

Fine Needle Aspiration Cytology of Bone Marrow

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Abstract

Background: Fine needle is defined as a needle with a diameter of less than 0.21 mm (21 gauge). Fine Needle Aspiration Cytology is a time tested, reliable technique for diagnosis of lesions of various organs. However this has not been yet tested in bone marrow.

Objective: Assess the feasibility of Fine Needle Aspiration Cytology in bone marrow.

Patients and Methods

Setting: Department of Pathology, Azad Jammu and Kashmir Medical College / Sheikh Zayed Bin Khalifa hospital Muzaffarabad

Subjects: Fine Needle Aspiration Biopsy was first performed on 30 patients referred for conventional bone marrow aspiration examination to our department with their consent. Procedure was performed using 22 gauge needle and 10 cc syringe.

Results: The Fine Needle Aspirate was quiet adequate in 27 cases (90%) revealing normal abnormal hematopoietic cells as well as non-hematopoietic elements.

Conclusion: In many cases, Fine Needle Aspiration Cytology of bone marrow has great potential of replacing conventional thicker bone marrow aspiration needle which is much more painful and uncomfortable.

Keywords: Bone marrow aspiration, bone marrow biopsy, Fine Needle Aspiration Cytology, FNAC, Hematological disorders

Introduction

Examination of the bone marrow aspirate and biopsy is a routine procedure performed for assessment of various conditions¹ such as cytopenias, primary hematologic neoplasms, nonmalignant disorders and metastatic neoplasms. However pain and discomfort remains a serious concern for most patients undergoing aspiration and biopsy.¹

Bone marrow aspiration is generally a safe procedure with a low morbidity incidence of 0.08% and includes hemorrhage, infection and persistent pain at the marrow site. Bleeding episodes may occur in thighs, buttocks, and retroperitoneum. Patients who undergo marrow aspiration and trephine biopsy simultaneously more are affected by bleeding episodes.²

Fine Needle Aspiration Cytology (FNAC) was introduced in 1930 by Martin and Ellis and Stewart in the United States. It employees obtaining samples using very thin fine needle of gauge of 21 or more (Gauge is inversely proportional to the diameter). In Scandinavia and in Holland, FNAC has been extensively practiced since 1950.

Due to its numerous advantages it has not surprisingly gained rapid popularity worldwide especially in last two decades.³

FNAC is not only used in suspected neoplastic disorders but also in various inflammatory, infectious and metabolic disorders of various organs such as lymph nodes, breast, thyroid, liver and spleen. Cancellous bone is no barrier to FNAC and so is bone with pathological lesions such as tumors, osteoporosis and osteomyelitis. The FNAC material is not only suitable for routine microscopic examination but also is useful for electron microscopy, culture, immune histochemistry and genetic tests. FNAC has thus obviated more invasive biopsy for many disorders.⁴

Advantages of FNAC include, procedure being less painful, quicker to perform, less technically demanding, easily repeatable, can be performed at multiple sites and may be set up anywhere like outpatient department, clinic, ward and operation theater. Local anesthesia is rarely required and chances of tumor implantation in the needle tracts are negligible

Adequacy or inadequacy of material obtained through FNAC generally depends on the skill of the operator, technique, nature of the tissue and type of pathological lesion.

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Materials & Methods

The FNAC procedure followed the general precautions used for bone marrow aspiration. We selected posterior iliac crest for FNAC bone marrow. Procedure was explained to the patient and verbal consent was obtained. Slides were labelled and area prepared. In FNAC procedure, we firmly held bone with one hand and with other, skin was punctured using 22 gauge needle attached to the 10 cc syringe and advanced to the periosteum. The bone marrow space entered with slow motion until the needle was firmly anchored in the bone (Figure 1)

When felt that we are in bone, strong suction applied with plunger to obtain a drop of bone marrow in the hub of the syringe. We then slowly removed needle with attached syringe. Afterwards we detached needle from the syringe and aspirated air in the syringe and reattached the needle. The material in the hub was then pushed on the glass slide (Figure 2). The specimen was then gently spread on the slides. This procedure was followed by conventional bone marrow aspiration.

