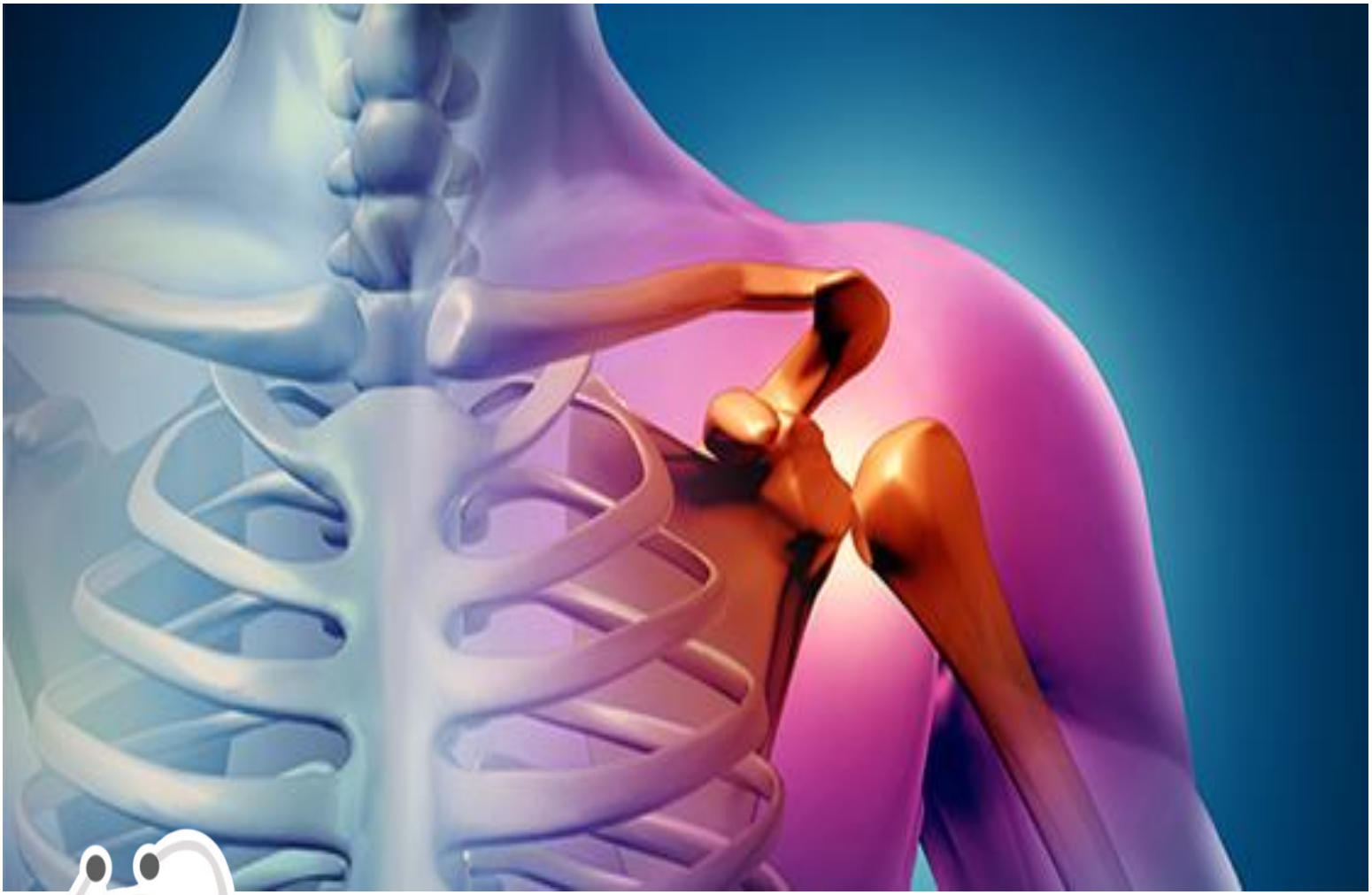
Orthopedics

9 Bone and Joint Infections



1st Edition:

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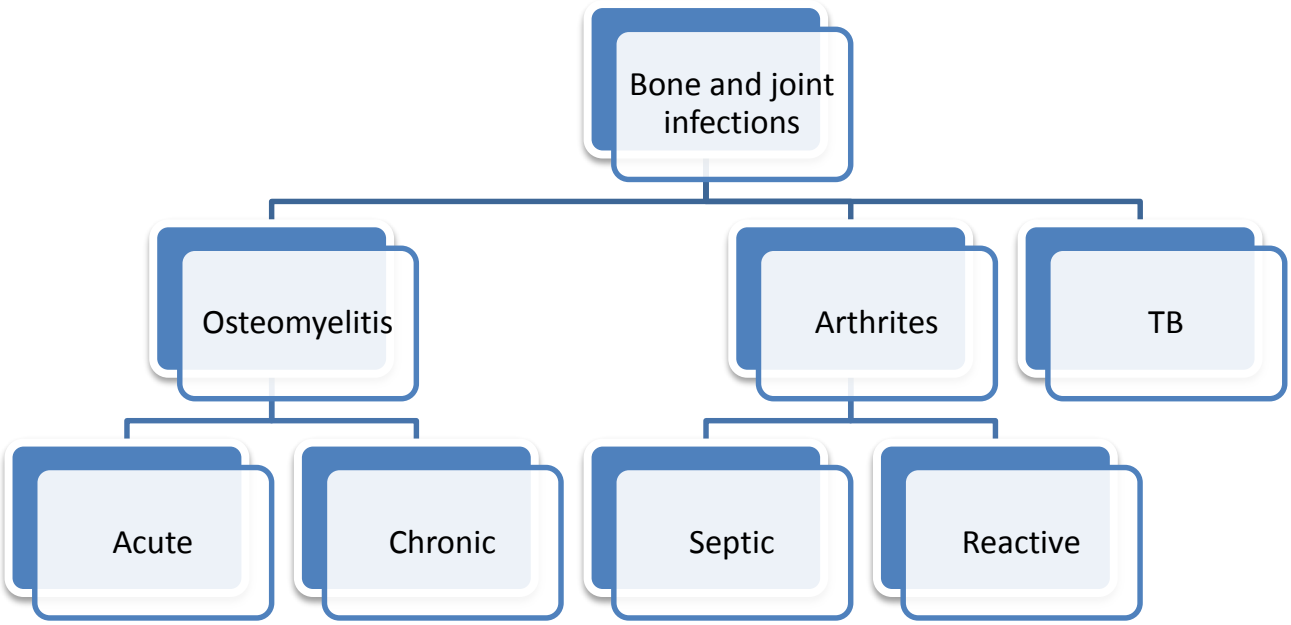
Color Code:

