RESEARCH PAPER

Fine Needle Aspiration Cytology of Bone Tumours: A Prospective Cytomorphological Study

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ABSTRACT

Background: Bone tumours present a broad diagnostic spectrum and are infrequently encountered in routine surgical pathology. Accurate diagnosis requires integration of clinical, radiological, and morphological findings. Although open biopsy has been the traditional standard, it is associated with procedural delays and complications. Objectives: To study the cytomorphological features of bone tumours and evaluate the diagnostic utility of Fine Needle Aspiration Cytology (FNAC) in these lesions.

Methods: A prospective study of 51 bone aspirations was performed over 18 months at JJM Medical College, Davangere. Smears were stained with Giemsa, Papanicolaou, and H&E stains; cytological findings were correlated with histopathology using the Galen and Gambino methodology.

Results: Adequate material was obtained in 92.16% of cases. Malignant lesions constituted 45.09%, benign lesions 31.37%, and tumour-like lesions 13.72%. The overall diagnostic accuracy was 81.25%, with sensitivity of 90.91% and specificity of 94.12% for detecting malignancy. Conclusion: FNAC is a safe, simple, and reliable technique for the preliminary diagnosis of bone tumours. A multidisciplinary approach combining clinical, radiological, and cytological assessment significantly improves diagnostic accuracy.

Keywords: Bone tumours; Fine Needle Aspiration Cytology; Osteosarcoma; Giant Cell Tumour; Cytomorphology; Diagnostic accuracy

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Conflict of interest: None

INTRODUCTION

Bone tumours represent a broad and diagnostically challenging spectrum of neoplastic and non-neoplastic lesions. They are infrequently encountered in routine surgical pathology, yet they carry significant clinical implications. An accurate and timely diagnosis is paramount in guiding treatment decisions and improving patient outcomes.

The traditional approach to diagnosis has relied on open surgical biopsy, which, although effective, is time-consuming and associated with procedural complications including haemorrhage, infection, and tumour seeding along the biopsy tract. These limitations have driven the search for less invasive alternatives.

Fine Needle Aspiration Cytology (FNAC) has emerged as a safe, simple, cost-effective, and minimally invasive technique widely used in diagnosing superficial lesions. However, its application to bone pathology has been slow to gain acceptance. The prevailing misconception is that bone lesions are difficult to sample with a fine needle due to the hardness of cortical bone.

Contrary to this perception, most bone lesions are associated with variable degrees of cortical destruction and soft tissue extension, making them accessible to fine needle aspiration. When performed by experienced hands and supplemented by clinical and radiological correlation, FNAC can provide a highly accurate pre-operative diagnosis and even eliminate the need for open biopsy in a substantial proportion of cases.

OBJECTIVES

1. To study the cytomorphological features of various bone tumours and tumour-like lesions.
2. To evaluate the diagnostic utility and accuracy of Fine Needle Aspiration Cytology in the diagnosis of bone lesions.
3. To correlate cytological findings with histopathological diagnosis and calculate sensitivity, specificity, and overall efficacy.

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MATERIALS AND METHODS

A prospective study was undertaken in the Department of Pathology, JJM Medical College, Davangere, from June 2013 to December 2014 — a period of 18 months. Ethical clearance was obtained from the institutional review board and informed consent was secured from all participants prior to the procedure.

Patient Selection

Patients presenting with clinically and/or radiologically suspected bone lesions were enrolled. All patients underwent thorough clinical evaluation and relevant radiological workup (plain radiographs, CT scan, or MRI as appropriate) prior to aspiration. Inflammatory bone lesions and lesions surrounded by compact, sclerotic bone (which precluded needle penetration) were excluded from the study.

FNAC Procedure

Fine Needle Aspiration was performed using an 18–22 gauge needle following standard aseptic technique. The procedure was performed as an outpatient procedure without sedation in the majority of cases. One to two smears were prepared for each aspiration. Where material was scant or inadequate, re-aspiration was performed immediately.

Non-palpable or anatomically inaccessible lesions were subjected to image-guided aspirations (ultrasound or CT-guided), which accounted for 4 of the 51 patients (7.84%).

