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## Bone and joint infection

### Objectives:

- What is bone and joint infection?
- Why we consider bone and joint infection as a red flag.
- How does the presentation in children and adults differ?
- What are the most involved organisms in children and adults?
- How do we diagnose and confirm diagnosis of bone and joint infection?
- Principles of management of bone and joint infection.
- Complications of bone and joint infection

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**Sources:** 435 Lectures And Notes, Toronto, 433 Team.

## Acute Osteomyelitis:

❖ **Definition** Osteomyelitis is an inflammation of bone and bone marrow caused by an infecting organism. **It is a serious condition.**

- **Duration:**
  - 1- Acute less than 3 weeks
  - 2- Subacute between 3 to 6 weeks
  - 3- Chronic more than 6 weeks

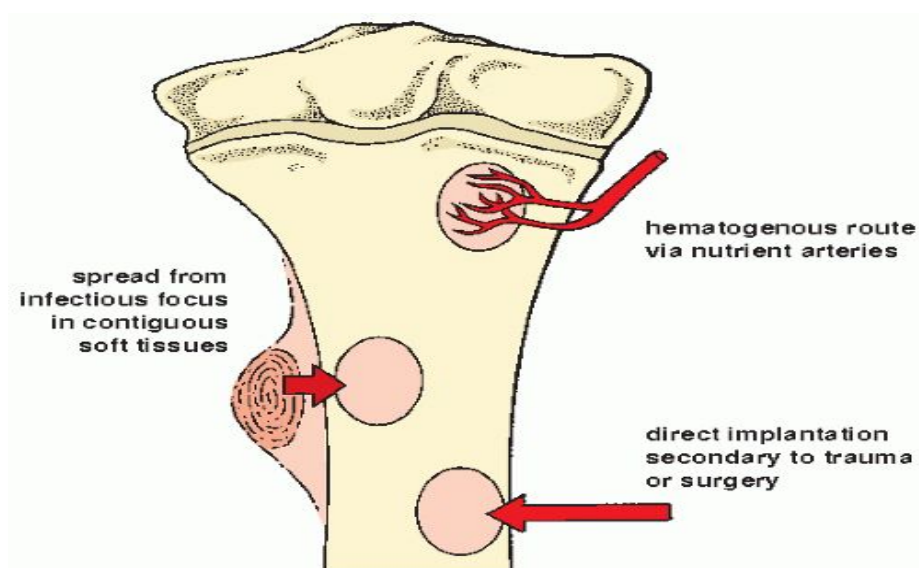
## Routes of spread:

### 1- Hematogenous :

- via blood stream from infected focus somewhere in the body **ex: (Untreated tonsillitis).**
- **Most common route of spread.**
- caused by blood-borne organisms.
- More common in children:
  - Boys > girls.
  - most common in long bone metaphysis or epiphysis .
  - Lower extremity >> upper extremity (**proximal and distal femur & proximal tibia**).

### 2- Direct Spread by nearby tissue ( **dermatitis** ).

### 3- After open fracture.

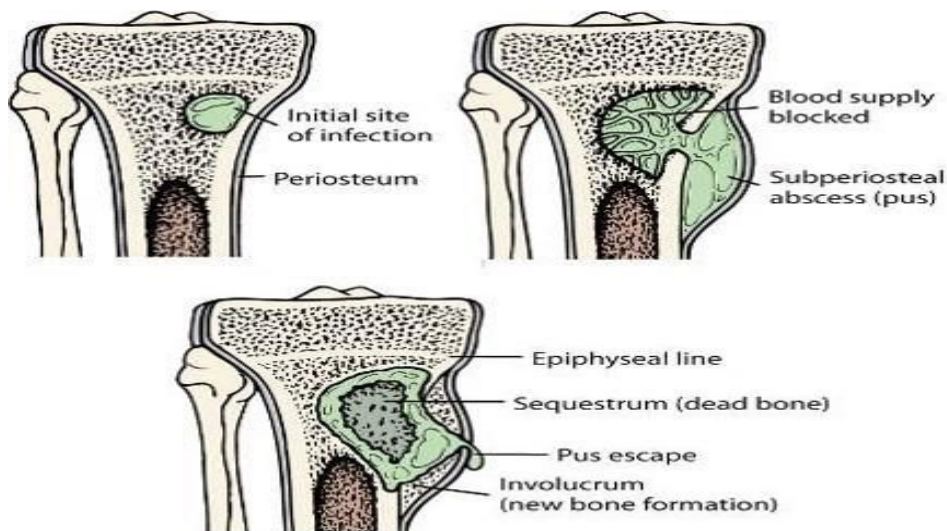


Organisms	
AGE	ORGANISM
Neonates	Staph aureus, strep
children	staph aureus, strep Pyogenes
Sickliers	Salmonella
drug addicts	Staph aureus , pseudomonas

REMEMBER!!! always suspect staph aureus first except for sicklers (salmonella).

