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Pre-operative Imaging Evaluation of Bone Tumours with Histopathological Correlation

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Abstract

Context: This ongoing study was performed on Seventy suspicious bone tumor patients, who had radiological examinations. A standard approach to the radiographic examination, clinical history, and histopathology is required for an appropriate diagnosis in order to overcome the challenges offered to the surgical pathologist when diagnosing a bone tumor

Aims: The main aim of this study was to find out the correlation between pre-operative imaging of bone tumors with histopathological lesions for better diagnosis of bone tumors.

Settings and Design: This is a prospective study conducted at the Department of Radiodiagnosis, Kakatiya Medical college / MGM, Warangal, with patients presented with swelling and pain from the Orthopaedics Department referred to the Department of Radio-Diagnosis.

Methods and Material: Conventional radiographs, MDCTs, and MRIs were performed to evaluate patients, then the Results were categorized as benign or malignant bone tumors, whenever possible by comparing them to histopathological findings. Histopathological testing was performed on the tissues from the afflicted regions.

Results: Results revealed that the majority of the cases, i.e., 44.28% belonged to the age group of 20-40 years, with male predominance (61.42%) observed as compared to females (38.57%). According to the majority of instances, i.e., 75.71% of cases, benign-type tumors were observed as compared to malignant-type (24.28%) tumours. Osteochondroma type of tumours was found to be in the majority, i.e., 17.14% among benign tumours, followed by giant cell tumour (14.28%), osteoid osteoma (11.42%), and giant cell tumour (14.28%). Among malignant tumours, metastasis types of tumors were found to be in the majority, i.e., 8.57%, followed by osteosarcoma (5.71%) and Ewing's sarcoma & multiple myeloma (4.28%), and chondrosarcoma (1.42%). The radiological findings correlated with histopathological findings with a statistical significance i.e., $p<0.001$, and Only Fifteen out of seventy cases of the association of bone tumours based on radiological and histopathological results were inaccurate.

Conclusions: Radiology accurately identifies the type of lesion even if it may not identify the specific histopathological variants of the bone tumour. This reinforces the use of imaging techniques to evaluate focal bone lesions. However, findings of the wrong diagnosis may be taken into consideration by clinicians, and the requisition of bone biopsy must be considered whenever available.

Keywords: Radiology, Histopathology, Osteochondroma, Osteosarcoma, Ewing's sarcoma

Introduction

Bone is an energetic heterogeneous tissue that is essential for structural support and is important for maintaining the minerals homeostasis and hematopoiesis. In addition to protecting viscera and determining the features of body size and shape, bones and joints function together to give mechanical support for movement.[1] Bone tumours are caused by either abnormal growth of bone-like tissue or soft tissue in the bones. Tumours are classified into benign or malignant and primary or secondary. Globally malignant bony lesions have two age incidences (between 10-20 years and 40-80 years). They also have gender predilection, with the incidence in males 1.5% more than in females.[2]

Bone tumors are comparatively rare, accounting for just 0.5% of total cancer rates worldwide.[3] Their true incidence is difficult to estimate because of their rarity.[4] Osteosarcoma, chondrosarcoma, and Ewing sarcoma/primitive neuroectodermal tumor are the common bone sarcomas, as per Western data, with rare tumours such as fibrosarcomas, chordomas, and undifferentiated pleomorphic sarcoma constituting as the remaining subtypes. Bone sarcomas constitute the third most common cause of mortality in adolescents. Remarkable achievements with multimodality management of these tumours have led to an increase in their 5-year survival rates, from approximately 50% in the year 1970 to the range of 75–80%, presently, in the adolescent age group.[5]