Staining Techniques

- **Air-dried smears:** Stained with May-Grünwald-Giemsa (MGG) stain
- **Wet-fixed smears:** Stained with Papanicolaou (PAP) stain and Haematoxylin & Eosin (H&E)

Histopathological Correlation

Surgical biopsy was performed at the discretion of the treating surgeons. Cytological diagnoses were subsequently correlated with histopathological findings. In one patient with suspected myeloma, serum protein electrophoresis was considered diagnostic and used as the reference standard. Diagnostic accuracy, sensitivity, and specificity were calculated using the methodology of Galen and Gambino.

RESULTS

Over the 18-month study period, 51 bone aspirations were performed, constituting 1.93% of the total 2,639 aspirates performed in the department during this period. A total of 63 aspirate specimens were collected from the 51 patients (reflecting repeat aspirations). Of these, 52 aspirates showed a haemorrhagic appearance, while the remainder yielded grey-white material.

Patient Demographics

The age of patients ranged from 8 to 80 years. A significant clustering was observed in the second and third decades of life, with 26 patients (50.98%) falling in the 10–29 years age group, consistent with the known peak incidence of primary bone tumours in adolescents and young adults. Bone tumours were less frequent below 9 years of age.

There was no significant sex predilection overall: 25 patients were male and 26 were female (M:F ratio 0.96:1). However, male predominance was noted in the 30–39 and 70–79 age brackets, while females predominated in other age groups.

Table 1: Age and sex distribution of patients (n=51)

Age Group (years)	Male	Female	Total
0–9	1	0	1
10–19	5	10	15
20–29	5	6	11
30–39	4	2	6
40–49	1	4	5
50–59	1	2	3
60–69	2	1	3
70–79	5	1	6
80–89	1	0	1
Total	25	26	**51**

Site Distribution

The lower end of the femur was the most common site of aspiration, accounting for 11 patients (21.57%). This was followed by the upper end of tibia and mandible (5 patients each; 9.8%), upper end of femur and upper end of humerus (4 patients each; 7.84%), and lower end of radius (3 patients; 5.88%).

Duration of Symptoms

The duration of symptoms ranged from 2 days to 10 years, with the majority of patients presenting within 2 to 6 months of symptom onset.

4.5 Cytological Diagnoses

Of the 51 patients, adequate material for cytological evaluation was obtained in 47 (92.16%). The breakdown of diagnoses is summarised in Table 2.

Table 2: Distribution of cytological diagnoses (n=51)

Category	No. of Patients	Percentage
Benign Lesions	16	31.37%

Enchondroma	1	—
Chondroblastoma	1	—
Chondromyxoid fibroma	1	—
Giant Cell Tumour	10	—
Ameloblastoma	3	—
Malignant Lesions	23	45.09%
Osteosarcoma	9	—
Malignant Fibrous Histiocytoma	1	—
Ewing's Sarcoma / PNET	2	—
Myeloma	3	—
Chordoma	1	—
Metastatic Malignancy	7	—
Tumour-like Lesions	7	13.72%
Aneurysmal Bone Cyst	2	—
Fibrous Dysplasia	1	—
Langerhans Cell Histiocytosis	2	—
Central Giant Cell Lesion	1	—
Non-ossifying Fibroma	1	—
Inconclusive / Non-diagnostic	4	7.85%
Total	**51**	**100%**

4.6 Diagnostic Accuracy and Errors

Biopsy was performed in 31 patients, and serum electrophoresis was considered diagnostic in one patient with myeloma. Of the 32 patients with a reference standard, cytological diagnosis was confirmed in 26, giving an overall diagnostic accuracy of 81.25%.

Three cases were false positive and one case was false negative, as detailed in Table 3.

Table 3: Discordant cases — FNAC vs. Histopathology. *Case 4 represents the false negative.