### Spread of infection:

- Infection starts at bone marrow.
- Then spreads to cortex **by the haversian canal** and lifts up periosteum, swelling becomes tense resulting in increased pain. **the periosteum prevents bacterial spreading).**
- Local blood vessels get obstructed **due to increased pressure in the bone, therefore antibiotics will not be to reach the infection. ( SO TREAT AS EARLY AS POSSIBLE).**
- Periosteom bursts into soft tissues and pus becomes under skin; eventually spontaneous discharge.
- If pus bursts into epiphysis; epiphyseal arrest will occur **(growth arrest).**
- **Symptoms Increase with every step .**



## Terminologies:

- **Sequestrum (Dead bone):** separated piece from its surroundings. This happens when blood supply is cut off from area of bone due to infection. **The dead bone is a source of infection by releasing millions of bacteria, so avoid reaching this point by (PROVIDING EARLY TREATMENT!!!) . When it happens it must be removed.**
- **Involucrum:** **New bone formed at site of infection and trapping a cavity of bone. It is a defense mechanism that uses calcium to cover the damaged space.**

## Clinical picture:

- **Sometimes the child is just very ill (تعبان بشكل عام)**
- The patients will have local and general complaints:
  - **General:** Pain, fever, malaise, restlessness, **Crying, refusing to eat**, loss of function( child is not moving involved limb and unable to bear weight on it if it was at lower limb usually).
  - **Local:** swelling at a limb usually near a joint like knee or hip or shoulder with increased local temperature, **redness, edema. eventually the pus will ooze out** **يطلع صديد من فتحة في الجلد.**

## Blood investigation:

- **CBC and differentials:** usually raised white cell count; predominantly polymorphs (neutrophils) .
- **ESR:** elevated but its takes time ( 24-36 hrs).
- **CRP:** elevated within 4-6 hours. It is most sensitive because it elevates rapidly, and decreases rapidly with treatment.
- **Blood culture:** Positive in 50% of cases if there spiking fever **If temperature reached (38.5-39) perform blood culture.**

## Radiological investigation:

- **Plain X ray:** Early X rays may not reveal any findings except soft tissue swelling at site of infection. Bony changes take up to 10-14 days to show suspected bone involvement, but osteopenia may appear earlier (not diagnostic). **REMEMBER the patient can present with symptoms without bony changes in the X ray**



★ **comment:**

First X image from the left was obtained in 2nd day with the patient experiencing symptoms. There are no changes seen in X ray.

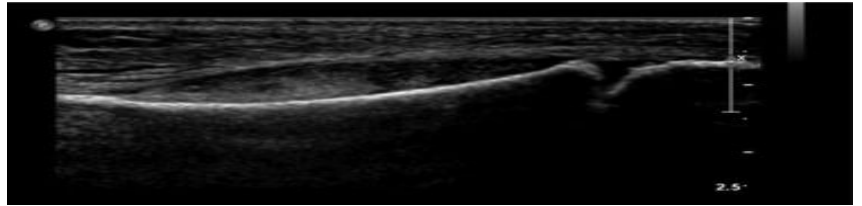
The 2nd image was taken in the 14th day, and it shows metaphyseal mottling and periosteal changes.

The 3rd image shows most of the shaft involved

- soft tissue swelling may be evident. (sometimes it gets confused with acute rickets).