Slides	Doctor's Notes	Team Notes	Important
431 team work	Arabic Words	Books' notes	Other Sources

Objectives

- Bone and joints infections presentation
- Assessment and work up for bone and joint infections
- Differential diagnosis for bone and joint infections
- Management of bone and joint infections
- Complication of bone and joint infections

Mind Map



Terminology

Psudoparalysis: Apparent paralysis due to voluntary inhibition of motion because of pain, incoordination, or other cause, but without actual paralysis.

Acute osteomyelitis

Definition:

Osteomyelitis is an inflammation of bone and bone marrow caused by an infecting organism

It may remain 1) local or 2) spread to marrow, cortex, periosteum and/or soft tissue.

We can classify by:

1) Duration

A) Acute less than 3 weeks

B) Subacute 3-6 weeks

C) Chronic >6 weeks

2) Route of Infection

a) Hematogenous tooth extraction, abrasions…

b) Exogenous (direct) trauma (open fracture), surgery…

Organisms:

Neonates: Staph aureus, Strep, E coli.

Children: Staph aureus, E coli, Serratia, Pseudomona (H. influenzae < 4 yrs, The most common in those whom not vaccinated [rural areas], but generally rare).

Sicklers: Staph aureus, **Salmonella** (most unique).

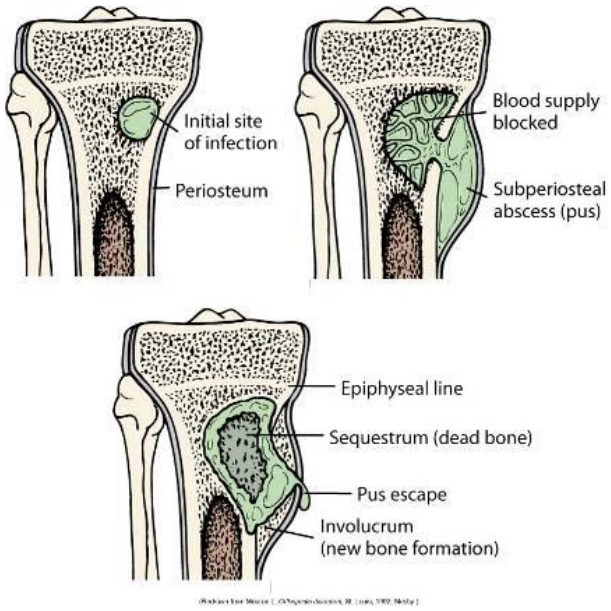
Drug addicts: Staph aureus, **Pseudomonas** (most unique).

The causal organism is usually *Staphylococcus aureus (found in over 70% of cases)*, less often *Streptococcus pyogenes* or *S. pneumoniae*. Curiously, patients

Spread of infection:

- Infection starts at bone marrow.
- Infection spreads to cortex and lifts up periosteom, swelling becomes tense= increase of pain.
- Local blood vessels get obstructed.
- Periosteom bursts into soft tissues and pus becomes under skin; eventually spontaneous discharge.

- If pus bursts into epiphysis; epiphyseal arrest will occur.



Incidence:

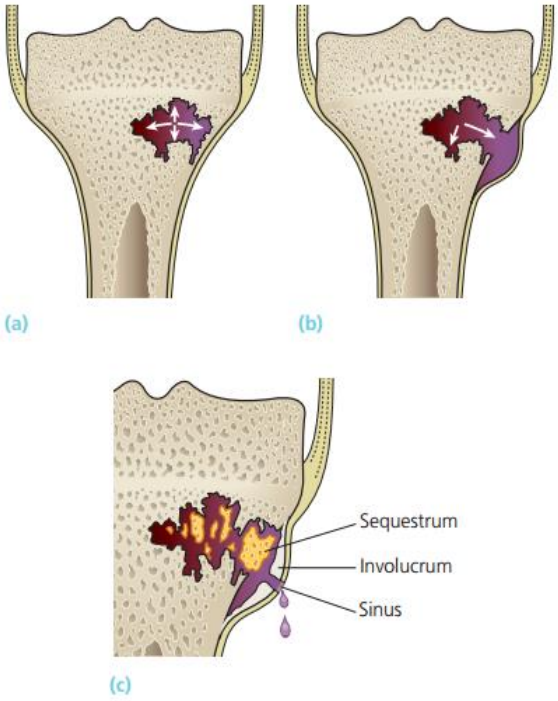
With sickle-cell disease are prone to infection by *Salmonella typhi*. (from apley's)
Age: more in **children** (b/w 2 and 6 yrs)
Sex: Boys > Girls
Site of infection: Metaphysis, why?