#	FNAC Diagnosis	Histological Diagnosis	Reason for Discordance
1	Enchondroma	Giant Cell Reparative Granuloma	Sampling error — inability to target the lesion precisely
2	Small Cell Osteosarcoma	Ewing's Sarcoma	Osteoid not seen; minimal pleomorphism created diagnostic overlap
3	Non-specific Inflammation	Metastatic Adenocarcinoma	Sampling error; secondary reactive changes around prosthesis obscured tumour cells
4*	Chondromyxoid Fibroma	Giant Cell Tumour	Mononuclear spindle cells misinterpreted as stellate cells (false negative)

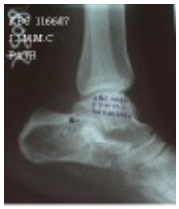
4.7 Non-diagnostic Cases

Four cases yielded non-diagnostic aspirates due to inadequate material, all attributed to sampling challenges. Repeat aspiration was attempted in three cases but also failed to yield sufficient material. Biopsy was subsequently performed in two of these patients.

Table 4: Statistical performance metrics for detection of malignant bone tumours

Metric	Value
Sensitivity	90.91%
Specificity	94.12%
Overall Diagnostic Efficacy	92.86%
Overall Diagnostic Accuracy	81.25%
Adequate aspirate rate	92.16%

CHONDROBLASTOMA



X-RAY RADIOLUCENT LESION- CALCANEOUS

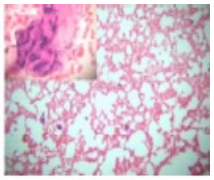
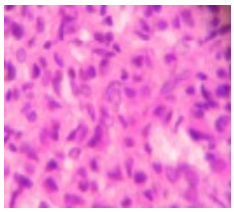
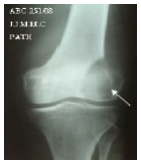


FIG 5 FNAC SCANT CELLULARITY WITH FIBROMYXOID MATRIX(4Xzoom) H&E

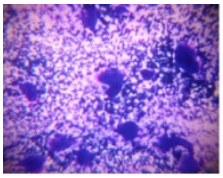


BIOPSY LOBULATED NUCLEI WITH CHONDROID MATRIX

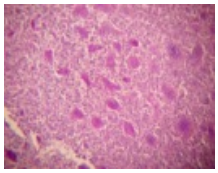
GIANT CELL TUMOUR



X-RAY OSTEOLYTIC LESION LOWER FEMUR



FNAC- OSTEOCLASTIC GIANT CELLS(4X) GEIMSA



BIOPSY-GIANT CELL TUMOUR(10X) H&E

OSTEOSARCOMA

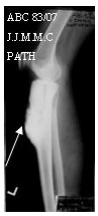


FIG 30 X-RAY .OSTEOBLASTIC LESION- UPPER TIBIA

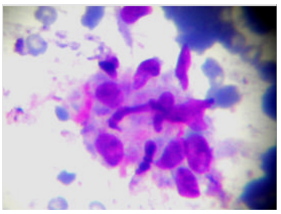


FIG 32 FNAC-PLEOMORPHIC OVOID CELLS WITH OSTEOID (40Xzoom) GIEMSA

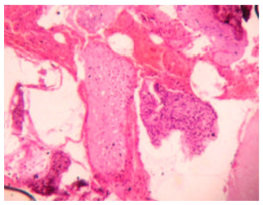


FIG 35 BIOPSY-PERIOSTEAL OSTEOSARCOMA(4Xzoom)H&E

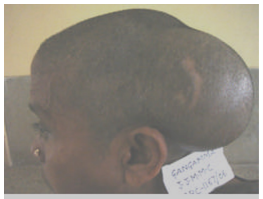


FIG 79 CLINICAL PICTURE-.OCCIPITAL SWELLING

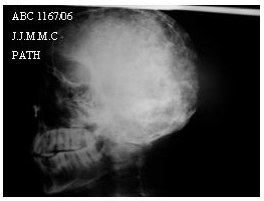


FIG 80.X-RAY=PUNCHED OUT LESION IN SKULL

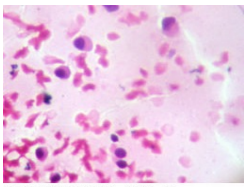


FIG 81.FNAC- PLASMA CELLS WITH ECCENTERIC NUCLEUS (10X zoom) H&E

FIG 66.X-RAY DIAPHYSEAL ECCENTERIC LYTIC LESION

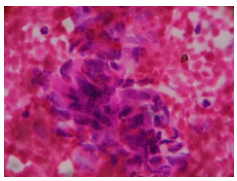
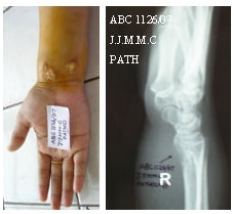