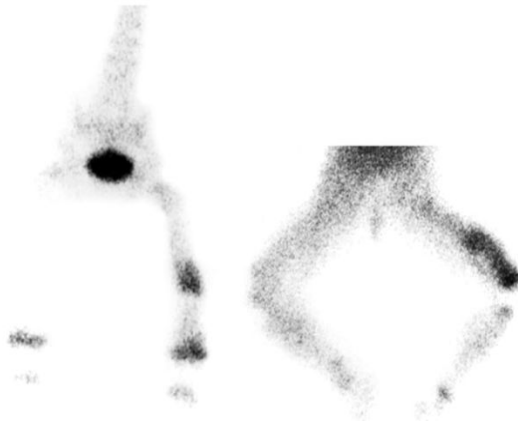


- **Ultrasound:** may diagnose **periosteal or** soft tissue swelling and abscess early , but it is operator dependent. **(the doctor said that US might not show any changes early into the infection)**

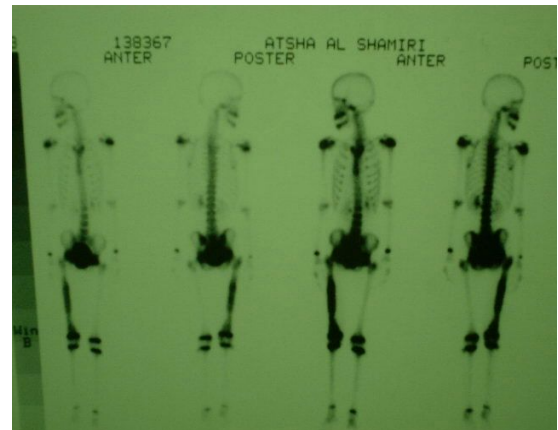


(subperiosteal abscess)

- **Isotope bone scan (Nuclear medicine):** Tcm99 bone scan(Technetium 99) or Gallium bone scan are diagnostic , as increased local tracer uptake; but take time to appear.  
( Gallium will raised > Tcm99)



(Increased uptake in the lower left femur)

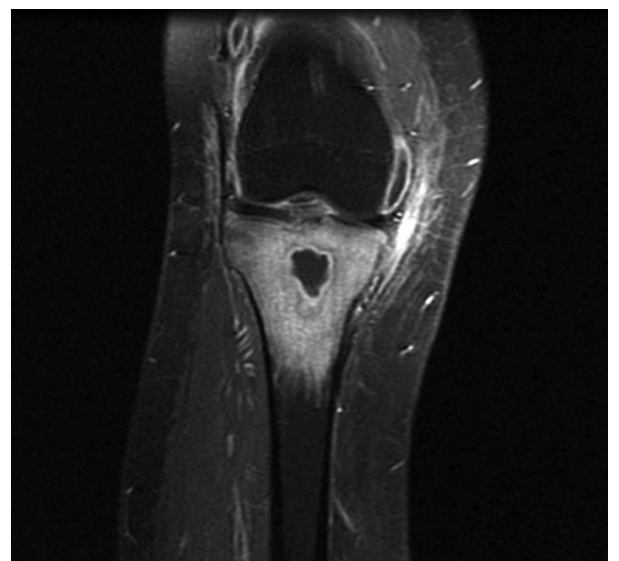


(Increase uptake in most of the right femur)

- **MRI:** best tool **(but not the first)** for radiological diagnosis as it is sensitive and specific, but difficult in young children as they require general anesthesia.

shows changes in bone and bone marrow before plain films

- ★ decreased  $T_1$ -weighted bone marrow signal intensity
- ★ **increased post gadolinium fat-suppressed  $T_1$ -weighted signal intensity**
- ★ increased  $T_2$ -weighted signal relative to normal fat  
( In  $T_1$  view , Fat appears white )



## Definite diagnosis:

- Ultrasound guided aspiration from site of swelling or abscess.
- X-ray guided aspiration of suspected bone involvement( according to MRI ).
- Via open incision (**most definite diagnosis**): drainage procedure( drilling of bone) when there is high suspicion.
- **Aspirated or obtained material at open incision are sent urgently for Direct Smear and C&S including anaerobic, TB and Fungal.**
- Histo-pathology examinations are recommended as well.

## Management:

### ◆ General principles:

- When there is suspicion that the diagnosis is : acute osteomyelitis ( **Red Flag**); patient should be admitted immediately.
- Patient should receive adequate hydration and pain relief at the same time as investigations.
- Pain relief include: analgesics and splintage.
- Broad spectrum IV antibiotics is started after obtaining material for culture or sending blood culture when there is fever.

