ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

Magnetic Resonance Imaging Evaluation of Primary Bone Tumors

Received: 27 October 2022, **Revised:** 25 November 2022, **Accepted:** 28 December 2022

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Keywords
radiographic, radiologist, bone tumor, lesion, diagnostic, destruction, skeletal, neoplastic, metastatic.

Abstract
The radiographic features of a bone tumor or tumor-like lesion help in the diagnosis or narrow this same diagnostic possibilities based on the patient's history, the pattern of bone destruction, the margins of the lesion, its location, site, and placement within the skeletal structure as well as within the individual bone, and whether or not it is a single lesion or a collection of lesions. When combined with clinical data, these radiographic characteristics assist determine whether a lesion is primary or metastatic, neoplastic or benign.

1. Introduction
Magnetic Resonance Imaging is most sensitive in diagnosing musculoskeletal soft tissue lesions. MRI narrows the possible differential diagnosis by combining the observations relating to the location, pattern of growth, specific MR signal character and contrast enhancement patterns.

MRI is the best modality for local staging and focal extent. MRI provides information regarding degree of

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marrow involvement, invasion of muscle, neurovascular structures, and adjacent fat planes. MRI is also superior in assessing presence of intra- tumoral haemorrhage or necrosis and intra- articular extension of the lesion.

Soft tissue changes inside an area of sclerosis that may be obscured on radiography and CT by the underlying sclerosis may be shown by magnetic resonance imaging (MRI). MRI is the most reliable method for detecting skip lesions, which are often undetected by conventional imaging techniques.

2. Objectives

1. The purpose of this study is to identify MRI characteristics of primary bone cancers.
2. To determine whether MRI can be used to reliably predict cancer.
3. The purpose of this study is to connect the results of Magnetic Resonance Imaging with those of Radiographs and Histopathology.

3. Review of Literature

Mineralized matrix patterns were shown to predict matrices and have diagnostic value in clinical radiography of primary bone malignancies and associated illnesses by Sweet DE et al.12 in 1981. Especially when just a little amount of additional osseous or non-representative biopsy material is available, these radiographic patterns may provide crucial information as to the real nature of a lesion. In bone infarcts, enchondromas, and orosteochondromas, mineralization patterns may be the sole evidence of a previous lesion that underwent sarcomatous transformation. Prognosis and often-precise diagnosis may be achieved by the integration of grid data with information of the anatomical location of a lesion, the nature of its borders, and the patterns of periosteal response it creates.

The real proximal and distal extent of a tumor in a long bone may be more accurately defined with MR imaging than with the other modalities, according to a 1986 prospective examination of MR imaging in 16 consecutive individuals who had a primary malignant tumour of the a long bone by Sundaram M et al. As compared to taking a large number of transverse pictures, coronal photos make surgery planning for limb salvage with an allograft much simpler.

Holland BR et al. compared MR to standard radiography and CT in the evaluation of 40 mainly sclerotic skeletal lesions in 1988. MRI was shown to be just as effective as conventional radiography and CT in demonstrating sclerosis and other changes in bone structure. In cases where new bone growth was suspected but couldn't be seen on radiography or CT due to the presence of sclerosis, magnetic resonance imaging (MRI) proved invaluable. High resolution surface coils showed that this was the case for both periosteal new bone and the calcium inside the nidus of an osteoid osteoma.

De Beuckeleer LH et al. conducted a retrospective analysis of 68 individuals in 1996 who were diagnosed with cartilaginous tumors by histological examination. They evaluated how well MRI imaging and plain radiography could make a diagnosis. In the end, they decided that MR imaging was a good way to increase the diagnostic accuracy of low-grade chondrosarcomas. MR imaging is only helpful in the diagnostic workup of situations when malignant transformation is suspected, since osteochondromas show a distinctive look on plain films.

In 2000, Margau et al. conducted a retrospective study of MR imaging results for twenty instances of unicameral bone cysts. Nineteen out of the twenty patients diagnosed with UBC had a history of either an acute or distant pathologic fracture at the time of presentation. T1-weighted (in 50% of cases) and T2-weighted (in 83% of cases) MR images of cysts with a history of fracture showed heterogeneous fluid signals. Fifteen out of eighteen UBC patients with a history of fracture received gadolinium-enhanced pictures. All of them showed augmentation, either in a subcortical, heterogeneous, or subcortical distribution. Areas of ground glass opacification on plain film corresponded with focal nodules of homogenous amplification (diameter >1 cm) inside the UBC (n=5). The identification of septations not seen on plain film (n=2), soft tissue alterations (n=2), and fluid-fluid levels (n=11) were further noteworthy aspects of MR. They determined that MR imaging of UBCs is often complex, with areas of nodular and thick peripheral enhancement attributable to past pathologic fracture and early healing, as well as heterogeneous fluid signals.

