2- Bone and joint infection

Objectives:

- What is bone and joint infection.
- Why we consider bone and joint infection as a red flag.
- Low 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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References: 435 team. Doctors' notes. 436 slides

Introduction

- Initial treatment → based on presumed infection type → clinical findings and symptoms. You give broad spectrum antibiotics until you can identify the organism from the final culture.
- Definitive treatment → based on final **culture**.
- Glycocalyx, Formation of biofilms around the lead and screws, it protects the organism by causing a filament that they antibiotic can not reach, can't be treated without removal of glycocalyx
  - Exopolysaccharide coating
  - Envelops bacteria
  - Enhances bacterial adherence to biologic implants
- Terminology:
  - Sequestrum (Dead Bone): This happens when blood supply is cut off from area of bone due to infection. click here
  - Involucrum: New bone formed at site of infection and trapping a cavity of bone.

Osteomyelitis Osmosis , Toronto note

Infection of bone and bone marrow.

★ Route of infection:

- Direct inoculation[1] → Open fractures
- Blood-borne organisms → hematogenous

Determination of the offending organism not a clinical diagnosis, **Deep culture** is essential. The deep culture is taken from deep bone not soft tissue unless there was pus for example.

★ Classification: Each of them presentation is different depend on patient age

- Acute hematogenous OM. (Acute less than 3 weeks)
- Acute OM.
- Subacute OM. (Subacute between 3 to 6 weeks)
- Chronic OM. (Chronic more than 6 weeks)

Acute hematogenous osteomyelitis

Caused by blood-born organisms

★ Clinical Features:

- More common in children.
  - Boys > girls
  - Most common in long bone **metaphysis or epiphysis**
  - Lower extremity >> upper extremity
- Pain, malaise, restlessness.
- Loss of function of the involved extremity. Fixed flexion deformity, contractures and stiffness
- Soft tissue abscess and swelling. Especially if the infection spread to soft tissues

★ Radiographic Changes:

- Early: Soft tissue swelling. No changes visible on x-ray

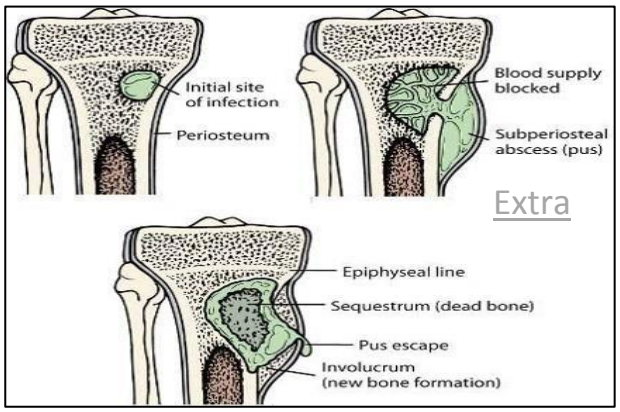
[1] تلقيح

- (10-14 days): Bone demineralization. bone changes
- Later: - **Sequestrum**[2] (indication of OM) dead bone with surrounding granulation tissue.
  - **Involucrum** periosteal new bone. formation

8 month old boy with **soft tissue swelling only!**

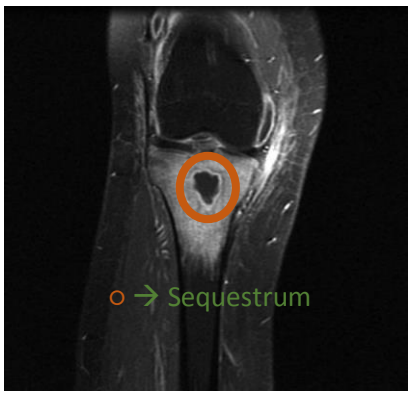
Early X rays may not reveal any findings except soft tissue swelling at site of infection. Bony changes take up to 10-14 days to show up. There is decreased blood supply due to it not being managed for a while which in turn causes osteopenia, (osteopenia may appear earlier not diagnostic).

REMEMBER the patient can present with symptoms without bony changes in the X ray.



★ Diagnosis: (blood work)
- ↑ WBC count mainly neutrophils
- ↑ ESR not specific
- Blood cultures may be positive in children, must be done especially if patient is febrile
- **C-reactive protein** monitor response to treatment
  - **Most sensitive monitor of infection course in children.** respond very fast
  - Short half-life.
  - Dissipates "start to reduce" in about 1 week after effective treatment.
- Nuclear medicine studies → may help when not sure of the course or source of infection.