Bone lesions are generally variety of types, often rare, and can be either harmless or suddenly destructive. It is crucial to properly diagnosis, stage, and treat bone tumours and tumour-like lesions due of such diversity.[3] In addition to secondary tumours, the structural complexity of bones can result in primary malignant tumours with various histogenesis.[6] From inflammatory to neoplastic disorders, the pathological bone lesions may range.[7] Osteomyelitis is an example of a benign disorder that can imitate a malignant tumor, while myeloma is an example of a malignant condition that can mimic a benign tumor. This makes it difficult to determine whether a bone lesion is benign or malignant using imaging to get a radiological diagnosis.[8] Understanding the range of bone lesions and studying about the various bone tumors that are prevalent in the population requires histopathological examination.[9] A standard approach to the radiographic examination, clinical history, and histopathology is required for an appropriate diagnosis in order to overcome the challenges offered to the surgical pathologist when diagnosing a bone tumor.[10]

With this context, the current prospective study was designed to conduct with the main purpose to assess the correlation between pre-operative imaging of bone tumors with histopathological lesions for better diagnosis of bone tumors.

Subjects and Methods:

This is a prospective study conducted at the Department of Radiodiagnosis, Kakatiya Medical college / MGM, Warangal, with patients presented with swelling and pain from the Orthopaedics Department referred to the Department of Radio-Diagnosis.

Ethical approval

Ethical clearance was obtained from the institutional ethics committee, Kakatiya Medical College / MGM Hospital, Warangal, before the commencement of the study.

Participants

A total of 70 cases of suspected bone tumours who have undergone radiological investigations in the Department of Radio-Diagnosis were included. Patients who presented with swelling and pain due to infective/traumatic etiology were excluded from the study. Patients who fulfilled the selection criteria were informed about the nature and purpose of the study and were enrolled after obtaining written informed consent. Pregnant women and patients not willing to participate in the study were excluded from the study. The patients who presented with pain and swelling to the orthopaedics department were sent to Radiology Department for further evaluation of suspected bone tumours to confirm the diagnosis. Patients' demography was recorded in a pre-defined proforma. A detailed history and laboratory parameters were noted.

Imaging

Conventional radiographs, MDCTs, and MRIs were performed to evaluate patients, then the Results were categorized as benign or malignant bone tumors,

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whenever possible by comparing them to histopathological findings.

Histopathology

Sensitive tissues were routinely treated in 10% neutral buffered formalin before being examined by paraffin division for light microscopy. The large bone portions were divided into smaller pieces i.e., (2–6 mm), and fixed in 10% neutral buffered formalin, then cleaned prior being treated to decalcification. The tissue was placed in a 5% nitric acid decalcification solution until it softened, and then further which was collected for processing. As thus, generated sections were stained with hematoxylin and eosin before being inspected and captured on camera with a light microscope.[11]

Results:

The majority of the cases, i.e., 44.28% belonged age group of 20-40 years, followed by 37.14%, 11.42% and 7.14% of cases belonged to the age group of <20, 40-60, and 60-80 yrs. of age. Male predominance (61.42%) was observed compared to females (38.57%). In the majority of cases, i.e., 75.71% of cases, benign type tumours were observed as compared to malignant type (24.28%) tumours (Table 1).

Table 1: Distribution of cases based on demographic characteristics

Variables	Frequency	Percentage (%)
Age-wise distribution (Years)		
<20	26	37.14
20 - 40	31	44.28
40 - 60	8	11.42
60 - 80	5	7.14
Gender wise distribution		
Male	43	61.42
Female	27	38.57
Distribution based on nature of tumours		
Benign	53	75.71
Malignant	17	24.28

The findings of the distribution of tumours based on radiological imaging are represented in Table 2 and Figures 1-3. These findings delineated that osteochondroma type of tumours was found to be in the majority, i.e., 17.14% among benign tumours, followed by giant cell tumour (14.28%) and osteoid osteoma (11.42%). Whereas among malignant tumours, metastasis type of tumours was found to be in the majority, i.e., 8.57%, followed by osteosarcoma (5.71%), and Ewing's sarcoma & multiple myeloma (4.28%), and chondrosarcoma (1.42%).