Predilection for this site has traditionally been attributed to the peculiar arrangement of the blood vessels in that area: the non anastomosing terminal branches of the nutrient artery twist back in hairpin loops before entering the large network of sinusoidal veins; the relative vascular stasis and consequent lowered oxygen tension are believed to favour bacterial colonization. *(form apley but the doctor had the same explanation so go through it)*

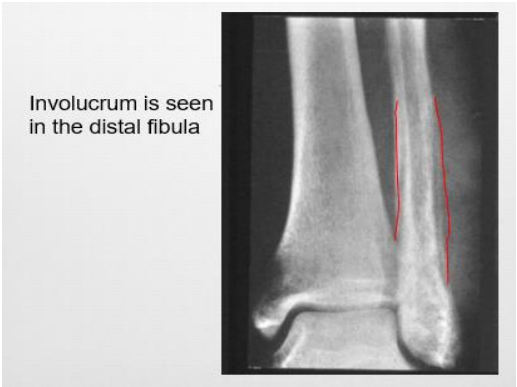
Bones: lower extremities > upper extremities. **Commonest are tibia and femur.** In children the organisms usually settle in the vascular metaphysis of a long bone, most often at the proximal or distal end of the femur or the proximal end of the tibia.

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

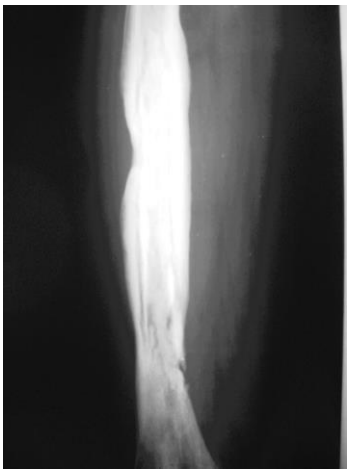


2.2 Acute osteomyelitis (a) Infection in the metaphysis may spread towards the surface, to form a subperiosteal abscess (b). Some of the bone may die, and is encased in periosteal new bone as a sequestrum (c). The encasing involucrum is sometimes perforated by sinuses.



Pathology:

- Bone infarction (Sequestrum)= Dead bone = separated piece from its surroundings.This happens when blood supply is cut off from area of bone due to infection.
- Subperiosteal(Involucrum) = New bone formed at site of infection and trapping a cavity of bone.



Large sequestrum inside involucrum.

CARDINAL FEATURES OF ACUTE OSTEOMYELITIS IN CHILDREN
Pain
Fever
Refusal to bear weight
Elevated white cell count
Elevated ESR
Elevated CRP

Clinical picture:

History

- Fever
- Psudoparalysis, limping, inability to walk due to pain
- Identified potential source like trauma

Symptoms

- Pain
- Fever
- Malaise
- Restlessness
- Vomiting usually seen in kids
- The limb is held still, loss of function (patient unable to walk and to carry) ((*pseudoparalysis*).
- **Locally= swelling at a limb** usually near a joint like knee or hip or shoulder with **increased local temperature**.

Laboratory signs:

- CBC: raised WBC (predominantly poly morphs.)
- ESR: 24-36hrs (takes time to rise)
- C-reactive protein: 4-6hrs (**the most sensitive monitor**)
- (CRP is most sensirive because it rapidly increase and rapidly decrease with treatment)
- Blood cultures (positive up to 50%of cases; usually higher on increased spike of fever)
- Aspiration (send for Gram stain and C&S)

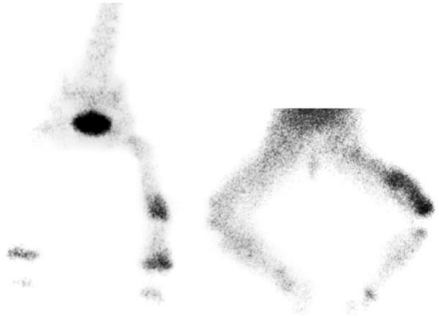
Radiology investigation:

Radiography (what is ortho without it?)

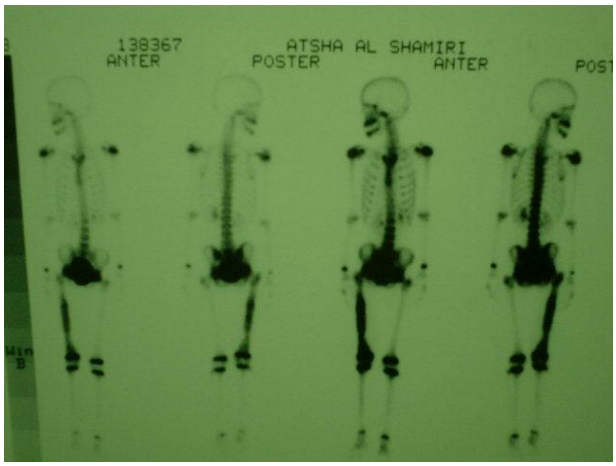
- Plain x-rays (may not reveal any findings except **soft tissue swelling** at site of infection.Bony changes take up to 14 days to show suspected bone involvement, but osteopenia may appear earlier. Later on may show abscess formation(baseline) (**x ray is not diagnostic**)
- Bone scan (very sensitive but not specific) to know where is the area of infection and to look for abscess
- Ultrasound(may show pus below periostium and it may show the defect earlier than xray)

- Isotope CT scan >**Tcm99** bone scan(or **Gallium** bone scan are diagnostic , as increased local tracer uptake; but take time to appear
- **MRI is the modality of choice** to detect early changes and for children. (fear of child they require general anesthesia, best diagnosis to localize the cavity)