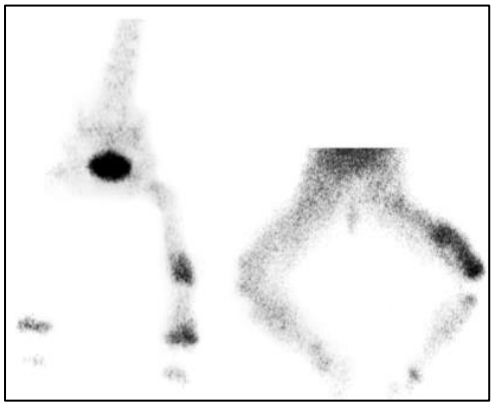
- MRI imaging: MRI bone changes appear before x-ray "best tool for radiological diagnosis as it is sensitive and specific, but difficult in young children as they require general anesthesia"



  - Shows changes in bone and bone marrow before plain films.
  - Decreased T_1-weighted[3] bone marrow signal intensity.
  - Increased post-gadolinium (contrast) fat-suppressed T_1-weighted signal intensity.
  - Increased T_2-weighted signal relative to normal fat.
  - Picture: "there's no activity in this area = dead, it doesn't have any blood supply. It could be a sequestrum or Brodie's abscess"
- Plain X-Ray

A piece of dead bone that has become separated during the process of necrosis from normal or sound bone.[2]
[3] MRI sequence.

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



- Bone scan > gallium scan (most imp for infections)
- , WBC labeled bone scan.
- **Increase uptake in femur bone, due to increase activity, so it's possibly infection, tumor or fracture we don't know**
- Useful in delayed cases, when we want to check if there is more than one focus of infection "if we treated one place but the child is not improving".

★ **Confirm Diagnosis:**

1. Ultrasound guided aspiration from site of swelling or abscess.
2. X-ray guided aspiration of suspected bone involvement (according to MRI).
3. Open incision –drainage procedure (drilling of bone) when there is high suspicion. Aspirated or obtained materials at open incision are sent urgently for Direct Smear and C&S including anaerobic, TB and Fungal. Early results of smear don't give the exact bacteria, but it will show infection.
4. Histopathology examinations are recommended as well. Definite Diagnosis By histopathology depends on seeing organisms at direct smear, or culturing organisms. It's important but usually result is late

★ Treatment Outline:

- Identify the organisms. (take culture)
- Select appropriate antibiotics.
- Deliver antibiotics to the infected site.
- Halt tissue destruction.

Empirical Treatment is initiated before definitive cultures become available, based on patient's age and other circumstances. (Before reach exact organism which cause the patient conduction by culture)

Empirical Treatment:		
Newborn (up to 4 months of age)	**Children** 4 years of age or older	**Adults** 21 years of age or older
The most common organisms: 1. **Staphylococcus aureus.** Most imp 2. Gram-negative bacilli. 3. Group B streptococcus. after URI Newborns: crying, pain, swelling, stiffness (loss of function) - May be **a**febrile. weak immunity هذه المشكلة إنهم بدون حرارة - 70% positive blood cultures. #Primary empirical therapy includes:	The most common organisms: 1. **Staphylococcus aureus.** 2. Group A streptococcus. 3. Coliforms (uncommon). #Empirical therapy includes: Oxacillin **or** cefazolin 2nd gen cephalosporins If suspecting gram-negative organisms → 3rd-generation cephalosporin. *Haemophilus influenzae* bone	Organisms: Most common organism **S. *aureus*** Wide variety of other organisms has been isolated. #Initial empirical therapy: Oxacillin or cefazolin. Oxacillin is key because it is the most important in all age groups

Oxacillin (penicillin) specific for staph. for group (+) **+** 3rd-generation cephalosporin for other groups. for group (-)	infections almost completely eliminated **due to vaccination.**	

Empirical Treatment 'Special cases':	
Sickle cell anemia	Hemodialysis and IV drug abuser
Salmonella is a **characteristic** organism. #The primary treatment is **fluoroquinolones** (only in adults). Can't be given to children. Alternative treatment is 3rd-generation cephalosporin.	Common organisms: 1. **Staphylococcus aureus** 2. *S. epidermidis* 3. *Pseudomonas aeruginosa* #Treatment of choice is penicillinase-resistant synthetic penicillins **(**PRSPs) **+** ciprofloxacin. Alternative treatment: Vancomycin **with** ciprofloxacin

