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Role of radiological modalities in bone tumors & tumor mimics

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***Abstract*---**Imaging bone tumors causes uncertainty,especially outside dedicated sarcoma treatment centres. Conventional radiographs remains the backbone of bone tumor diagnostics, but MR imaging has a role.Radiographs are crucial for assessing tumor matrix and aggressiveness. MR imaging is the best modality for local staging. This article reviews semiological aspects of bone tumors: patient age, tumor localization,pattern of bone destruction,periosteal reaction.

***Keywords*---**bone tumors semiology, bone tumors, MR imaging, X-rays.

Introduction

Bone lesions are diverse in size, gross & histological features, natural history from the innocuous to rapidly fatal. This diversity makes it critical to diagnose tumors correctly, stage them accurately & treat them appropriately, so that the patient not only survives but also maintains the optimal function of the affected body parts.[1] In the present study, imaging of bone tumors are considered, starting from plain radiograph to USG & modern & advance imaging like CT & MRI. X-ray is preliminary & most important imaging investigation in determining differential diagnosis of bone lesion. Cortical destruction, soft tissue expansion & faint mineralization are more readily appreciated on CT scan. USG gives idea about soft tissue component & cortical involvement.[2] MRI give more information about marrow involvement. It accurately & precisely delineates extent of the tumor into soft tissues & the medullary canal, involvement of joint, crossing of the lesion through & around the growth plate, any skip lesion in the same bone & across the joint in other bone, proximity & encasement of the neurovascular bundle by the tumor.

Aims and Objectives

Radiological diagnosis to compare accuracy of imaging modalities. To study the relative incidence of various tumor and tumor like conditions.

Approach to Diagnosis

Most bone tumors are osteolytic. The most reliable indicator in determining whether these lesions are benign or malignant is the zone of transition between the lesion and the adjacent normal bone. [3] Age is the most important clinical clue. Finally, other clues need to be considered, such as a lesion's localization within the skeleton and within the bone, any periosteal reaction, cortical destruction, matrix calcifications, etc.

Zone of transition

In order to classify osteolytic lesions as well-defined or ill-defined, we need to look at the zone of transition between the lesion and the adjacent normal bone.[4] The zone of transition is the most reliable indicator in determining whether an osteolytic lesion is benign or malignant. The zone of transition only applies to osteolytic lesions since sclerotic lesions usually have a narrow transition zone.[5]

Small zone of transition

A small zone of transition results in a sharp, well-defined border and is a sign of slow growth.[6] A sclerotic border especially indicates poor biological activity.

Wide zone of transition

An ill-defined border with a broad zone of transition is a sign of aggressive growth. It is a feature of malignant bone tumors.

Periosteal Reaction

A periosteal reaction is a non-specific reaction and will occur whenever the periosteum is irritated by a malignant tumor, benign tumor, infection or trauma.[7] There are two patterns of periosteal reaction: a benign and an aggressive type. The benign type is seen in benign lesions such as benign tumors and following trauma. An aggressive type is seen in malignant tumors, but also in benign lesions with aggressive behavior, such as infections and eosinophilic granuloma.[8]

Benign periosteal reaction

Detecting a benign periosteal reaction may be very helpful, since malignant lesions never cause a benign periosteal reaction. A benign type of periosteal reaction is a thick, wavy and uniform callus formation resulting from chronic irritation. In the case of benign, slowly growing lesions, the periosteum has time to lay down thick new bone and remodel it into a more normal-appearing cortex.

