Original Article

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Pathology Section

Role of Fine Needle Aspiration Cytology in Evaluation of Bony Lesions

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ABSTRACT

Introduction: Fine Needle Aspiration Cytology (FNAC) is increasingly being recognised for its diagnostic utility in evaluation of bone tumours. Though open surgical biopsy is the procedure of choice for diagnosis of bony tumours.

Aim: To evaluate the efficacy and reliability of FNAC in diagnosis of bony tumours.

Materials and Methods: This cross-sectional study included 40 patients with bony lesions from July 2018 to December 2019 in tertiary level centre of Rajasthan. The FNAC was performed after clinical and radiological assessment. The smears were stained using standard techniques. Also, open biopsy was performed in the patients who presented with bony lesions of patients and slides prepared for histopathological examination using standard techniques. The data was entered in Excel sheets and the results were evaluated using Statistical Package for Social Sciences (SPSS) software version 20.0.

Results: Adequate material was obtained in FNAC in 29 (72.5%) cases. Out of 29 cases, FNAC results were accurate in 96.5% cases. False Negative report was obtained in one case with no false positives. Sensitivity of FNAC in diagnosing bony lesions comes to be 90% and Specificity was 100%. The Positive Predictive Value (PPV) was 100% and the Negative Predictive Value (NPV) 95.4%.

Conclusion: The FNAC is invaluable tool in primary diagnosis of bony lesions. The technique of obtaining sufficient material though needs to be mastered and will definitely improve with more experience and radiologic correlation.

Keywords: Biopsy, Bone tumours, Diagnosis

INTRODUCTION

Bone tumours are frequently encountered in orthopaedic practice. Benign neoplasms are 100 times more common than malignant ones [1,2]. The FNAC is increasingly being recognised for its diagnostic utility in evaluation of bone tumours. The FNAC is a simple, cost-effective procedure which is widely used to diagnose lesions in various sites such as breast, thyroid, lymph node, soft tissue, and viscera but has a relatively less utility in bone lesions.

The FNAC of bone lesions are difficult to aspirate due to fibrotic or cystic nature of bone lesions. According to Association of Directors of Anatomic and Surgical Pathology, FNAC is not recommended in bony lesions and open surgical biopsy is the procedure of choice for diagnosis of bony tumours. Open surgical biopsy bears the risk of contamination of adjacent tissue by disruption of compartments, increase the risk of pathological fracture and is also costly [3]. Also, in developing countries like India, facilities for open biopsy are not available in rural places and high rate of patients suspected clinicoradiologically of bone tumours are lost to follow-up. In comparison to open biopsy, FNAC is easy to perform, cheap and rapid method which is available even at small centres. The FNAC also gives an early diagnosis with minimal disruption of lesion. Another benefit is that multiple attempts can be done if the specimen is inadequate with very lower incidence of complications. Thus, FNAC is a minimally invasive alternative to open biopsy to achieve diagnosis.

In view of the above facts, this study was conducted to evaluate the efficacy and reliability of FNAC in diagnosis of bony tumours in the institute.

MATERIALS AND METHODS

This cross-sectional study was conducted in all patients presenting with bony lesions in Department of Pathology of a tertiary level health care centre of western Rajasthan, India between July 2018 to December 2019 after obtaining ethical clearance (IEC/SNMC/2018/144).

Inclusion criteria: All the patients who presented in the Department of Pathology, SN Medical College, Jodhpur, Rajasthan, during the study time period, had palpable bony lesions, and those who gave detailed informed consent for the study, were included.

Exclusion criteria: All patients with previous surgeries, multiple sites involvement and those who were not willing to give consent, were excluded from the study.

Study Procedure

After detailed history and clinical examination patients were subjected to radiological examination (X-ray and MRI were done in all cases) for assessment of extent and associate. Lesions of bone were discussed with orthopaedic surgeon to select the appropriate site for FNAC keeping in mind, the line of incision for future surgery.

