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ROLE OF MRI IN EVALUATION OF PRIMARY AND SECONDARY BONE TUMORS

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ABSTRACT

Aim: The aim of the present study was to assess Magnetic Resonance Imaging in the evaluation of Primary and Secondary bone tumours.

Methods: The Prospective study was conducted at Padmashree Dr D. Y. Patil Medical College and Hospital and research centre, Pimpri Pune from September 2020 to July 2022. 100 cases were included in the study.

Results: Males were 51% and females were 49% among the patients. Femur was the most common location of the tumor (38%), followed by tibia (8%) in our patients. 30% of the patients had soft-tissue component in MRI. Out of soft tissue component of tumors in MRI, 17% were not defined and there was no soft tissue component in 70%. Cortical involvement was noted in 50% of the patients in the MRI. Outgrowth-continuation of cortex (14%) followed by Cortical destruction (8%) were the most common cortical involvement findings. Neurovascular findings were found in 8% of the patients.

Conclusion: Overall, the characteristics of the primary and secondary bone tumours were well observed in the MRI. Osteochondroma was the most common diagnosis from MRI. Margins were found in the almost all the patients, with 50% being well-defined. Cortical involvement was noted in 50% of the patients. Neurovascular findings were found in 8% of the patients.

Keywords: MRI, primary tumours, secondary tumours

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INTRODUCTION

Bone tumours develop when cells in the bone divide abnormally and uncontrollably, they can form a mass or lump of tissue. This lump is called a tumour. As the tumour grows, abnormal tissue can displace healthy tissue. Some tumours are benign, meaning they aren't cancerous. While benign bone tumours won't spread to other parts of the body and are unlikely to be fatal, they can still be dangerous and may require treatment. Benign tumours can grow and could compress your healthy bone tissue. The cause of bone tumours isn't known. The tumours often occur when parts of the body are growing rapidly.[1]

Radiographs are the primary screening technique used for bone tumours and tumour-like lesions. When a lesion is indeterminate or shows signs of aggressiveness, magnetic resonance imaging (MRI) is indicated for further characterization.[2] It can extend the diagnostic evaluation by demonstrating components such as cartilage, vascular tissue, fat, liquid and haemosiderin. Even when a specific diagnosis cannot be made, MRI can help by narrowing the differential diagnosis. These are the reasons why MRI has changed from a single study-based diagnosis (solely based on radiographs) to a multimodal imaging approach (which now includes MRI). Faint lytic/sclerotic bone lesions can be difficult to visualize using only radiographs. MRI is superior to the other imaging modalities in detecting bone marrow lesions.[3]

Aggressive indeterminate cases will require histological confirmation before proceeding to staging and establishing a therapeutic approach. The high percentage of biopsy tract contamination indicates that this track should be included in the surgically removed area.[4] Contrast-enhanced MRI (CEMRI) can reveal the most vascularised parts of the tumour and MRI guidance makes it possible to avoid biopsing necrotic areas.[3]

For staging, prognosis, and using preventative and therapeutic strategies to limit morbidity and mortality early diagnosis of bone metastases is critical. As non-invasive diagnostic tools, a variety of radiographic modalities have been used to diagnose both primary and secondary bone cancers. Bone metastases can be categorized as osteolytic, sclerotic (osteoblastic), or mixed based on imaging examinations.[5] Plain radiography is the first examination performed to identify the origin of bone discomfort. Due to the likelihood that metastatic lesions may not initially emerge on X-ray, plain radiography is quite specific but has a low sensitivity (44–50%).[6] In terms of detecting bone metastases, CT has a sensitivity of 70%-100%.[7]

The gold standard for determining the extent of a local tumour is still an MRI scan. Modern methods have been employed to evaluate tumour response to treatment and allow for improved definition of high-grade tumour regions, including dynamic MRI.[8] MRI is used to detect spinal cord compression and to image bone marrow for tumour involvement. Specificity is 73-100%, while sensitivity is 82-100%.[9] Even though radiographs are the primary screening modality, when radiographs are unclear or aggressive to narrow the differential or diagnose a lesion, MRI is useful.