Aggressive periosteal reaction

This type of periostitis is multilayered, lamellated or demonstrates bone formation perpendicular to the cortical bone. It may be spiculated and interrupted - sometimes there is a Codman's triangle. A Codman's triangle refers to an elevation of the periosteum away from the cortex, forming an angle where the elevated periosteum and bone come together. [9]

Cortical destruction

Complete destruction may be seen in high-grade malignant lesions, but also in locally aggressive benign lesions like EG and osteomyelitis. More uniform cortical bone destruction can be found in benign and low-grade malignant lesions. Endosteal scalloping of the cortical bone can be seen in benign lesions like FD and low-grade chondrosarcoma. Ballooning is a special type of cortical destruction. In ballooning the destruction of endosteal cortical bone and the addition of new bone on the outside occur at the same rate, resulting in expansion. This 'neocortex' can be smooth and uninterrupted, but may also be focally interrupted in more aggressive lesions like GCT.[10]

Location within the skeleton
Location: Epiphysis-metaphysis-diaphysis
Epiphysis

Only a few lesions are located in the epiphysis, so this could be an important finding. In young patients it is likely to be either a chondroblastoma or an infection. In patients over 20, a giant cell tumor has to be included in the differential diagnosis. In older patients a geode, i.e. degenerative subchondral bone cyst must be added to the differential diagnosis.

Metaphysis

NOF, SBC, CMF, Osteosarcoma, Chondrosarcoma, Enchondroma and infections.
Diaphysis
Ewing's sarcoma, SBC, ABC, Enchondroma, Fibrous dysplasia and Osteoblastoma.

Location: centric - eccentric – juxtacortical

Centric in long bone
SBC, eosinophilic granuloma, fibrous dysplasia, ABC and enchondroma are lesions that are located centrally within long bones.
Eccentric in long bone
Osteosarcoma, NOF, chondroblastoma, chondromyxoid fibroma, GCT and osteoblastoma are located eccentrically in long bones.
Cortical
Osteoid osteoma is located within the cortex and needs to be differentiated from osteomyelitis.
Juxtacortical
Osteochondroma. The cortex must extend into the stalk of the lesion. Parosteal osteosarcoma arises from the periosteum.

Methods and Material

Prospective Observational study was carried out in Department of Radio-Diagnosis,Dhiraj Hospital , SBKS Medical College, Vadodara with Allengers MARS 50 HF X-ray machine, SIEMENS SOMATOM 16 slice CT machine and PHILIPS 1.5 T MRI machine. About 50 consecutive patients presenting with bony complaints, pain/ restriction of joint movement due to swelling, pathological fracture etc were included in study.

Observation & Results

Sex Distribution

SEX	NO. OF CASES	%
Male	34	68
Female	16	32

Age Distribution

AGE GROUP	**NO, OF CASES(N=50)**	**PERCENTAGE (%)**
0-10	04	08
11-20	14	28
21-30	06	12

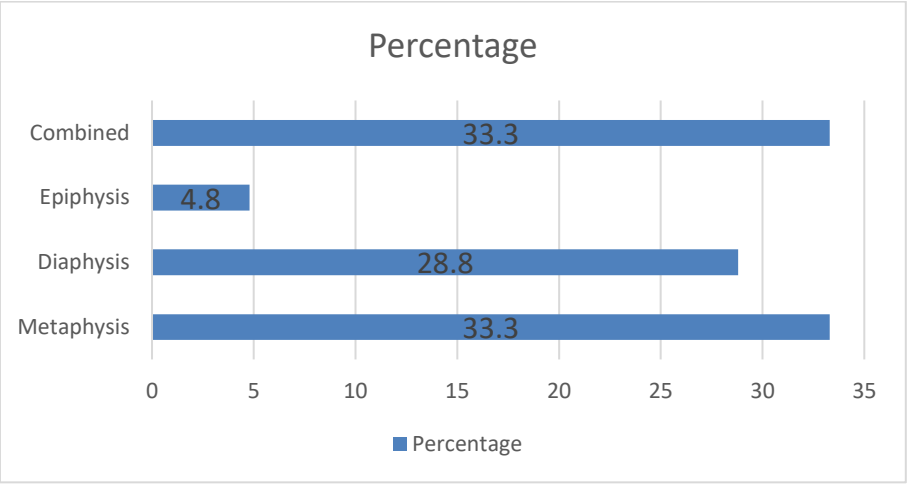
31-40	05	10
41-50	06	12
51-60	07	14
61-70	06	12
>70	02	04
Total	50	100

