Imaging of Musculoskeletal system

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Objectives

Radiographic anatomy of the bone
Imaging signs of bone disease
Imaging of osteomyelitis
Infection of the spine

Imaging signs of bone disease:

Decrease in bone density

Focal → lytic area
Generalized → osteopenia

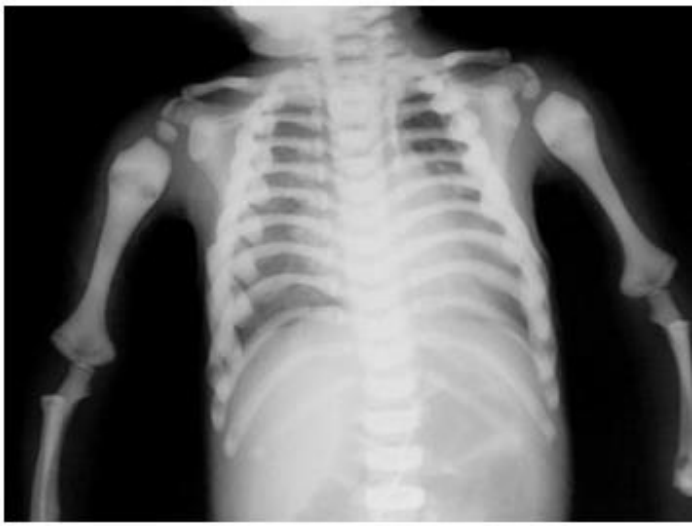
increase in bone density

→ Sclerosis

Lytic lesion

osteopenia

Sclerotic lesion



generalized increase in density

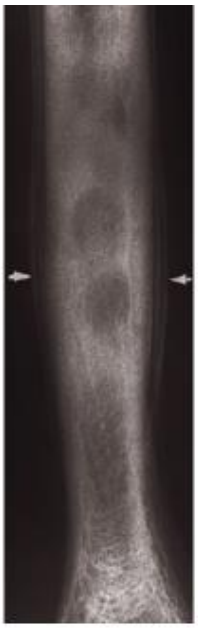
Periosteal reaction

Excess bone produced by the periosteum (appears as separate lines or spicules of calcification)

Types: Single lamellar
Spiculated
Onion skin
Codman's triangle

Solid lamellar

Spiculated

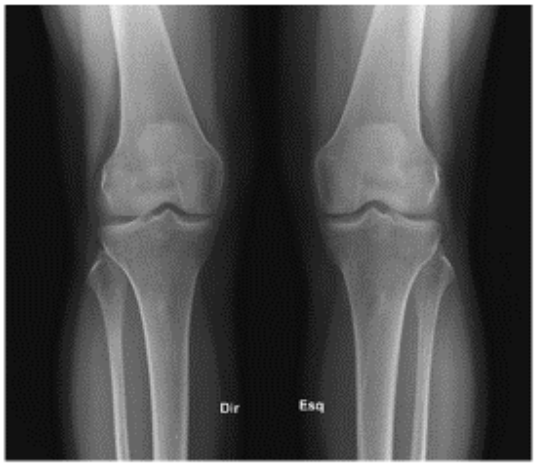


Onion skin

Codman's triangle

Cortical thickening
Also involve lying down of new bone by periosteum but the process is very slow or has healed → the new bone shows the same homogenous density as does the cortex

Alteration in trabecular pattern
Reduction in the number of trabeculae with an alteration in the remaining trabeculae
e.g. osteoporosis, Paget's disease



Normal knee osteoporosis

Alteration in the shape of a bone
is another complex response with many causes. Some are congenital in origin; some are acquired, e.g. acromegaly and expanding bone tumours.

Alteration in bone age
The time of appearance of the various epiphyseal centers and their time of fusion depends on the age of the child.
So x ray can be used to detect discrepancy between chronological age and biological age.