Open Biopsy of the same lesion was also performed by the orthopaedic surgeon in every case. The FNAC was performed by a single pathologist throughout the study maintaining all the aseptic precautions. Twenty two or 23 gauge needles were used for aspiration with 10 cubic centimetres (cc) syringes. The preferred site of FNAC was the area of cortical breach and soft tissue extension of the neoplasm. For some cases with thick intact cortex aspirated by radiologist, cutting needle was first introduced under imaging guidance as leader through which aspiration needle was inserted to obtain the material.

In every case, three attempts were taken. May Gruenwald Giemsa stain was done in air dried smears which were fixed in methanol. Open biopsy was taken by orthopaedic surgeon under anaesthesia. Tissue samples were fixed in 10% formalin, paraffin blocks were prepared and sections were studied using H&E staining. FNAC diagnosis was associated with histological diagnosis made on cell block of subsequently performed surgical biopsies. Special staining was not done in any of the case. Lesions were classified as benign and malignant bony lesions.

STATISTICAL ANALYSIS

The data was entered in MS Excel sheets and the results were evaluated using SPSS 20.0 software using binary classification tests including sensitivity, specificity, PPV and NPV.

RESULTS

Forty patients between the ages of 7-83 years with bony masses with or without pain were included in this study. A total of 28 patients were male and 12 patients were female. Adequate sample was obtained in 29 (72.5%) out of 40 cases [Table/Fig-1]. In the remaining 11 cases, adequate material could not be obtained even after more than three attempts [Table/Fig-2]. In osteoid osteoma and osteochondroma, the sclerotic peripheral bone prevents collection of adequate tissue material. The other malignant lesions where sample could not be obtained were deeply located and could not be localised well.

On FNAC of these, 19 lesions were benign on both FNAC and biopsy (true negative) and 9 were malignant on both FNAC and biopsy (true positive). One lesion was falsely diagnosed as enchondroma on FNAC which was later proved to be chondrosarcoma on histopathology (false Negative) [Table/Fig-3]. Absolute diagnosis could not be obtained in two cases though benign/malignant categorisation was correctly done.

Cases	Site of bony lesion	No. of attempts of FNAC	Cytological diagnosis		Histopathological diagnosis	
			Benign	Malignant	Benign	Malignant
1.	Tibia	1	GCT	-	GCT	-
2.	Femur	2	-	Osteosarcoma	-	Osteosarcoma
3.	Humerus	3	-	Secondaries	-	Secondaries
4.	Tibia	2	Aneurysmal bone cyst	-	GCT	-
5.	Humerus	1	Aneurysmal bone cyst	-	Aneurysmal bone cyst	-
6.	Femur	2	-	Osteosarcoma	-	Osteosarcoma
7.	Phalanx	2	Enchondroma	-	Enchondroma	-
8.	Femur	3	-	Malignant Tumour	-	Secondaries
9.	Tibia	2	GCT	-	GCT	-
10.	Radius	2	GCT	-	GCT	-
11.	Femur	2	Enchondroma		-	Chondrosarcoma
12.	Metacarpal	3	Enchondroma	-	Enchondroma	-
13.	Femur	3	GCT	-	GCT	-
14.	Humerus	3	-	Osteosarcoma	-	Osteosarcoma
15.	Radius	1	GCT	-	GCT	-
16.	Fibula	3	-	Ewings sarcoma	-	Ewings sarcoma
17.	Femur	1	Osteochondroma	_	Osteochondroma	-
18.	Femur	3	-	Synovial sarcoma	-	Synovial sarcoma
19.	Humerus	2	Aneurysmal bone cyst		Aneurysmal bone cyst	
20.	Humerus	3	Simple bone cyst	-	Simple bone cyst	-
21.	Tibia	1	GCT	-	GCT	-
22.	Femur	1	-	Multiple myeloma	-	Multiple myeloma
23.	Femur	2	Aneurysmal bone cyst	-	Aneurysmal bone cyst	-
24.	Tibia	3	Osteochondroma	-	Osteochondroma	-
25.	Femur	2	GCT	-	GCT	-
26.	Femur	2	Simple bone cyst	-	Simple bone cyst	-
27.	Metacarpal	1	Enchondroma	-	Enchondroma	-
28	Tibia	3	-	Malignant sarcoma	_	Osteosarcoma
29	Tibia	3	Aneurysmal bone cyst	-	Aneurysmal bone cyst	-