Axial Vs. Appendicular	No. of cases (N=50)	Percentage (%)
Axial	22	44
Appendicular	22	44
Combined	06	12
Total	50	100

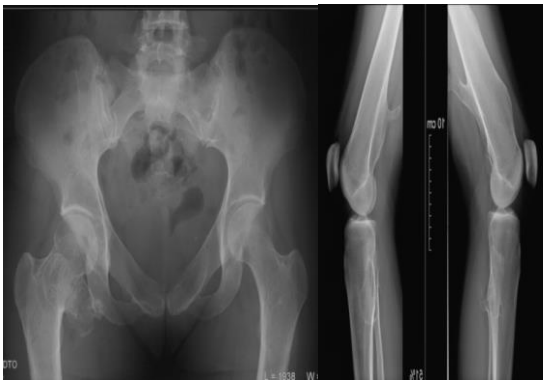
Bone involvement	No. of cases (N=50)	Percentage
Mono-ostotic	28	56
Poly-ostotic	22	44
Total	50	100

Location within bone	No. of cases (n=21)	Percentage (%)
Metaphysis	07	33.3
Diaphysis	06	28.6
Epiphysis	01	4.8
Combined	07	33.3

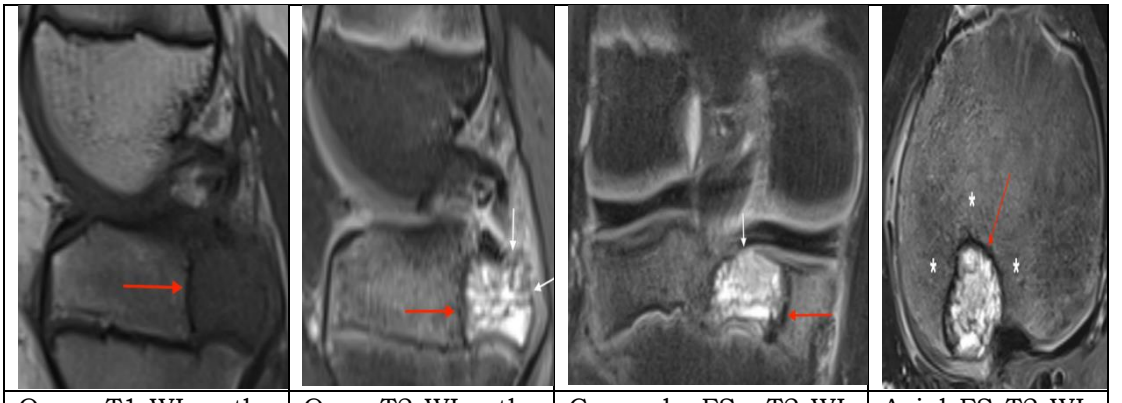
Location within Tubular Bone



CASES
Multiple Hereditary Osteochondromatosis



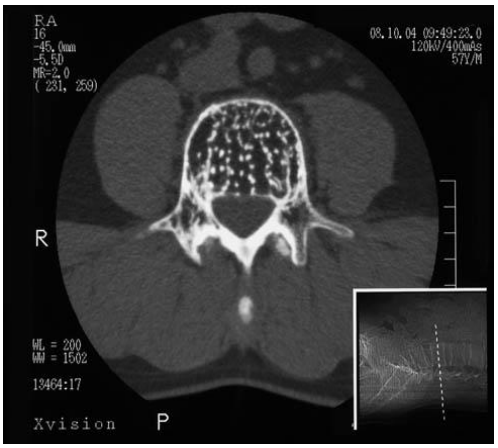
Chondroblastoma



On T1-WI the	On T2-WI the	Coronal FS T2-WI.	Axial FS T2-WI.