Slides prepared from FNAC aspirate were Giemsa stained and examined microscopically. Each slide was examined by both investigators and a consensus was reached.



Fig 1:- FNAC is being performed on a 15 years old boy referred for pancytopenia

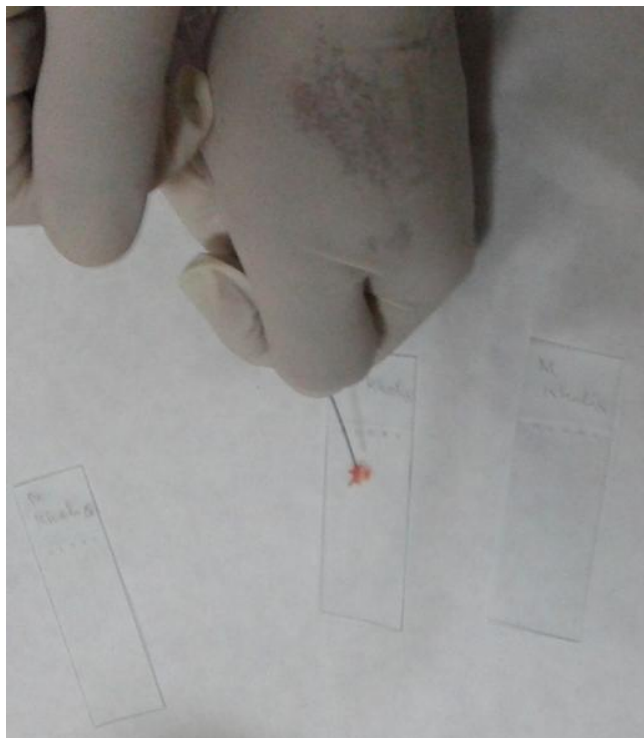


Fig 2: - Aspirated bone marrow material.

Results

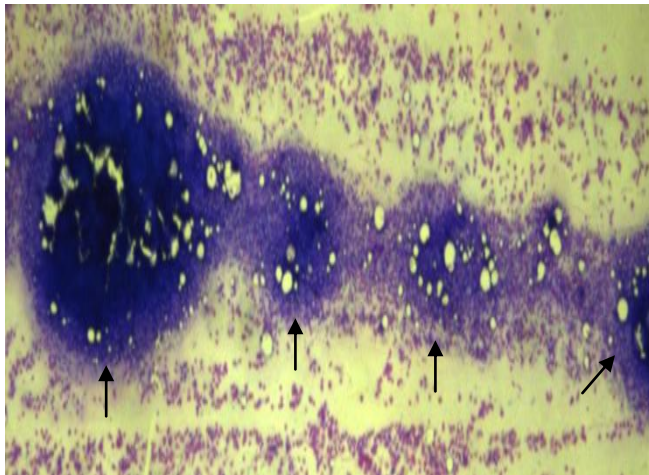
FNAC bone marrow aspirates were composed of trabecular soft osseous particles or fragments containing marrow cellular components.(Figure 3)

26 aspirates contained definite particles comprised of adipocytes mixed with marrow elements. One aspirate however despite not having definite particles still contained dispersed marrow elements.

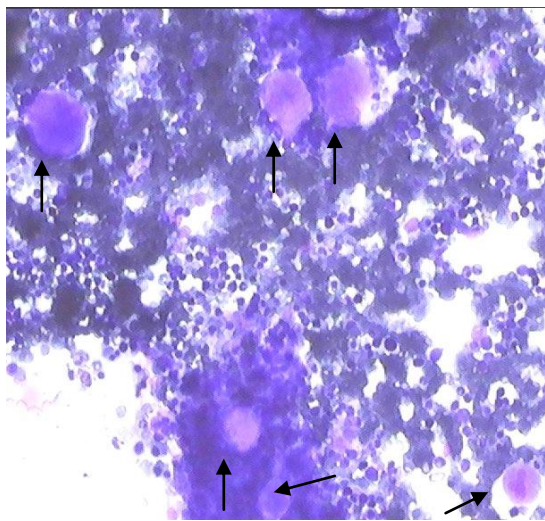
Table 1: Comparison of FNAC versus conventional bone marrow aspirate (Number of particles)