[Table/Fig-1]: Cytological and histological diagnosis of patients with sufficient samples.
GCT: Giant cell tumour; FNAC: Fine needle aspiration cytology

Cases	Site of bony lesion	No. of attempts of FNAC	Cytological diagnosis		Histopathological diagnosis	
			Benign	Malignant	Benign	Malignant
1.	Femur	>3	-	-	Osteiod osteoma	
2.	Femur	>3	-	-	-	Osteosarcoma
3.	Pubis	>3	-	-	-	Chondrosarcoma
4.	Femur	>3	-	-	Osteochon-droma	-
5.	Femur	>3	-	-	-	Osteosarcoma
6.	Femur	>3	-	-	-	Aneurysmal bone cyst
7.	Pubis	>3	-	-	-	Secondaries
8.	Tibia	>3	-	-	-	Giant cell tumour
9.	Humerus	>3	-	-	-	Osteosarcoma
10.	Tibia	>3	-	-	-	Secondaries
11.	Femur	3	-	-	-	Multiple myeloma

[Table/Fig-2]: Cytological and histological diagnosis of patients with insufficient samples.

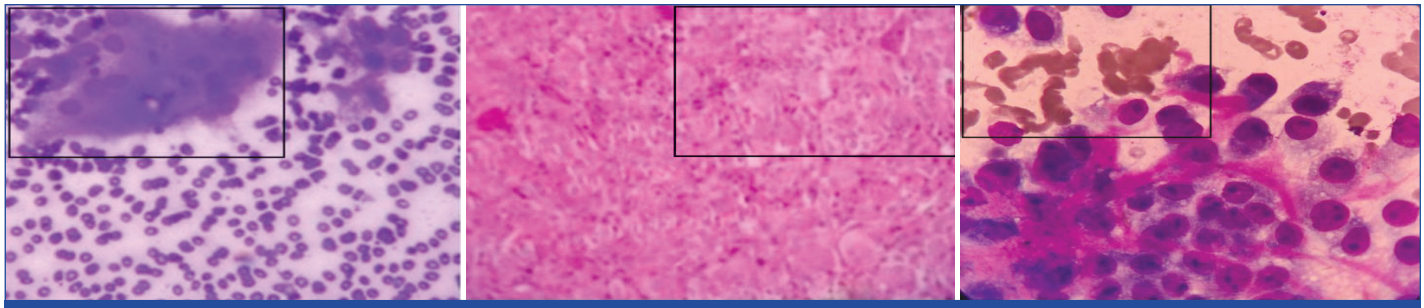
FNAC results	No of cases
Malignant on both FNAC and HPE	9 (True Positive)
Benign on both FNAC and HPE	19 (True Negative)
Benign on FNAC but malignant in Biopsy	1 (False Negative)
Malignant on FNAC but Benign on HPE	0 (False Positive)

[Table/Fig-3]: Results of FNAC.
FNAC: Fine needle aspiration cytology; HPE: Histopathological examination; N=29