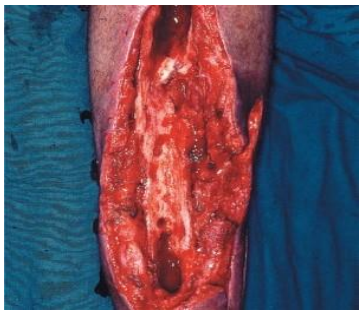
★ Operative Treatment:

- Started after cultures. Starting treatment beforehand masks the results
- **Indications** for operative intervention:
  - Drainage of an abscess, if we're sure there's pus (as a result of our investigations).
  - Debridement of infected soft tissues to prevent further destruction. dead tissue can't respond to Abx so its removed.
  - Refractory cases that show no improvement after nonoperative treatment.

- In case of presence of sequestrum it must be removed (Sequestrectomy)

Acute Osteomyelitis

After open fracture or closed fracture with open reduction and internal fixation (iatrogenic) Ex: Somebody have surgery then AOM.
Clinical findings similar to acute hematogenous OM.



Pic: Big sequestrum with pus

★ Treatment:

- Radical Inscision&Drainage.
- Removal of orthopedic hardware "device" if necessary. External fixator, screws. These FB have no communication with blood so they must be removed as they act as a good media for colonization
- Rotational or free flaps (tissue transplant) for open wounds if needed.

★ Most common organisms:

- S. aureus
- P. aeruginosa
- Coliforms

Empirical therapy before doing culture **Oxacillin + ciprofloxacin**

Complications:

1- Septicemia and distant abscesses.

2- Septic arthritis.

3- Growth disturbance in skeletally immature and deformity.

4- Pathological fracture.

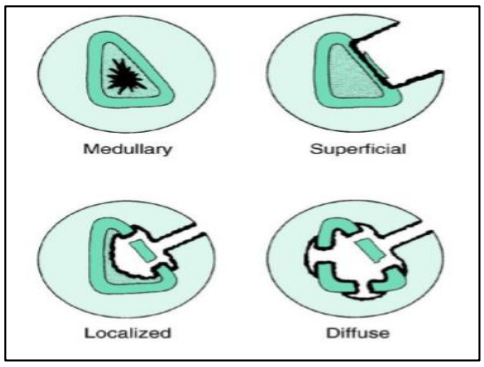
5- Chronic osteomyelitis.

Chronic Osteomyelitis

★ Common in:

- Inappropriately treated acute OM. presences of sequestrum[4] "source of bacteria" antibiotics cannot reach it.
- Trauma.
- Immunosuppressed. They will present with sinus discharging pus **without fever**
- Diabetics.
- IV drug abusers.

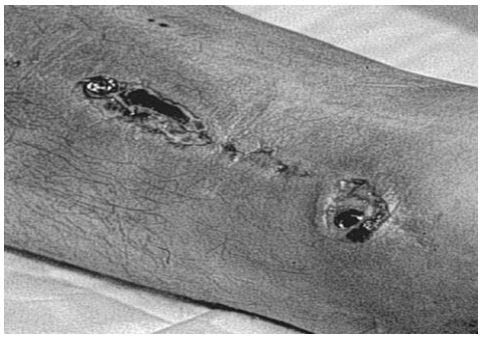
★ Anatomical classification:



4 types:

- Medullary.
- Superficial. Only surface (cortex and soft tissue around it)
- Localized. Sinus formation with pus "draining" between outside and medulla
- Diffuse. Whole medullary canal, the sinus has destroyed the whole bone

★ 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. E.g. Bone scan, gallium scan to tell if the lesion is old, remission, reactive.
  anything that wasn't useful in acute is useful here: plain x rays, CT scans
- **Best test** to identify the organisms → Operative sampling of deep specimens from multiple foci.

★ Most common organisms:

- *S. aureus*
- *Enterobacteriaceae* (mainly with IV drug abuse)
- *P. aeruginosa*

★ Treatment:

[4] This complication requires urgent intervention.

