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ROLE OF MRI IN EVALUATION OF MUSKULOSKELETAL TUMOURS

Radiodiagnosis

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ABSTRACT

INTRODUCTION: Magnetic resonance imaging is a useful technique in the detection, evaluation and staging of the musculoskeletal tumours. Its excellent soft tissue contrast and its capability to image in multiple planes provides significant superiority over the other imaging techniques.
AIMS AND OBJECTIVES: The main aim of study was to assess the role of magnetic resonance imaging in diagnosis, management and follow up of musculoskeletal tumours.
MATERIALS AND METHODS: The study was conducted on 50 patients suspected of musculoskeletal tumors referred to the Department of Radiodiagnosis, at MMIMSR, Mullana. All the studies were conducted on PHILIPS MULTIVA 1.5T and PHILIPS ACHIEVA 1.5T MRI machine which included T1 W turbo spin echo, T2W turbo spin echo and STIR/PDFS sequences.
RESULTS: The result of the study showed that tenderness was the most common presenting complain seen in 46/50 cases (92.0%) followed by pain in another 45/50 cases (90.0%). In the current study 22 cases (44%) were found to be involved by benign lesions and 28 cases (56%) were found to be involved by malignant lesions. Among the benign osseous tumors, osteoid osteoma constituted 5/13 (38.4%) of cases, followed by osteochondroma 2/13 (15.3%) of cases. Majority of the malignant osseous tumors were ill defined lytic lesions with a wide zone of transition, with cortical breech and aggressive periosteal reaction.
CONCLUSION: The study concluded that MR imaging has become a premier imaging modality to detect musculoskeletal tumors because of its excellent soft tissue contrast, its sensitivity to bone marrow & soft tissue oedema.

KEYWORDS

MRI, Bone tumours, Soft tissue, Malignant

INTRODUCTION

Imaging evaluation of musculoskeletal tumours often involves a multimodality approach, with each modality serving a specific function in the workup. Initial evaluation is typically performed with conventional radiography, followed by a more advanced imaging modality, such as computed tomography (CT) and magnetic resonance imaging. The imaging of these tumours serve three purposes: (1) detection (2) diagnosis and differential diagnosis and (3) staging.[1]

Conventional Radiography provides excellent resolution, allows for assessment of lesion characteristics and is often more specific than nonaggressive from aggressive osseous disease.[2]

Once the lesion has been assessed radiographically if there are aggressive features, further imaging evaluation is required. This is particularly true in the setting of cortical destruction or suspected extension into the adjacent soft tissues. The degree of soft tissue involvement is more accurately characterized by contrast enhanced CT or MRI which allow better discrimination of the extent of disease.[3]

Magnetic resonance imaging (MRI) has become a useful technique in the detection, evaluation and staging of the musculoskeletal tumors. Its excellent soft tissue contrast and its capability to image in multiple planes provides significant superiority over the other imaging techniques, including computed tomography. The role of MRI in differentiating recurrent neoplasms from postoperative and radiation changes continues to grow.[4]

The advantages of MR imaging over other imaging techniques include multiplanar capability, high sensitivity in assessing medullary cavity involvement, better depiction of the soft-tissue extent, excellent demonstration of the neurovascular bundles, muscles, fascia and other soft tissue structures, better soft tissue contrast and tissue characterization ability.

MRI is used to monitor neoadjuvant therapy before surgery to check the treatment response. It is also useful after surgery for the detection of post-operative residual or recurrent tumors.[5]

MR imaging has an exceptional impact on the treatment of patients with musculoskeletal tumours due to its high precision in local staging which has greatly aided in reconstructive and limb salvage procedures, therefore avoiding the need for amputation or disarticulation for majority of patients with musculoskeletal tumors.[6]

This study was undertaken with the purpose to evaluate the role of MRI in the diagnosis, management and follow up of musculoskeletal tumors.

AIMS AND OBJECTIVES

The main aim of study was to assess the role of magnetic resonance imaging in diagnosis, management and follow up of musculoskeletal tumors with special attention:

- To describe the MRI Imaging features of musculoskeletal tumors.
- To determine the origin of musculoskeletal tumors, to characterize nature of tumour and to see the extent of involvement of such tumors.
- To distinguish benign and malignant tumours on MRI.

MATERIALS AND METHODS

The study was conducted on all patients suspected of musculoskeletal tumors referred from Department of Orthopaedics to the Department of Radiodiagnosis, at MMIMSR, Mullana.