The aim of the present study was to assess Magnetic Resonance Imaging in the evaluation of Primary and Secondary bone tumours.

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MATERIALS AND METHODS

The Prospective study was conducted at Padmashree Dr. D. Y. Patil Medical College and Hospital and research centre, Pimpri Pune from September 2020 to July 2022. 100 cases were included in the study.

Methods of diagnosis: Siemens Vida Magnetic Resonance Imaging (3 Tesla) and Siemens Magnetom Avanto (1.5 Tesla)

The Institutional Ethical Committee (IEC) clearance was obtained before the start of the study. Informed written consent was obtained from all the patients.

MRI ADVANTAGES:

MRI can expand diagnostic evaluations by detection of:

- Cartilage
- Fat
- Liquid
- Vascular tissue.

Intramedullary extensions joint and muscle compartment invasion, neurovascular bundle involvement, and skip lesion detection can all be assessed by MRI.

MRI DISADVANTAGES:

The major disadvantages of MRI include:

- The prolonged examination time,
- The high cost,
- The possibility that the study will be inconclusive in individuals who have claustrophobia.

INCLUSION CRITERIA

- Tumors of all the bones including spine and skull are included.
- Metastatic tumours are included.
- Patients of age more than 5 years will be included.
- Among this age group all patients clinically suspected with bony swelling will be included.

EXCLUSION CRITERIA

- Postoperative cases and patients undergoing radiation therapy
- Pregnant women are excluded.
- Patient presenting with abnormal RFT, claustrophobia, cardiac pacemakers, metallic foreign body, in-situ biostimulators, in-situ neurostimulators, and in-situ cochlear implants bation

RESULTS

Table 1: Patient characteristics

Gender	Frequency	Percentage
Male	51	51%
Female	49	49%

Location of tumors		
FEMUR	41	41
TIBIA	14	14
FIBULA	3	3
CALCAEENUM	4	4
HUMERUS	10	10
RADIUS	3	3
METACARPAL	4	4
Metatarsal	1	1
Frontal bone	2	2
Parietal bone	1	1
Lumbar vertebra	7	7
Sacral vertebra and sacrum	4	4
Pelvis	4	4
Rib		2

Males were 51% and females were 49% among the patients. Femur was the most common location of the tumor (38%), followed by tibia (8%) in our patients.

Table 2: Distribution of study subjects according to involvement of soft tissue component of tumors in MRI

Soft tissue component of tumors in MRI	**Frequency**	**Percentage**
Anterior epidural soft tissue involvement	1	1
EDEMA	1	1
Extending b/w fibularis longus and brevis	1	1
Indenting and displacing the tendons of tibialis posterior, flexor digitorum longus and flexor hallucis longus , extensor hallucis longus and extensor digitorum longus tendons	1	1
Indenting and stretching musculotendinous junction and tendon of Sartorius	1	1
Indenting vastus lateralis	1	1
Indenting vastus intermedius and lateralis	2	2
Mass effect of semimembranous	1	1
Mass effect of vastus medialis	1	1
No	70	70
periosseous soft tissue comp	1	1
Posteriorly it is extending into the left posterior paraspinal muscles. Medially it is bulging into the epidural compartment, causing canal stenosis and adjacent cord compression	1	1

Vastus medialis	1	1
Yes but not defined	17	17

30% of the patients had soft-tissue component in MRI. Out of soft tissue component of tumors in MRI, 17% were not defined and there was no soft tissue component in 70%.