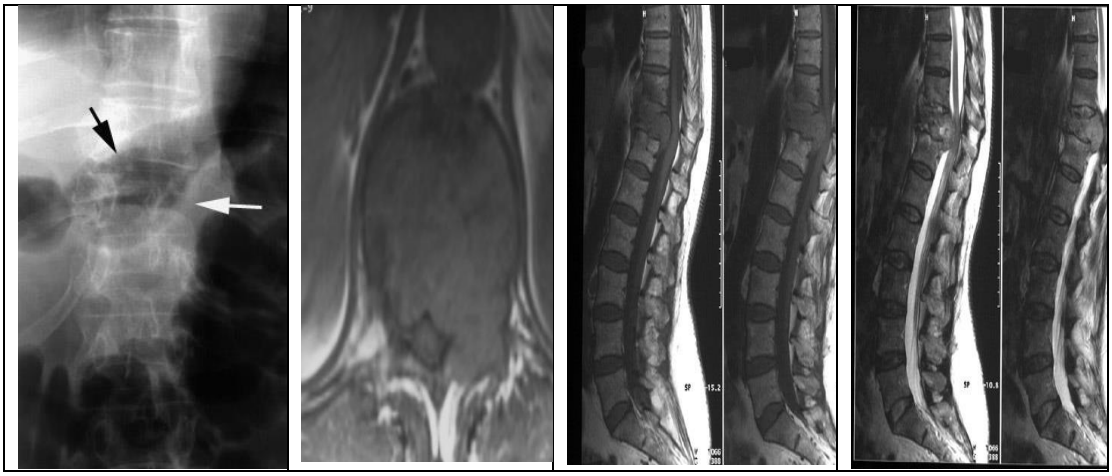
lesion is isointense to muscle and is partially surrounded by a hypointense border corresponding with a sclerotic rim on CT.	lesion is inhomogeneous, hyperintense with interspersed areas of low signal intensity. The lesion is relatively well-demarcated and has a hypointense rim.	There was suspicion of breakthrough of the articular cortex and the posterior cortex of the proximal tibia.	Marked surrounding bone marrow oedema . There is an overall lobular structure of the lesion.

Haemangioma



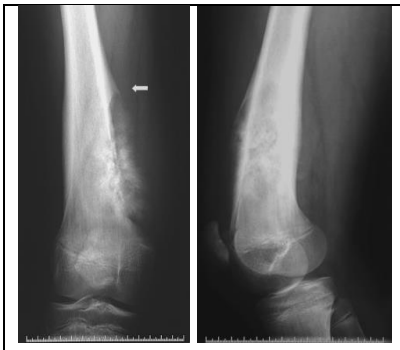
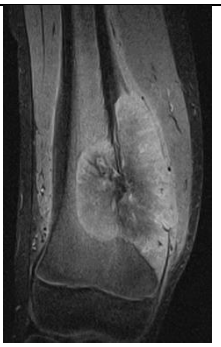
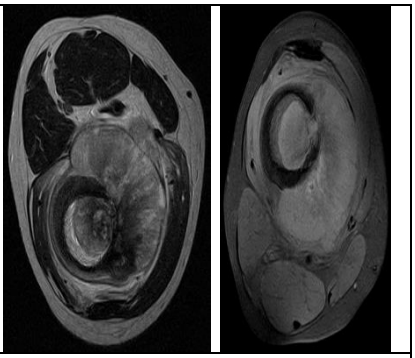
Typical haemangioma with a polka dot sign presented in the entire vertebral body. It extended to the pedicles