Malignant lymphoma of the bone was researched in 2002 by Durr HR et al. They looked at the clinical and radiological features of 36 cases. Primary lymphoma of the bone, which is a subtype of non-lymphoma Hodgkin's (NHL), was found in 17 individuals (PLB). In 13 of the instances, the illness had spread and was affecting several bones or organs (dNHL). Hodgkin's illness affected the bones of six people (HD). On average, bone involvement occurred 57 months after the

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
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original diagnosis in secondary patients. Fifty-eight percent of the lesions showed an osteolytic pattern. The most common indicator of this disease's presence was the presence of soft-tissue involvement (71% of cases; PLB 80%, dNHL 73%, HD 40%). Survival after 5 years was 61% (PLB 88%, dNHL 38%, HD 50%). The prognosis was most strongly influenced by whether or whether many bones were involved, as opposed to a single bone. The risk of dying was greatly increased by participation outside of the skeleton. Survival rates were not different based on demographics such as gender, age, geographic region, or histological subtypes. Later in the progression of NHL, the illness spreads to the bones. The clinical presentation was vague, and there is typically a protracted lag time between the beginning of symptoms and a diagnosis. The presence of a soft-tissue tumor in the bone's periosteum with little bony involvement was a key radiologic finding.

Murphey MD. et al. (2004) examined the relationship between imaging and pathological data in 40 individuals with periosteal osteosarcoma. “Patients ranged in age from 10 to 37, with 25 being male (62%), and 15 being female (38%). (average age, 20 years). Diaphyseal fractures of the tibia (16 patients) and femur (14 patients) were the most common types of fractures (15 patients). Radiographs revealed a soft-tissue mass with a wide base that was linked to the cortex in all cases, with cortical thickening (33 patients), cortical scalloping/erosion (37 patients), and/or vertical periosteal reaction (38 patients) extending into to the soft-tissue mass.” (1)

In 2007, Gould CF et al. investigated frequent mimics among bone tumors. “Common benign and non-neoplastic entities that can sometimes be confused with tumors are the following: cortical desmoids”, "Brodie's abscess, synovial herniation pit, pseudocyst, enostosis, intraosseous ganglion cyst, fibrous dysplasia, stress fracture, avulsion fracture (healing stage),bone infarct, myositis ossificans, brown tumor and subchondral cyst." Knowledge of the epidemiology, clinical manifestations, anatomic distributions, imaging findings, differential considerations, and treatment choices for these lesions is essential for their accurate diagnosis and management. (2)

A cystic appearance of Ewing's sarcoma with a benign clinicoradiological history was observed and analyzed by Maheshwari AV et al in 2009. Pathologic fracture through a radiographically benign-looking single bone cyst in the distal tibial metaphysis was documented in a 27-year-old man. Conservative therapy repaired the fracture, but the patient returned a year later complaining of discomfort and difficulties bearing weight. A second sample confirmed the diagnosis of Ewing's sarcoma after curettetting and bone grafting were performed elsewhere. He had comprehensive local excision and repair using an intercalary allograft in addition to the conventional neo-adjuvant chemotherapy. After 2 years of postoperative monitoring, the patient showed no signs of either local or distant recurrence. Because of the potential benefits of an earlier diagnosis and less diagnostic uncertainty, being aware of this unusual presentation is crucial.

4. Material and Methods

Detail Research Plan

“The observational study was done in the department of Radio Diagnosis, KRISHNA INSTITUTE OF MEDICAL SCIENCES & HOSPITAL. All the patients referred to department of Radio diagnosis with suspected bone tumors were first evaluated with plain radiograph followed by MRI evaluation. The accuracy of both modalities was analysed statistically and correlation was done with the histopathological reports.”

Inclusion Criteria:

(1) Patients who are clinically suspected with primary bone tumors.

(2) Patients of all age group and all gender.