Table 2: Distribution of tumours based on radiological imaging

Nature of Tumours	Type	Frequency	Percentage (%)
Benign	Osteoma	2	2.85

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	Osteoid osteoma	8	11.42
	Enchondroma	5	7.14
	Osteochondroma	12	17.14
	Simple bone cyst	6	8.57
	Aneurysmal bone	5	7.14
	Fibrous dysplasia	5	7.14
	Giant cell tumour	10	14.28
Malignant	Osteosarcoma	4	5.71
	Chondrosarcoma	1	1.42
	Ewing's sarcoma	3	4.28
	Multiple myeloma	3	4.28
	Metastasis	6	8.57

The findings of the distribution of tumours based on histopathological findings are represented in Table 3 and Figures 4-6. These findings depicted that osteochondroma type of tumours was found to be in the majority, i.e., 28.57% among benign tumours, followed by giant cell tumour (17.148%) and simple bone cyst (10.00%). Whereas among malignant tumours, metastasis type of tumours was found to be in the majority, i.e., 8.57%, followed by osteosarcoma (5.71%), and Ewing's sarcoma & multiple myeloma (4.28%), and chondrosarcoma (1.42%).

Table 3: Distribution of tumours based on histopathological findings

Nature of Tumours	Type	Frequency	Percentage (%)
Benign	Osteoma	1	1.42
	Osteoid osteoma	2	2.85
	Enchondroma	4	5.71
	Osteochondroma	20	28.57
	Simple bone cyst	7	10.00
	Aneurysmal bone	4	5.71
	Fibrous dysplasia	3	4.28
	Giant cell tumour	12	17.14
Malignant	Osteosarcoma	4	5.71
	Chondrosarcoma	1	1.42
	Ewing's sarcoma	3	4.28
	Multiple myeloma	3	4.28
	Metastasis	6	8.57

The correlation of bone tumours based on radiological and histopathological findings was mismatched for only 15 cases out of 70 cases. Out of those 15 mismatched diagnoses, the majority of the cases belong to the osteochondroma variety, wherein six were misdiagnosed as osteoid osteomas, one osteoma and one

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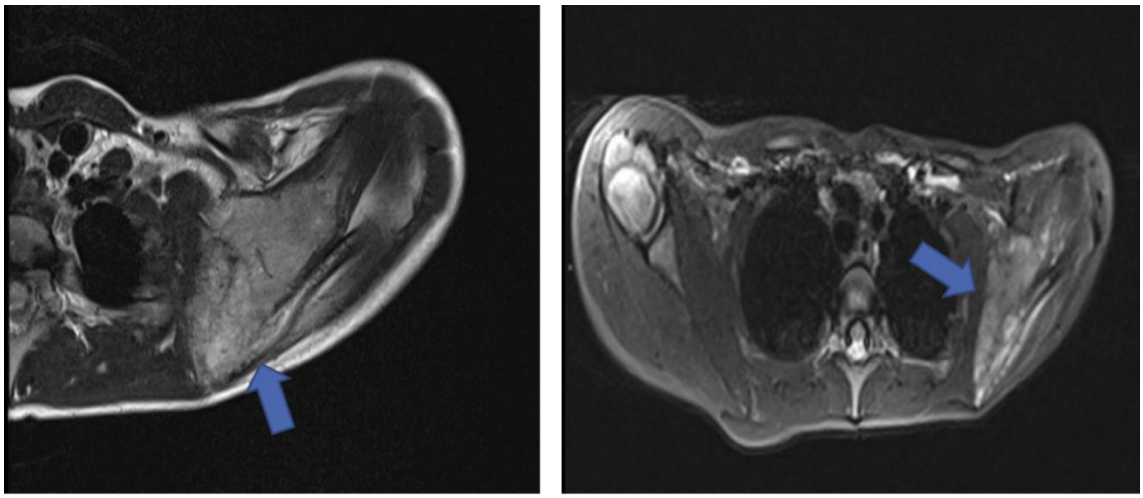
enchondroma (Table 4 and Figure 1-6). Hence, the radiological findings were correlating with histopathological findings with a statistical significance ($p<0.001$).

