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Original Research Article

THE CLINICO-PATHOLOGICAL EVALUATION OF BONE LESIONS: AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Bone lesions, encompassing benign, malignant and intermediate entities, present diagnostic challenges due to overlapping clinical and radiological features. As histopathology remains the diagnostic gold standard, this study evaluates the types of bone lesions and demographic associations. **Materials and Methods:** It is a retrospective study and was conducted in the department of pathology at a ESIC medical college and Hospital during January 2017 and December 2024. A total of 97 histopathological confirmed cases of appendicular skeletal bone lesions were retrieved from medical records were included in the study. Patient demographics, lesion type and histological diagnoses were recorded. Cases were classified according to WHO 2020 guidelines. **Result:** A total of 97 patients ranging from 3 to 75 years with maximum patients in the 21–30 years group (23.71%). The highest prevalence of malignant lesions (23.52%) was observed in 41–50 years age group, whereas 11–20 years age group had more benign lesions (36.58%), and 21–30 years age group had intermediate bone lesions (33.33%). Analysis of the data revealed benign lesions as the predominant (42.46%), followed by intermediate lesions (40.20%) and malignant lesions (17.52%). Bone lesions were comparatively more common in males (61.85%) than in females (38.14%) with an overall male to female ratio of 1.62: 1. The most common bone lesions are giant cell tumours (37%), osteochondroma (12%) and osteoid osteoma (10%), which commonly affected the phalanges (37.14%), femur (41.66%) and tibia (40%) respectively. The common site of bone lesions was found to be femur (25.77%) followed by phalanges (19.58%) and tibia (15.46%). **Conclusion:** Benign bone tumors are more common than intermediate and malignant types, with peak incidence in young adults. Histopathological analysis should be correlated with clinical and radiological findings for precise classification and effective treatment planning.

INTRODUCTION

Bone lesions constitute a heterogeneous group of disorders that may affect any part of the skeletal system and can arise in any component of bone, ranging from the cortical surface to the medullary cavity. These lesions may develop as localized or diffuse processes and can exhibit a wide spectrum of biological behaviour. A progressively enlarging bone lesion has the potential to destroy normal bone architecture, compromise mechanical strength, and predispose the affected bone to pathological fractures. Clinically, bone lesions may present abruptly or evolve gradually as a slow-growing mass, and they may be encountered across all age groups, including children, adults, and the elderly population.[1]

From a pathological standpoint, bone lesions pose a significant diagnostic challenge to histopathologists due to their diverse aetiologies and overlapping morphological features. Pathological bone lesions may manifest as inflammatory, infective, benign neoplastic, intermediate, or frankly malignant conditions.[2] These lesions demonstrate considerable variation in their clinical presentation, radiological appearance, histomorphology, and biological behaviour, ranging from indolent benign entities to highly aggressive malignancies.[3] Due to the varied histopathological spectrum and overlapping features, an accurate diagnosis is essential, for appropriate management and avoid adverse patient outcomes.

An integrated and structured diagnostic approach that correlates clinical findings, radiological

features, and histopathological characteristics is crucial in the evaluation of bone tumors. Such an approach not only enhances diagnostic accuracy but also facilitates effective communication and collaboration among pathologists, radiologists, and treating clinicians. Precise diagnosis, appropriate tumour staging, and timely institution of suitable treatment modalities are fundamental to improving patient survival, preserving limb function, and maintaining overall quality of life.[4]

Demographic factors play a pivotal role in the distribution and prevalence of bone tumours. Age is a major risk determinant, with specific tumours showing predilection for age groups. Similarly, gender-related differences are observed, with certain bone tumours occurring more frequently in males than females.[5] Bone tumours predominantly occur between the first and fourth decades of life and can have a potentially devastating impact on the affected population, particularly due to their occurrence during the most productive years of life.[6] The age distribution of bone tumours typically follows a bimodal pattern, with one peak observed during adolescence and a second peak in individuals over 60 years of age.[7]

In terms of biological behaviour, benign bone tumours significantly outnumber malignant tumours. The anatomical distribution of bone lesions also shows considerable variation. In a large series comprising 566 patients with bone tumours, the femur was identified as the most involved site (39.9%), followed by the tibia (17.7%) and the humerus (11.8%). In contrast, involvement of flat bones such as the scapula was relatively rare, accounting for only 1.6% of cases.[8] These findings underscore the importance of site-specific considerations in the diagnostic evaluation of bone lesions.