### ◆ Empirical treatment:

- **When patient is acutely ill; empirical IV antibiotic treatment to be started immediately after sending samples for culture.**
- **we avoid giving antibiotics before the getting the smear because the antibiotics will kill all of bacteria and our smear might come falsely negative.**
- This empirical treatment depends on suspected organisms **according to age**: newborn, young or adult. Presence of other circumstances like **sickle cell** disease or Hemodialysis or drug addicts.
- Empirical treatment for **Sickle cell anemia**: The primary treatment fluoroquinolones (only in adults). alternative treatment 3rd generation cephalosporin.

### ➤ To make it simple:

- Always suspect staph aureus (**most common**): ( oxacillins **like flucloxacillin & Ciprofolxacin** ) except sicklers.
- 3<sup>rd</sup> generation IV antibiotics for special cases
- **Definitive treatment depend on the culture results** (consult infectious department)



## When do we consider surgery ?

- When we are sure( as a result of our investigations) there is pus or highly suspect that there is pus inside the bone or in the soft tissues near bone.
- We have to let pus out( drain the pus out ) to stop bone and tissue destruction and improve the general condition by getting rid of source of infection in the body.
- **When IV antibiotics are not working. go for mechanical debridement, and whenever there is sequestrum we have to operate.**

## How do we do Surgery for Bone Infection ?

- Patient should be prepared well for surgery.
- Surgery is done under GA ( general anesthesia) usually.
- X-ray guidance ( image intensifier ) is used usually to help exact location of site of drainage.
- Soft tissue abscesses are drained and bone site of infection is drilled or a window is opened in the cortex to drain pus and curette infected material from inside medulla.
- **In case of presence of sequestrum it has to be removed.**
- Drain is to be left at site of drainage till discharge is minimal.



## Post Operative management:

- Definite antibiotic should be continued via IV route for 6 weeks usually.
- Monitoring of general condition and blood investigations should be done frequently **(every 2 days until it returns to normal)**, especially CBC, ESR and CRP.
- Repeat follow up plain X-rays or CT or MRI may be required.
- Patient should be pain free and generally well before discharge.
- Long term follow up should be done to exclude late complications.



## Complications:

- 1- Septicemia and distant abscesses.
- 2- Septic arthritis.
- 3- Growth disturbance in skeletally immature and deformaty.
- 4- Pathological fracture.
- 5- Chronic osteomyelitis.



Left image:

destruction of the growth plate

middle image pathological fracture

right image Chronic Osteomyelitis

## Differential Diagnosis:

- 1- Acute septic arthritis.
- 2- Cellulitis (If doubt remains about the diagnosis, MRI will help to distinguish between bone infection and soft-tissue infection).
- 3- Ewing's Sarcoma (malignant <10 years of age. symptoms: rapid swelling , pain , fever), lymphoma.
- 4- Sickle cell bone crisis (Occlusion of the BV. very painful).
- 5- Acute rheumatoid arthritis ( can affect the joint muscle and tendon).
- 6- acute rickets.

## Risk factors:

**Table 2.1 Factors predisposing to bone infection**

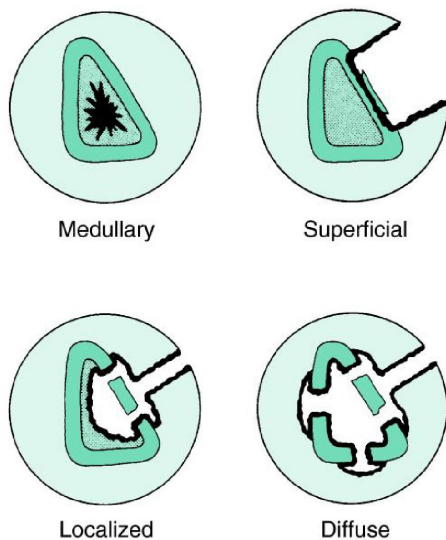
Malnutrition and general debility
Diabetes mellitus
Corticosteroid administration
Immune deficiency
Immunosuppressive drugs
Venous stasis in the limb
Peripheral vascular disease
Loss of sensibility
Iatrogenic invasive measures
Trauma

Growth disturbance

# Chronic osteomyelitis:

❖ **Chronic osteomyelitis** used to be a common sequel to acute osteomyelitis; nowadays it more frequently follows an open fracture or operation.

