



Microbiology of Bone and Joint Infections (Osteomyelitis & Septic Arthritis)



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Objectives



- Recognize the differences between osteomyelitis and arthritis.
- Recall the route of infection of bone and joint.
- Describe how infections reach the bone /joint.
- Discuss the epidemiology, risk factors and pathogenesis of both osteomyelitis and arthritis
- Recall the commonest causative organisms of acute and chronic osteomyelitis and arthritis.
- Recall the differential diagnosis of both conditions.

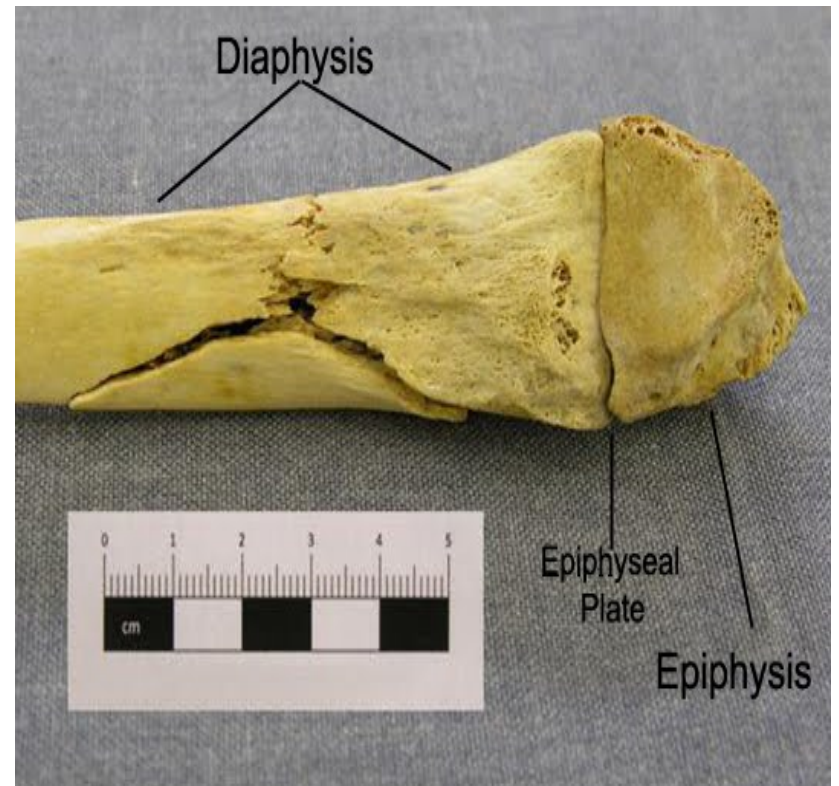
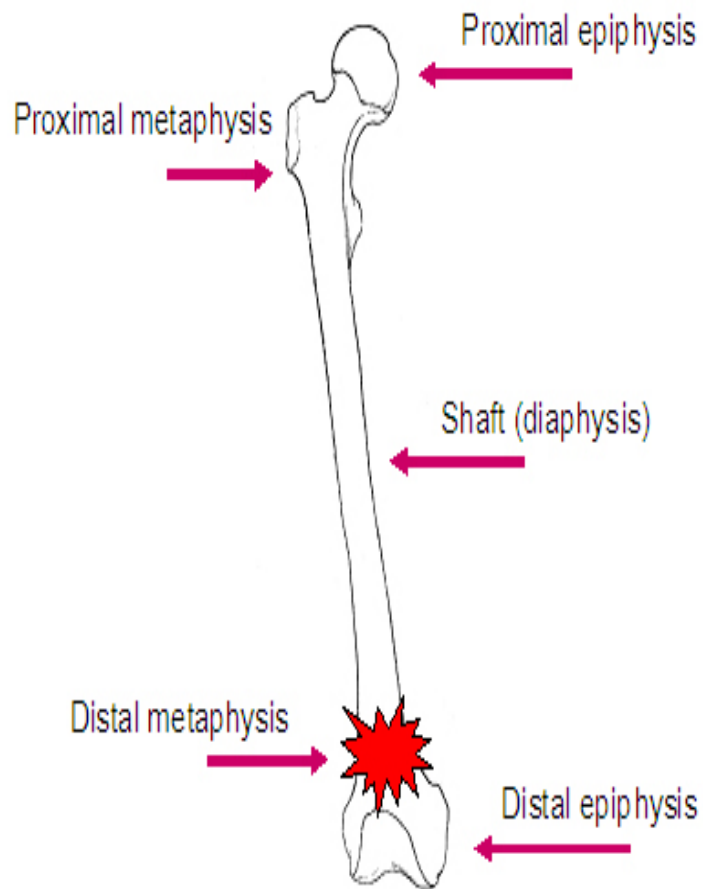