The present study focuses on the clinicopathological evaluation of bone lesions received in the histopathology section, with an emphasis on correlating clinical presentation, radiological findings, and histomorphological features. The present study aims to contribute to a better understanding of the spectrum of bone lesions encountered in routine diagnostic practice and to reinforce the importance of a multidisciplinary approach in achieving accurate diagnosis and optimal patient management.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective descriptive study conducted in the Department of Pathology, ESIC Medical College and Hospital, Hyderabad. The study involved a systematic review of histopathologically confirmed bone lesions of appendicular skeletal system, received during an eight-year period from January 2017 to December 2024.

Study Population

All patients diagnosed with bone lesions of the appendicular skeletal system and having complete medical records during the study period were considered eligible for inclusion. A total of 97 cases were included in the final analysis. Patients of all age groups and both genders were included to ensure comprehensive demographic representation.

Inclusion Criteria

- Histopathologically confirmed bone lesions
- Lesions involving the appendicular skeleton
- Availability of complete clinical and pathological records
- Patients of all age groups and both sexes

Exclusion Criteria

- Odontogenic bone tumours
- Infective bone lesions
- Inflammatory bone diseases
- Cases with incomplete medical records

Data Collection

Relevant clinical and pathological data were retrieved from the Medical Records Department. The parameters collected included patient age, gender, anatomical location of the tumour, and histopathological diagnosis. Histopathology slides were reviewed to confirm the diagnosis and classification of each lesion.

Histopathological Classification

All bone tumors were classified according to the World Health Organization (WHO) classification of bone tumors. Classification was based on histomorphological features observed in routinely processed haematoxylin and eosin–stained sections.

Data Analysis

The collected data were compiled and analyzed using descriptive statistical methods. Results were expressed in terms of frequencies and percentages to evaluate the distribution of bone lesions with respect to age, gender, tumour location, and histological type. Data analysis was performed manually.

RESULTS

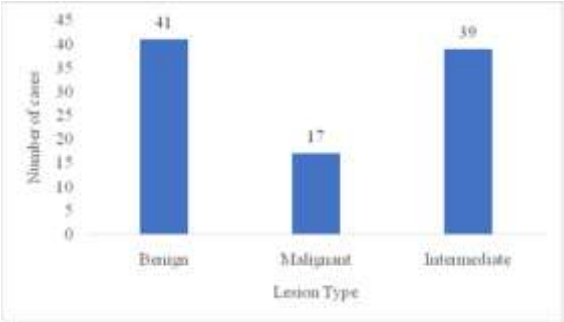

Figure 1: Study participants according to the type of lesions

A total of 97 cases of bone lesions were recorded in the period of January 2017 to December 2024which on histopathological diagnosis revealed 41(42.26%) cases of benign lesions followed by intermediate 39

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(40.20%) and malignant cases 17 (17.52%) (Figure 1).

Table 1: Assessment of histology in relation to gender

Category	Tumour Type	Male (%)	Female (%)	Total (%)
Malignant	Ewing's Sarcoma (ES)	0(0)	1(100)	1(1.03)
	Osteosarcoma (OS)	3(60)	2(40)	5(5.14)
	Chondrosarcoma (CS)	5(83.33)	1(16.67)	6(6.18)
	Metastatic Adenocarcinoma (MS)	2(100)	0(0)	2(2.06)
	Plasma Cell Neoplasm (PCN)	1(100)	0(0)	1(1.03)
	Anaplastic Large Cell Lymphoma (LCL)	1(100)	0(0)	1(1.03)
	Chordoma (CM)	0(0)	1(100)	1(1.03)
Benign	Osteochondroma (OC)	9(75)	3(25)	12(12.37)
	Osteoid Osteoma (OSM)	7(70)	3(30)	10(10.30)
	Enchondroma (ENC)	2(100)	0(0)	2(2.06)
	Chondromyxoid Fibroma (CMF)	1(50)	1(50)	2(2.06)
	Fibroma of Tendon Sheath (FTS)	1(0)	2(100)	3(3.09)
	Differentiated Adamantinoma (ADM)	1(100)	0(0)	1(1.03)
	Fibrous Dysplasia (FD)	5(71.42)	2(28.58)	7(7.21)
	Simple Bone Cyst (SBC)	1(33.33)	2(66.66)	3(3.09)
	Aneurysmal bone cyst (ABC)	0(0)	1(100)	1(1.03)
Intermediate	Giant Cell Tumour (GCT)	20 (55.55)	16(45.71)	37(37.11)
	LiposclerosingMyxofibrous Tumour (LMF)	1(100)	0(0)	1(1.03)
	Fibrous Histiocytoma (FHC)	0(0)	1(100)	1(1.03)
	Non Ossifying Fibroma	0(0)	1(100)	1(1.03)
	Total	**60(61.85)**	**37(38.14)**	**97(100)**