Exclusion Criteria:

(1) Patients with history of metallic implants, cardiac pacemakers, metallic foreign body.

(2) History of allergy to contrast.

Total Study Period: 18 months

Study Area: “Department of Radio diagnosis, KRISHNA INSTITUTE OF MEDICAL SCIENCES & HOSPITAL”

Sample Size: 44

Study Variables:

(1) Age
(2) Sex
(3) Clinical Features:
a. Pain
b. Swelling
(4) Axial/ Appendicular skeletal involvement
(5) Bone involved
(6) Site involved
(7) Single/multiple site involvement
(8) Radiographic findings:
a. Expansile

ISSN: 2309-5288 (Print)
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b. Lytic/sclerotic/mixed
c. Cortical/ medullary
d. Margins
e. Zone of transition
f. Sclerotic rim
g. Cortical break
h. Periosteal reaction
i. Matrix mineralisation
j. Trabeculation
k. Soft tissue

(9) MRI findings:

a) Signal characteristics on T1W, T2W, PDFS/ STIR sequences
b. Post contrast enhancement
c. Soft tissue
d. Marrow edema
e. Periosteal reaction
f. Joint involvement
g. Muscle involvement
h. Skip lesions
i. Neurovascular structure involvement

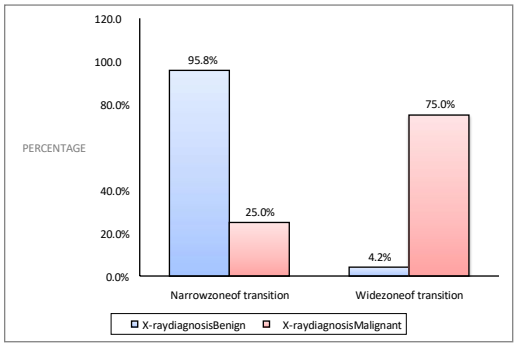
5. Results and Discussion

In our study we can observe that, most of the subjects with age less than or equal to 20 years were affected. In our study, 13 cases (29.55%) were in the age group of <20 years followed by11 casesin31-40 (25%) age groups and 9 cases in 21-30 age groups. Average age observe in our study was 32.5±15.19 years. Minimum and maximum age observed in the study was 10 year and 70 years, respectively. There were 24 (54.55%) males and 20 (45.45%) females in the study. In our study males were most commonly affected than female patients.

Table1: Distribution of patients based on age and gender

Variables		Number of Subjects (%)
Age(in years)	≤20	13(29.55%)
	21-30	9(20.45%)
	31-40	11(25%)
	41-50	5(11.36%)
	51-60	5(11.36%)
	61-70	1(2.27%)
Gender	Male	24(54.55%)
	Female	20(45.45%)

Figure 1: Distribution of subjects by zone of transition and radiographic Output.



In our study, 14 cases hade wide zone of transition out of which 13 cases were malignant and 1 case was benign looking on radiograph (chordoma which was diagnosed as malignant lesion on MRI).30 cases had a narrow zone of transition of out of which 23 cases were benign and 5cases were malignant out of which 1case was osteochondroma with malignant transformation diagnosed on MRI and 4 cases were malignant GCT.

Figure 2: Distribution of subjects by cortical break and MRI output.

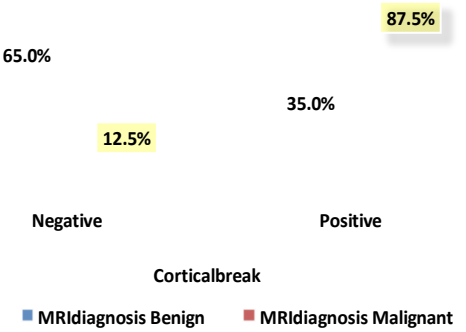
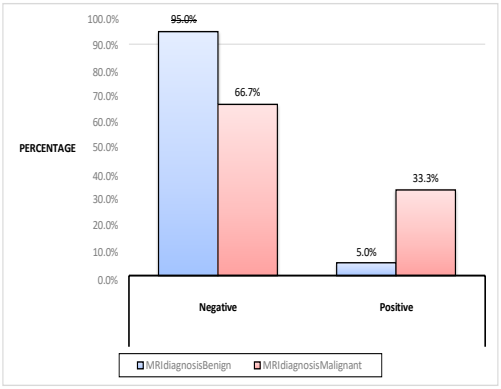


Figure 3: Distribution of subjects by joint involvement and MRI output.