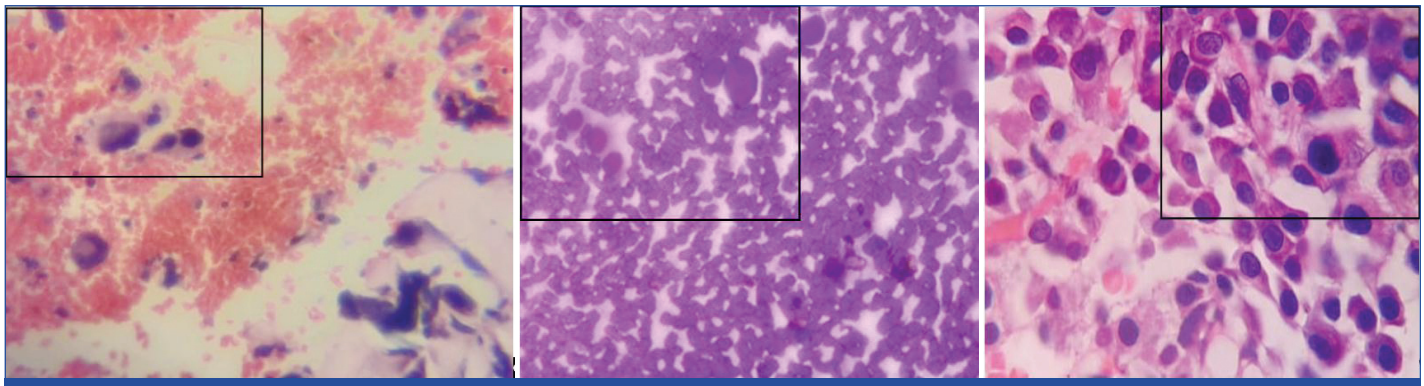
The most common location was femur (11 cases, 37.9%) followed by tibia (7 cases, 24.1%) and humerus (5 cases, 17.2%), metacarpal (2 cases, 6.8%), radius (2 cases, 6.8%), fibula (1 case, 3.4%) and phalanx (1 case, 3.4%).

The most common tumour found in the study was giant cell tumour [Table/Fig-4,5] 8 cases followed by osteosarcoma [Table/Fig-6,7] -4 cases, aneurysmal bone cyst -4 cases, enchondroma -3 cases and secondaries, osteochondroma, and simple bone cyst -2 case,

multiple myeloma [Table/Fig-8,9], chondrosarcoma, ewings sarcoma and synovial sarcoma (one case each).



[Table/Fig-4]: FNAC- Giant cell tumour aspirate showing mono nuclear stromal giant cells with osteoclastic giant cells (Giemsa 40X). **[Table/Fig-5]:** Biopsy: Giant cell tumour numerous evenly dispersed osteoclast like cells with vascular stroma (H&E 40X). **[Table/Fig-6]:** Osteosarcoma- FNAC Pleomorphic tumour cells in background of osteoid material. (Images from left to right)



[Table/Fig-7]: Osteosarcoma - biopsy spindle shaped stromal cells with atypical and irregularly shaped nuclei (H&E 40X). **[Table/Fig-8]:** Multiple myeloma- FNAC aspirate smear showing dispersed plasma cell with eccentric nuclei, binucleation and loss of normal clockwork chromatin (Giemsa 40X). [**Table/Fig-9]:** Multiple myeloma: biopsy trephine biopsy showing plasma cells (approx 50% cellularity) with interstitial pattern (H&E 40X). (Images from left to right)

For statistical evaluation 11 cases with insufficient material were excluded. The sensitivity of FNAC in diagnosing bony lesions comes to be 90% and specificity was 100% the PPV comes to be 100% and the NPV is 95.4%. The rate of accuracy for FNAC was 96.5% in this study.

DISCUSSION

Open surgical biopsy is considered gold standard for diagnosis of bony tumours though FNAC is increasingly being added in diagnostic work-up of such lesions. Its first use in bony lesions was described by Coley BL et al., in 1931 [4].

In a study by Layfield LJ et al., FNAC is found to be 38.5% cheaper compared to open surgical biopsy [5]. Though no such study is done in India but FNAC is definitely cheaper compared to open biopsy and more easily available in semi urban areas of India. According to Soderlund V et al., FNAC is of great value in cases of bony lesions as it can reduce risk of false diagnosis to around 1% only [6].

The main problem in using FNAC for bony lesions is to obtain adequate material. In the present study, adequate material could not be obtained in 11 out of 40 cases (27.5%) which is comparable to another study by Layfield LJ et al., rate (33%) [7]. Though some studies report low rate of failure in obtaining material like Hand U et al., (18.2%) [8] and Chakrabarti S et al., (13.7%) [8,9]. Technique of obtaining material in bony lesions requires expertise and clinicoradiological correlation to localise exact site. It is easier to obtain material in tumours which are superficially located or when there is soft tissue spread in deeper lesions..