- Describe the laboratory diagnosis and investigation of osteomyelitis and arthritis.
- Recognize the management and treatment of both osteomyelitis and arthritis.
- Recall the complications of both conditions.
- Discuss the causative organisms ,diagnosis , management and treatment of infection of the joint prosthesis.

Introduction



- Bone & joint infections may exist separately or together.
- Both are more common in infants and children.
- **Usually caused by blood borne spread ,but can result from local trauma or spread from contiguous soft tissue infection.**
- Often associated with **foreign body** at the primary wound site.
- If not treated can lead to devastating effect.



Acute Osteomyelitis



- Acute osteomyelitis is an acute infectious process of the bone and bone marrow .
- **How the pathogen reaches the bone ?**
 - 1- **Hematogenous route**
 - 2- **Contiguous soft tissue focus** (post operative infection, contaminated open fracture, soft tissue infection , puncture wounds)
 - 3- **In association with peripheral vascular disease** (diabetes mellitus ,severe atherosclerosis, vasculitis)
- **May have a short duration** (few days for hematogenous acquired infection) **or may last several weeks to months** (if secondary to contiguous focus of infection).

Etiology, Epidemiology & Risk Factors



- **Primary hematogenous** is most common in infants & children.

Infants: *S.aureus*, group B Streptococcus, *E.coli*.

Children: *S.aureus*, group A streptococci, *H.influenzae*.

Site : Metaphysis of long bones (femur, tibia & humerus)

Adults: Hematogenous cases less common, but may occur due to **reactivation** of a quiescent focus of infection from infancy or childhood. **Most cases are due to *S.aureus*.**

Septic arthritis is common as the infection begins in the Diaphysis.

Other causes -special clinical situations



- **Streptococci and anaerobes** may be the cause in fist injuries, diabetic foot and decubitus ulcers.
- *Salmonella* or *Streptococcus pneumoniae* in sickle cell patients.
- *Mycobacterium tuberculosis* (MTB) or *Mycobacterium avium* in AIDS patients.

Common causes of acute osteomyelitis

Age /special conditions

- Infants
- Children
- Adults
- Sickle cell disease
- Infection after trauma ,injury or surgery
- Infection after puncture wound of foot.
- AIDS patients

Common causative organisms

- *S.aureus*, group B Streptococcus, Gram negative rods (eg. *E.coli*, *Klebsiella*).
- *S. aureus*, group A Streptococcus & *H. influenzae*
- *S.aureus*
- *S.aureus*, *S. pneumoniae*, *Salmonella* species
- *S.aureus*, group A Streptococcus, Gram negative rods, anaerobes.
- *Pseudomonas aeruginosa*, *S.aureus*
- *Mycobacterium tuberculosis* or *M. avium*.