Study Design: Descriptive

Sample Size: 50 subjects

Inclusion Criteria-
Patients with clinically suspected/diagnosed musculoskeletal tumours.

Exclusion Criteria

1. Patient's general condition not permitting the study which was carried out.
2. Patients having pacemaker/ metallic implants in place which were not MR compatible.

METHODOLOGY

Before evaluating a patient by magnetic resonance imaging, informed

consent was obtained from the patient. A detailed enquiry was made regarding the possibility of any contraindication to MR imaging like aneurysmal clips, metallic implants, metallic stents, pacemakers etc.

An initial radiograph of the area of interest was obtained and the radiographic features such as presence of an osseous lesion including location, number and nature of the lesion, cortical integrity, periosteal reaction, matrix mineralisation, presence of soft tissue swelling and loss of fat planes etc. were recorded.

Equipment:

All the patients under study were imaged on PHILIPS MULTIVA 1.5 Tesla and PHILIPS ACHIEVA 1.5 Tesla superconducting MR scanner. All the studies included T1 W turbo spin echo, T2W turbo spin echo and STIR/PDFS sequences. Images were obtained in axial, coronal and/or sagittal planes. Fat suppressed T1 weighted images were obtained after contrast administration wherever required. The dose of the contrast (Gadolinium DTPA) was 0.1mmol/kg body weight intravenously.

RESULTS

Table 1: Age distribution of cases.

Age group (in years)	No. of cases	Percentage
0-10.0	6	12.0%
11-20.0	16	32.0%
21-30	6	12.0%
31-40	7	14.0%
41-50	3	6.0%
>50	12	24.0%
Total	50	100.0%

Table no. 1 shows the age distribution of the studied patients, maximum number of patients were in the age group 11-20 years i.e., 16 (32.0%), followed by >50 years i.e., 12 (24.0%).

Table 2: Distribution of musculoskeletal tumours as per nature of tumour.

Nature	No. of cases	Percentage
Benign	22	44.0%
Malignant	28	56.0%
Total	50	100.0%

Table no. 2 shows the distribution of musculoskeletal tumors of the studied patients as per their nature. Of the total 50 musculoskeletal tumors, 22 cases (44.0%) were found to be benign lesions and 28 cases (56.0%) were found to be malignant lesions.

Table 3: MRI features of benign primary bone tumours.

Benign Bone tissue	Total	Margins		T1	T2			STIR		Bone Marrow Involvement	Muscle Involvement	Intermuscular Plane	articular/epiphyseal extension	Soft Tissue Involvement	Nvs Involvement	Tendon sheath involvement	Fluid fluid Levels	Cartilage Cap	Enhancement	
Diagnosis		**Well defined**	**ill-defined**	**Hypointense**	**Iso to hyper**	**Hyperintense**	**Heterogeneously hyperintense**	**Hyperintense**	**Heterogenous**										hetero genous	homogenous
Aneurysmal bone cyst	2	2	0	2	0	0	2	2	0	1	0	0	2	1	0	0	2	0	2	0
Chondroblastoma	1	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Enchondroma	1	1	0	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0
Osteochondroma	2	2	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	2	0	0
Osteoclastoma/gct	1	1	0	1	0	0	1	1	0	1	0	0	1	0	0	0	1	0	1	0
Osteoid osteoma	5	5	0	3	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Simple bone cyst	1	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Total	13	13	0	9	1	2	3	5	2	7	0	0	6	1	0	0	3	2	4	0

The study included 13 cases of benign bone tumors. Most of the lesions were hypointense on T1-weighted images. Fluid fluid levels were observed in two cases of ABC and one case of GCT (suggesting cystic degeneration).

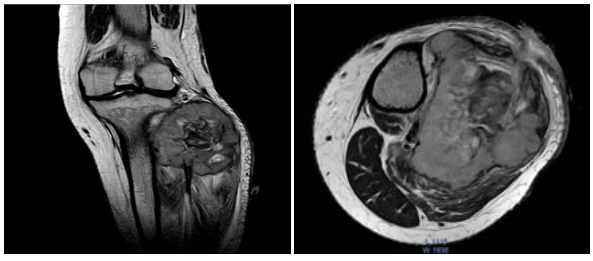
Cartilage cap was observed in all the cases of osteochondroma as well defined smooth marginated T2W hyperintense structure, all measuring less than 1 cm. Soft tissue component was observed only in ABC. Rim enhancement was noted in SBC while heterogenous septal enhancement in ABC. Enhancement of solid component of GCT was evident with sparing of cystic component. Heterogenous enhancement pattern was observed in enchondroma and chondromyxoid fibroma.