FIG 69.FNAC-NUCLEAR PLEOMORPHISM AND HYPERCHROMASIA(40X zoom),H&E



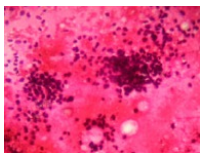


FIG 70.FNAC-MODERATE CELLULARITY,ROUND CELLS(10Xzoom)H&E

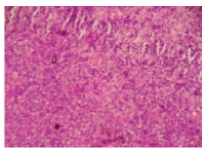
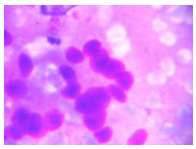


FIG 72.BIOPSY-SHEETS OF SMALL ROUND CELLS(10Xzoom)H&E



CHORDOMA

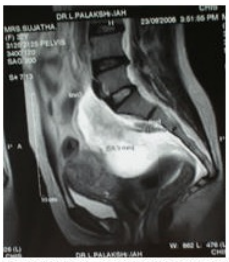


FIG 94.MRI-LYTIC DESTRUCTIVE SACRAL LESION WITH PRESACRAL MASS

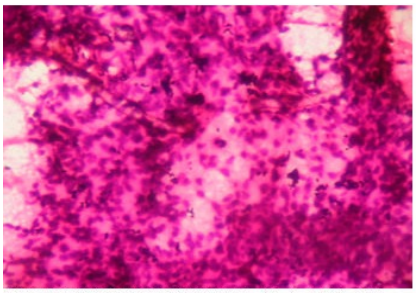


FIG 96.FNAC-HYPERCELLULAR SMEAR WITH EPITHELIAL AND VACUOLATED CELLS(10X zoom) H&E

METASTATIC CARCINOMA

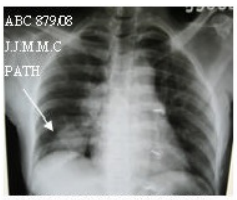
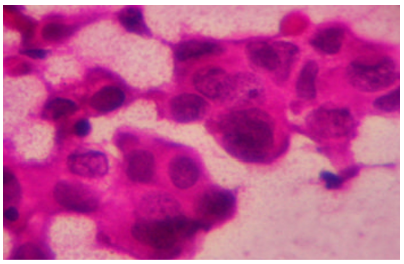
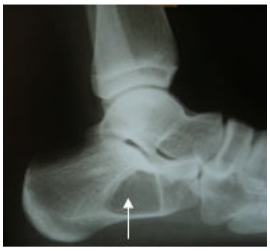