Clinical presentation & investigation



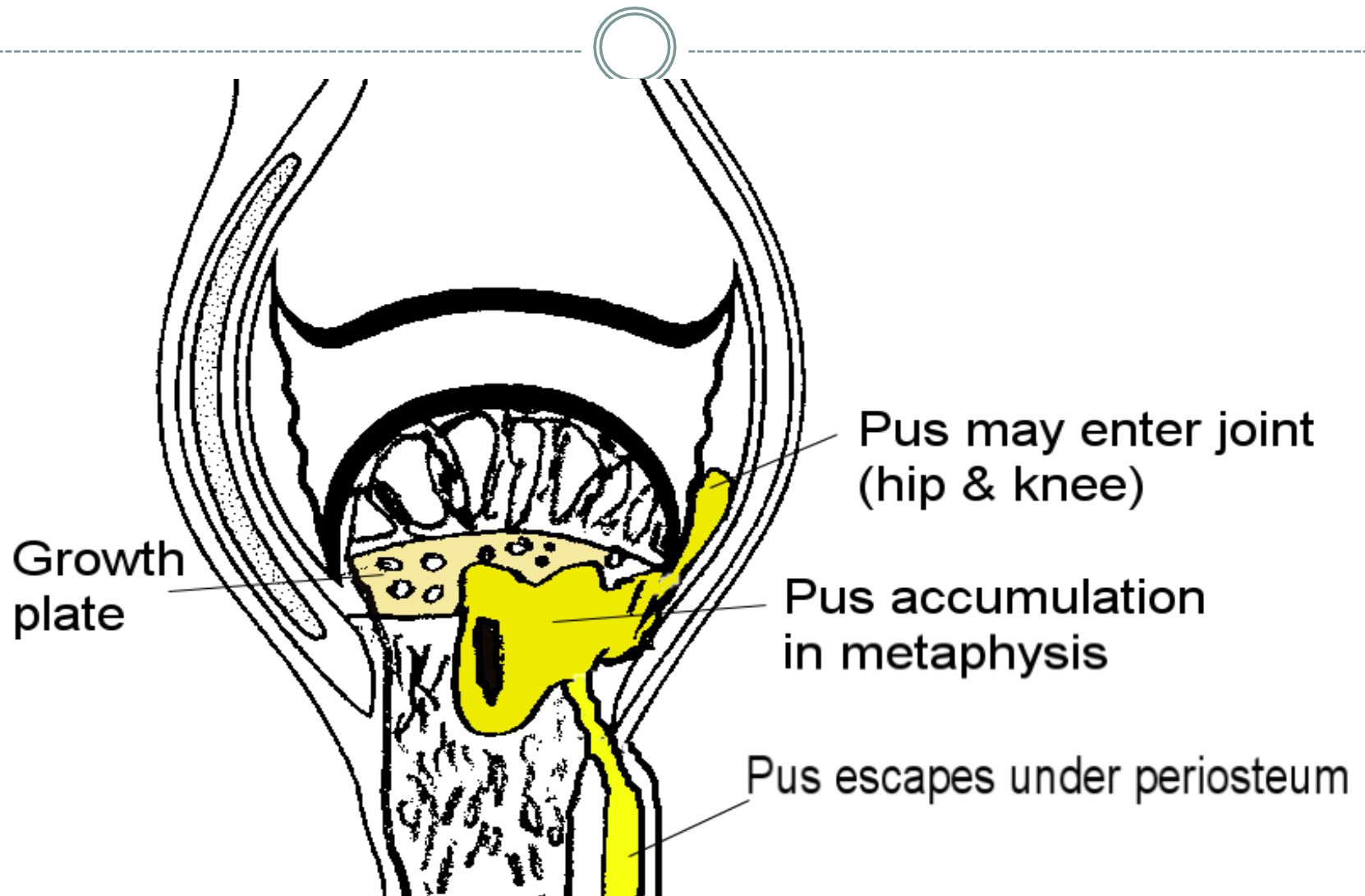
- Acute osteomyelitis usually of abrupt onset
- **Clinically** : fever, localized pain , heat , swelling, tenderness of affected site (one or more bones or joints affected in hematogenous spread).May be local tissue infection (abscess or wound) .
- **Blood tests**: leukocytosis, high ESR and C-reactive protein.
- **X-ray** : normal at early stages. Swelling of soft tissues followed by elevation of periosteum , demineralization and calcification of bone later on.

