MRI EVALUATION OF MUSCULOSKELETAL TUMOURS

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ABSTRACT

CONTEXT

Musculoskeletal tumours are diverse in their gross and morphological features and range in their biologic potential from the innocuous to the rapidly fatal. This diversity makes it critical to accurately diagnose and stage tumours and treat them appropriately.

AIMS

The present study was undertaken to evaluate musculoskeletal tumours by Magnetic Resonance Imaging (MRI) and to correlate findings of MRI with histopathological/surgical findings.

SETTINGS AND DESIGN/METHODS AND MATERIAL

The present study includes 50 patients of musculoskeletal tumours suspected clinically and/or on plain radiography. All patients included in the study were subjected to detailed clinical history and physical examination in order to determine the nature, site of origin and extent of musculoskeletal mass. Plain roentgenogram in anteroposterior and lateral views, MRI examinations with 1.5 T units on GE HDXT 1.5 Tesla 16 channel MRI were done. Sequences used were conventional. Proton density fat suppression (axial/coronal/sagittal), T1WTSE (axial/coronal) [TR = 600 msec, TE = 15 msec], T2WTSE (axial/coronal) [TR = 3780 msec, TE = 100 msec], Merge/Gradient [TR = 500 msec; TE = 18 msec] in multiple planes. Intravenous contrast (post contrast T1 FS in all 3 planes) was used in all patients. The findings of MR were correlated with histopathological/surgical findings.

STATISTICAL ANALYSIS USED/RESULTS

Out of 50 patients with musculoskeletal tumours, maximum number of patients was seen in age group of 11-30 years. The most commonly encountered tumours were osteosarcoma and malignant soft tissue tumour contributing 16% each of total. Giant cell tumour was the most common benign primary bone tumour followed by osteochondroma. All cartilaginous tumours are profoundly hyperintense on T2W image. MRI was better in delineating the adjacent soft tissue involvement and neurovascular bundle involvement. Adjacent joint involvement was seen in 66% of Ewing's sarcoma.

CONCLUSIONS

MRI was found to be the imaging modality of choice for delineating zone of transition, joint involvement, soft tissue involvement and neurovascular bundle involvement in evaluation of musculoskeletal tumours.

KEYWORDS

MRI, Musculoskeletal Tumours.

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INTRODUCTION

Many imaging modalities are available for evaluation of musculoskeletal tumours. When evaluated together with clinical data, radiographs are the best predictors of the histologic condition of the lesion. Detection of soft tissue extension is more critical to staging and pre-surgical planning than the diagnosis of skeletal lesions. MRI is superior in determining muscle compartment and vascular involvement because of intrinsic contrast between tumour mass, muscle and fat without the need for contrast enhancement and to produce images in multiple planes.[1] Detection of the lesion, actual insensitivity to calcifications. MRI combines the sensitivity of radionuclide scans with spatial resolution of CT.

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Many of the diagnosis and precise limits of the lesion in bone or soft tissue for treatment planning constitute the interpretational process. MRI provides detailed information about the lesion such as cortical destruction or local spread and bone marrow infiltration assessment before osseous destruction appears in CT.[2] Whole body MRI has successfully been applied for bone marrow screening of metastasis and systemic primary bone malignancies like multiple myeloma along with assessment of systemic bone disease predisposing for malignancy (e.g. multiple cartilaginous exostoses) and muscle disease (e.g. muscular dystrophy).[3] MRI has emerged as the most significant advancement for imaging musculoskeletal tumours because of its excellent soft tissue contrast and multiplanar imaging capability. MRI is the imaging modality of choice for detection of central skeletal lesions and for treatment planning of central and peripheral skeletal lesions. Its strength includes detection of skeletal lesions, evaluation of bone marrow and soft tissue and detection of soft tissue tumours.[4] Its weakness includes lack of specificity, poor bone detail and relative basic parameters that are evaluated in conventional films and CT particularly patterns of cortical destruction and

periosteal new bone formation are also evident on MR images.[5]

SUBJECTS AND METHODS

Study Design

A prospective study to assess musculoskeletal tumours by Magnetic Resonance Imaging on patients with suspected musculoskeletal tumours attending the outdoor patient department or admitted to Kempegowda Institute of Medical Sciences and Research Centre, Bengaluru, were included in the study. The period of study was from June 2012 to May 2013.