FIG 103.X-RAY-RT LOWER LOBE SHADOW

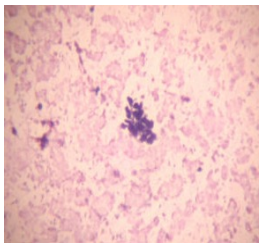


FNAC-PLEOMORPHIC CELLS WITH ABUNDANT CYTOPLASM-METASTATIC SCC (40X) H&E

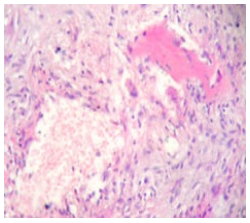
ANEURYSMAL BONE CYST



X-Ray osteolytic lesion

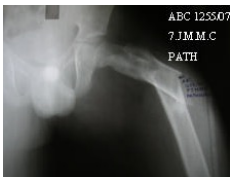


FNAC- Scant cellularity with hemorrhagic backgroud (4X) , H&E

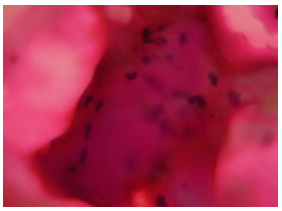


BIOPSY- Blood filled spaces immature bone , fibrous stroma(4X), H&E

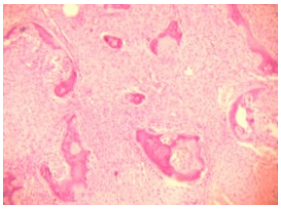
FIBROUS DYSPLASA



X-RAY- Fracture with diaphyseal ground glass appaeranace

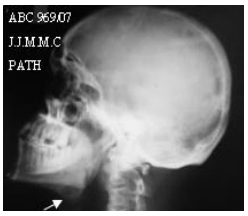


FNAC- Three dimensional bony fragments irregularly lined by osteoblasts

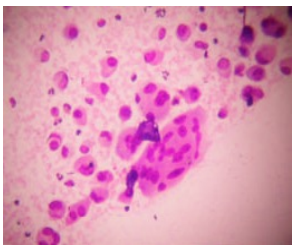


BIOPSY- Bony trabeculae with chinese chracters, spindle stroma(10X) H&E

Langerhan Cell histiocytosis

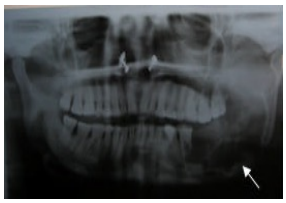


X-Ray- Osteolytic lesion -Mandible

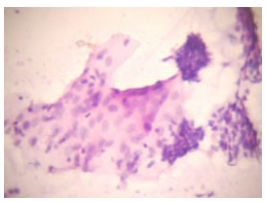


FNAC- Dispersed histiocytes, Multiple nuclei in histiocytes

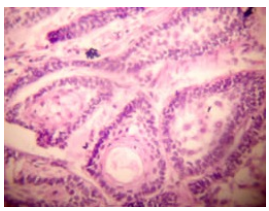
AMELOBLASTOMA



XRAY MULTILOCULATED LESION



FNAC_ Polygonal basaloid cells(10X) H&E



BIOPSY- Acanthomatous ameloblastoma

DISCUSSION

Giant Cell Tumour

Giant cell tumour (GCT) is reported to represent approximately 20% of benign primary bone tumours in published literature. In the present study, GCT accounted for 19.61% of all aspirated bone lesions and 76.9% of benign primary bone tumours (excluding jaw tumours), consistent with established epidemiological data.

The diagnostic accuracy of FNAC for GCT in our study was 100% (excluding inconclusive aspirates), which compares favourably with the reported literature range of 88–100%. The characteristic cytological picture of osteoclastic giant cells with mononuclear stromal cells against a haemorrhagic background facilitated confident diagnosis.

Osteosarcoma

Osteosarcoma constituted 17.65% of all bone tumours and 39.13% of primary malignant neoplasms in our series, reflecting its position as the most common primary malignant bone tumour in the young. The presence of osteoid in FNAC smears, a hallmark of osteosarcoma, was

demonstrable in 44.4% of our cases, which falls within the published range of 35–40%.

The diagnostic accuracy of FNAC for osteosarcoma in our study was 83.3%, comparable to figures reported in the literature. The main diagnostic challenge arises in the subclassification of osteosarcoma variants, particularly in distinguishing small cell osteosarcoma from Ewing's sarcoma — a distinction with significant therapeutic implications.

Ewing's Sarcoma

Two cases of Ewing's sarcoma were included in our study. Diagnostic accuracy was 100% in the confirmed case, though the limited case numbers preclude meaningful comparison with published data. The distinctive morphology of small round blue cells in a necrotic background, combined with clinical and radiological correlation, supported the diagnosis.

Metastatic Carcinoma

Metastatic carcinoma was the single most common malignant diagnosis in our series, accounting for 13.7% of all patients. This finding is consistent with the fact that secondary metastases represent the commonest form of malignant bone disease in adults. The reported diagnostic accuracy of FNAC for skeletal metastases ranges from 80–100%.

Tumour-like Lesions

Aneurysmal Bone Cyst (ABC):

Two cases of ABC were identified. The condition is more common in patients aged 10–20 years and typically involves the metaphyseal end of long bones. FNAC smears showed scant cellularity with a haemorrhagic background and scattered spindle cells (representing osteoblasts). The diagnosis rested heavily on clinico-radiological correlation, with FNAC providing supporting evidence.

