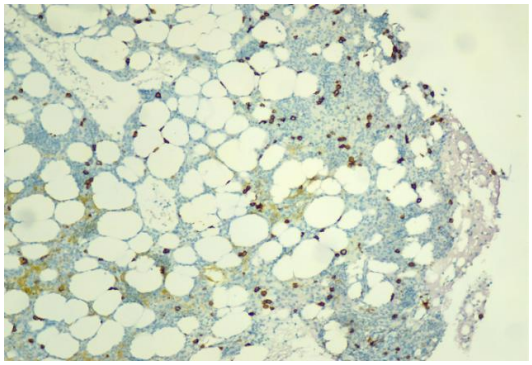


Fig. 4. BMB 10x IHC CD 138

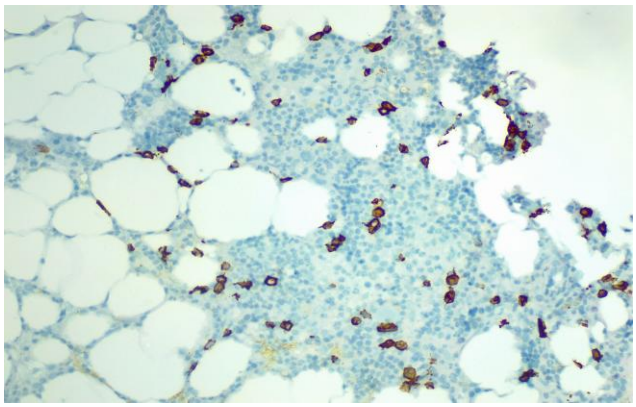


Fig. 5. BMB 40x IHC kappa light chain

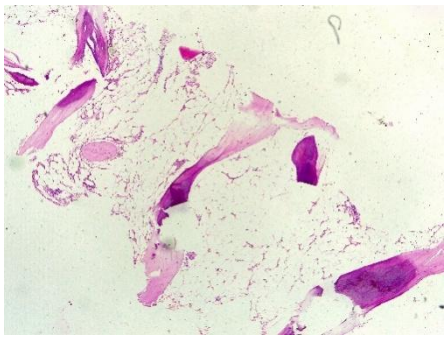


Fig. 6. (H&E) BMB x Aplastic anaemia

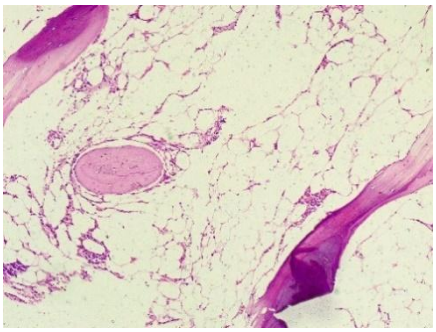


Fig. 7. (H&E) BMB 10x Aplastic anaemia

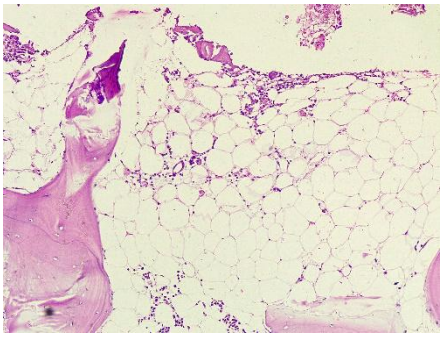


Fig. 8. (H&E) BMB 20x Aplastic anaemia

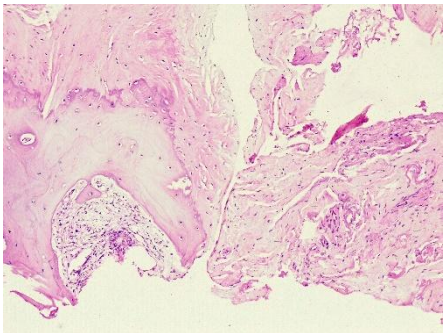


Fig. 9. (H&E) BMB 4 x Bone marrow fibrosis

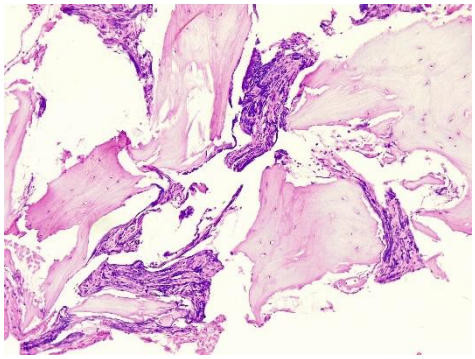


Fig. 10. (H&E) BMB 10x Bone marrow fibrosis

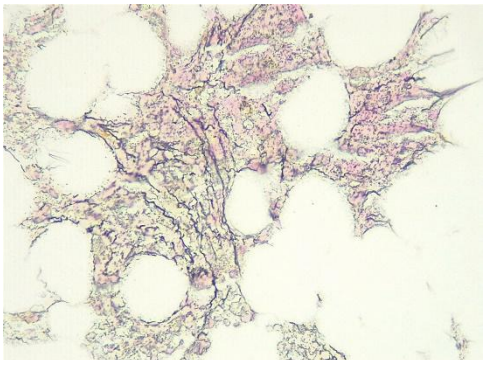


Fig. 11. (Reticulin) BMB 40x Bone marrow fibrosis

Ancillary testing: Bone marrow procedure serve as a primary tool for providing biological samples for ancillary testing including flowcytometry, cytogenetic and molecular studies. In the current era most these techniques are needed for exact diagnosis, prognosis and deciding the targeted treatment options. It also helps in assessment of early relapse detections. In our audit amongst the diagnostic procedures most commonly performed investigation is flowcytometry followed by IHC. In follow up samples, again the most common investigation done is flowcytometry followed by IHC. The detailed account of various ancillary test performed, is represented in the following table and bar diagrams. (Table: 8 to 13, Graph: 5 to 10)

2.2 Our Experience

Bone marrow aspirate and biopsy are the common procedures in hematopathology. As a consultant in haematology, after explaining the procedure, written consents is taken and the procedure is performed. Patient feedback is documented.

Pain was the most common complication of bone marrow procedure. In our experience, psychological anxiety depends on the priming of

the patient about procedure, & how you converse with the patient during procedures. In our setting, pain was “mostly well tolerated”. We didn’t encounter any other procedure related side effect like, bleeding or local site infection.

We used all steel Salah’s needle for bone marrow aspiration procedure and Jamshedi needle for bone marrow biopsies. We used local anaesthesia, Lignocaine 2%, for both the procedures. All the procedures performed, yielded adequate samples including bone marrow aspirates, biopsies and imprint smears on case-to-case basis.

3. CONCLUSION

Bone marrow examination play a significant role in diagnosis and response assessment of haematological neoplasms. A thorough pre procedural assessment, clinical corelation and adequacy of bone marrow sample further improves the importance of bone marrow procedure in a tertiary care oncology centre.

CONSENT

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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