Metastases

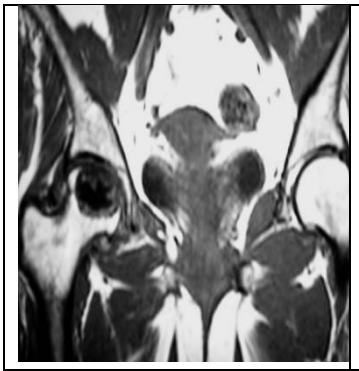
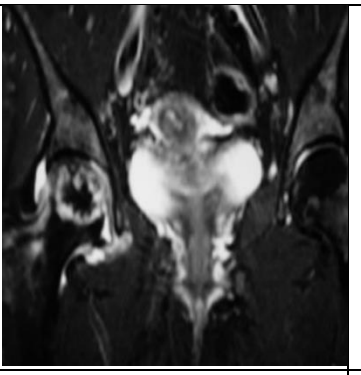
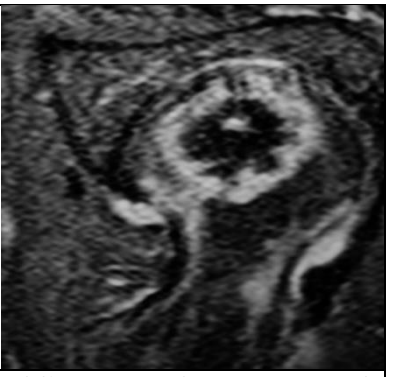


AP radiograph of the thoracic spine demonstrating destruction of the left pedicle of T11) and inferior end-plate of T 10.	Axial T1-weighted image demonstrating extensive involvement of the body,left pedicle and lamina of T11 .	Sagittal T1 – weighted images of the thoraco-lumbar spine demonstrating abnormal signal and extensive collapse of the T11 vertebral body with a large extra-osseous mass displacing the spinal cord posteriorly.	Sagittal T2 – weighted images of the thoraco-lumbar spine demonstrating abnormal signal and extensive collapse of the T11 vertebral body with a large extra-osseous mass displacing the spinal cord posteriorly.

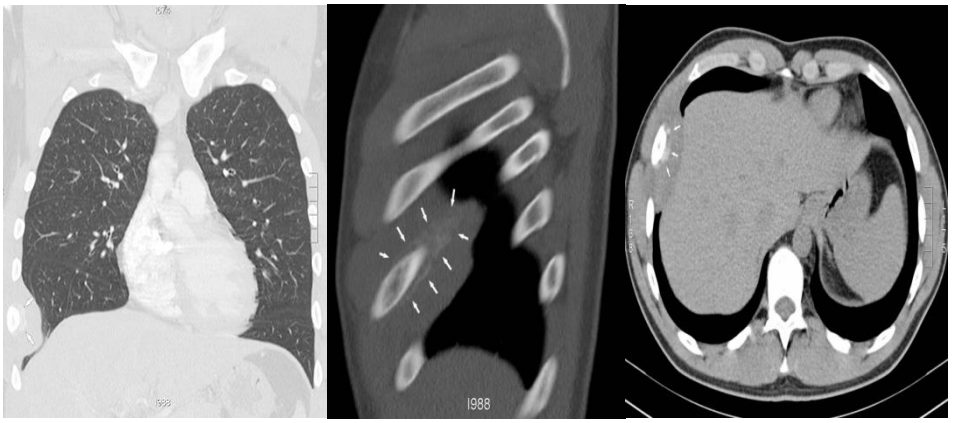
Osteosarcoma

		
There is bone destruction along with new bone formation in a "sun-ray" pattern. At the upper end the tumor has lifted the periostium causing a Codman's triangle. There is evidence of a soft tissue mass.	Coronal proton density inverse recovery image clearly demonstrating both the intra- and extraosseous extent of the tumour, the extraosseous component is larger than the intraosseous. The tumour has not reached the epiphyseal plate.	Axial T2-weighted turbo spin echo image showing the heterogeneous tumour mass that has breached the cortex and extended into the soft tissue.