Table 4: MRI features of malignant bone tumours.

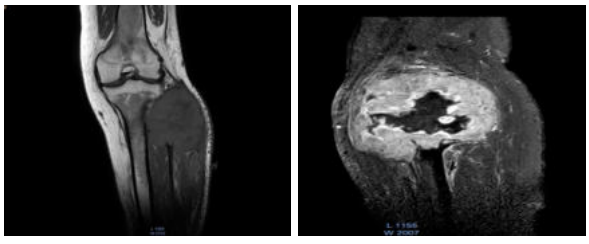
Malignant Bone tissue	Total	Margins		T1	T2			STIR		Bone Marrow Involvement	Muscle Involvement	Intermuscular Plane	articular/epiphyseal extension	Soft Tissue Involvement	Nvs Involvement	Tendon sheath involvement	Fluid fluid Levels	Cartilage Cap	Enhancement	
Diagnosis		**Well defined**	**Ill-defined**	**Hypo**	**Hyper**	**Hyper**	**Heterogeneous**	**Hyper**	**Heterogeneous**										hetero geneous	homo genous
Chondrosarcoma	4	0	4	2	1	0	3	0	3	4	3	3	3	4	3	0	0	1	4	
Ewing's sarcoma	6	0	6	4	2	0	6	1	5	6	5	5	6	6	4	1	0	0	6	
Lymphoma	1	0	1	1	0	0	1	0	1	1	0	0	0	1	1	0	0	0	1	
Metastasis	4	0	4	3	1	1	1	1	0	3	2	1	0	1	0	0	0	0	4	
Myeloma	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
Osteosarcoma	3	0	3	1	2	0	3	0	1	2	3	0	2	3	2	0	0	0	3	

Total	19	0	19	12	6	1	14	2	10	16	13	10	11	15	10	1	0	1	19	0

The study depicted 19 total subjects with malignant bone tumours out of which all the malignant osseous tumours revealed ill-defined margins with most exhibiting hypointense signal on Tl W images. Cortical breech and soft tissue extension were seen in all patients of osteosarcoma and chondrosarcoma. All cases of Ewing's sarcoma depicted bone marrow involvement with epiphyseal extension. Neurovascular involvement was seen in osteosarcoma, Ewing's sarcoma and chondrosarcoma. Contrast enhancement was heterogenous in 19/19 (100%) cases.



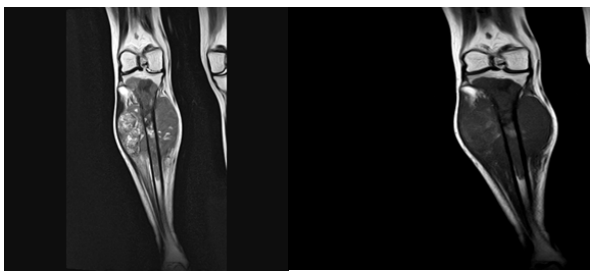
a.T2W coronal b. T2W Axial



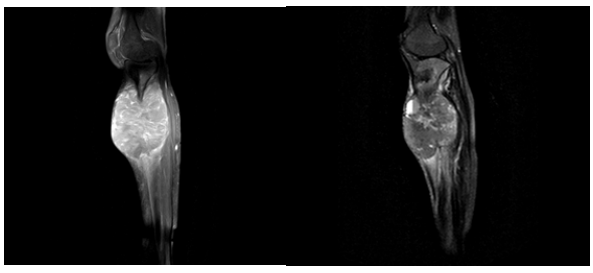
c. T1W Coronal d. Post contrast

Figure 1. Giant Cell Tumour of Fibula

A large expansile mass is seen arising from the proximal fibula showing low to intermediate signal on T1W and relatively high signal on T2W images. On post contrast images there is inhomogeneous moderate peripheral enhancement and non-enhancing central necrosis.



a.PD SPAIR coronal b.T1W coronal



c.Post contrast sagittal d. T2W sagittal

Figure 2. Osteosarcoma of tibia

The images show a long segment intramedullary lesion in the upper and mid part of tibia involving the epiphysis, metaphysis, and upper and mid diaphysis. The lesion appears heterogeneously hypointense on T1W and hyperintense on T2W/STIR sequences. Cortical erosions, irregular periosteal thickening and sunray type of periosteal reaction is seen. There is an associated large soft tissue mass involving the peri-osseous muscles showing significant heterogeneous enhancement. The neurovascular bundle is also encased.