Clinical presentation & investigation

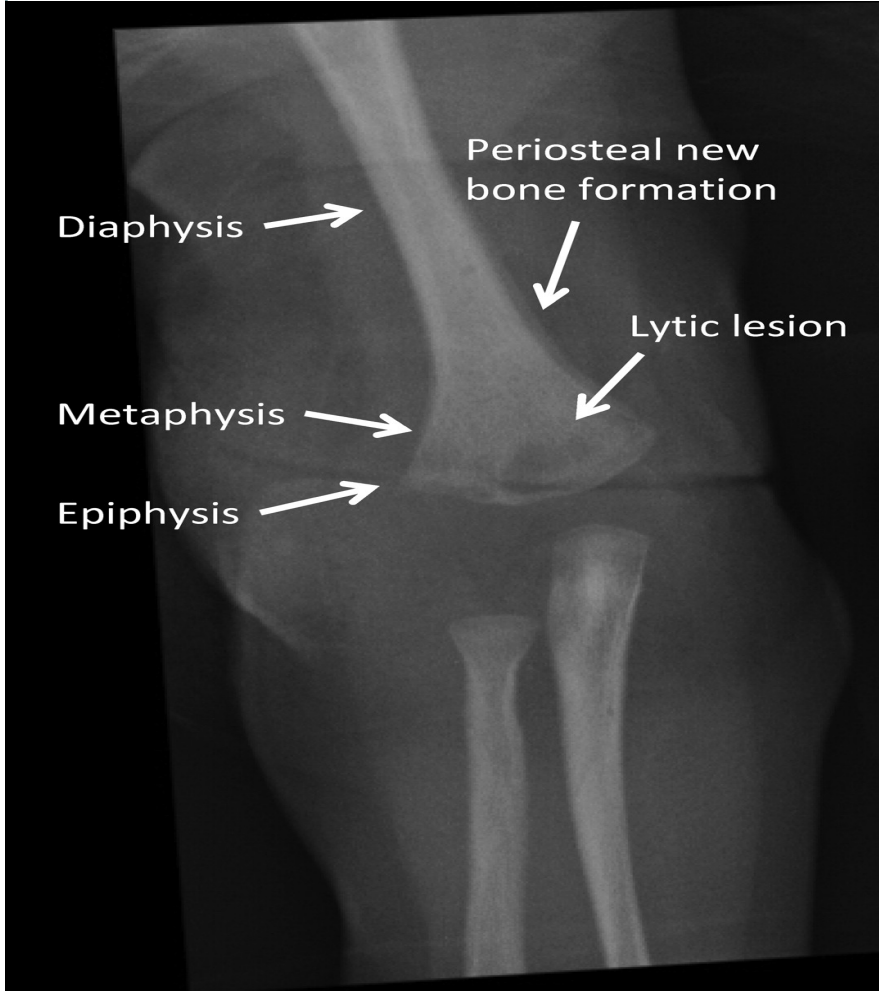


- **Ultrasound**: fluid collection (abscess) and surface abnormalities of bone.
- **CT scan**: reveal small areas of osteolysis in cortical bone.
- **MRI** : early detection, helps in unclear situations. Defines bone involvement in patients with negative bone scan.

Acute osteomyelitis



Radiography of acute osteomyelitis



Diagnosis of acute osteomyelitis



- **Blood culture:** bacteremia common.
- **Biopsy of periosteum or bone or needle aspiration** of overlying abscess *if blood culture is negative.*
- Blood test: complete blood and differential counts .
- Erythrocyte sedimentation rate (ESR) .
- C-reactive protein
- **Imaging studies:**
 1. **X-RAY, MRI, CT-SCAN**

Blood Culture bottles



Differential diagnosis & complications



Differential diagnosis of acute osteomyelitis includes:

- Rheumatoid arthritis
- Septic arthritis
- Fractures
- Sickle cell crises

Complications of acute osteomyelitis include:

- Septic arthritis
- Chronic osteomyelitis
- Metastatic infection to other bones or organs
- Pathological fractures

Management & Treatment



Bed rest and analgesia , splint & antimicrobial therapy:

- **MSSA** (methicillin sensitive *S.aureus*) : Cloxacillin, or Clindamycin .
- **MRSA**(methicillin resistant *S.aureus*): Vancomycin , Clindamycin, Linezolid, or TMP-SMX.
- **Polymicrobial infection**: Piperacillin-Tazobactam or Quinolone with Metronidazole.