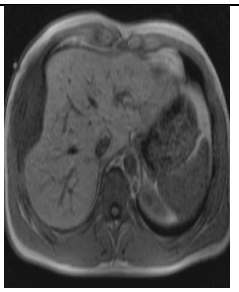
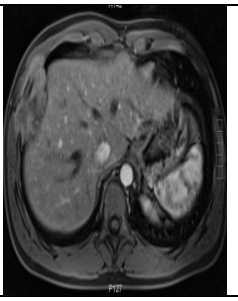
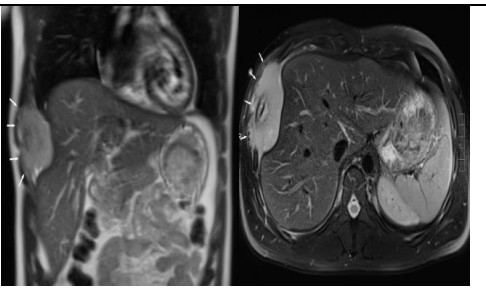
Chondrosarcoma

		
A coronal T1-weighted spin-echo image shows the low signal intensity lesion in the right femoral head. The spherical contour of the head is intact.	A coronal T2-weighted fat-suppressed turbo-spin-echo image shows the low signal intensity central calcified matrix of the lesion, the high signal intensity halo corresponding to the non-mineralised matrix and a moderate intraarticular effusion.	Oblique fat-suppressed contrast-enhanced T1-weighted spin-echo image demonstrates intense enhancement in the non-mineralised portions of the lesion.

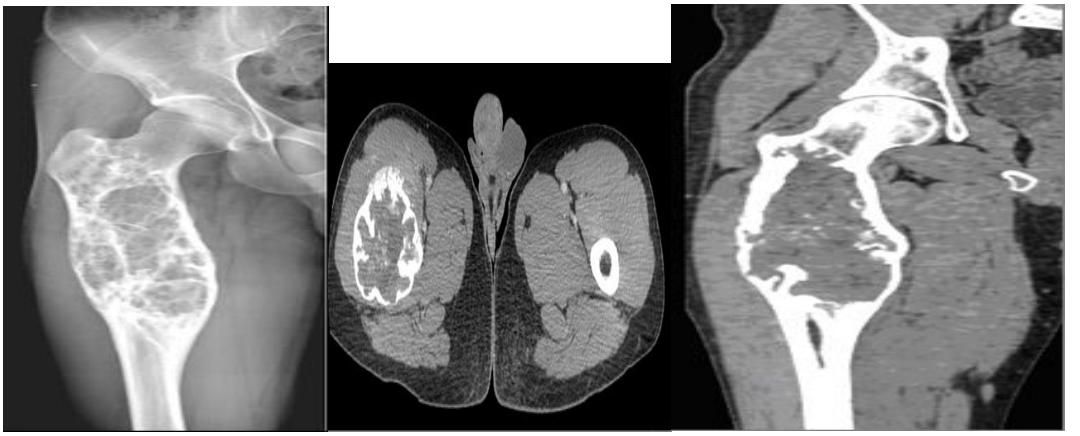
Ewing's sarcoma



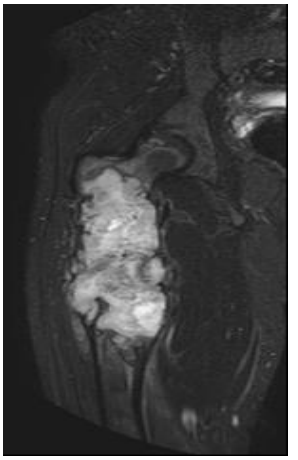
Extrapleural soft-tissue mass encasing the seventh right rib. An aggressive sunburst type periosteal reaction is associated.

		
On axial T1-weighted image, the lesion is iso-intense to muscle and wraps around the anterolateral part of the seventh right rib.	Axial fat suppressed (FS) T1-WI after intravenous administration of gadolinium contrast shows heterogeneous enhancement, predominantly at the periphery of the lesion. The lesion invades the muscles of the chest wall.	On axial FS T2-WI, the lesion is of high signal and invades the muscles of the chest wall . There is a broad based extrinsic impression on the liver.