Out of 29 cases where adequate material was obtained rate of accuracy was obtained to be 96.5 which is comparable to study by Kreicbergs A et al., (80%) [10] though less than Chakrabarti S et al., (93.1%) Bommer KK et al., (97.1%), and Wahane RN et al., (90.5%) [9,11,12].

In the present study, the sensitivity of FNAC in diagnosing bony lesions was 90%. Though this is slightly lower than Chakarbarti S et al., (93.33%), Nnodu OE et al., (95%) it is still high and encourages the use of FNAC in bony tumours [9,13]. Diagnosis by aspiration depends on the yield of diagnostic material and experience in the interpretation of cytological smears. Lesions surrounded by thick cortical bone or calcified stroma are always difficult to aspirate and obtain sufficient material for FNAC.

The two cases where absolute diagnosis was not possible were osteosarcoma and secondaries from lung but categorisation into benign or malignant was possible. In this study, one of the case was found to be giant cell tumour after open biopsy but was reported to be aneurysmal bone cyst on FNAC. It has been reported in literature in previous study by Murphey MD et al., that secondary aneurysmal bone cyst get formed in 14% giant cell tumours and sample was probably obtained from that part of lesion [14]. The another case where diagnosis of benign chondroid tumour on FNAC was changed to low grade chondrosarcoma as both these lesions resemble closely. In previous studies by Layfield LJ et al., [7] and Sanerkin NG [15] also differentiation between low grade chondrosarcoma and enchondroma has been found to be difficult.

All osteosarcoma lesions where sample was adequate were accurately diagnosed on FNAC. This is similar study by Dodd LG et al., where conclusive cytological diagnosis was possible in 65% cases [16]. Two of the cases with secondaries were accurately diagnosed on FNAC. Correct diagnosis of metastatic lesion by FNAC aids in appropriate management of these lesions. Early initiation of neoadjuvant chemotherapy or radiotherapy is possible by FNAC of malignant tumours which is important because neoadjuvant chemotherapy has become standard treatment for many malignant bony tumours like osteosarcoma as was very well depicted in study by Bielack S et al., [17]. The GCT was most common bone tumour diagnosed in the present study as in study by Vangala N et al., [18]. Bone tumours have specific morphological appearances on FNAC, such as multinucleated, osteoclast-like giant cells, along with mononuclear cells in a giant cell tumour of bone , and polygonal cells with intranuclear grooves in a chondroblastoma [19,20]. The FNAC may alleviate the need for an open biopsy for diagnosis and deciding appropriate treatment [21]. A similar study in 2019

concluded that FNAC is complimentary to biopsy, for preoperative decisions and triage [22].

Limitation(s)

There was lack of long term follow-up to check if any correlation exists in appearance of lesion with time. Also, In this study, the sample size was limited.

CONCLUSION(S)

This study concluded that FNAC is invaluable tool in primary diagnosis of bony lesions. The technique of obtaining sufficient material though needs to be mastered and will definitely improve with more experience and radiologic association. If radiologic information is not associating or sufficient material is not obtained than open biopsy can always be obtained later on. The FNAC is easily available at most of the places in India, produces quick results. Future studies with larger sample size are recommended for better generalisation of the results.