Table 4: Showing diagnosis based on histopathological and radiological findings

Type	Radiological imaging	Histopathological finding	Wrong diagnosis
Osteoma	2	1	1 (Osteochondroma)
Osteoid osteoma	8	2	6 (Osteochondroma)
Enchondroma	5	4	1 (Osteochondroma)
Osteochondroma	12	12	0
Simple bone cyst	6	6	0
Aneurysmal bone cyst	5	4	1 (GCT)
Fibrous dysplasia	5	3	2 (GCT, SBC)
Giant cell tumour	10	10	0
Osteosarcoma	4	3	1 (Ewing's sarcoma)
Chondrosarcoma	1	1	0
Ewing's sarcoma	3	2	1 (Osteosarcoma)
Multiple myeloma	3	2	1 (Metastasis)
Metastasis	6	5	1 (Multiple myeloma)
$X^2=616.80$, df (187), $p<0.001$.			

Figure 1: MRI image showing Ewing's sarcoma



MRI: The abnormality at the left scapula is confirmed and clearly seen as a large soft tissue mass arising from the scapula and extending posteriorly between the scapular spine and the coracoid suggestive of likely EWINGS SARCOMA.

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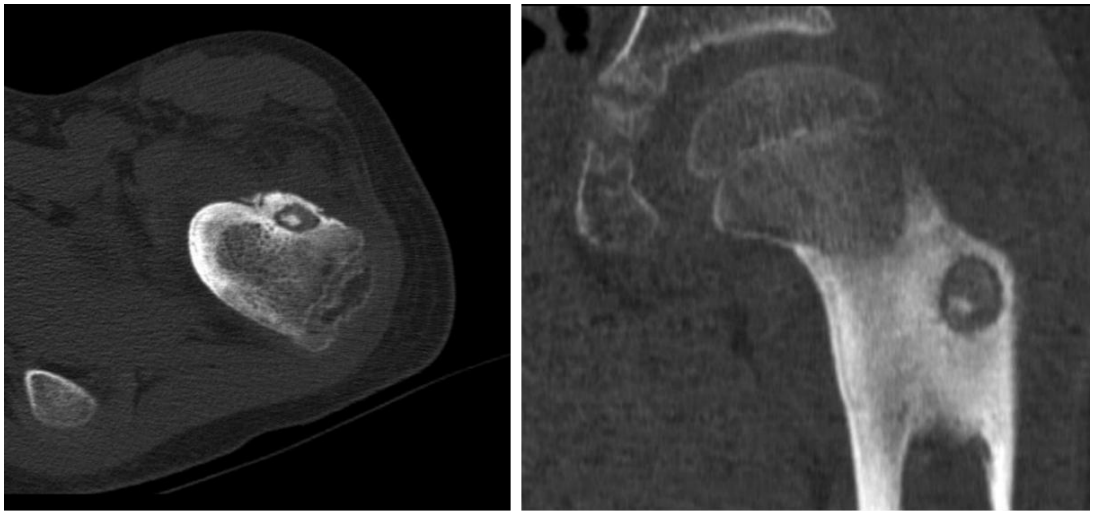
Figure 2: X-ray image showing fibrous dysplasia

Radiograph of left knee shows Diffuse bubble sclerotic and ground glass change involving the proximal and mid-tibial diaphysis with expansion of the medullary cavity s/o **Fibrous Dysplasia**

Figure 3: X-ray image showing osteoid osteoma



Lesion and sclerosis are confirmed on CT which demonstrates a sharply demarcated oval lesion, with a central focus of sclerosis s/o **Osteoid osteoma**