Table 3: Cortical involvement of tumours in MRI in the study subjects

Cortical involvement of tumors in MRI	**Frequency**	**Percentage**
Collapse of D10 vertebra	1	1
Cortical break	1	1
Cortical destruction	8	8
Cortical destruction of medial femoral condyle	1	1
Cortical erosions	1	1
Cortical thinning	3	3
Cortical thinning and break	1	1
Cortical thinning and destruction	1	1
Cortical thinning and erosion	3	3
Cortical thinning with cortical breaks	3	3
Destruction of right sacral ala, anterior and posterior cortices and right articular surfaces of sacrum	1	1
Destruction of S1 body	1	1
Destruction of the posterior cortex at D9 and d10 levels	1	1
Erosions and destruction of lateral crotex ,anterio and posterio cortex of lower femur	1	1
Fracture of proximal shaft of humerus	1	1
Interrupted areas of cortical breach are seen in the anterior tibial cortex	1	1
No	50	50
Outgrowth-continuation of cortex	14	14
Sclerosis and demineralization	1	1
thinning and scaloping	1	1
thinning and scaloping with break	1	1
thinning and scaloping with break and erosions	1	1
Yes but not defined	1	1

Cortical involvement was noted in 50% of the patients in the MRI. Outgrowth-continuation of cortex (14%) followed by Cortical destruction (8%) were the most common cortical involvement findings.

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Table 4: Distribution of study subjects according to neurovascular involvement of tumours in MRI

Neurovascular involvement of tumors in MRI	**Frequency**	**Percentage**
Displacement of right internal iliac vessels, mass effect of right sciatic nerve	1	1
Focal loss of fat plane with neurovascular bundle	1	1
Indenting and displacing posterior tibial neurovascular bundle and anterior tibial vessels	1	1
Left 2nd intercostal nerve is displaced	1	1
Mild post displacement of saphenous nerve and tributaries of GSV	1	1
No	92	92
popliteal vessels	1	1
Thecal sac compression, involving neural formaina and lateral recess B/L at L5-S1 ans S1-S2 levels.	1	1
Yes	1	1

Neurovascular findings were found in 8% of the patients.

Table 5: Distribution of study subjects according to extension of tumours in MRI and scan according to contrast scans done

	Frequency	**Percentage**
No	93	93
Yes	7	7
Contrast scans		
Yes	23	23
No	77	77

Tumour extension was found among 7% of the patients in MRI. Contrast scan done among 23% of the patients.

Table 6: Correlation between MRI and X-ray findings

Feature	Kappa	p value
Soft Tissue component	0.579	<0.001
Cortical involvement	0.886	<0.001
Extension of tumor	1	<0.001

In terms of the soft tissue component, cortical involvement, and extension of the tumour, there was a significant degree of agreement between the findings of the MRI and those of the X-ray (p0.05).

Case images

Figure 1: showing a case of Osteochondroma of femur.

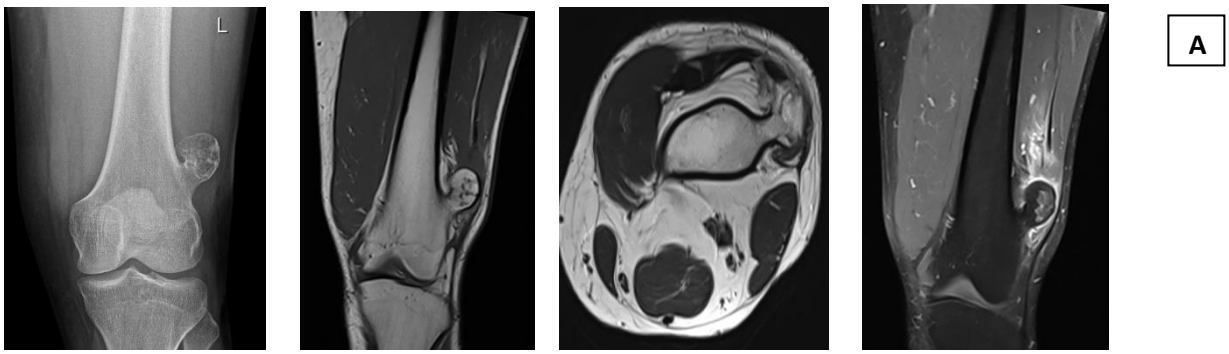

Fig. 1A **Fig. 1B** **Fig. 1C** **Fig. 1D**

1.A- X ray shows a well-defined exostosis arising from the lateral aspect of the femoral metaphysis directed away from the joint.
1.B- TIW coronal picture exhibiting pedunculated distal femoral metadiaphysis outgrowth. Outgrowth continues cortical and medullary cavity. Bony outgrowth exhibits iso to hypointense cartilaginous cap on T1 image.
1.C- The bony outgrowth appears hyperintense on T2W axial image.
1.D-Shows patchy enhancement on post contrast coronal image.