DISCUSSION

The study was undertaken to evaluate the role of MRI in musculoskeletal tumours. The study group comprised of 29 male subjects (58.0%) and 21 female subjects (42.0%) ranging from 3yrs to 79 yrs.

Tenderness was the most common presenting complain seen in 46/50 cases (92.0%) followed by pain in another 45/50 cases (90.0%). Swelling was the presenting complain in 34/50 cases (68.0%).

In the current study 22 cases (44%) were found to be involved by benign lesions and 28 cases (56%) were found to be involved by malignant lesions. Overall prevalence of malignant musculoskeletal tumours is estimated between 5.1 and 15.5% of all sarcomas.[7]

Benign Bone Tumours

Among the benign osseous tumors, osteoid osteoma constituted 5/13 (38.4%) of cases, followed by osteochondroma 2/13 (15.3%) of cases. Two cases were of aneurysmal bone cyst with one case of chondroblastoma, GCT, SBC and Enchondroma. One case of ABC involved the calcaneum. Rest of the benign bone tumours (i.e., 88.2%) involved long bones. In a study comprising 3482 cases by **Bergovec M, et al. (2015)[8],** the long bones of lower extremity (femur 26.7%, tibia 20.3%) held primacy over all other localizations. No soft tissue component was associated with benign bone tumors.

Most common benign bone tumors seen in our study was osteoid osteoma (38.4%). The tumor shows a solid periosteal reaction with cortical thickening. The nidus was visible as a well circumscribed lucent region, occasionally with a central sclerotic dot. The findings are consistent with study conducted by **Jaffe HI, et al. (1935).[9]**

Matrix mineralisation in the form of punctate calcifications was seen in chondroblastoma with a sharply defined sclerotic margins.

Solid periosteal reaction with surrounding sclerosis was noted in all 5 cases of osteoid osteoma with a central radiolucent nidus.

On MR evaluation all the benign osseous tumors were well defined with most exhibiting hypointense signal on Tl W images. 2 out of 13 cases (15.3%) were homogenously hyperintense on T2W1 including one case each osteochondroma and simple bone cyst. Heterogeneity was noted in ABC due to fluid fluid levels, GCT due to cystic degeneration. Chondroblastoma exhibit heterogenous signal on T2WI due to hypointense punctate calcifications.

Malignant Bone Tumors

Our study included a total of 19 malignant tumors of which six were Ewing's sarcoma, four chondrosarcoma, three osteosarcoma and one each lymphoma and myeloma. Four of the lesions were metastatic deposits.

MR revealed hypointense signal on Tl WI and heterogenous high signal on T2WI. Similar observations were made by **Sun Y, et al. (2017).[10]**

Zone of transition was wide in all the malignant bone tumors. Associated soft tissue component was present in most of the cases.

On evaluation with MRI, 19/19 malignant osseous masses showed ill-defined margins with most exhibiting hypointense signal on Tl W images.

In our study, neurovascular involvement was seen in two cases of osteosarcoma, three cases of chondrosarcoma and four cases of Ewing's sarcoma.

In our study heterogeneous contrast enhancement pattern was shown by all malignant osseous tumours. Most studies have found contrast enhancement progression significant for benign malignant differentiation**.**

CONCLUSION

This study has demonstrated that MR imaging has become a premier imaging modality for the evaluation of musculoskeletal tumors because of its excellent soft tissue contrast, its sensitivity to bone marrow & soft tissue oedema and its multiple imaging planes. Its ability to demonstrate adjacent joint involvement or skip lesions and involvement of neurovascular bundle helps in proper preoperative

assessment of extent of lesion and thereby guiding appropriate management.

Osteoid osteoma was the most common benign osseous tumor with a benign periosteal reaction.

On MR, all benign osseous lesions were well defined with characteristic fluid levels in ABC. None of the benign osseous lesion showed evidence of neurovascular invasion except osteoid osteoma. Majority of the malignant osseous tumors were ill defined lytic lesions with a wide zone of transition. Cortical breech with soft tissue component and aggressive periosteal reaction was more commonly associated with malignant osseous tumors.

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