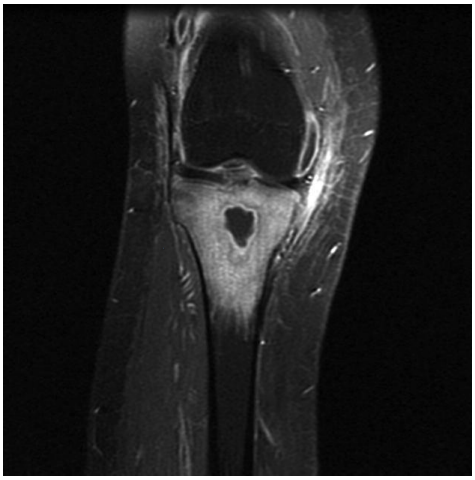
Plain x-rays In early days : No bony changes ,but soft tissue swelling may be evident.



Isotope bone scan. Increased uptake in the lower left femur



Increased uptake of most of right femur



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

Differential Diagnosis:

- **Acute septic arthritis**
- Cellulitis this is often mistaken for osteomyelitis. There is widespread redness and lymphangitis. A source of skin infection may not be obvious and should be searched for (e.g. between the toes). If doubt remains about the diagnosis, MRI will help to distinguish between bone infection and soft-tissue infection. (from apley's)
- Ewing's Sarcoma
- Sickle cell bone crisis patients with sickle-cell disease may present with features like those of acute osteomyelitis. Where *Salmonella* is endemic it would be wise to treat these patients with suitable antibiotics until infection is definitely excluded.
- Acute rheumatoid arthritis

Ewing sarcoma of femur. Frontal radiograph and lateral radiographs of the femur demonstrate mottled, osteolytic lesion (blue circle) with poorly marginated edges in the diaphysis of the bone. There is sunburst periosteal reaction (red circle) and lamellated periosteal reaction (white arrows). For additional information about this disease, click on this icon if seen above.

How to confirm diagnosis?

- Ultrasound guided aspiration from site of swelling or abscess.
- X-ray guided aspiration of suspected bone involvement(according to MRI).
- Via open incision –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.

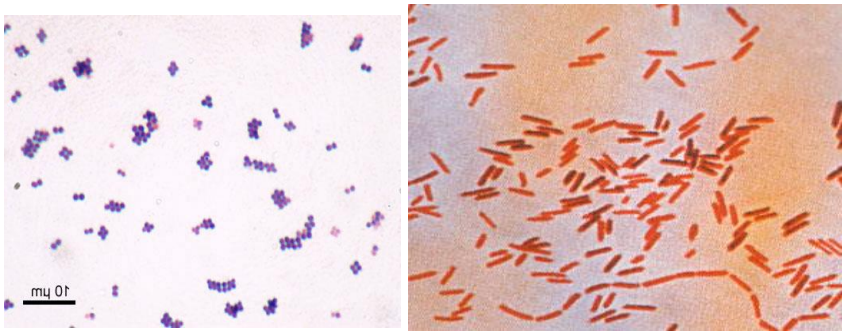
Treatment out line

If osteomyelitis is suspected on clinical grounds (RED flag) , blood and fluid samples should be taken for laboratory investigation and then treatment started immediately without waiting for final confirmation of the diagnosis. (from apley's, I think it's important to be mentioned)

- 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.
- **Definitive diagnosis depends on seeing organisms at direct smear, or culturing organisms**
- When treating patients with bone or joint infection it is wise to maintain continuous collaboration with a specialist in microbiology

Empirical Treatment

1. **When patient is acutely ill; empirical IV antibiotic treatment to be started immediately after sending samples for culture.**
2. **This empirical treatment depends on suspected organisms according to :**
3. **Age: Newborn, young or adult.**
4. **Presence of other circumstances: sickle cell disease or Hemodialysis or drug addicts. sal*monella* is a characteristic organism,** the **primary treatment → fluoroquinolones (only in adults) alternative treatment → 3rd -generation cephalosporin**



To simplify empirical treatment:

1. **to make it simple: always suspect staph aureus: (oxacillins) except sicklers.**
2. **3rd generation IV antibiotics for special cases.**

When do we consider surgery?

- **When we are sure(as a result of our investigations) there is pus or suspect highly 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.**

How do we do Surgery for Bone Infection?

1. **Patient should be prepared well for surgery.**
2. **Surgery is done under GA usually.**
3. **X-ray guidance (image intensifier) is used usually to help exact location of site of drainage.**
4. **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.**
5. **In case of presence of sequestrum it has to be removed.**
6. **Drain is to be left at site of drainage till discharge is minimal.**

Post-Operative management:

7. **Definite antibiotic should be continued via IV route for 6 weeks usually.**
8. **Monitoring of general condition and blood investigations should be done frequently as in patient, especially CBC, ESR and CRP.**
9. **Repeat follow up plain X-rays or CT or MRI may be required.**
10. **Patient should be pain free and generally well before discharge.**
11. **Long term follow up should be done to exclude late complications**

Complication (very imp):

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

Growth disturbance

Pathological fracture

Chronic osteomyelitis

KEY POINTS

- Osteomyelitis can be a result of haematogenous or direct spread.
- The earliest radiographic change is periosteal elevation.
- MRI is effective in the early detection of osteomyelitis.
- The bacterial pathogen varies on the basis of the patient's age and mechanism of infection.