Number of Bone marrow particles in one slide	FNAC cases	Conventional bone marrow aspirate - Cases
No particles seen	4	1
1 to 4 particles	5	3
5 to 19 particles	12	5
20 to 50 particles	5	10
> 50 particles	4	11

All specimens examined contained hematopoietic cells. Three smears without marrow particles were excluded due to lack of adequate marrow elements. The specimens showed normal bone marrow elements such as, promyelocytes, myelocytes, metamyelocytes, band cells, eosinophils, basophils, lymphocytes, erythroid series, plasma cells, macrophages, osteoblasts, megakaryocytes (Figure-4), osteoclasts (Figure-5) and osteoblasts. Some smears contained numerous blast cells, abnormal plasma cells (Figure-6), epitheloid cells (Figure-7), granulomas (Figure 8), blood vessels, osteoid material (Figure-9), and Leishmanidonorovani bodies (Figure-10), Hemophagocytosis (Figure-11), and marrow trabeculae (Figure-12)



**Fig-3: Marrow particles (arrows)
(Bone Marrow FNAC Giemsa X40)**



**Fig-4: Numerous megakaryocytes (arrows) in a patient suspected of peripheral platelet consumption
(Bone Marrow FNAC Giemsa X400)**

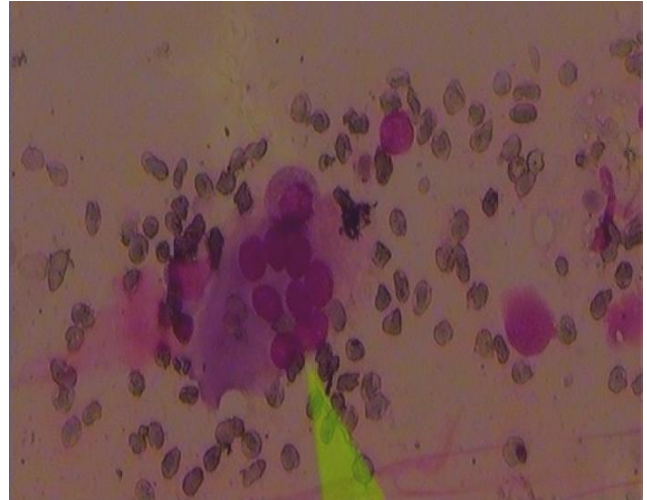
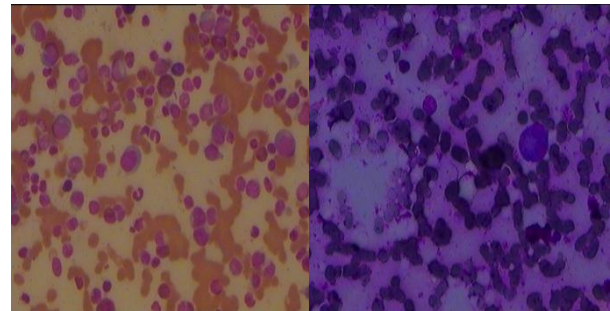


Fig-5: Osteoclast in a 7 years old boy (Bone Marrow FNAC Giemsa X400)



**Fig-6: Abnormal plasma cells in a 55-years-old man with ESR 99 mm/hr suggestive of myelomatosis
(Bone Marrow FNAC Giemsa X400)**