Bone lesions were comparatively more common in males (61.85%) than in females (38.14%) with an overall male to female ratio of 1.62: 1. Of the forty-one benign lesions, there were 27 males and 14 females. Among 39 intermediate lesions, 21 were males and 18 were females while twelve malignant lesions were recorded in males and four in females. Metastatic adenocarcinoma, plasma cell neoplasm, anaplastic large cell lymphoma, enchondroma, differentiated adamantinoma, pigmented villonodular synovitis, liposclerosingmyxofibrous tumour observed exclusively in males (100%) whereas Ewing's sarcoma, Chordoma, aneurysmal bone cyst, fibrous histiocytoma, peripheral ossifying fibroma are found only in females (100%). Notably, chondromyxoid fibroma was observed equally in both males and females (50%) (Table 1).

Table 2: Prevalence of bone lesions among various age groups

Tumour Type	Age (Years)								Total
	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71+	
Malignant									
ES	1	0	0	0	0	0	0	0	1
OS	1	3	0	1	0	0	0	0	5
CS	0	0	0	0	4	1	1	0	6
MS	0	0	0	0	0	0		2	2
PCN	0	0	0	0	0	1	0	0	1
LCL	1	0	0	0	0	0	0	0	1
CM	0	0	0	0	0	1	0	0	1
Total	3	3	0	1	4	3	1	2	17
Benign									
OC	1	6	1	1	2	0	0	1	12
OSM	1	3	3	1	1	0	0	1	10
ENC	0	0	2	0	0	0	0	0	2
CMF	0	0	1	1	0	0	0	0	2
FTS	0	0	1	1	0	1	0	0	3
ADM	0	1	0	0	0	0	0	0	1
FD	0	5	1	1	0	0	0	0	7
SBC	0	0	1	0	0	2	0	0	3
ABC	0	0	0	0	0	0	1	0	1
Total	2	15	10	5	3	3	1	2	41
Intermediate									

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GCT	0	3	11	9	9	3	1	0	35
LMF	0	0	0	0	0	1	0	0	1
FHC	0	0	1	0	0	0	0	0	1
NOF	0	0	1	0	0	0	0	0	1
Total	0	3	13	9	9	4	1	0	39
Grand Total	5	21	23	15	16	10	3	4	97

ES=Ewing's Sarcoma, OS=Osteosarcoma, CS=Chondrosarcoma, MS=Metastatic Adenocarcinoma, PCN=Plasma Cell Neoplasm, LCL=Anaplastic Large Cell Lymphoma, CM= Chordoma, OC=Osteochondroma, OSM= Osteoid Osteoma, ENC=Enchondroma, CMF=Chondromyxoid Fibroma, FTS= Fibroma of Tendon Sheath, ADM= Differentiated Adamantinoma, ABC=Aneurysmal bone cyst,GCT=Giant Cell Tumour, FD= Fibrous Dysplasia ,SBC=Simple Bone Cyst, LMF= Liposclerosing Myxofibrous Tumour, FHC=Fibrous Histiocytoma, NOF = Non Ossifying Fibroma,

The frequency of bone lesions in different age groups is explained in Table 2. Patients were aged between 3 to 75 years with a mean age of 32.41 years. Majority of cases were observed in 21 - 30 years of age. The highest number of malignant lesions occurred in the 41-50 years age group, accounting for 4 cases (23.52%). Age groups<10 years,11-20 and 51-60 years showed three cases each (17.64%). The lowest cases were observed in individuals of age groups 31-40 and 61-70 years with zero cases in 21-30 years age group. Most of the benign lesions are found between 11–20 years age group (36.58%), followed by 21–30 years age group (24.39%) while the age group between 61 and 70 years showed the lowest cases (2.4%). The most common age group for intermediate bone lesions was 21–30 years (33.33%). Age groups 31-40 and 41-50 years showed nine cases each (23.07%). No cases were found above 71 years and <10 years of age. The most common malignant lesions in this study were chondrosarcoma 6(6.18%) and osteosarcoma 5(5.14%) while osteochondroma 12 (12.37%) and osteoid osteoma 10 (10.30%) were the most common benign instances. Among the recorded intermediate lesions Giant Cell Tumour (GCT) accounts for maximum 37(37.11%).