Chronic osteomyelitis

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

- Common in
  - Inappropriately treated acute OM. like people who are treated by giving them oral antibiotic
  - Diabetics due to imperilment of chemotaxis and of phagocytosis
  - Trauma
  - Immunosuppressed
  - IV
  - drug abuse

Anatomical classification

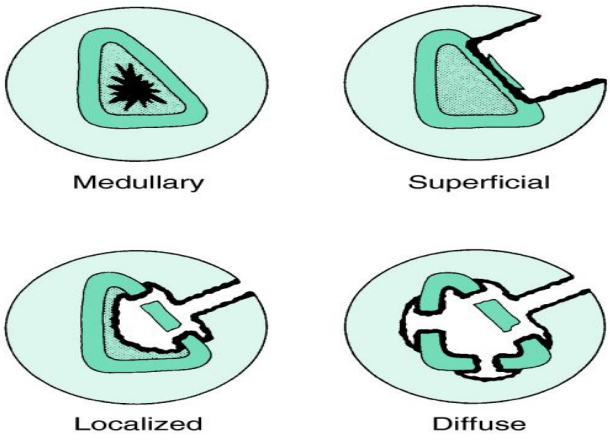


Table 2.2 Staging for adult chronic osteomyelitis

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

Features:

- Skin and soft tissues involvement.
- Sinus tract formation → 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 the CSR, ESR and WBC levels may be increased; these non-specific signs are helpful in assessing the progress of bone infection but they are not diagnostic.
- *CT* and *MRI* are invaluable in planning operative treatment: together they will show the extent of bone destruction and reactive oedema, hidden abscesses and sequestra.

Treatment

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; and (B) to control acute flares.

- Empirical therapy is not indicated
- IV antibiotics → must be based on deep cultures
- Most common organisms
    - S. aureus
    - Enterobacteriaceae
    - P. aeruginosa

Bacterial colonization and resistance to antibiotics is also enhanced by the ability of certain microbes (including *Staphylococcus*) to adhere to avascular bone surfaces and foreign implants, protected from both host defences and antibiotics by a protein polysaccharide slime (glycocalyx).

We have to take the implants out ☹

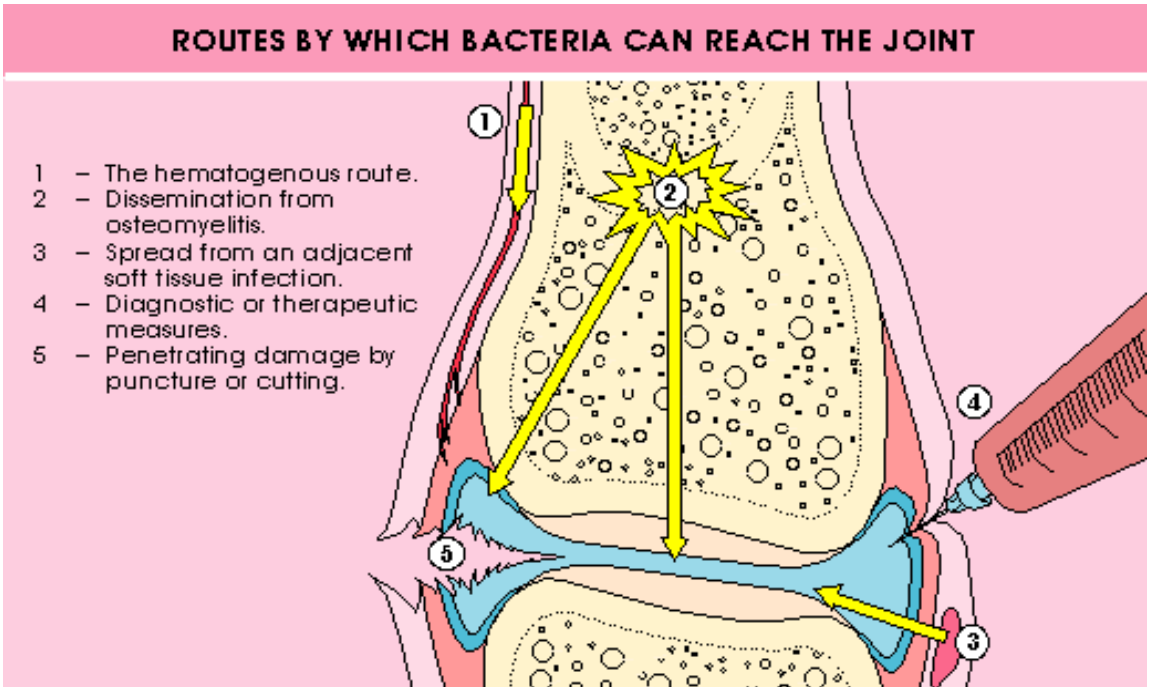
Complications:

- Recurrence
- Pathological fracture
- Growth disturbance in skeletally immature
- Squamous cell carcinoma transformation (fistula)
- Amputation