Osteomyelitis

Definition: infection of the bone

Sources of invading organisms:
Haematogenous spread from distant foci
Contiguous source of infection (from an infected wound or from an infected adjacent joint)
Direct implantation (trauma or surgery)

Stages of osteomyelitis:

*Acute * Subacute *Chronic

Causative organism:

Most commonly pyogenic (bacterial) usually streptococcus in infants and staphylococcus in adults.
Other non pyogenic causes e.g. T.B , syphilis ,fungi.

Location of osteomyelitis within the bone:

Infants : metaphysis and/or epiphysis (acute pyogenic arthritis is a relatively common sequel of osteomyelitis)
Children(1-16yr): metaphysis (epiphysis and joint less frequently infected)
Adults: metaphysis and epiphysis

Imaging modalities

-Plain x ray
-Radionuclide bone scan
-MRI
-Ultrasound
-CT scan
Note: thorough clinical examination and laboratory investigations are extremely important in diagnosis, before imaging evaluation is performed.

Radiological features on X ray

- Soft-tissue changes: Swelling, with edema and blurring of fat planes.

(may be immediately apparent especially in infants)

- Bone destruction: may be visualized within 10 to14 days of onset of symptoms. In children this is usually metaphyseal.
- Periosteal reaction: may become very extensive and surround the bone to form **Involucrum** which is usually visualized after 3 weeks and is more prolific in infants and children than in adults
- Sequestrum: separate dense fragment formed due to death of part of original bone (As sequestra are devitalized they remain

denser than surrounding vital bone, which becomes demineralized due to hyperaemia and immobilization).

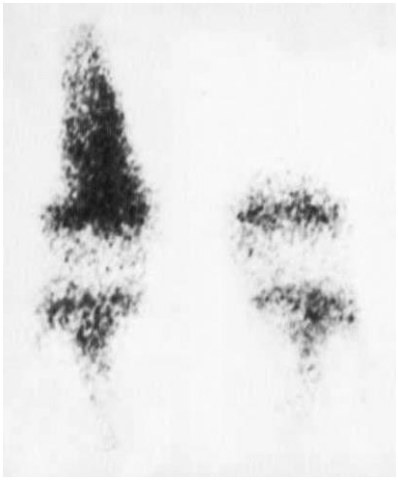
- In areas of dead periosteum, defects in the involucrum occur (***cloacae***), these allow pus and sequestra to escape, sometimes to the skin via a sinus.
- Sinus tract: opening from the infection to the skin surface.

(A) Early metaphyseal infection. There is very minimal focal bone destruction at the distal radial metaphysis. (B) With progressive destruction, metaphyseal abnormality is now very evident

Osteomyelitis. (a) Initial films reveal no abnormality. (b) Films taken 3 weeks later show some destruction of the upper end of the tibia and an extensive periosteal reaction along the tibia, particularly the medial side (arrow).

Radionuclide bone scan

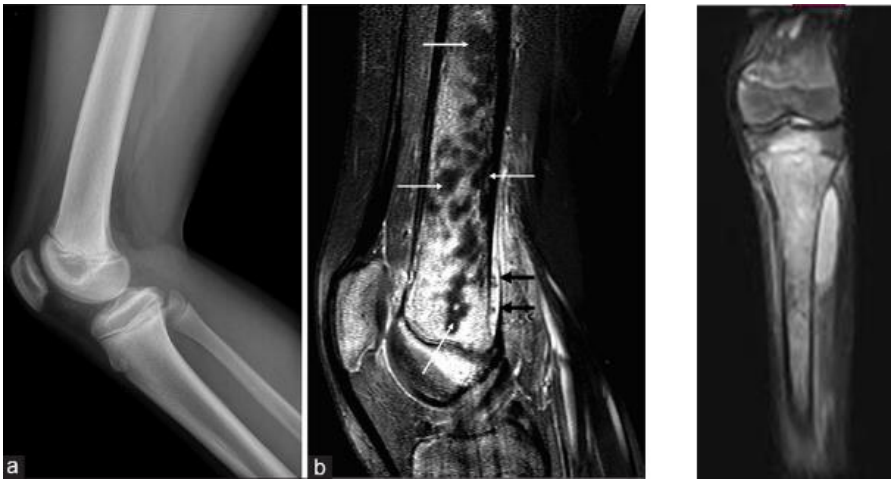
*Use ^{99m}Tc MDP (methylene diphosphonate).
*3 phases scan: blood flow, blood pool, delayed scan.
*On osteomyelitis there is increase uptake on all phases.
*Changes appear much earlier in the course of the disease within a day or two.