Duration for 4-6 weeks to ensure cure and prevent progression to chronic osteomyelitis.

- **Surgical drainage** (*as needed*) if there is local purulent process

Chronic Osteomyelitis



- A chronic infection of the bone and bone marrow usually secondary to inadequately treated or relapse of acute osteomyelitis or foreign body.
- Management difficult , prognosis poor.
- Infection may not completely cured.
- May recur many years or decades after initial episode.
- Most infections are secondary to a contiguous focus or peripheral vascular disease.
- Chronic infection due to hematological spread is rare.

Chronic Osteomyelitis



- ***S.aureus* is the most common pathogen**
- **Other microorganisms:** *S.epidermidis*, *Enterococci*, streptococci, *Enterobacteriaceae*, *Pseudomonas* and anaerobes.
- Polymicrobial infection common with decubitus ulcers and diabetic foot infections.
- **Tuberculosis and fungal osteomyelitis** clinically have indolent “chronic” course

Chronic Osteomyelitis



- *Mycobacteria and fungi may be the cause in immunosuppressed patients.*
- **Tuberculous osteomyelitis** primarily results from haematogenous spread from lung foci or as an extension from a caseating lymph node (50% in spine). It resembles *Brucella* osteomyelitis .
- TB & *Brucella* are common in KSA.
- Haematogenous osteomyelitis due to **fungi** eg. *Candida* species, *Aspergillus* species and other fungi may occur.

Diagnosis of chronic osteomyelitis



- Blood culture is not very helpful because bacteremia is rare.
- WBC usually normal, ESR elevated but not specific.
- Radiological changes are complicated by the presence of bony abnormalities.
- **MRI helpful for diagnosis and evaluation of the extent of disease.**

Management & Treatment



- **Extensive surgical debridement with antibiotic therapy.** Parenteral antibiotics for 3-6 weeks followed by long term oral suppressive therapy.
- Some patients may require life long antibiotic ,others for acute exacerbations.
- **MSSA:** Cloxacillin
- **MRSA & S.epidermidis:** Vancomycin then oral Clindamycin or TMP-SMX.
- Other bacteria: treat as acute osteomyelitis.
- **MTB:** combination of 4 drugs : INH+RIF +Pyrazinamide & Ethambutol for 2 months followed by RIF + INH for additional 4 months. **Brucella** is treated with Tetracycline and Rifampicin for 2 to 3 months.



Septic Arthritis

Septic (Infectious) Arthritis is an acute inflammation of the joint space secondary to infection.

Generally affects a single joint and results in suppurative inflammation. May be caused by bacteria or viruses.

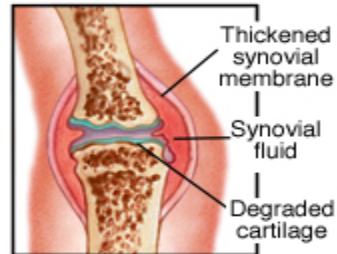
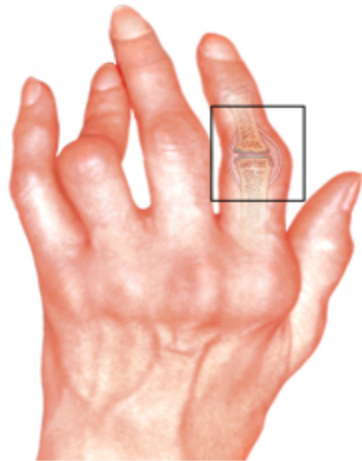
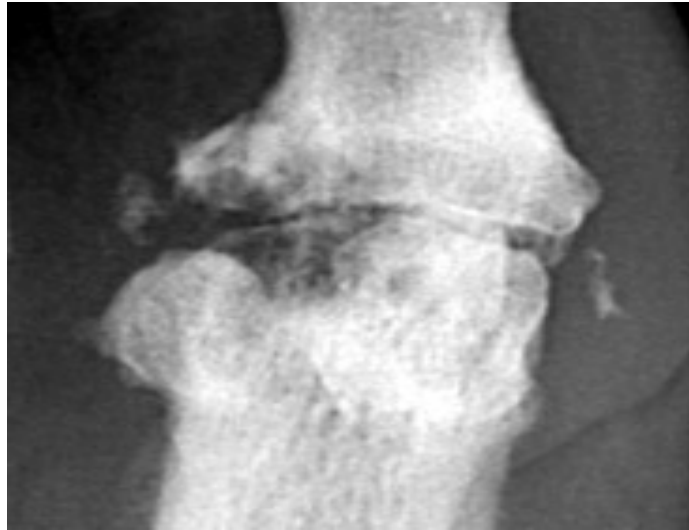
Haematogenous seeding of joint is most common.