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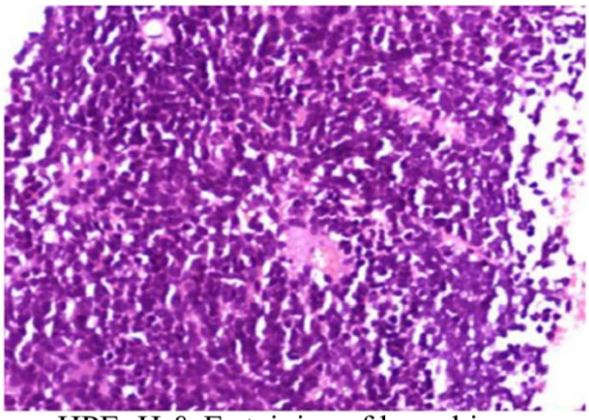
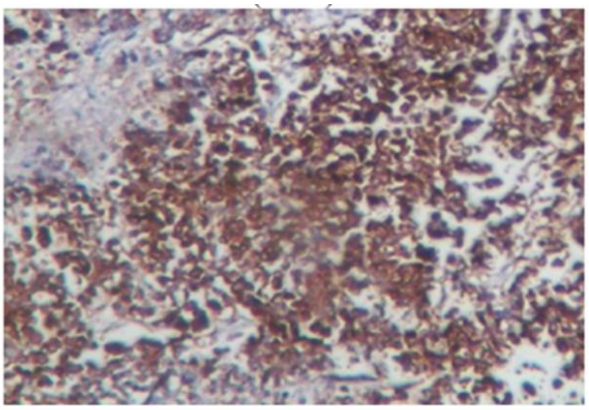
Figure 4: Histopathology lesions of Ewing's sarcoma

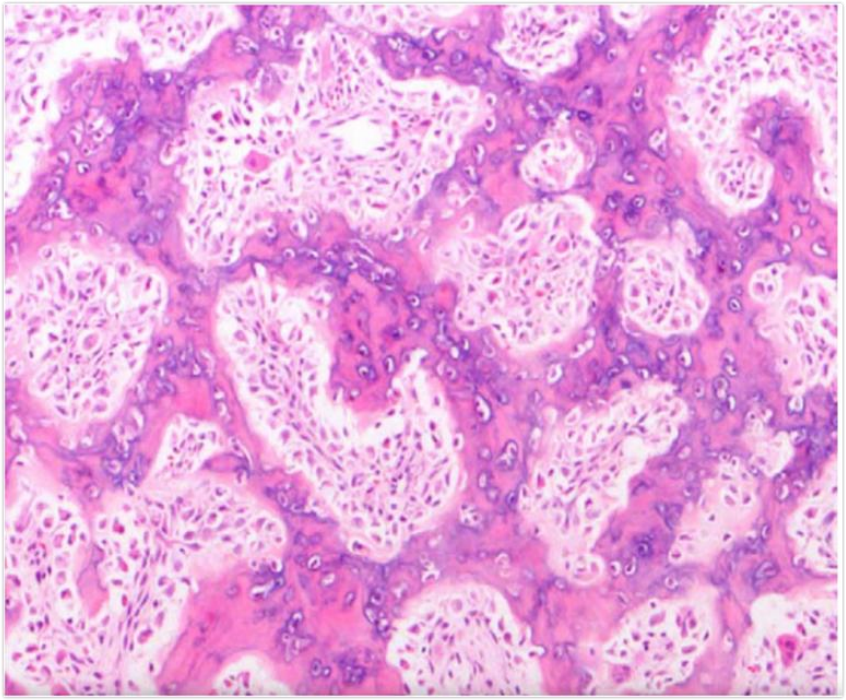


HPE: H & E staining of bone biopsy specimen showing small round tumorigenic cells (100x)



CD 99 stained bone biopsy specimen showing CD 99 positivity for tumour cells, confirming the diagnosis

Figure 6: Histopathology lesions of osteoid osteoma



HPE - Small, circumscribed anastomosing, irregular trabeculae or solid, sclerotic nidus of woven bone with variable mineralization rimmed by single layer of osteoblasts plus frequent osteoclasts, confirming **Osteoid Osteoma**

Discussion:

Bone tumours are one of the most complicated cases to study histologically and also, they are comparatively uncommon. The clinical characteristics and pathologic properties of primary benign as well as malignant bone tumours differ significantly.[10,12] The most common reason for differences between the first diagnosis determined on clinic-radiological assessment and the final histological diagnosis is the low occurrence of these tumours and lack of experience in non-specialized centres.[13] The behaviour and histopathologic type of a bone tumour can be determined via a biopsy, and which is crucial for describing the features of bone tumours. However, it is difficult to determine the exact incidence of bone lesions because the majority of them are not biopsied.[14] Hence, in the present

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study, we aimed to find a correlation between pre-operative imaging of bone tumours with histopathological lesions for better diagnosis of bone tumours.