Empirical therapy not indicated because bone is dead. The main difference between acute and chronic is that in chronic there is no rush to start therapy because the damage has already occurred. Do culture and sampling > once you get the results you can do debridement > start treatment

__Glycocalyx (the sneaky bacteria when there's a cell coming to attack them or when they sense an Abx, they form a circular shield around them. Most commonly under the plate and screws, so if it happened, we have to remove them).

This happens after surgery and after total knee replacement. exopolysaccharide coating that envelops bacteria and enhances bacterial adherence to biologic implants. What to do? Hardware has to be removed, but stability should be maintained (consider Ex-Fix)

- **IV antibiotics** must be **based on** deep cultures.

Surgical debridement:

- Complete removal of compromised bone and soft tissue. Due to the excessive destruction of bone, soft tissue and vessels we remove all infected/unhealthy tissue to avoid much worse consequences like amputation (best to remove everything all at once than to remove small pieces one at a time, it may cause a huge scar but the results are better)
- Hardware: Most important factor
  - Almost impossible to eliminate infection without removing implant.
  - Organisms grow in a glycocalyx (biofilm) around the foreign body "device" shields them from antibodies and antibiotics. We have to take out the glycocalyx
- Bone grafting and soft tissue coverage is often required. You use a flap (containing muscle, soft tissue and skin) rather than skin alone
- Amputations are still required in certain cases. Diabetes mellitus, if huge area of bone and soft tissue is destructed

Subacute Osteomyelitis

★ May occur in:

- Partially treated acute osteomyelitis.
- Occasionally in fracture hematoma.

★ Diagnosis:

- Painful limp. not sever like acute
- No systemic and often no local signs or symptoms.
- Signs and symptoms on plain radiograph.

Cyst surrounded by sclerotic area, hypodense in the middle. Abscess very well circumscribed

An area of osteopenia surrounded by a thick cortex which is very well localized and wont spread

Frequently normal WBC count and negative blood cultures.

- Usually useful tests: any infection you need to rule out tumor
  - ESR not very specific could be elevated due to sore throat
  - Bone cultures only a small percentage have a +ve result
  - Radiographs:
    Brodie's abscess → localized radiolucency seen in long bone metaphysis difficult to differentiate from **Ewing's sarcoma** (which is a differential diagnosis) You should do more investigations to differentiate between the tumor and abscess, bone scan will show a high uptake for both. You could open the area and send for culture and histopath to differentiate between inf and tumour

★ Treatment:

- Most commonly involves femur and tibia. lower limb, Hip and knee pain.
- It can cross the physis = growth plate even in older children.
- Metaphyseal Brodie's abscess → surgical curettage. (The only treatment for brodie's abscess)

Septic arthritis osmosis

★ Route of infection:

- Hematogenous spread.
- Extension of metaphyseal/diaphyseal osteomyelitis in children.
- Complication of a diagnostic or therapeutic joint procedure.

Most commonly in infants (hip) and children.

- Metaphyseal osteomyelitis can lead to septic arthritis in:
  - Proximal femur → **most common** in this category. It may go up to the hip and cause septic arthritis
  - Proximal humerus.
  - Radial neck.
  - Distal fibula.

- **Adults at risk for septic arthritis are those with:**
  - **Rheumatoid arthritis:**
    - **Tuberculosis → most characteristic** because of immunosuppression
    - *S. aureus* most common
  - **IV drug abuse → Pseudomonas most characteristic.**

Clinical presentation and Investigations almost like Acute Osteomyelitis.

★ Empirical therapy is prior to the availability of definitive cultures based on the patient's age and/or special circumstance.

★ Empirical therapy	
Newborn (up to 3 months of age)	**Children** (3 months to 14 years of age)
Most common organisms almost same as acute OM newborn: 1. *S. aureus* 2. Group B streptococcus Less common organisms: 3. Enterobacteriaceae 4. *Neisseria gonorrhoeae* ○ 70% with adjacent bony involvement. ○ Blood cultures are commonly positive. #Initial **treatment** PRSP **+** 3rd-generation cephalosporin.	Most common organisms: 1. *S. aureus* 2. *Streptococcus pyogenes* 3. *S. pneumoniae* 4. *H. influenzae* markedly decreased with vaccination 5. gram-negative bacilli #Initial **treatment** PRSP **+** 3rd-generation cephalosporin. Alternative treatment vancomycin **+** 3rd-generation cephalosporin.