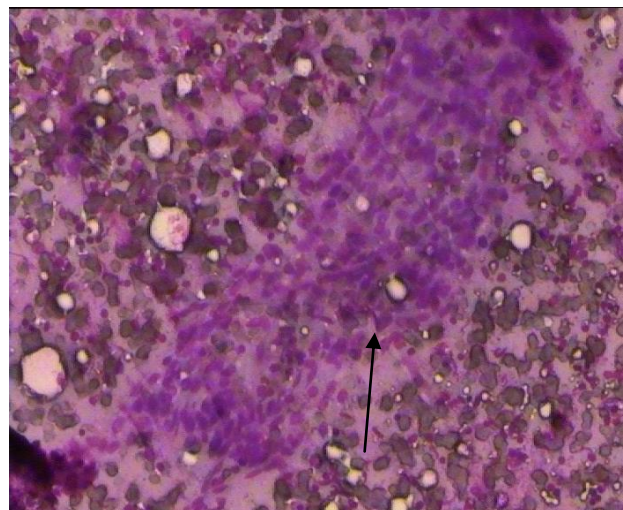


Fig-7: A collection of ill-defined epitheloid cells in a patient with fever of two months duration (Bone Marrow FNAC Giemsa X400)

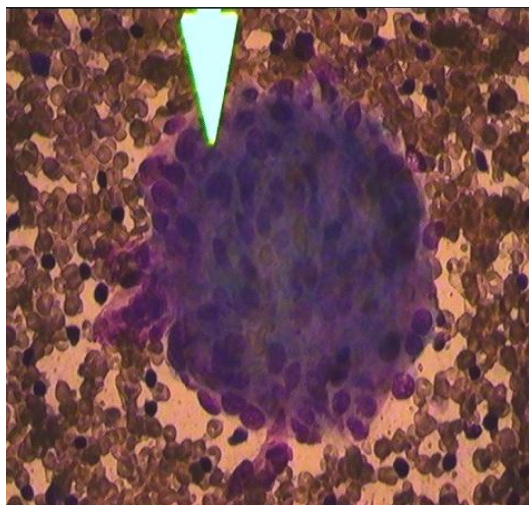


Fig-8: Collection of epithelioid cells suggestive of granuloma in a patient presenting with pyrexia of unknown origin (Bone Marrow FNAC Giemsa X40)

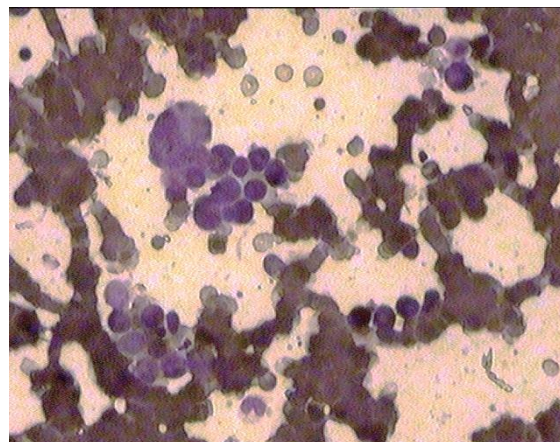


Fig11: Hemophagocytosis in a child with Hepatosplenomegaly (Bone Marrow FNAC Giemsa X1000)

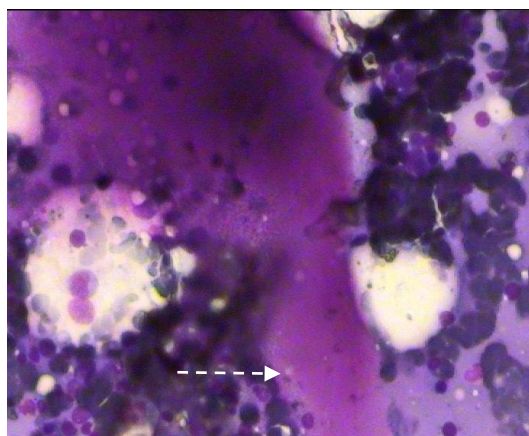


Fig-9: Osteoid (Bone Marrow FNAC Giemsa X400)



Fig-12: Bone Marrow Trabeculae suggesting that some bone disorders may also be diagnosed by FNAC (Bone Marrow FNAC Giemsa X400)