## ❖ Anatomical classification



**Table 2.2 Staging for adult chronic osteomyelitis**

LESION	TYPE
Stage 1	Medullary
Stage 2	Superficial
Stage 3	Localized
Stage 4	Diffuse
HOST CATEGORY	
Type A	Normal
Type B	Compromised by local or systemic conditions
Type C	Severely compromised by local and systemic conditions

## ❖ Common In:

- Inappropriately treated acute OM.
- Trauma.
- Immunosuppressed.
- Diabetics.
- IV drug abusers.

## ❖ Features:

- Skin and soft tissues involvement.
- Sinus tract may occasionally develop squamous cell carcinoma.
- Periods of quiescence followed by acute exacerbations.

#### ◆ Diagnosis:

- Nuclear medicine activity of the disease.
  - **Best test to identify the organisms Operative sampling of deep specimens from multiple foci.**
  - During acute flares and WBC levels are increased. they help assess the progression of infection , but they are not diagnostic .
  - In plain X you will always see changes (we might see sequestrum ).
  - CT Scan views bone destruction better than MRI.
- Clinical picture: Reappearance of discharge after treatment of acute OM is a sign of chronic change, look for Sequestrum. In addition, there sinus where pus is discharging ( chronic discharge of pus)

#### ◆ Treatment :

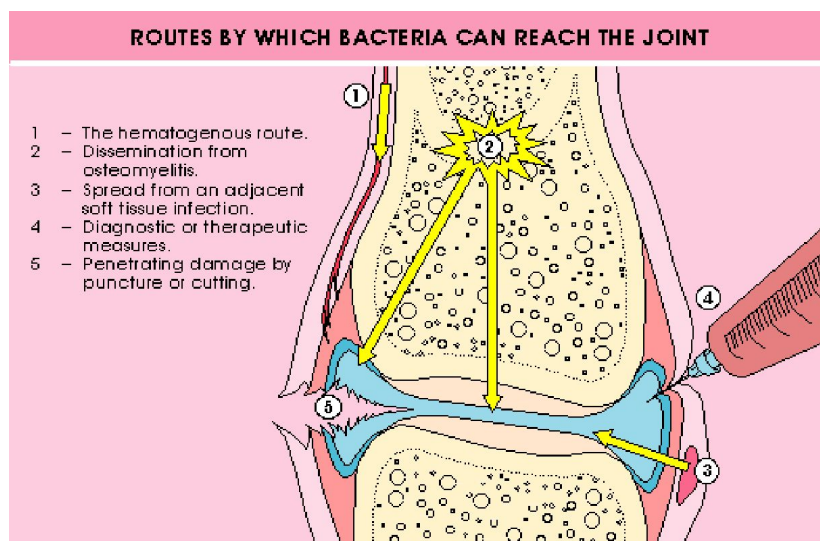
- Empirical therapy is not indicated
- IV antibiotics must be based on deep cultures
- Most common organisms :S. aureus, Enterobacteriaceae , P. aeruginosa, Streptococcus in children < 10 years
- **surgical debridement :complete removal of compromised bone and soft tissue**
- Chronic infection is rarely eradicated by antibiotics alone. Yet bactericidal drugs are important:
  - A. to suppress the infection and prevent its spread to healthy bone
  - B. to control acute flares.
- **Hardware:**
  - most important factor
  - almost impossible to eliminate infection without removing implant because organisms grow in a glycocalyx (biofilm) shields them from antibodies and antibiotics.
  - **Glycocalyx:** exopolysaccharide coating envelops bacteria enhances bacterial adherence to biologic implants
  - Stability still need to maintained, so consider external fixation.
- bone grafting and soft tissue coverage is often required.
- amputations are still required in certain cases.

### ◆ Introduction:

- Infection of the joint.
- May affect any age and any joint.
- The knee and hip are most affected.
- **Pathology:** hematogenous (ex:bladder infection) or from adjacent bone.
- In neonates: transphyseal vessels
- Common in the big joints (Hip, Knee, shoulder)
- In joints where the metaphysis is intracapsular (Hip, shoulder, proximal radius and distal fibula).
- starts as synovitis. the synovium gets thick and produces pus . the pus destroys the articular surface (cartilage) and ligaments
- The causal organism is usually *S. aureus*; in children between 1 and 4 years old, *H. influenzae* is an important pathogen unless they have been vaccinated against this organism.