Sample Size: 50 subjects.

Patient Inclusion Criteria

1. Patients having a proven or strongly suspected neoplasm arising from bone or non-visceral soft tissue structures were selected.
2. Patients who were suitable to undergo MRI.
3. Patients who did not have any contraindication for MRI.

A prior informed consent was taken.

Patient Exclusion Criteria

1. Patients who had undergone previous treatment for the neoplasm.
2. Patients having extensive primary process in the bone or soft tissues (such as Paget`s disease, neurofibromatosis, fluorosis, etc.)
3. Patients with contraindication to MR imaging.

All patients included in the study were subjected to detailed clinical history and physical examination in order to determine the nature, site of origin and extent of musculoskeletal mass. Relevant investigations like Hb, TLC, DLC, ESR, etc. were done as per proforma. Plain roentgenogram in anteroposterior and lateral views were done in all cases. Chest X-ray (PA view) and Ultrasonography were done in cases wherever required.

MR Imaging Protocol

All patients underwent MRI examinations with GE HDXT 1.5 Tesla 16 channel MRI.

Sequences used were conventional proton density fat suppression (axial/coronal/sagittal), T1WTSE (axial/coronal) [TR=600 msec, TE=15 msec], T2WTSE (axial/coronal) [TR=3780 msec, TE=100 msec], MERGE/GRADIENT [TR=500 msec; TE=18 msec] in multiple planes. Intravenous contrast (postcontrast T1 FS in all 3 planes) was used in all patients.

MRI image was analysed for specific features that were relevant to the evaluation of musculoskeletal neoplasms as given in the proforma. The findings of MR were correlated with histopathological/surgical findings.

RESULTS

The present study was carried out on 50 patients of musculoskeletal tumours suspected clinically and/or on plain radiography. Patients were examined radiologically and findings were recorded as per proforma attached in all cases. In all patients, plain radiographs were done first followed by MRI (T1W, T2W, STIR, T1WCE sequences were used to obtain images in coronal, sagittal and axial planes). FNAC/Biopsy/Histopathological/Surgical findings were recorded.

Age Distribution

Patients of all age groups were included in the study. The youngest patient was 1 year 5 months old and the oldest was 80 years old. Maximum number of patients was in the age group 11-30 years (48%) as shown in Table 1.

Sex Distribution

Out of 50 patients, 28 (56%) were males and 22 (44%) were females. Second decade was the commonest age group in males and third and fourth decade was commonest age group in females for musculoskeletal tumours.

Location of Lesion

Appendicular skeleton was involved in 30 patients (60%), axial skeleton was involved in 12 patients (24%) and soft tissue in 8 patients (16%).

Demographic Profile

The demographic profile of the patients revealed pain and swelling to be the most common presenting symptoms.

Nature of Lesion

Twenty patients (40%) had benign musculoskeletal tumours and 26 patients (52%) had malignant musculoskeletal tumours and 4 patients (8%) had metastases.

Zone of Transition

Sixteen patients (38%) had narrow zone of transition and 26 patients (62%) had wide zone of transition on Radiographs whereas on MRI 20 patients (48%) had narrow zone of transition and 22 patients (52%) had wide zone of transition (52%).

Soft Tissue Involvement

Soft tissue involvement was depicted in 24 patients on radiographs (48%) whereas MRI demonstrated soft tissue involvement in 33 patients (66%) and surgery demonstrated soft tissue involvement in 29 patients (67%).

Adjacent Joint and Neurovascular Bundle Involvement

Radiographs showed adjacent joint involvement in 12 patients (24%). MRI demonstrated adjacent joint involvement in 22 patients (44%) and surgery demonstrated adjacent joint involvement in 18 patients (42%). Neurovascular bundle involvement was seen in 19 patients (38%). Surgery demonstrated neurovascular bundle involvement in 14 patients (32.5%).