Fibrous Dysplasia:

One case of fibrous dysplasia was included. Histopathological examination confirmed the cytological diagnosis. The characteristic FNAC finding is the presence of three-dimensional bony fragments irregularly lined by osteoblasts, set against a spindle cell stromal background.

Ameloblastoma:

Three cases of ameloblastoma were diagnosed, constituting 1% of jaw lesions as expected. FNAC demonstrated characteristic polygonal basaloid cells, enabling pre-operative diagnosis. Pre-operative cytological diagnosis of ameloblastoma is clinically important as it influences the choice and extent of surgical intervention, potentially reducing recurrence rates.

Langerhans Cell Histiocytosis (LCH):

Two cases of LCH were encountered — one with multifocal, multisystem involvement and one with unifocal unisystem disease. The age distribution of LCH is wide, ranging from infancy to the eighth decade; our patients were aged 16 and 40 years respectively. FNAC revealed dispersed histiocytes with characteristic grooved and multilobated nuclei. Histopathological confirmation was obtained in one case.

Sources of Diagnostic Error

The primary sources of error in our series were sampling inadequacy and morphological overlap between entities. Sampling errors were particularly problematic in sclerotic lesions, deeply situated tumours, and lesions adjacent to implants where secondary inflammatory changes obscured tumour morphology. Morphological overlap between small cell tumours (osteosarcoma vs. Ewing's sarcoma) represents an inherent limitation of cytological diagnosis that may require ancillary techniques for resolution.

CONCLUSION

This prospective study demonstrates that Fine Needle Aspiration Cytology is a valuable and reliable tool in the preliminary diagnosis of bone tumours. Contrary to the general perception that bone lesions are inaccessible to fine needle aspiration, our results confirm that the technique can yield adequate diagnostic material in the vast majority of cases (92.16%), provided appropriate case selection criteria are applied.

The overall diagnostic accuracy of 81.25%, with sensitivity of 90.91% and specificity of 94.12% for malignancy, supports the role of FNAC as an effective first-line diagnostic modality. FNAC can significantly reduce or eliminate the need for open surgical biopsy in a substantial number of patients, thereby lowering morbidity and enabling faster initiation of appropriate therapy.

A structured, multidisciplinary approach integrating clinical evaluation, radiological assessment, and cytomorphological analysis is essential for maximising diagnostic accuracy. In selected cases, simultaneous or sequential core needle biopsy and ancillary techniques — such as immunohistochemistry, flow cytometry, and molecular studies — can enhance specific diagnosis and tumour subtyping, particularly in the small round blue cell tumour category.

REFERENCES

1. Nielsen GP, Layfield LJ, Rosenberg AE. Neoplastic and tumour-like lesions of bone. In: Silverberg SG, DeLellis RA, Frable WJ, Livolsi VA, Wick MR, editors. Silverberg's Principles and Practice of Surgical Pathology and Cytopathology. 4th ed. Philadelphia: Churchill Livingstone; 2006. Vol 1. p. 701–87.
2. Kilpatrick SE, Renner JB, Creager A, editors. Diagnostic Musculoskeletal Surgical Pathology. 1st ed. Philadelphia: Saunders; 2004. p. 1–345.
3. Jorda M, Rey L, Hanly A, Azar PG. Fine needle aspiration cytology of bone. J Cancer Cytopathol. 2000;90:47–54.
4. Pai MR, Vasudev R, Naik R, Lugade M. Role of fine needle aspiration cytology in the diagnosis of bone tumours. J Cytol. 2002;19(1):33–9.

5. Maheshwari V, Khan L, Mehdi G, Sherwani KA, Prasad S. Cytomorphological diagnosis of bone tumours. J Cytol. 2005;22(2):69–72.
6. Akerman M. Bone. In: Orell SR, Sterett GF, Whitaker D, editors. Fine Needle Aspiration Cytology. 4th ed. Singapore: Churchill Livingstone; 2005. p. 433–44.
7. Rosenberg AE. Bones, joints, and soft tissue tumours. In: Kumar V, Abbas AK, Fausto N. Robbins and Cotran Pathologic Basis of Disease. 7th ed. Philadelphia: Saunders; 2004. p. 1273–1324.