Septic Arthritis

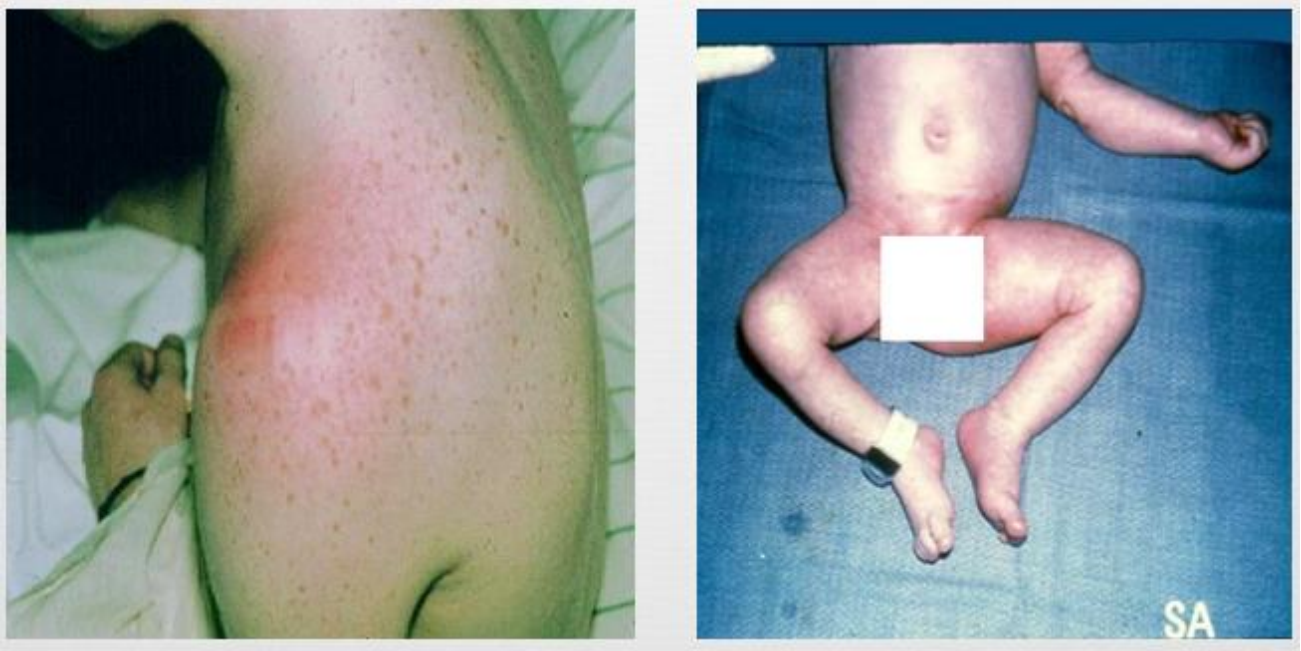
- May affect any age and any joint.
- The knee and hip are most affected.
- Pathology: hematogenous or from adjacent bone.
    - In neonates: transphyseal vessels
    - In joints where the metaphysis is intracapsular (Hip, shoulder, proximal radius and distal fibula)

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



routes by which the bacteria can reach the join

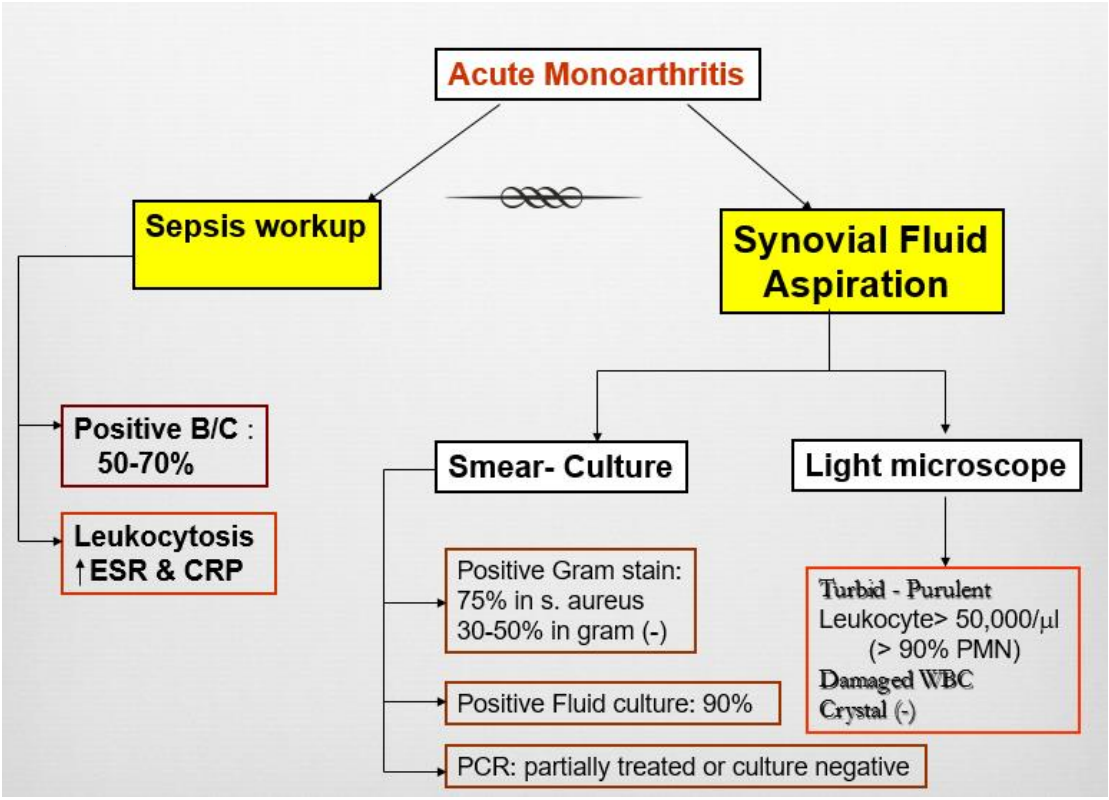
- Symptoms: like acute osteomyelitis
- Signs: hot swollen joint which is painful to any motion, inability to bear weight
- Joint is fixed in the position of ease



Typical features are acute pain and swelling in a single large joint – commonly the hip in children and the knee in adults. However, any joint can be affected. The patient becomes ill, with a rapid pulse and swinging fever. The WBC is raised and blood culture may be positive.