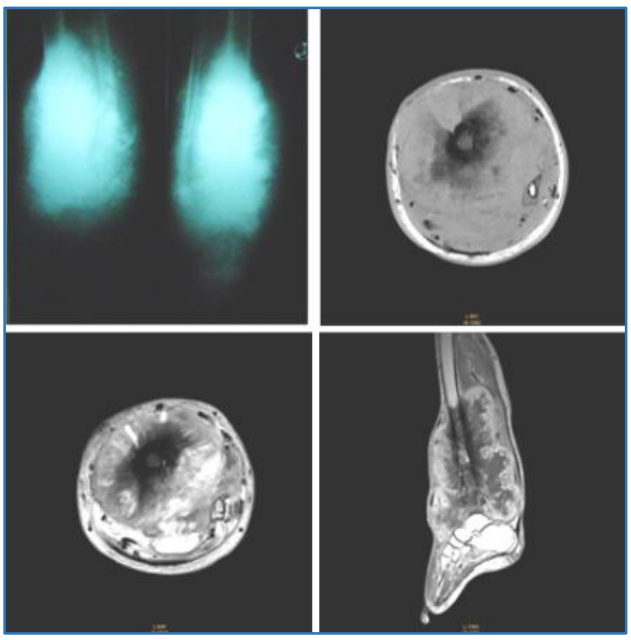

Fig. 1: Osteosarcoma Radiograph Demonstrated a Radiodense Epimetadiaphyseal Lesion Involving Left Lower Tibia with Wide Zone of Transition with Soft Tissue Components, Ossification and Sunray Type of Periosteal Reaction

MRI demonstrated a heterogeneous hypointense lesion on T1W and T2W images involving epimetadiaphyseal region of left lower tibia with surrounding soft tissue involvement, cortical break, multiple areas of necrosis, adjacent joint involvement and neurovascular bundle compression with formation of multiple collaterals.

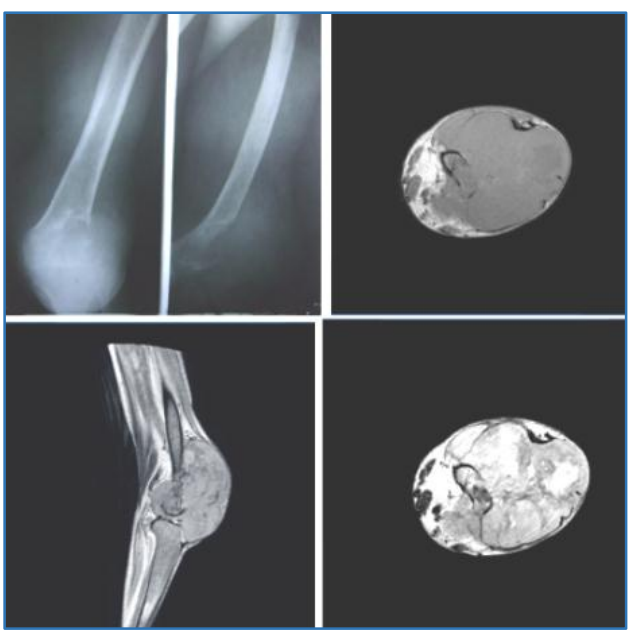

Fig.2: Malignant Giant Cell Tumour Radiograph AP and Lateral View of Knee Joint with Femur Demonstrated Expansile Lytic Lesion Involving Lower End of Left Femur with Wide Zone of Transition, Cortical Break and Few Specks of Calcification

MRI demonstrated a heterogeneously hypointense lesion on T1W and heterogeneously hyperintense lesion on T2W images involving lower end of left femur with invasion into adjacent knee joint and surrounding bone oedema.

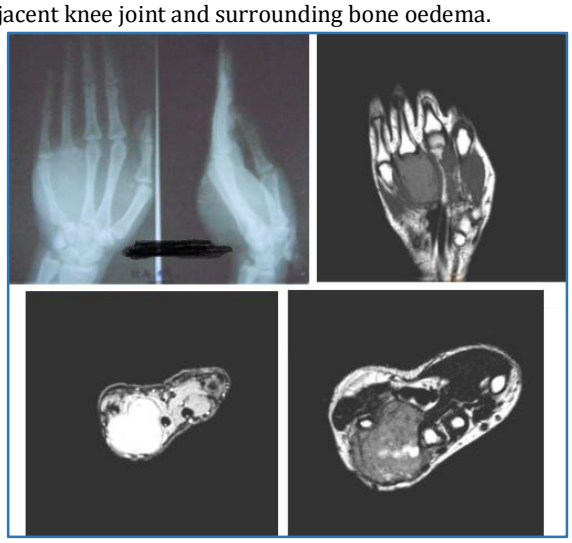

Fig. 3: Chondrosarcoma On Radiograph, There was a Single Well-Defined Radiolucent and Expansile Lesion Involving Fourth Metacarpal of Right Hand with the Destruction of Overlying Cortex and Narrow Zone of Transition