★ Empirical therapy	
Acute monoarticular[5] septic arthritis in **Adults**	Chronic monoarticular septic arthritis[6]
The most common organisms: 1. *S. aureus* 2. Streptococci 3. Gram-negative bacilli #Antibiotic treatment is PRSP **+** 3rd-generation cephalosporin Alternative treatment PRSP **plus** ciprofloxacin	Most common organisms: 1. Brucella most common 2. Nocardia 3. Mycobacteria 4. Fungi
Polyarticular septic arthritis	
Most common organisms: Gonococci, B. burgdorferi, acute rheumatic fever and viruses.	

★ Surgical treatment:

- Mainstay of treatment:
  - Surgical drainage → open **or arthroscopic.** Clean and wash with a scope but if its difficult you can open
  - Daily aspiration.
- Tuberculosis infections lead to pannus[7] (soft tissue granuloma) similar to that of inflammatory arthritis (Rheumatoid Arthritis). Pannus "hypertrophied synoviunm" has to be rempoved.
- Late sequelae of septic arthritis → soft tissue contractures → may require soft tissue procedures (such as a quadricepsplasty[8]). The quads become short and you cant extend the knees anymore

Infected total joint arthroplasty "TJA"

If joint got infected, we have to take deep aspiration of knee, remove prosthesis, treat, put new prosthesis.

★ Prevention:

- Perioperative intravenous antibiotics most effective method for decreasing its incidence.
- Good operative technique. You must be very gentle with soft tissue
- Laminar flow avoiding obstruction between the air source and the operative wound. (Video Explains Laminar Flow) air suction mechanism
- Special "space suits". Everything is sterile even the face area
- Most patients with TJA do not need prophylactic antibiotics for dental procedures. Unless they have an infection/abscess then Abx are given
- Before TKA revision knee aspiration is important to rule out infection. The culture may be -ve but it doesn't rule out an infection

Laminar flow

Most common pathogen:

- *S. epidermidis* → Most common with any foreign body
- *S. aureus*

[4] One joint is involved.
[5] Cartilage damage.
.[6] Inflammation and proliferation of the synovium leads to formation of pannus.
corrective surgical procedure on the quadriceps femoris muscle and tendon to release adhesions and improve mobility.[8]

- Group B streptococcus

★ Diagnosis:

- ESR → most sensitive but not specific.
- Culture of the hip aspirate → sensitive and specific.
- C-RP may be helpful.
- Preoperative skin ulcerations → ↑ **risk**. If the patient shaves before the operation he will cause small skin openings and ulcerations that will be a good medium for infections, all shaving must be done in the OR to avoid scratches of the skin
- Most accurate test → **tissue culture**.

★ Treatment:

- **Acute** infections **within 2-3 weeks** of arthroplasty: prosthesis has metal part and plastic part
  - Prosthesis salvage stable prosthesis
  - Exchange polyethylene (plastic part) components you open the joint and keep the prosthesis and cover the surface of the tibia and femur with polyethylene (don't remove the prosthesis)
  - Synovectomy beneficial if synovium is infected

- **Chronic** TJA infections **>3 weeks** of arthroplasty:
  - Implant and cement removal
  - Staged exchange arthroplasty stage 1: after removal of prosthesis, put spacer (cement and anti-biotic) and keep it there for 6 weeks, then do new culture, stage 2: put the new prosthesis.
  - Glycocalyx:
    - Formed by polymicrobial organisms
    - Difficult infection control without removing prosthesis and vigorous debridement
  - Helpful steps:
    - Use of antibiotic-impregnated cement. Abx used are usually vancomycin tobramycin and gentamycin
    - Antibiotic spacers/beads. مثل السبحة وعليها مضاد

      You could do both Abx-impregnated cement and antibiotic spacers/beads

435 team, not in our slides but important to know!

TB of the musculoskeletal system (parts other than the spine)

Clinical Picture:

Secondary to TB at lung, kidney, bowel and lymph nodes.

- ★ **Symptoms:** Fever, malaise, weight loss and night sweat → May not be present these days.
- ★ Suspicion of disease by previous history of TB presence of osteopenia and loss of joint space.