Figure 2 – showing a case of chondrosarcoma of femur.

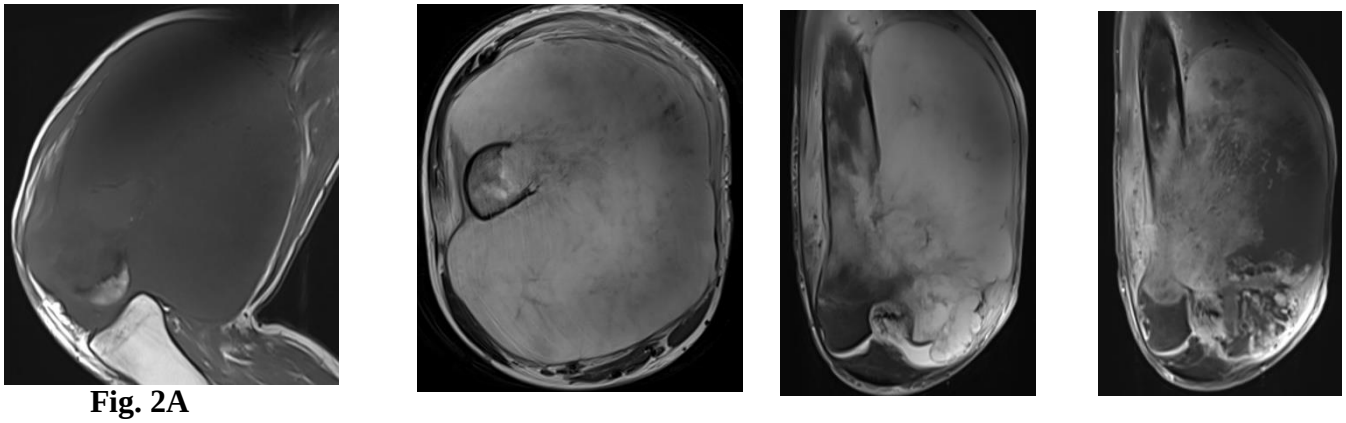

Fig. 2A **Fig. 2B** **Fig. 2C** **Fig. 2D**

2.A-T1W sagittal image indicates hypointense soft tissue mass in distal metadiaphysis of femur involving medial femoral condyle. It has a intraosseous and large extraosseous component.
2.B and 2.C-A massive, well-defined soft tissue mass including the medial femoral condyle can be seen on both the T2W axial imaging and the PDFS coronal picture at the distal metadiaphysis of the femur. The cortex of the medial femoral condyle has been destroyed. Inferiorly it is extending into the subarticular region with extension into the medial compartment of knee joint. Fatty atrophy of the anteromedial compartment muscle is noted.
2.D-shows heterogeneous post-contrast enhancement with linear enhancement of the septae as well as incomplete arc like enhancement.

DISCUSSION

Bone tumours and tumour-like lesions are frequently encountered by radiologists. Although radiographs are the primary screening technique, magnetic resonance imaging (MRI) can help

narrow the differential or make a specific diagnosis when a lesion is indeterminate or shows signs of aggressiveness. MRI can extend the diagnostic evaluation by demonstrating several tissue components. Even when a specific diagnosis cannot be made, the differential diagnosis can be narrowed. MRI is superior to the other imaging modalities in detecting bone marrow lesions and tumoral tissue (faint lytic/sclerotic bone lesions can be difficult to visualise using only radiographs). Contrast-enhanced MRI can reveal the most vascularised parts of the tumour and MRI guidance makes it possible to avoid biopsing necrotic areas.

The current study examined MRI's effect on bone tumours in 100 patients. Azad H, et al.[10] correlated imaging techniques with histology in 92 bone tumours. Salazar C, et al.[11] examined imaging in 64 individuals with bone malignancies. In this survey, males (51%) and females (49%) were nearly equal. In research by Azad H et al.[10], females were 53.3%. In the study by Salazar C, et al.[11] and Kinnunen A-R, et al.[12] men were slightly high at 64.1% and 57%.