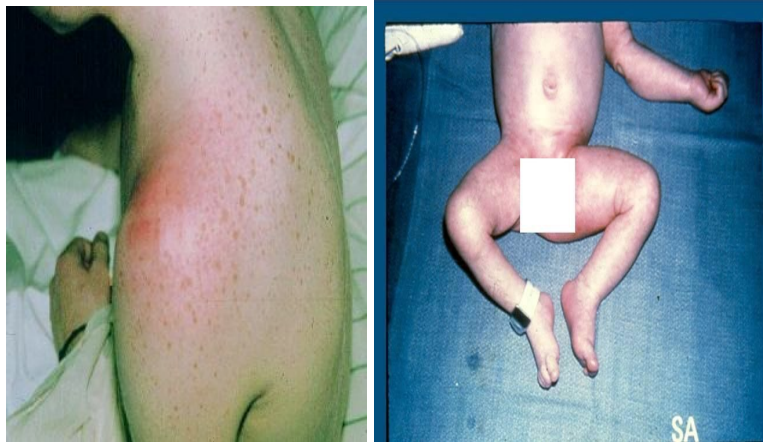
### ◆ Route of transmission

- 1- hematogenous spread
- 2- spreads from an **osteomyelitis focus**
- 3- spread from an **adjacent soft tissue** infection
- 4- **Diagnostic** or therapeutic measures
- 5- **penetrating** trauma by pounce or cutting.



#### ❖ Clinical presentation:

- **Symptoms** : like Acute Osteomyelitis.
- **Signs**: hot swollen joint which is painful to any motion, inability to bear weight.
- Joint is fixed in the position of ease. (the key difference between septic arthritis and acute OM is that the patient with septic will not allow you to move the joint. In OM the patient allows some range of motion )



- Both Images show the position of rest
- The right Image show the position of rest of the hip (external rotation and flexion)

#### ❖ Investigations:

- Basic lab for infection (CBC,ESR and CRP) and Blood cultures.
- Plain films and Ultrasound.
- Joint aspiration: WBC >50,000 (>90%PMNL), damaged WBC and No crystals .
- Organisms: similar to Acute Osteomyelitis.

#### ❖ Treatment:

- Admission for Emergency arthrotomy and washout, broad spectrum IV antibiotics and splintage

#### → Emergency drainage of the septic joint:

- Either arthroscopic.
- Or Open.
- Joint should receive lavage and debridement, and a drain should be left at joint till discharge is clear and minimal.
- IV antibiotics should be administered for 4 weeks.

❖ **Differential diagnosis:**

- 1- Acute osteomyelitis.
- 2- Transient synovitis (<10 year). It is the main differential
- 3- Reactive arthritis.
- 4- Vasculitis , eg: Henoch-Schonlein purpura.
- 5- Traumatic hemarthrosis.
- 6- Haemophilic arthritis

❖ **Complications:**

- 1- Septicemia.
- 2- Abscess.
- 3- Osteomyelitis.
- 4- Joint destruction.
- 5- Joint subluxation and dislocation.
- 6- Ankylosed joint. If infection last long there pannus formation or scar tissue formed which will cause ankylosis (التصاقات), which can be either bony or fibrous
- 7- Avascular necrosis of the femoral head.
- 8- Growth disturbance



**KEY POINTS**

- Any acutely hot or painful joint is septic arthritis until proven otherwise.
- Investigation of choice is aspiration of the joint fluid and microbiological assessment.
- In likely cases of septic arthritis, commence antibiotic therapy as soon as possible.

**Chronic Septic Arthritis:**

- Happens to patients with infected arthroplasty
- Take a sample, remove the prosthetic , clean the bone, IV antibiotics, take another sample, then return the prosthetic