Management of TB

- ★ **Usually non surgical by Triple or Quadruple drugs=**
  - Isoniazid (INH), Rifampicin, Ethambutol, Pyrazinamide. We don't use streptomycin because it causes ototoxicity
  - Drug therapy to continue up to **18 months.**

- ★ **Surgery in TB** is done to relieve pressure
  Surgery to be done to evacuate abscess, or decompress spinal cord, or to stabilize joint or spine.

Brucellosis

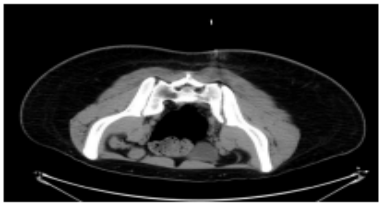
- Milk and milk products.
- Now less incidence in Saudi Arabia due to milk pasteurisation and awareness about not consuming unboiled camel's milk.
- Less destructive than TB.
- Affects **Sacroiliac** joint.

★ **Symptoms:** Back pain and stiffness, Muscle spasm, Fever (mild).
★ **Diagnosis:** CT guided aspiration, Brucella titer: **Diagnostic if > 1/640**)
★ **Treatment:** Antibiotics (Rifampicin – Doxycycline- Septrin)

★ Case - A patient suspected of having Brucellosis Right Sacroiliac joint

Young patient= 17 years old.
Complaining of severe Low Back Pain radiating to right buttock.
Has antalgic gait right lower limb.
Very tender over Right S-I joint.
ESR= 35mm/1st hour
CRP= 45
Drinks camel milk every weekend.

After 4 weeks
Patient is pain free.
Normal gait.
ESR=4
CRP=2



CT guided needle Aspiration
Right Sacro-Iliac Joint

Tuberculosis (Granulomatous bone infection)

- Tuberculosis is chronic bone infection that may affect any age. reactivation of infection usually.
- **Causative organism is: Mycobacterium Tuberculosis**. It is acid fast bacillus. When bacillus is seen it is diagnostic of TB. Can be diagnosed sometimes by direct smear.
- It takes up to **6 weeks** to culture.
- **In current time it's** Endemic in poor underdeveloped countries. Still present sporadically at Saudi Arabia.
- In developed countries TB patients are immunocompromised patients. (AIDS and drug addicts)

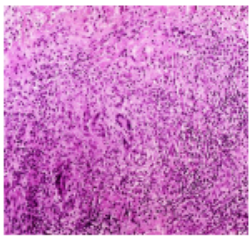
To Confirm Diagnosis

★ Histopathology

- **We need to see acid fast bacillus**. Also to see: Langhans giant cells.
  Or to see: caseation in a bed of lymphocytes and monocytes. Multinucleated cells, stroma of lymphocytes.

We can diagnose TB either by direct smear, or by culture which takes 6wks.

TB Follicle



Pott's disease (TB in the spine)

- Affect any part of spine; **most commonly dorsal** spine. **Sacroiliac joint.**
- Can lead to **dorsal kyphosis.** Destruction of vertebral body, there will be collapse.
- Famous for causing psoas abscesses and paraspinal abscesses.
- TB spinal abscess may compress spinal cord= Pott's paraplegia.
- 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.
- Infection spreads to adjacent level under the longitudinal ligaments and hematologically.
- Eventually a kyphotic deformity occurs
- 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
- Paravertebral abscess is common and may be distant as well,
  Cervical > retropharyngeal abscess,
  Lumbar > psoas abscess.
- **Reversible if treated early.** **Mostly treated non-surgically.**

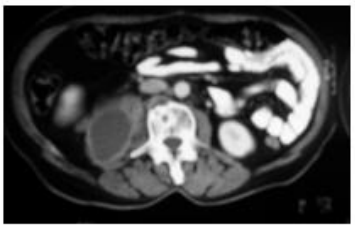
TB spine, Dorsal kyphosis

Diagnosis

★ Radiology - Plain x-rays (Spine)

- Erosion and destruction of end plates.
- Narrowing of disc space.
- Soft tissue mass shadow.
- Anterior wedging of vertebrae.
- Kyphus deformity.

TB spine with Psoas abscess



MRI: TB lesion of dorsal spine

★ Special tests

- Tuberculin (Mantoux) skin test.
- Spine - **CT guided** needle biopsy
- Joints - Synovial aspiration, but it's low yield.
  - ➢ Should get bone/soft tissue. Send for aerobic/non-aerobic bacteria, fungal, AFB, enriched culture media **Takes up to 4-6 weeks**