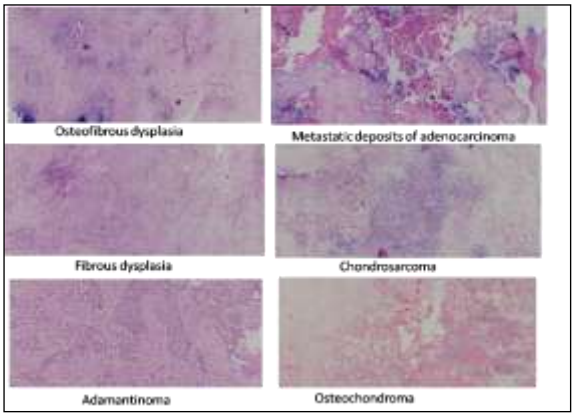

Figure 1: Representative Histopathological Spectrum of Benign and Malignant Bone Lesions (H&E Stain)

Table 3: Type of bone lesion and its frequency in the affected bone

Affected Bone	Malignant	Benign	Intermediate
Femur	9	8	8
Fibula	0	1	1
Tibia	2	11	2
Humerus	1	1	3
Radius	1	2	2
Ulna	0	2	0
Ileum	2	0	0
Knee	0	1	2
Sacrum	1	0	0
Phalanges	0	6	13
Ankle	0	2	0
Others	1	7	8
Total	17	41	39

In our study, the common site of bone lesions was found to be femur25 cases (25.77%) followed by phalanges 19 cases (19.58%) and tibia 15 cases (15.46%). The most commonly affected bone in both benign and malignant lesions was femur (52.94%, 19.51%). The most damaged bone in intermediate tumours is phalanges (33.33%) followed by femur (20.51%). The site wise distribution is shown in Table 3.

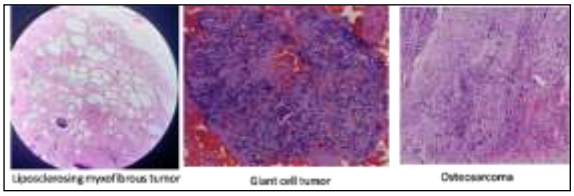

Figure 2: Histopathological Appearance of Common Primary Bone Neoplasms

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Table 4: Most frequent bone tumours and their frequency in affected bones

Affected Bone	Type of Tumour		
	Osteoid Osteoma (OSM) (%)	Osteochondroma (OC) (%)	Giant cell tumour (GCT) (%)
Femur	1(10)	5(41.66)	8 (22.85)
Fibula	0(0)	0(0)	1(2.85)
Tibia	4(40)	1(8.33)	2(5.71)
Humerus	0(0)	1(8.33)	0 (0)
Radius	2 (20)	0(0)	2 (5.71)
Ileum	0(0)	0(0)	0(0)
Ulna	0(0)	1(8.33)	0(0)
Knee	0 (0)	0(0)	1 (2.85)
Sacrum	0(0)	0(0)	0 (0)
Phalanges	1 (10)	0 (0)	13(37.14)
Ankle	0(0)	2(16.66)	0(0)
Others	2(20)	2(16.66)	7 (20)
Total	10	12	35

Table 4 shows that, Giant cell tumour is the most frequent bone lesion often affecting phalanges 13(37.14%) followed by femur 8 (22.85%). Results also show that, the areas where GCT has no effect are the humerus, ileum, ulna, sacrum, and ankle. The other two most common bone lesions are osteochondroma and osteoid osteoma frequently affecting the femur (41.66%, 45.45%). Whereas, the areas where no effect was observed were the sacrum, ilium and fibula.

DISCUSSION

This retrospective study evaluated the clinicopathological spectrum of 97 bone lesions, highlighting the predominance, demographic correlations and affected site. In the current study, the most common lesions were benign (42.46%), followed by intermediate and malignant lesions. A study by Gururaj prasad et al. on histological examinations of tumours in bones and joints supported our findings by demonstrating that benign lesions were more prevalent.[9]

The 21–30-year age group had the highest incidence of bone lesions (23%). Osteosarcomas and chondrosarcoma are the most common malignant bone tumours typically affecting people between the ages of 9 and 19 years for osteosarcoma and 18 and 58 years for chondrosarcoma.[10] In the present study we observed 11-20 years and 41-50 years are the most affected age range for osteosarcoma and chondrosarcoma with an overall 41-50years age range as frequently affecting age for malignant lesions.