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 AO S. aureus, H.influnza.
- Rx: Admission for Emergency arthrotomy and washout, broad spectrum IV antibiotics and splintage **it's an emergency.**
- Main DDx: transient synovitis of the hip in children causes symptoms and signs which are less acute, but there is always the fear that this is the beginning of an infection.



Synovial Fluid Aspiration For simulated cases vimto+oil=fracture

Differential diagnosis:

- **Acute osteomyeliyis**
- **Transient synovitis (<10 years)**
- **Reactive arthritis**
- **Vasculitis eg: Henoch-Schonlein purpura**
- **Traumatic haemoarthrosis**
- **Haemophilic arthritis**

Complications:

- Septicemia
- Abscess
- Osteomyelitis
- Joint destruction
- Joint subluxation and dislocation
- Ankylosed joint
- Avascular necrosis of the femoral head
- 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.

Tuberculosis

Granulamatous bone infection=TB

- Causative organism:
  - Mycobacterium tuberculosis
  - Mycobacterium Bovine
  - Mycobacterium africanum

Tuberculosis is on the increase; bones or joints are affected in about 5% of patients. *Mycobacterium tuberculosis* has a predilection for the vertebral bodies and the large synovial joints.

Where pulmonary tuberculosis is endemic, skeletal tuberculosis is seen mainly in children and young adults. In non-endemic areas the disease usually appears in patients with chronic debilitating disorders or reduced immune defence mechanisms (e.g. acquired immunodeficiency syndrome [AIDS]).

Mycobacterium Tuberculosis (VERY IMP)

- Thin non-motile rod
- Strictly aerobic
- Acid fast bacillus
- Requires enriched culture medium to grow
- Takes as long as 4-6 weeks to see the colonies
- Known to affect humans from about 5000 BC
- Discovered by Laennic in the early 18th century
- Common in our region and other developing countries
- Endemic in poor non-developed countries
- Increasing in developed countries along with the increase in AIDS
- Affects anyone at any age, but it is more common in the immunocompromised (AIDS, chronic renal failure, substance abuser)
- Usually affects young individuals in developing countries while it affects the older in developed countries

Pathology:

- Inflammation Hyperemia
- TB Follicles (tubercle): Lmyphocyte – monocytes, Endothelial cells, Langhans giant cells
- Coalesce
- Caseation

Musculoskeletal TB

- Secondary to other primary TB lesions

- (Pulmonary, Renal, LN)
- 1-8% of all T.B
- 50% associated with pulmonary primary site
- Route of spread:
    - Hematogenous ****
    - Direct (much less): Bone to joint, Soft tissue to bone
- The primary lesion
    - Quiescent
    - Active: (Apparent, Latent)
- **MSK targets:**
    - Spine (50%)
        - Thoracic (50%)
        - Lumbar (25%) can cause equda equine
        - Cervical (25%)
    - Pelvis > Hip > Knee > Ankle and shoulder
- What can it do to the site
    - **Spine:**
    - Deformity (gibbus, kyphus)
    - Neurological compromise (motor>sensory)
    - Muscle spasm
    - **Joints:** Swelling, Stiffness, Locking, Loss of function
    - **Bones:** Ulcers, Sinuses, Swelling, Deformity

Presentation

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

Radiology

- Plain x-rays:
    - Joints: usually monoarticular

PHEMISTER'S TRIAD

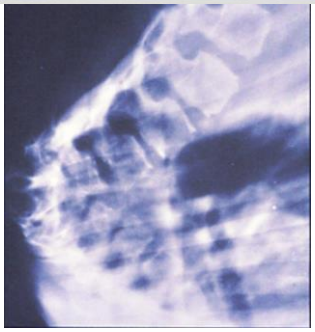
- Peri-articular osteopenia
- Subchondral and peripheral erosions affecting both sides of the joint
- Loss of joint space

T.B of The Spine: (Pott's disease)

- Usually secondary to hematogenous spread
- Can affect two or more adjacent vertebrae
- May skip levels
- Primarily does not affect the disc but eventually the disc is affected
- Affects most commonly the anterior part of the vertebral endplates
- Causing erosion and destruction and finally anterior wedging of the vertebrae
- The disc herniates into the weakened and destructed body and narrowing of the disc height follows
- 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

Diagnosis

- **History and physical**
  - High risk
  - Constitutional symptoms
  - Atypical clinical picture



- **Blood work:**
  - Lymphocytosis
  - Anemia
  - Elevated ESR
  - ELISA
  - PCR
  - Brucella titre
- **Radiology:**
  - **Plain x-rays**:
    - Spine:

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

- **Computerized tomography:**
  - Further delineate bony destruction and sequestrum
    - **Magnetic resonance imaging with contrast:**
      - Soft tissue mass, abscess
      - Nerve root, cord status
      - Distant abscess
      - Non-enhanced cold abscess with enhanced peripheral ring
- **Special tests:**
  - Mantoux skin test
  - Spine: CT guided needle biopsy
  - Joints: Synovial aspiration (low yield)

Should get bone/soft tissue. Send for aerobic/non-aerobic bacteria, fungal, AFB, enriched culture media. Takes up to 4-6 weeks

Treatment

a) Mainstay of treatment is a combination anti-microbial agent.
b) Usually 3-4 medications needed
c) Isniazide, Rifampin, Ethambutol, Pyrazinamide are commonly chosen
d) Modify according to culture results
e) Given for prolonged period of time (6 months up-to 18 months)

- **Indications of surgery:**

A. Marked and progressive neurological deficit not responding to medical treatment requiring decompression
B. Spinal instability requiring stabilization
C. Tissue biopsy to confirm diagnosis
D. Joint lavage and removal of rice bodies
E. Abscess drainage if resistant to conservative treatment