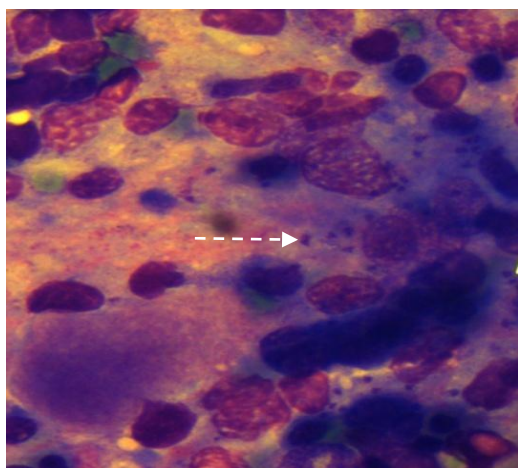


Fig-10: LD Bodies (Bone Marrow FNAC Giemsa X400)

Discussion

Bone marrow is a hematopoietic and reticuloendothelial tissue. It is involved in hematological diseases as well as disorders of reticuloendothelial system such as storage disorders. It may occasionally be involved in bone diseases like osteomyelitis, metastatic diseases and infectious diseases.

Bone marrow aspiration is a routine diagnostic tool. Generally it is a safe procedure with low morbidity. It is painful and discomforting. As a result many patients tend to avoid bone marrow aspiration. Up to 0.08 % morbidity is reported in conventional bone marrow aspiration. Common adverse events are hemorrhage, infection and persistent pain at the marrow aspiration site. The bleeding episodes occur

mainly in the buttocks, thighs and retro-peritoneum. Mostly at risk of bleeding are those who undergo both aspiration and biopsy. There is much less chance of hemorrhage in FNAC as compared to conventional bone marrow aspirates.⁵

FNAC Technique is frequently used for palpable lesions. However in combination with imaging techniques, FNAC can be performed on deep seated lesions.⁶

FNAC is very popular, is used worldwide and has made its place in patient management in almost all spheres of health care.⁷ The technique is frequently used in breast lumps, thyroid lesions salivary gland swellings, prostate, lung lesions, spleen, lymph nodes, liver, pancreas and renal lesions. FNAC is helpful in differentiating metastatic lesions from primary bone marrow diseases like myeloma.⁸ Large volume of studies has documented the accuracy of diagnosis in separating benign from malignant neoplasms. Frequently, FNAC is effectively used in classification and prognosis of malignancies. FNAC has proven value in the diagnosis of non-neoplastic lesions as well. For example FNAC is very commonly used in tuberculosis affecting various organs including bone.

In suspected osteomyelitis FNAC material is used for culture and sensitivity and direct examination.⁹ Use of FNAC in isolation and in association with other diagnostic methods like imaging techniques, flow cytometry, immunological techniques, electron microscopy, cell culture and genetic testing has greatly enhanced its diagnostic potential.⁴ Ability to aspirate adequate, representative material is the foremost requirement for FNAC. Sensitivity and specificity of diagnosis by FNAC also depends upon the spreading fixing and satisfactory staining technique. This art requires considerable experience and patience.³

A specimen is first examined at low power to determine the overall cell population and the predominant pattern if any. Individual cell morphology is then studied at higher magnification i.e. at 100, 400 and 1000 times enlargement. The procedure is significantly less painful and reduces worries, hassle and other logistic problems and family related issues.

In our study, bone marrow particles were obtained in most of FNAC bone marrow slides but overall yield of fragments is lesser than the yield in conventional bone marrow aspirate smears.

Still we obtained representative material in 90% of cases. As we observed granulomas, Leishmanidonovani bodies, plasma cells suspected of myelomatosis, metastatic

deposits, megaloblastic changes, changes suggestive of micronormoblastosis, osteoclasts, vascular structure, osteoid and chondroid material in our cases. It is needless to say that FNAC bone marrow has great potential to diagnose much large variety of diseases affecting different components of bone marrow.

In combination with clinical and peripheral smear examination, FNAC can become an indispensable initial procedure for diagnosis of bone marrow disorders.

The procedure enables the clinician to obtain a definitive diagnosis in patients quickly with minimal discomfort. FNAC is particularly useful in differentiating patients with metastatic disease or primary bone neoplasm. Our study supports the value of bone FNAC in workup of hematological patients. FNAC may be easily used for follow up of patients with bone marrow diseases as minimal discomfort will yield more compliance.