In our study, joint involvement was seen in 9 cases, out of which 1 was ABC, 2 were osteosarcoma, 1 was chordoma and 5 were GCT.

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
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Table 2: Distribution of Subjects by Bone Tumor.

Bone Tumour	Number of subjects (%)
SBC	2(4.55%)
OSTEOSARCOMA	3(6.82%)
CHORDOMA	1(2.27%)
OSTEOBLASTOMA	1(2.27%)
EWINGS SARCOMA	2(4.55%)
CHONDROSARCOMA	4(9.09%)
NOF	3(6.82%)
ENCHONDROMA	2(4.55%)
OSTEOIDOSTEOMA	4(9.09%)
OSTEOCHONDROMA	WITH
GCTWITHSECONDARY ABCCHANGES	3(6.82%)
OSTEOCHONDROMA	3(6.82%)
CONVENTIONALOSTE OSARCOMA	1(2.27%)
ABC	2(4.55%)
GCT	6(13.64%)
DIAPHYSEALACLASIS	2(4.55%)
PLASMACYTOMA	1(2.27%)
MULTIPLEMYELOMA	2(4.55%)

Forty-four patients with possible primary bone tumors were analyzed in this investigation. First, plain radiographs were taken of all patients, and then MRI was performed. Histopathological correlation was performed as a follow-up wherever feasible.

In our research, patients younger than 30 made up 29.55 percent of the sample, with those between the ages of 31 and 40 making approximately 25 percent. Males (54.55%) outnumbered females (45.45%) when it came to the prevalence of lesions.

In 2010, Obalum DC et al. looked back at instances of primary bone tumors at three hospitals for a total of 25 years. Cases ranged in age from 6 to 85 years old, with a mean age of 25.8 years old and highest incidence between the ages of 11 and 20. The male to female ratio was 1.5:1, with 60.6% of the population being male and 39.4% female.

In the analysis of 1355 cases of tumour and tumour-like lesions of the bone, He **XH et al** identified peak ages affected in primary bone tumors were 11- 40 years**. Baena-Ocampo Ldel C et al** in their retrograde analysis, found that 53.7% cases were males and 46.3% were females with an average age of occurrence 25 years.

Out of a total of 44 instances of primary bone tumors, 9 (20.4%) were diagnosed with a giant cell tumor, 5 (11.3%) with osteochondroma, and 4 (9.0%) with osteoid osteoma. There were 356 benign cases (51.0%) and 342 malignant cases (49.0%) in the retrospective review research by Obalum DC et al. Osteosarcoma accounted for 197 instances (28.2%), followed by osteochondroma at 106 (15.2%), and germ cell tumors at 78 (11.2%).

Epidemiologic analysis of 585 cases by **Barbosa et al** most common benign neoplasms were osteochondroma (45.3%) followed by enchondroma (19.6%).Osteosarcoma was the most common malignant tumour (30.0%) followed by myeloma (16%).

Statistical analysis of 571 cases of primary bone tumours by **Yang DZ et al**[68], most common benign tumour was osteoma followed by osteochondroma and enchondroma. Most common malignant tumour was osteosarcoma chondrosarocma and giant cell tumour.

In our study, 54% cases were benign and 46% cases were malignant lesions.In our data, most common benign tumour was GCT and most common malignant tumour was chondrosarcoma followed by osteosarcoma and malignant GCT. These findings were in agreement with the pertinent literature.

6. Conclusion

Twenty-year-olds accounted for 29.55 percent of patients in our survey, with those between the ages of 31 and 40 coming in second. Males (54.55%) outnumbered females (45.45%) when it came to the prevalence of lesions.

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The majority of the 44 instances of primary bone tumors were Giant Cell Tumors, accounting for 20.4%. This was followed by Osteochondroma at 11.3% and Osteoid Osteoma at 9.0%. The majority of bone tumors have nonspecific signal features, such as "low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and increased signal intensity during STIR sequences. Thirty-two instances had a positive histopathological association."

The absence of a control group, the relatively small sample size, and the fact that MRI cannot distinguish between different types of tumor cells all act as limitations to this research. In spite of its drawbacks, MR imaging remains a very effective technique for distinguishing between benign and malignant tumors. Moreover, the degree of tumor, soft tissue, and joint involvement may be more clearly defined by MRI.

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