MRI

MRI demonstrates osteomyelitis as early as isotope scanning and it's the method of choice to diagnose musculoskeletal infection
Demonstrate edema in cortex, medulla, lack of enhancement in area of destruction and necrosis, soft tissue extension and pus accumulation in the bone and soft tissues

MR is much better at demonstrating the extent of pathology in bone and surrounding soft tissues
US and CT scan.

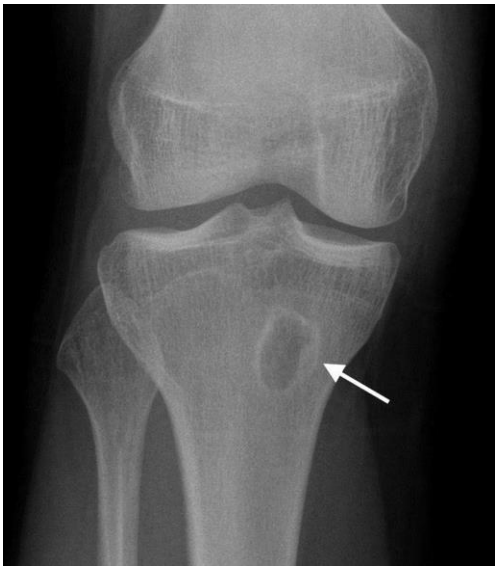


Ultrasound: can demonstrate subperiosteal collections of pus well before bone changes are evident on plain film.

CT scan: demonstrates changes related to cortical bone or periosteum. Sequestra are shown as area of high attenuation spicules of bone within area of osteolysis. Cloaca, periosteitis and soft tissue lesions are also shown, Ct guided biopsy can be obtained for culture.

Sub-acute osteomyelitis:

Brodie abscess is a characteristic lesion of sub acute osteomyelitis, consisting of well-circumscribed area of bone destruction has a surrounding zone of reactive sclerosis.
It may have a finger-like extension into neighboring bone toward the physeal plate, which, when present, is pathognomonic of infection.


Brodie abscess

Chronic osteomyelitis

It is an indolent infection lasting greater than 6 weeks
It is a result of osteonecrosis caused by disruption of intraosseous and periosteal blood supply during the acute stage of the disease → sequestrum.
Infective agents within the devascularised sequestrum become protected from antibiotics and the endogenous immune response, forming a nidus for chronic infection.
This may persist for years.
Chronic osteomyelitis can cause a mixed lytic and sclerotic appearance, with a thickened cortex on plain radiograph
CT may provide information regarding the presence of sequestra, cloaca, cortical destruction and the thickness of the involucrum

Distinction of neoplasm from osteomyelitis

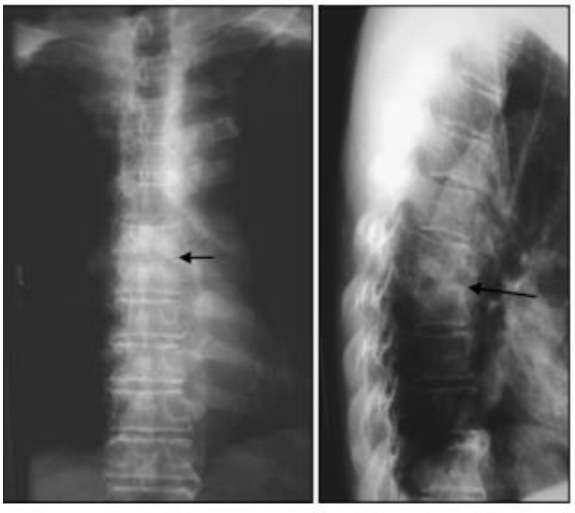
The clinical history is clearly important. With malignant bone tumors, the radiographs are usually abnormal when the patient first presents, whereas with osteomyelitis the initial films are often normal.
Fat planes are often blurred in osteomyelitis while fat planes in neoplasm are displaced but preserved.
Chronic osteomyelitis may simulate a benign bone tumor on imaging examinations but the presence of fever, and sometimes of discharging sinuses, usually helps to diagnose an infective lesion.
It is not always possible using imaging tests to distinguish osteomyelitis from a bone tumour and biopsy is then needed.