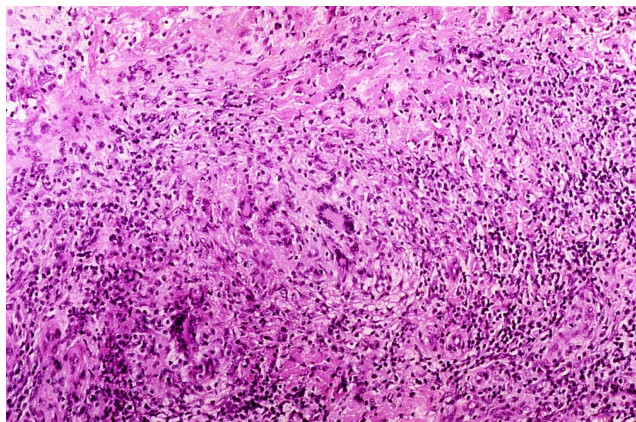
## ❖ Introduction

- Tuberculosis is chronic bone infection.(can affect joint)
- May affect any age.
- Causative organism is: Mycobacterium Tuberculosis.
- It is acid fast bacillus.
- Endemic in poor underdeveloped countries.
- Still present sporadically at Saudi Arabia.
- common In developed countries
- TB are common in immunocompromised patients.(AIDS and drug addicts)

## ❖ Diagnosis:

- Can be diagnosed sometimes by direct smear.
- When bacillus is seen it is diagnostic of TB.
- It takes up to 6 weeks to culture.
- Histopathology: To confirm diagnosis we need to see acid fast bacillus.Also to see: Langhans giant cells,or to see caseation in a bed of lymphocytes and monocytes.

**TB follicle**



there Langerhans cells , lymphocytes, monocytes, and caseation

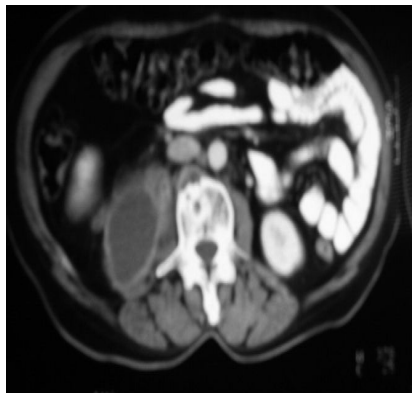
### ❖ TB spine: Pott's Disease

- Affect any part of spine; most commonly dorsal spine.
- Can lead to dorsal kyphosis. (TB affects the body of the vertebra causing collapse)
- effect most commonly the anterior vertebral end plate .
- If affects the cervical spine it can cause quadriplegia.
- If affects the lumbar spine it can cause cauda equina
- Famous for causing psoas abscesses and para-spinal abscesses.
- TB spinal abscess may compress spinal cord= Pott's paraplegia
- Infection spreads to adjacent level under the longitudinal ligaments and hematologically
- Eventually a kyphotic deformity occurs
- **Para vertebral** abscess is common and may be distant as well

Cervical > retropharyngeal abscess

Lumbar > psoas abscess

- Compression of the spinal cord is more likely to occur at the thoracic level
- Neurological deficits occur due to the compression secondary to the deformity or compression from the abscess.
- Paraplegia may occur.
- **Reversible if treated early.**
- **Mostly treated non-surgically.**



(Psoas abscess)



(Kyphosis)

### ❖ Presentation:

- Constitutional symptoms: Fever, Weight loss, Night sweats, Anorexia
- Pain
- Stiffness
- Deformity

### ❖ Diagnosis

- **Plain X ray:** (early might not show changes)
  - Spine Erosion and destruction of end plates.
  - Narrowing of disc space.
  - Soft tissue mass shadow.
  - Anterior wedging of vertebrae.
  - Kyphus deformity.

### ❖ Special tests:

- Tuberculin( Mantoux )skin test.
- Spine:CT guided needle biopsy
- Joints: Synovial aspiration (low yield)
- Should Get bone & soft tissue and send for aerobic/non-aerobic bacteria, fungal, AFB, enriched culture media. Takes up to 4-6 weeks

### ❖ TB of MSK system

- Usually lesion is secondary to TB at lung, kidney, bowel and lymph nodes.
- **Joints:** Swelling, Stiffness, Locking, Loss of function  
**Bones:** Ulcers, Sinuses, Swelling, Deformity Presentation
- Other Famous symptoms : Fever, malaise, weight loss and night sweat , may not be present these days.
- Suspicion of disease , previous history of TB presence of osteopenia and loss of joint space.