According to our research, the vast majority of incidences, i.e., 44.28%, belonged to the age group of 20-40 years, with male predominance (61.42%) observed as compared to females (38.57%). These findings were in accordance with the findings of Nayar et al.[15] The vast majority of cases in the present research that is, 75.71% of cases, benign type tumours were observed as compared to malignant type (24.28%) tumours. These results were close to those reported in the literature, where the findings by Chitale AR, Jambhekar NA, and Nayar M et al. were 52.5% and 66.4% respectively.[12,15]

In this study, Osteochondroma type of tumours was found to be in the majority, i.e., 17.14% among benign tumours, followed by giant cell tumour (14.28%) and osteoid osteoma (11.42%). The incidences of osteochondroma type of tumours were comparatively less in our study as compared to studies reported by Rao et al. is 45.7% followed by Dorfman HD, Czerniak B is 35.9%.[16,17] The incidences of giant cell tumours (14.28%) reported in our study were also lesser as compared to the study of Broehm CJ et al.[18] In our study, among malignant tumours, metastasis types of tumours were found to be in the majority, i.e., 8.57%, followed by osteosarcoma (5.71%), and Ewing's sarcoma & multiple myeloma (4.28%), and chondrosarcoma (1.42%).

According to Patil et al., the intensity of agreement among clinico-radiological diagnosis and histological diagnosis has been shown as significant and kappa value:0.749[11] and similar to the findings of the study conducted by Negash et al. (kappa value:0.82).[9] According to the Patil et al., research outcome described those thirteen patients of osteosarcoma, twelve were consistent and one was inconsistent.[11] Clinic-radiological examination confirmed that the case having Ewing sarcoma. Discordance was caused by a small sclerotic edge on the radiograph and a less normal position, namely the metadiaphysis. Because of the lytic lesion radiologically, a case of desmoplastic fibroma was detected as a giant cell tumor. Two of the 17 incidences of Giant cell tumours with biopsy evidence were inconsistent. One was brought on by a clinical association with a known incidence of cervical squamous cell carcinoma and also a focal lytic lesion radiographically including the ilium and pubic symphysis. Another case involved a 13-year-old male boy who was identified as having an aneurysmal bone cyst. One of the 3 cases of Ewing sarcoma recognized by radiologic identification was later determined by histopathology to be osteosarcoma, although having a radiologic mimicry of Ewing due to late presentation. A 24-year-old man had a case of biopsy-confirmed lymphoma it was radiologically determined to be Ewing sarcoma. The case has been investigated by immunohistochemistry. Finally, one of the five chondrosarcoma cases was radiologically determined to be a benign cartilage-generating lesion chondromyxoid fibroma. The fundamental explanation for the discordancy was that, radiologically speaking, bone development or destruction might be linked to numerous other illnesses besides bone tumors. Since definite lesions are often common in specific age groups and at particular sites in the bone, as well as the type of bone implicated and a 2nd lesion in the discrepancy radiological diagnosis and such examples are Ewing sarcoma or lymphoma, were taken into consideration for contract with histopathological diagnosis and also the clinical signs and symptoms have a significant importance.[11] In concurrence with the findings of Patil et al., in the present study, the radiological findings were correlating with histopathological findings with a statistical significance ($p<0.001$), and the correlation of bone tumours based on radiological and histopathological findings were mismatched for only 15 cases out total 70 cases.

Conclusion:

The examination of bone lesions is improved significantly by this investigation. Radiology accurately identifies the type of lesion even though it may not provide the particular histological variant of the bone tumor. This reinforces the use of imaging techniques to evaluate focal bone lesions. However, findings of the wrong diagnosis may be taken into consideration by clinicians, and the requisition of bone biopsy must be considered whenever available.

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