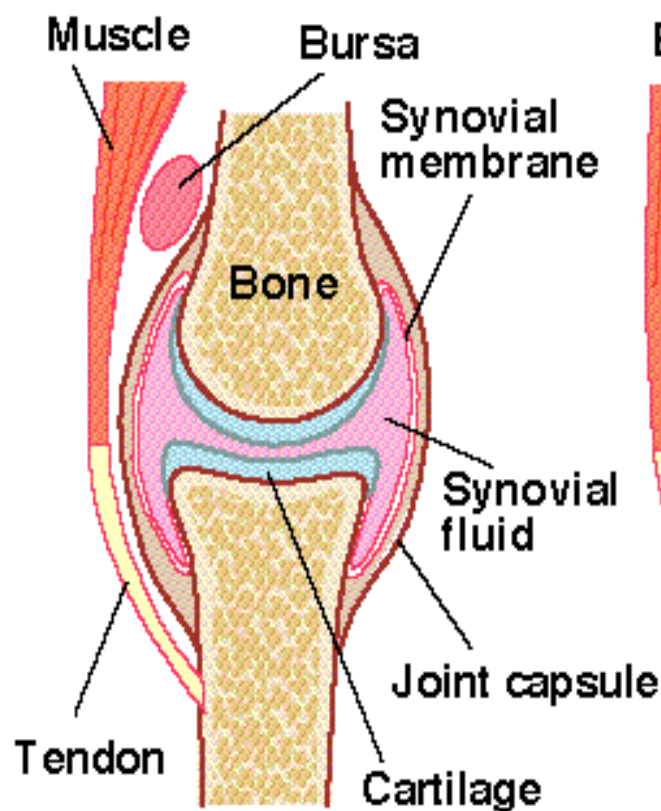
Common symptoms : pain, swelling, limitation of movement.

Diagnosis by **Arthrocentesis** to obtain synovial fluid for analysis; Gram stain, culture & sensitivity

Drainage & antimicrobial therapy important management.