Radiology:

Joints: usually monoarticular “PHEMISTER’S TRIAD”

Peri-articular osteopenia

Subchondral and peripheral erosions affecting both sides of the joint

Loss of joint space



( X ray shows osteopenia to the right femur, and reduction in the joint space in acetabulofemoral joint )

### ❖ Management of TB :

- Usually non surgical by Triple or Quadruple drugs:  
Isoniazide(INH), Rifampicin, Ethambutol, Pyrazinimide.  
side effects INH : peripheral neuropathy , rifampicin : liver damage
- Drug therapy to continue up to 18 months.

### ➤ Surgery to be done :

- to evacuate abscess
- or decompress spinal cord
- or to stabilize joint or spine.
- Tissue biopsy to confirm diagnosis
- Joint lavage and removal of rice bodies

## Brucellosis:

- Ask about Milk and milk products “milk pasteurization”
- It begins as general infection before MSK infection
- Back pain and stiffness
- Muscle spasms
- Fever (mild)
- Most common **Sacro-iliac joint**
- Less destructive than TB
- **Brucella titer Diagnostic if > 1/640 “antibodies”**
- **CT guided biopsy**
- Antibiotics: E.g. Septrin – Oxytetracycline

# Toronto notes

## Acute osteomyelitis

- bone infection with progressive inflammatory destruction

### Etiology

- most commonly caused by *Staphylococcus aureus*
- mechanism of spread: hematogenous (most common) vs. direct-inoculation vs. contiguous focus ( for adjacent focus )
- **risk factors:** recent trauma/surgery, immunocompromised patients, DM, IV drug use, poor
- vascular supply, peripheral neuropathy

### Clinical Features

- **symptoms:** pain and fever
- **On exam:** erythema, tenderness, edema common ± abscess/draining sinus tract; impaired function
- Rapid progression of signs and symptoms (over hours) necessitates need for serial examination

### Diagnosis

- **see Medical Imaging**
- **workup includes:** WBC and diff, ESR, CRP, blood culture, aspirate culture/bone biopsy

- **Plain Film Findings of Osteomyelitis:**

Soft tissue swelling

Lytic bone destruction

periosteal reaction

Generally not seen on plain films until 10-12 d after onset of infection

## Treatment

Acute osteomyelitis is a medical emergency which requires an early diagnosis and appropriate antimicrobial and surgical treatment.

Acute osteomyelitis	chronic osteomyelitis
IV antibiotics 4-6 wk; started empirically and adjusted after obtaining blood and aspirate cultures ± surgery (I&D) for abscess or significant involvement	Surgical debridement Antibiotics: both local (e.g. antibiotic beads) and systemic (IV)

± hardware removal (if present)	
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## Septic arthritis

joint infection with progressive destruction if left untreated

risk factors: young/elderly (age >80 yr), RA, prosthetic joint, recent joint surgery, skin infection/ ulcer, IV drug use, previous intra-articular corticosteroid injection, immune compromise (cancer, DM, alcoholism)

Most commonly affected joints in descending order (knee, hip, elbow, ankle, sternoclavicular joint )

### Etiology

- **most commonly caused by *Staphylococcus aureus* in adults**
- consider coagulase-negative *Staphylococcus* in patients with prior joint replacement  
consider *Neisseria gonorrhoeae* in sexually active adults and newborns
- most common route of infection is hematogenous

### Clinical Features

- inability/refusal to bear weight, localized joint pain, erythema, warmth, swelling, pain on active and passive ROM, ± fever

### Investigations

#### X-ray

- (To rule out fracture, tumour, metabolic bone disease)
- **Plain Film Findings in a Septic Joint**

Early (0-3 d): usually normal; may show soft-tissue swelling or joint space widening from localized edema.      Late (4-6 d): joint space narrowing and destruction of cartilage.

- **Blood work:** ESR, CRP ( can be used to monitor treatment), WBC, blood cultures
- **joint aspirate:** cloudy yellow fluid, WBC >50,000 with >90% neutrophils, protein level >4.4 mg/dL, joint glucose level < 60% blood glucose level, no crystals, positive Gram stain results
- **listen for heart murmur** (to reduce suspicion of infective endocarditis, use Duke Criteria

### Treatment

IV antibiotics, empiric therapy (based on age and risk factors), adjust following joint aspirate C&S results



non-operative( therapeutic joint aspiration, serially if necessary (if early diagnosis and joint superficial)

operative arthroscopic/open irrigation and drainage ± decompression

CRP is used to monitor treatment.