Brucellosis

1) Milk and milk products
2) Back pain and stiffness
   i. Muscle spasms
   ii. Fever (mild)
3) Sacro-iliac joint
4) Less destructive than TB
5) Brucella titer Diagnostic if > 1/640
6) Antibiotics: E.g. Septrin – Oxytetracycline

Summary

1) Be aware about red flags
2) Acute osteomyelitis: Empirical wide spectrum IV Abx till final culture
3) Chronic osteomyelitis: IV Abx according to C/S
4) Septic arthritis:
   A. Joint aspiration under GA for children
   B. Emergency Joint washout
   C. Required Immediate wide spectrum IV Abx till final culture
   D. Bone and joint infection requires prolonged antibiotic

1-

History

A young primigravida mother has become concerned about her newborn child. She is accompanied in the clinic by her aunt who recognized that something was not quite right but was not sure what to advise. The baby has general symptoms of fever, fatigue, irritability and malaise. There is no history of trauma.

Examination

Close inspection of the left leg reveals some localized oedema and erythema. On palpation the baby appears to have pain overlying the proximal tibia. Passive manipulation shows a full range of movement of the leg without any obvious indications of pain.

Investigations

Initial investigations show a markedly elevated C-reactive protein (CRP). Imaging studies of the knee show periosteal elevation of the proximal tibial metaphysis (Fig. 1.1).

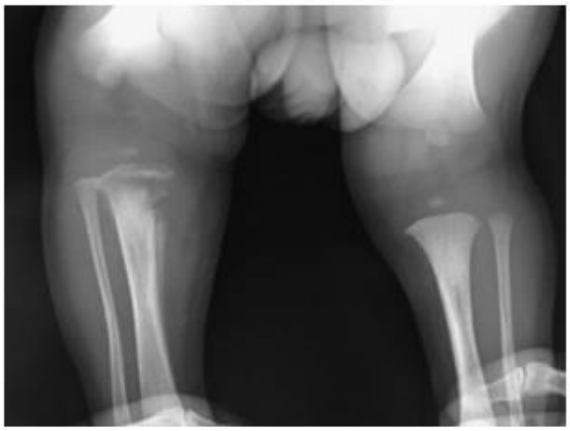


Figure 1.1

Questions

- What is the diagnosis?
    - Septic arthritis
    - Osteomyelitis

2-

History: An 84-year-old woman with diabetes has been admitted to the emergency department with an acutely swollen and painful left knee. She has been unwell with a raised temperature and productive cough for the last week and for the last 24 hours has been unable to bear weight because of her knee pain.

Examination: This elderly woman is unwell, sweaty and febrile. Her pulse is 108 bpm and blood pressure 98/60 mmHg. Oxygen saturation on room air is 92 per cent. Her left knee is held rigid in fixed flexion and is hot and red with a moderate effusion. Her respiratory rate is 22/min. There is decreased expansion on the right side, with dullness to percussion, increased vocal resonance and coarse crackles at the base. The remainder of her examination is normal.

INVESTIGATIONS

		Normal range
Haemoglobin	14.2 g/dL	13.3–17.7 g/dL
White cell count	18.3 × 10^9/L	3.9–10.6 × 10^9/L
Platelets	542 × 10^9/L	150–440 × 10^9/L
ESR	45 mm/h	<10 mm/h
CRP	>160 mg/L	<5 mg/L
Chest X-ray	Right basal consolidation	

What does she have?

- Septic arthritis
- TB
- Osteomyelitis
- **Regarding likely infecting organisms involved in causing acute osteomyelitis in adults, all of the following statements are true EXCEPT:**

  A. Polymicrobial infections, which include *Staphylococcus aureus, Staphylococcus pyogenes*, coliforms and anaerobes cause oeteomyelitis in poorly controlled diabetics.
  B. *Staphylococcus aureus* and *Pseudomonas* are common in injecting drug users.
  C. Coagulase negative *Staphylococci* are likely to be involved in causing infection associated with orthopaedic hardware.
  D. Gram-negative enteric bacteria is the most common cause in the elderly.

- **Regarding acute septic arthritis and osteomyelitis in children, which ONE of the following statements is TRUE?**

  A. Both conditions most commonly occur secondary to direct inoculation from an overlying local wound.
  B. Widening of the joint space is an early sign seen on X-ray in acute septic arthritis.
  C. Osteomyelitis most commonly affects metaphysis of long bones

D. *Streptococcal* species are the most commonly isolated organisms in children.

Answers: B-A-D-C

Summery

Pathology	Clinical picture	investigation	Treatment
Acute osteomyelitis	-severe pain,malaise and a fever - Even the gentlest manipulation is painful and joint movement is restricted(*pseudoparalysis*).	-CBC: raised WBC -ESR -C-reactive protein (most sensitive) -Blood cultures -Aspiration	Start on wide spectrum antibiotic
Septic Arthritis	- hot swollen joint which is painful to any motion, inability to bear weight - Joint is fixed in the position of ease	-Joint aspiration: WBC >50,000 (>90%PMNL), damaged WBC and No crystals	Admission for Emergency arthrotomy and washout, broad spectrum IV antibiotics and splintage
Transient Synovitis	-Sudden onset of hip pain -low grade favorite	-WBC count <12,000 -Mildly elevated ESR (<40), CRP (<2)	-Self-limited after 2-7 days -NSAIDs
Vasculitis	purpura, arthritis and abdominal pain	-High urea and creatinine -Raised IgA -Diagnosis confirmed by biopsy