Epithelioid Haemangioendothelioma

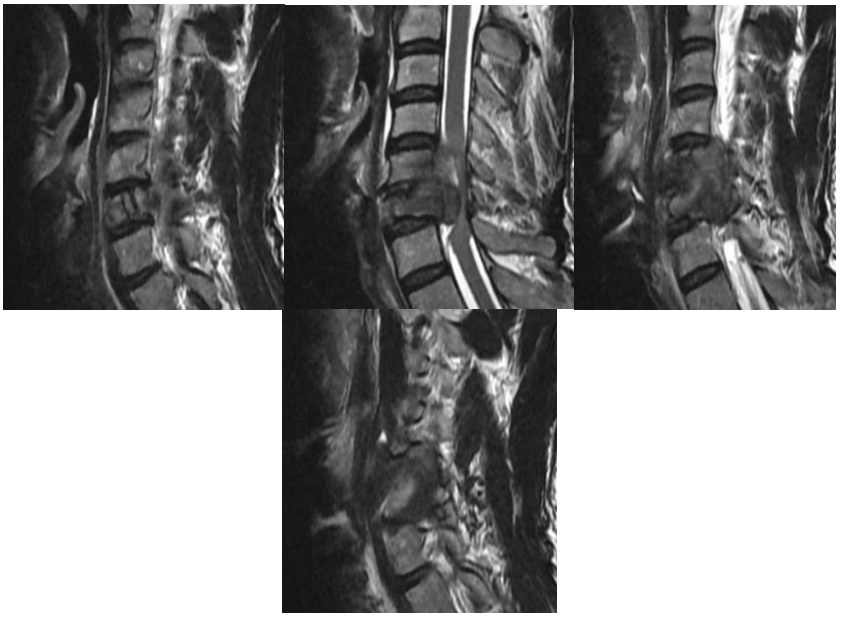


Presence of an extended endosteal bone neoformation in the context of a proximal diaphysis morphostructural alteration. Presence of a gross inhomogeneous expansive solid lesion with calcifications involving the right femur proximal diaphysis, which appears to swell the cortical bone with discontinuities and periosteal reaction.

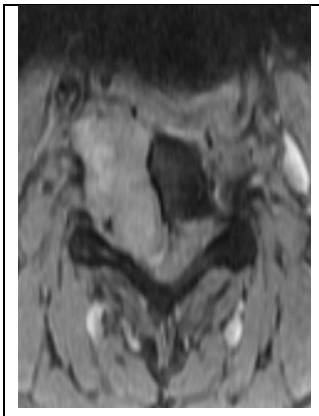
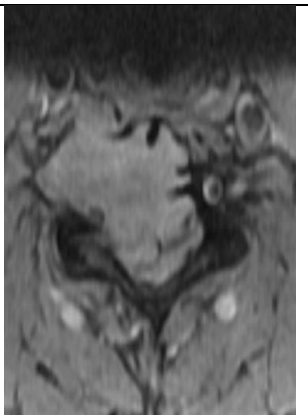
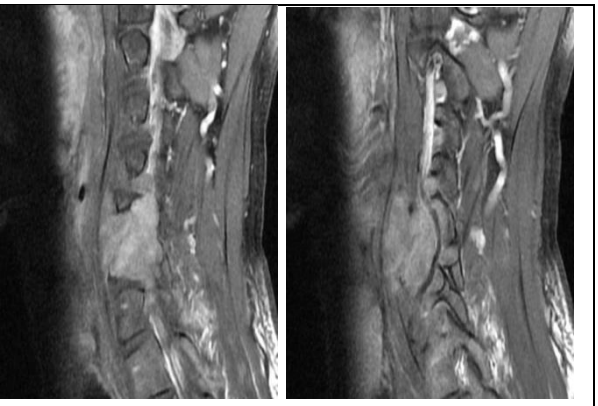


T1-weighted MR image with fat suppression after Gadolinium i.v. injection demonstrates a lesion composed of juxtaposed hypocellular tissue, with mild-high contrast enhancement.