MR images demonstrated hyperintense lesion on T2W and hypointense lesion on T1W with cortical destruction of right fourth metacarpal posteriorly and surrounding soft tissue involvement.

Age (Years)	Frequency	Percent
1-10	2	4
11-20	12	24
21-30	12	24
31-40	7	14
41-50	6	12
51-60	6	12
61-70	3	6
71-80	2	4
Total	**50**	**100**

Table 1

Diagnosis	Frequency	Percent
Osteosarcoma	8	16
GCT	4	8
Osteochondroma	3	6
ABC	1	2
Chondrogenic Osteosarcoma	1	2
Chondrosarcoma	3	6
Chordoma	2	3.3
Ewing's Sarcoma	1	2
Malignant Fibrous Histiocytoma	1	2
Malignant GCT	1	2
Malignant Mesenchymal Tumour	8	16
Osteoid Osteoma	2	4
Plasmacytoma	1	2
Simple Bone Cyst	2	4
Glomus	2	4
Haemangioma	1	2
Metastasis	4	8
Non-Ossifying Fibroma	1	2
Osteoma	1	2
Enchondroma	2	4
Langerhans Cell Histiocytosis	1	2
Total	**50**	**100**

Table 2: Final Diagnosis

Tumour Origin	T1W	T2W
I. Fibrous Connective Tissue		
1. Non-Ossifying Fibroma	Hypointense	Hypointense
II. Fibrohistiocytic		
1. Malignant Fibrous Histiocytoma	Heterogeneously Hypointense	Heterogeneously Hypointense
III. Vascular		
1. Haemangioma	Hyperintense	Hyperintense
IV. Haematopoietic		
1. Ewing's Sarcoma	Hypointense with Areas of Necrosis	Hyperintense with Areas of Necrosis
2. Plasmacytoma	Hypointense with Areas of Necrosis	Hyperintense with Areas of Necrosis
V. Miscellaneous		
1. Simple Bone Cyst	Hypointense	Hyperintense
2. Aneurysmal Bone Cyst	Hyperintense with Fluid-Fluid Levels and Septations	Hyperintense with Fluid-Fluid Levels and Septations
3. Metastasis	Hypointense	Hyperintense
4. Giant Cell Tumour	Hypointense with Focal Areas of Necrosis	Iso-to-Moderate Intensity with Focal Cystic Areas of High Signal Intensity
5. Malignant Giant Cell Tumour	Hypointense with Focal Areas of Necrosis Hypointense	Iso-to-Moderate Intensity with Focal Cystic Areas of High Signal Intensity Hyperintense Hypointense
6. Glomus	Hypointense	
7. Langerhans Cell Histiocytosis		
VI. Malignant Soft Tissue Tumour	Hypo-to-Isointense with Central High Intensity Haemorrhage	Predominantly Hyperintense With High Intensity Haemorrhage and Necrosis

Table 3: Musculoskeletal Tumours were Characterised by their Intensity Pattern to Allow a Specific Diagnosis in Certain Situations

Enhancement Pattern	Frequency	Percent
Heterogeneously Enhancing	3	6
Homogenous Enhancing	5	10
Minimal Peripheral Enhancement	2	4
Homogenous Enhancing with Central Hypointensity	5	10
Heterogeneously Enhancing with Few Areas of Hypointensity	24	48
Multiple Enhancing Septations Within Lesion with Fluid Levels	2	4
Hyperintense Lesion with Peripheral Enhancement	1	2
Peripheral Enhancement of Cartilaginous CAP	3	6
Non-Enhancing	5	10
Total	**50**	**100**

Table 4: T1W Contrast-Enhanced Image

DISCUSSION

The present study was undertaken to evaluate musculoskeletal tumours by Magnetic Resonance Imaging (MRI) and to correlate findings of MRI with histopathological/surgical findings. A total of fifty patients with musculoskeletal mass lesions suspected clinically and/or on plain radiography were evaluated. Forty three out of fifty patients had histopathological/biopsy/FNAC/surgical findings for correlation. Seven patients, however, were not operated upon for varied reasons (4 - metastasis, 2 - simple bone cyst and 1 - haemangioma).