REFRENCES

[1] Rosenberg AE. Bone, joints and soft tissue tumours. In: Kumar V, Abbas AK, Fausto N, Aster JC, editors. Robbins and Cotran Pathologic Basis of Disease. 8th ed. Philadelphia: Elsevier; 2010. pp. 1205-56.
[2] Rosai J. Soft tissue. In: Rosai J, editor. Rosai and Ackerman's Surgical Pathology. 9th ed. New Delhi: Thomson Press; 2005. pp. 2137-237.
[3] Mankin HJ, Lange TA, Spanier SS. The hazards of biopsy in patients with malignant primary bone and soft-tissue tumours. J Bone Joint Surg Am. 1982;64(8):1121-27.
[4] Coley BL, Sharp GS, Ellis EB. Diagnosis of bone tumours by aspiration. Am J Surg. 1931;13:214-24.
[5] Layfield LJ, Dodd LG, Hischowitz S. Carbtee NS. Fine-needle aspiration of primary osseous lesions: A cost effectiveness study. Diagn Cytopathol. 2010;38(4):239-43.
[6] Soderlund V, Skoog L, Kreicbergs A. Combined radiology and cytology in the diagnosis of bone lesions: A retrospective study of 370 cases. Acta Orthop Scand. 2004;75:492-99.
[7] Layfield LJ, Glasgow BJ, Anders KH, Mirra JM. Fine needle aspiration cytology of primary bone lesions. Acta Cytol. 1987;31(2):177-84.
[8] Hand U, Bal A, Mohan H, Bhardwaj S. Fine needle aspiration cytology in the diagnosis of bone lesions. Cytopathology. 2005;16(2):59-64.
[9] Chakrabarti S, Datta AS, Michael H. Critical evaluation of fine needle aspiration cytology as a diagnostic technique in bone tumours and tumour like lesions. As Pac Journ Canc Prevention. 2012;13(7):3031-35.
[10] Kreicbergs A, Bauer HC, Brosjo O. Cytological diagnosis of bone tumours. J Bone Joint Surg Br. 1996;78(2):258-63.
[11] Bommer KK, Ramzy I Mody D. Fine-needle aspiration biospy in the diagnosis and managment of bone lesions: A study of 450 cases. Cancer. 1997;81(3):148-56.
[12] Wahane RN, Lele VR, Bobhate SK. Fine needle aspiration cytology of bone tumours. Acta Cytol. 2007;51:711-20. https://doi.org/10.1159/000325833.
[13] Nnodu OE, Giwa SO, Eyesan SU, Abdulkareem FB. Fine Needle aspiration cytology of bone tumours the experience from the national orthopaedic and Lagos University teaching hospitals, Lagos, Nigeria. Cytojournal. 2006;3:16. Doi: 10.1186/1742-6413-3-16.
[14] Murphey MD, Nomikos GC, Flemming DJ, Gannon FH, Temple HT, Kransdorf MJ. Imaging of giant cell tumour and giant cell reparative granuloma of bone: Radiologic-pathologic correlation: AFIP archives. Radiographics. 2001;21:1283-309. Doi: 10.1148/radiographics.21.5.g01se251283.
[15] Sanerkin NG. The diagnosis and grading of chondrosarcoma of bone: A combined cytologic and histologic approach. Cancer. 1980;45(3):582-94.
[16] Dodd LG, Scully SP, Cothran RL, Harreson JM. Utitlity of fine-needle aspiration in the diagnosis of primary osteosarcoma. Diagn Cytopathol. 2002;27(6):350-53.
[17] Bielack S, Jurgens H, Jundt G, Kevric M, Kühne T, Reichardt P, et al Osteosarcoma: The COSS experience. Cancer Treat Res. 2009;152:289-308. Doi: 10.1007/978-1-4419-0284-9_15.
[18] Vangala N, Uppin SG, Pamu PK, Hui M, Nageshwara Rao K, Chandrashekar P. Fine-needle aspiration cytology in preoperative diagnosis of bone lesions: A three-year study in a tertiary care hospital. Acta Cytol. 2021;65(1):75-87.
[19] Jain M, Aiyer HM, Singh M, Narula M. Fine-needle aspiration diagnosis of giant cell tumour of bone presenting at unusual sites. Diagn Cytopathol. 2002;27(6):375-78.
[20] Krishnappa A, Shobha SN, Shankar SV, Aradhya S. Fine needle aspiration cytology of chondroblastoma: A report of two cases with brief review of pitfalls. J Cytol. 2016;33(1):40-42.
[21] Kaur I, Handa U, Kundu R, Garg SK, Mohan H. Role of fine-needle aspiration cytology and core needle biopsy in diagnosing musculoskeletal neoplasms. J Cytol. 2016;33(1):07-12.
[22] Rekhi B. Core needle biopsy versus fine needle aspiration cytology in bone and soft tissue tumours. J Cytol. 2019;36(2):118-23.

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