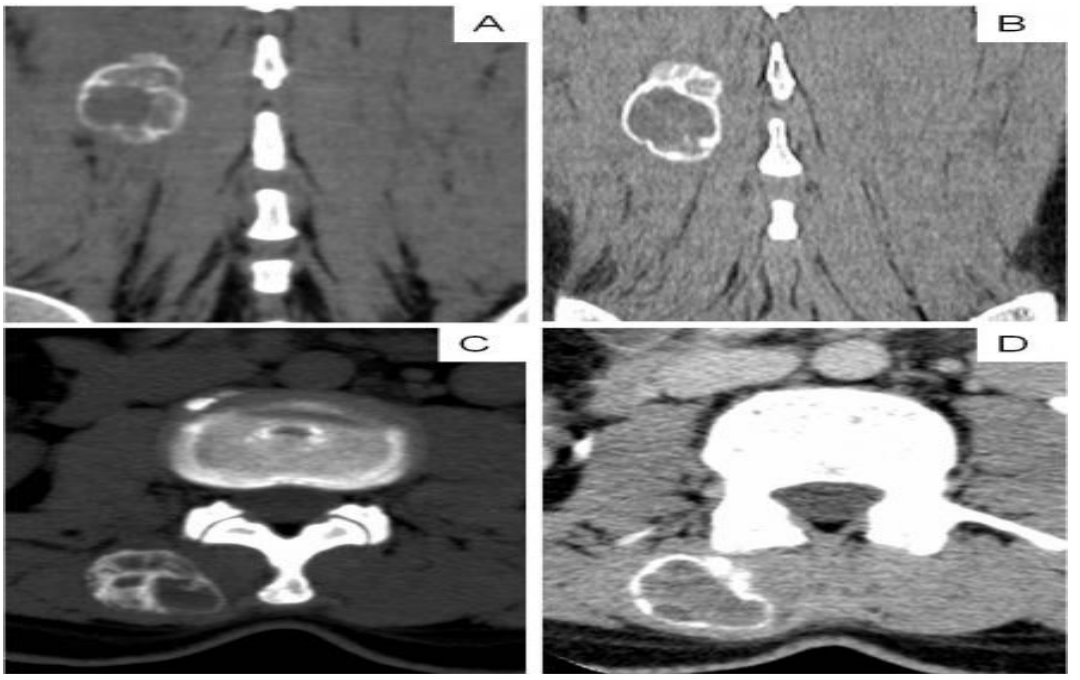
Plasmacytoma



Sagittal T2 image of cervical spine revealed hypointense thick cortical struts in left side of C6 vertebral body with adjacent hyperintense lesion. Hypointense lesion in C5 and C6 vertebral body with destruction of C5-6 disc, extending into the epidural region & right paravertebral region, causing compression of the cervical spinal cord.

		
Axial GRE image revealed homogeneous hyperintense lesion involving vertebral body, right transverse process and right articular facet of C5 vertebrae.	Hypointense thick cortical struts in C6 vertebral body and hyperintense lesion between struts, showing a "Mini Brain" appearance.	Sagittal post-contrast T1 image of cervical spine revealed enhancing lesion in the right-sided articular and transverse process of C5 and C6 vertebrae with right vertebral artery encasement.

Myositis Ossificans Circumscripta



Ossification in the periphery and lucent area in the center.

Summary and Conclusion

After evaluating 50 patients with bone tumors & tumor mimics using plain X-ray & 1.5 T MRI machine for 1 year, following conclusion are obtained. Higher male preponderance with male:female ratio of 2.13:1. Highest incidence in 2nd & 6th decades. Almost half of them involve axial skeleton & half involve appendicular skeleton. Most commonly involved bones were femur, tibia & spine with involvement of metaphysis>diaphysis>epiphysis. Malignant tumors > Benign tumors> Tumor mimics. Most common primary malignant bone tumor is osteosarcoma, secondary malignant bone tumor is metastases & benign tumor is osteochondroma. X-ray is still 1st line radiological modality at present for imaging bone tumors & its mimics as it give basic information about its characteristics, cortical breach & its aggressiveness.[9] However sensitivity of MRI scan for lesion detection was higher. It is essential for lesion characterization,marrow edema, neurovascular bundle involvement, staging of tumor, treatment planning and follow up.[10]

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