Specific types of tumours affect certain age groups and anatomic sites. For instance, most osteosarcomas occur during adolescence and about half of them arise in the metaphysis around the knee either in distal femur or proximal tibia. These are the sites of greatest skeletal growth activity. In contrast, chondrosarcomas tend to develop during mid-to-late adulthood and frequently involve the trunk limb girdles and proximal long bones. Giant cell tumours almost always arise in the epiphysis of long bones by comparison Ewing's sarcoma lesions most often are centered in diaphysis. Thus, the location of a tumour provides important diagnostic information.

The most common malignant tumour of bone is metastatic carcinoma. Osteosarcoma was the most frequent malignant primary bone tumour (8 cases-16% of total cases) in our study. The frequency of the tumour types is estimated from the extensive experience with 8542 bone tumours at the Mayo Clinic for more than 40 years in which also most common malignant tumour consisted of osteosarcoma (43% of all cases). MRI was better in delineating the adjacent soft tissue involvement (100% of cases), cortical break (100% of cases) and adjacent joint involvement in four cases (50% of cases). Giant cell tumour was the most common benign primary bone tumour in our series of 50 patients (4 patients-8% of all cases). MRI was superior to CT and plain films in demonstrating areas of tissue inhomogeneity within the giant cell tumour as well as soft tissue extension. Similarly in present study, MRI demonstrated tissue inhomogeneity on T2W images and soft tissue extension.

Osteochondroma was the next common benign lesion in our study. Lee et al[6] performed MR imaging in 8 patients with osteochondroma and found MRI was particularly useful in

assessing the presence and thickness of cartilage cap. The cartilage cap was clearly seen as a region of high signal intensity on T2W images similar to present study.

There was one case of malignant giant cell tumour of humerus, which showed cortical permeation and an associated soft tissue mass as shown by Murphey et al.[7]

One case of Ewing's sarcoma was present in our study, which was confirmed on histopathology in which MRI gave better information on soft tissue involvement and extension within the bone marrow similar to study done by Frouge C et al.[8]

Two cases of sacrococcygeal chordoma were present in our study, which showed adjacent soft tissue involvement and bilateral sacroiliac joints involvement was seen in one case.

There was one case of solitary plasmacytoma in our study in which MRI was superior in defining internal heterogeneity and infiltration or encasement of adjacent structures.

There was one case of haemangioma in present study in which MR imaging demonstrate the classic vertical trabecular or radiating pattern of thickening seen at radiography with high signal intensity on T1 and T2 weighted images due to the presence of intratumoral fat.

In the present study, there was one case of malignant fibrous histiocytoma of left tibia, which on plain radiograph showed a lytic lesion of proximal tibia with pathological fracture of lateral tibial plateau. Coronal MR imaging showed complete cortical destruction in the region of the intercondylar notch with direct invasion of the joint and associated joint effusion.

There were eight cases of malignant mesenchymal tumours, which showed adjacent joint involvement in 3 cases (37.5%) and neurovascular bundle involvement in 4 cases (50%).

In the present study, there were 12 cases of bone forming tumours, 8 cases (16%) of osteosarcoma, 1 case (2%) of chondrogenic osteosarcoma, 2 cases (4%) of osteoid osteoma and 1 case (2%) of osteoma. MRI was found to be the imaging modality of choice for delineating zone of transition, joint involvement, soft tissue involvement and neurovascular bundle involvement in evaluation of musculoskeletal tumours.

There were two patients of glomus tumours in present study located in the subungual region of hands in which tumours are markedly hyperintense relative to subcutaneous fat on T2 and T1 weighted images.

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