There was a reluctance to perform FNAC in bone and bone marrow possibly with a thought that fine needle may not pass through bone material. However our study confirms that cancellous bone is no barrier to fine needle. In some instances, FNAC is proven to be superior over wider diameter needle biopsy for example in neoplastic liver disease; FNAC enables sampling from multiple sites thus enabling greater possibility of diagnosis.

Numerous studies mentioned the use of FNAC for diagnosis of bone diseases. We don't find any evidence of needle breakage in these studies. Similarly we did not encounter any incidence of needle breakage in the bone marrow.

FNAC bone marrow because of many virtues has potential to replace more painful conventional¹⁰ bone marrow procedures in many cases.

Limitations

Limitations of the present study included single FNAC pass from one site only. In routine practice if the material is inadequate, FNAC can there and then be easily repeated and material may be obtained from multiple sites without much discomfort and patients reluctance. Another limitation was using ordinary injection needle which don't contain stylet. This at times may get blocked by cortical bone and obstruct further aspiration of material. Short length of ordinary needle may also pose problem as it may not adequately reach bone marrow spaces. To circumvent this limitation we plan to do further study using 23

gauge lumber puncture needle with stylet. This will still be considered FNAC as gauge of the needle will be less than 21 (Higher the gauge, thinner the needle)

Conclusion

FNAC bone marrow could provide adequate material for diagnosing variety of hematological and non-hematological disorders. Benefits of fine needle aspiration are that it causes much less pain and patient acceptance for the procedure is very high. To the best of our knowledge this is the first study ever conducted so the past references may not be found in the literature. Notion that cells will be destroyed by the fine needle during the procedure is contradicted by the fact that millions of FNACs are performed every year on various organs and are contributing significantly to the diagnosis of various disorders. Further prospective studies are needed in individual hematological disorders on large number of patients.

References

1. Talamo G, Liao J, Bayerl MG, Claxton DF, Zangari M (2010) Oral administration of analgesia and anxiolysis for pain associated with bone marrow biopsy. Support Care Cancer 18(3):301-305

2. Bain, B.J. (2005) Bone marrow biopsy morbidity: review of 2003. J ClinPathol 58:406-408
 3. Haque AU, Moatasim A. A Comparative Study of Various Needle Gauges in Diagnostic Fine Needle Aspiration Cytology; International Journal of Pathology; 2005; 3(1)
 4. Jennings CD, Foon KA. Recent advances in flow cytometry application to the diagnosis of hematologic malignancy. *Blood*. 1997;90:2863-2892.
 5. Bain BJ. Morbidity associated with bone marrow aspiration and trephine biopsy - A review of UK data for 2004. *Haematologica* 2006;91:1293-4.
 6. BommerKK, Ramzy I, Mody D: Fine needle aspiration biopsy in the diagnosis and management of bone lesions: A study of 450 cases. *Cancer* 81:148-156, 1997.
 7. Saha A, Mukhopadhyay M, Das C , Sarkar K, Saha AK,Sarkar D K : FNAC Versus core needle biopsy:A comparative study in evaluation of Palpable Breast Lump; *Journal of clinical and diagnostic research*:2016 Feb, vol-10(2)
 8. Ward WG, Kilpatrick S. Fine needle aspiration biopsy of primary bone tumours. *ClinOrthop* 2000; 373:80-7.
 9. Howard CB, Einhorn M, Dagan R, Yagupski P, Porat S. Fineneedle bone biopsy to diagnose osteomyelitis. *J Bone Joint Surg Br* 1994; 76: 311-14
 10. Hjortholm N, Jaddini E, Halaburda K, et al. Strategies of pain reduction during bone marrow biopsy. *Ann Hematol* 2013;92:145-9.

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KEY FOR CONTRIBUTION OF AUTHORS:

- A. Conception/Study Designing/Planning
- B. Experimentation/Study Conduction
- C. Analysis/Interpretation/Discussion
- D. Manuscript Writing
- E. Critical Review
- F. Facilitated for Reagents/Material/Analysis