Femur (39%) and humerus (10%) were the most prevalent tumour sites. In the current study, 68% were in the long bones (femur, humerus, tibia, fibula). Ewings sarcoma and osteosarcoma are most common in long bones (69.2% and 86.4%, respectively). Long bones had 23% fibrous dysplasia, according to Kinnunen A-R et al[12] and he reported the same findings about femur. In the current study spine was involved in 17% of the patients on MRI.

1% of the study's MRIs showed sclerosis and demineralization. In the Azad H, et al.[10] investigation, 37% exhibited sclerotic MRI lesions. 31% of Ewings sarcoma patients and 42.8% of Osteosarcoma patients exhibited sclerotic lesions in a research by Parlak et al.(50). MRI demonstrated no joint involvement in the current investigation. MRI is sensitive in detecting joint involvements, according to Schima et al.[13]

The current report showed that there was a significant agreement between the MRI and X-ray findings in terms of soft tissue component, cortical involvement and extension of tumor. Salazar C, et al.,[11] also and reported that X rays were inferior to MRI in terms of the diagnostic accuracy (90% vs 95.1%), sensitivity (92.9% vs 94.4%), specificity (87.5% vs 95.7%), positive predictive value of (86.7% vs 94.4%) and negative predictive value (93.3% vs 95.7%) of Xray was lower in X ray than MRI. Cappabianca S, et al.[14] had also mentioned that MRI had proved to be superior to CT in characterizing tissue and evaluating soft tissue involvement. The current study reported that soft tissue involvement in bone tumours was detected in 30% of the patients. In accordance with the current findings Miwa S, et al.[15] also reported that MRI differentiated the vessel and soft tissue relation of the bony tumour and this ability was enhanced with contrasts.

In the current study, neurovascular involvement of tumors was found in 8% of the patients on MRI. Hogeboom WR, et al.[16] also mentioned that MRI was better than CT in distinguishing bone tumors from neurovascular structures, soft tissues and joint involvement. The current study however did not show any joint involvement on MRI. In the current study MRI showed that about 50% had cortical involvement. But Hogeboom WR, et al.[16] had said that CT gives a better report of cortical bone involvement.

MRI has a perfect sensitivity and specificity for diagnosing fibrous dysplasia. Consistent with the present results, Cappabianca S, et al.[14] and Shah ZK, et al.[17] stated that MRI can detect fibrous

dysplasia. Because neither CT nor MRI are adequate for making a definitive diagnosis of dysplastic disease, Cappabianca S, et al.[14] and Tokano H, et al.[18] concluded that a biopsy is necessary for a diagnosis of fibrous dysplasia. Clinical reports have indicated that MRI is useful for identifying intralesional cystic degeneration and associated oedematous components.

It has been reported by Bloem JL, et al.[19] that MRI is more accurate than CT at determining the depth of bone marrow extension. It has also been reported by Hogeboom WR, et al.[16] that MRI is more effective than CT at detecting bone cancers. However, the research also noted that, due to variations in breathing motions, MRI could not be used to quantify precise length. The primary use of MRI in bone cancers, according to Berquist TH, et al.[20], was staging, and the modality was not useful for distinguishing between tumours of different histological subtypes. The study also found that contrast-enhanced MRIs are superior to standard MRIs for identifying malignancies in the bones.

CONCUSION

Overall, the characteristics of the primary and secondary bone tumours were well observed in the MRI. Osteochondroma was the most common diagnosis from MRI. Margins were found in the almost all the patients, with 50% being well-defined. Cortical involvement was noted in 50% of the patients. Neurovascular findings were found in 8% of the patients. Tumour extension was found among 7% of the patients in MRI. There was a significant agreement between the MRI and X-ray findings in terms of soft Tissue component, Cortical involvement and Extension of tumor. MRI had the 100% sensitivity to diagnose majority of the bone tumors. Contrast scan done among 23% of the patients.

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