Osteochondroma most commonly present in the first four decades of life and almost 75% of these lesions are present before the age of 20 years.[11,12] The peak age of incidence of osteochondroma was 16-20 years followed by 11-15 years.[13] The frequency of osteoid osteoma is highest in the second decade of life and is more common in people aged 5 to 30 years.[14] It is also estimated that 70% of osteoid osteomas occur in people under the age of 20 years.[15,16] The occurrence of benign bone tumours varies depending on the type. However, they commonly arise in people less than 30 years old.[17] Similar results were obtained in our study.

Our study shows that GCT is more common between the age groups of 21-50 years. Although in second to fourth generations, elderly patients have also been known to have GCT.[18] Giant-cell tumour (GCT) can develop in the phalanx of a finger. This often affects adults between the ages of 30 and 50years.[19]

Our study showed a male predominance of 61.85%, which is in line with the findings of Ragini et al.[20] Similar results were reported by Jayanthi and Niranjan Gowda while studying tumour and tumour like lesions of the bone.[21] The study conducted by Rhutso et al. on the histological assessment of bone cancers revealed a male preponderance.[22] However, certain tumours like Ewing's sarcoma, chordoma, aneurysmal bone cyst, fibrous histiocytoma and peripheral ossifying fibroma showed female exclusivity whereas metastatic adenocarcinoma, plasma cell neoplasm, anaplastic large cell lymphoma, enchondroma, differentiated adamantinoma, pigmented villonodular synovitis and liposclerosing myxofibrous tumour suggesting hormonal or genetic influences.

In our study femur (25.77%) was the most often impacted bones, which is consistent with the results of Kethi reddy et al.[23] Histological examination of neoplastic and non-neoplastic bone lesions by Megha et al. showed highest femoral involvement, which is consistent with our findings.[24] Studies on clinical evaluations of diaphysis malignant tumours of femur and tibia by Yu et al., showed that femur was the most frequently involved skeletal site followed by the tibia.[25] Malignant bone tumours were mainly seen in the femur, tibia and ileum which lines up with reports in the literature[26] We found in this study that, femur was the most commonly affected bone in malignant tumour while tibia was the most common bone involved in the benign bone tumour which conforms with the results of previous studies.[27,28]

In our study, Giant cell tumour (37%) was the most frequent benign lesion, followed by osteochondroma (12%) and osteoid osteoma (10%). A benign osteoblastic tumour, osteoid osteoma accounts for

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12% of all benign bone tumours.[29] Our study shows that approximately 11% of benign lesions is accounted by osteoid osteoma with tibia being the most affected site in the lower extremities and radius being the most impacted site in the upper extremities. Osteoid Osteomas are more common in the lower extremities than the upper extremities. The lower extremities, particularly the femur and tibia, are where more than half of osteoid osteomas develop. The most frequently affected location in the upper extremities is the humerus, followed by the ulna and radius.[30] Osteochondromas are situated at the metaphysis and grow away from the joints. Long bones are the preferred site, particularly distal femur 30%, proximal tibia 15-20%, and humerus 10-20%, followed by feet and hands 10%.[31] In the current study second most frequent bone tumours is osteochondroma (12%) primarily affecting femur. More rapid growth and a higher recurrence rate are observed in GCT in the hand region compared with conventional types.[32] The most common location of giant cell tumours in this study was the phalanges, which is comparable to the findings of Asuman Kilitci.[33]

Limitation of study: The present study being a retrospective study radiological images were not possible to retrieve.

CONCLUSION

The study demonstrates that, benign bone tumours predominate, most commom being Giant cell tumour, osteochondroma and osteoid osteoma. Along with uncommon tumors like liposclerosing myxofibrous tumor. Phalanges, femur and tibia are the most common affected site. Majority of cases occur in patients under 30 years of age, underscoring the need for early evaluation of bone-related symptoms in this population. Histopathological examination remains the definitive diagnostic tool and should be integrated with radiological and clinical assessments for accurate categorization and effective management.

Declarations
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