Infection of the Spine:

The hallmark of infection is destruction of the intervertebral disc and adjacent vertebral bodies.

- **Radiographic features:**

Early in the course of the disease, there is narrowing of the disc space with end plates irregularities and erosion of the adjoining surface of the vertebral body.
Later, bone destruction may lead to collapse of the vertebral body, resulting in a sharp angulation known as a gibbus. A paravertebral abscess is usually present.



- **CT scan**

shows the bone destruction and paravertebral soft tissue swelling to advantage and disc space narrowing can be shown with sagittal reconstructions.

- **MRI**

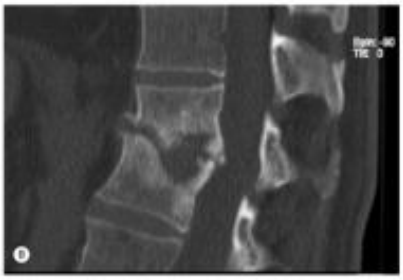
Is the preferred investigation as it can, with one examination, demonstrate disc space narrowing, altered signal in the adjacent vertebral body, adjacent soft tissue swelling and any spinal cord or nerve root compression.

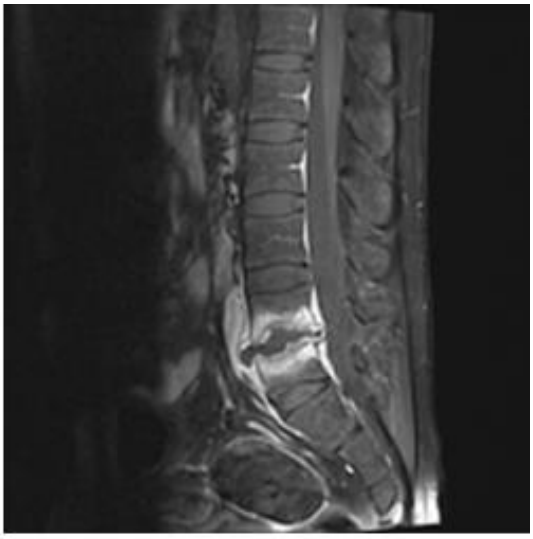
Patients with spinal osteomyelitis often have a history of skin or pelvic infections. Spread of infection is usually to the vertebral body rather than to appendages and is mainly blood-borne, though osteomyelitis may follow spinal surgery.

Spread of disease from the pelvis is facilitated through Batson's vertebral venous plexus which is a valveless system of veins joining the pelvis with the rest of the axial skeleton via the spinal canal.

The common infecting organisms are *Mycobacterium tuberculosis* and *Staphylococcus aureus*.

Though there are some differences in the signs produced by these two infections, there is considerable overlap.





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Variable	Pyogenic spondylitis	Tuberculous spondylitis
Commonly involved region	Lumbar spine	Thoracic spine
Involvements of vertebral bodies	≤ 2 vertebral bodies	Multiple levels
Degree of disc preservation	Moderate to complete disc destruction	Mild disc destruction
Bony destruction	Mild to moderate	More severe
Para spinal abscess	Less frequent	More and larger
Abscess wall	Thick and irregular	Thin and smooth
Calcification in abscess	Absent	Present
Sclerosis	Usually present	Lesion usually lytic