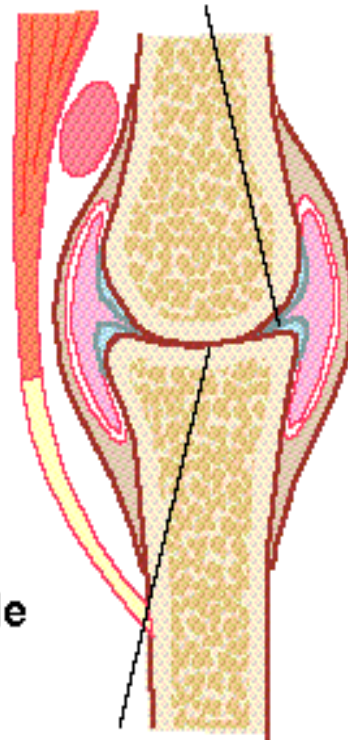
Septic Arthritis





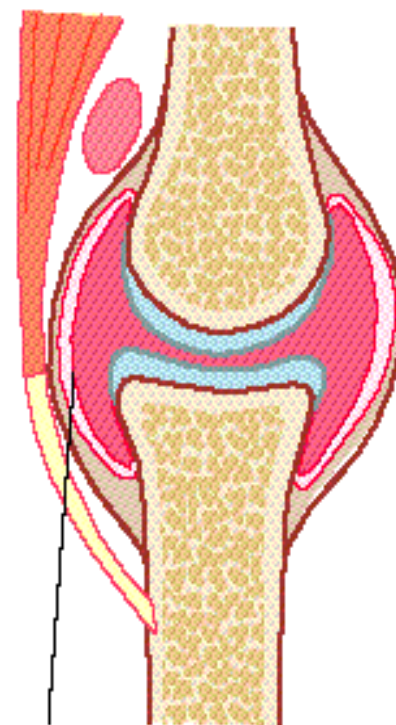
Normal joint

Eroded cartilage



**Bone ends
rub together**

Osteoarthritis



**Swollen inflamed
Synovial membrane**

**Rheumatoid
arthritis**

NORMAL and ARTHRITIC JOINTS *A. Bonsall*

Common causes of septic arthritis

Age/special conditions

- Neonates
- Infants /children
- Adults
- Sickle cell disease
- Trauma /surgical procedure
- Chronic arthritis
- Prosthetic arthritis

Common organism

- *S.aureus*, group B *Streptococcus*, Gram negative rods (eg. *E.coli*, *Klebsiella*, *Proteus*, *Pseudomonas*) .
- *S.aureus*, group A *Streptococcus*, *S.pneumoniae*, *H. influenzae* type b
- *S.aureus*, *Neisseria gonorrhoeae*
- *Salmonella* species, *S.aureus*
- *S.aureus*
- *Mycobacterium tuberculosis* , Fungi
- Skin flora

Other causes of septic arthritis



Viruses:

Include: Rubella, Hepatitis B, mumps, Parvovirus B19, Varicella, EBV, Adenovirus, ..etc. These are self-limiting

Reactive arthritis due to:

- *Campylobacter jejuni*
- *Yersinia enterocolitica*
- Some *Salmonella* species

Non –infectious causes of arthritis:

- Rheumatoid arthritis
- Gout
- Traumatic arthritis
- Degenerative arthritis

Risk factors



- **Gonococcal** infection most common cause in young, sexually active adults caused by *Neisseria gonorrhoeae*. Leads to disseminated infection secondary to urethritis/cervicitis. **Initially present with polyarthralgia, tenosynovitis, fever, skin lesions. If untreated leads to suppurative monoarthritis.**
- **Nongonococcal** arthritis occurs in older adults. Results from introduction of organisms into joint space as a results of bacteremia or fungaemia from infection at other body sites.

Risk factors



Occasionally results from direct trauma, procedures (**arthroscopy**) or from contiguous soft tissue infection.

S.aureus is most common cause. Other organisms : streptococci and aerobic Gram negative bacilli.

- **Lyme disease due to tick bite in endemic areas.** Uncommon in KSA.
- In sickle cell disease patients , arthritis may be caused by *Salmonella species*.
- Chronic arthritis may be due to **MTB** or **fungi**.

Diagnosis of Septic Arthritis



- History/examination to exclude systemic illness.
Note history of tick exposure in endemic areas
- **Arthrocentesis** should be done as soon as possible;
 - 1-Synovial fluid is cloudy and purulent
 - 2- Leukocyte count generally $> 25,000/\text{mm}^3$, with predominant neutrophils.
 - 3- Gram stain and culture are positive in $>90\%$ of cases.
 - 4-Exclude crystal deposition arthritis or noninfectious inflammatory arthritis.



- **Blood cultures indicated**
- If Gonococcal infection suspected, take specimen from cervix, urethra, rectum & pharynx for culture or DNA testing for *N.gonorrhoeae*. Investigate for other sexually transmitted diseases.
- Culture of joint fluid and skin lesions .

Management & treatment



- Arthrocentesis with drainage of infected synovial fluid.
- Repeated therapeutic Arthrocentesis often needed
- Occasionally, arthroscopic or surgical drainage/debridement
- Antimicrobial therapy should be directed at the suspected organism and susceptibility results:
 1. **Gonococcal arthritis:** IV Ceftriaxone (or Ciprofloxacin or Ofloxacin) then switch to oral Quinolone or Cefixime for 7-10 days.



- **Nongonococcal infectious arthritis:**
 1. **MSSA:** Cloxacillin or Cefazolin
 2. **MRSA:** Vancomycin
 3. **Streptococci:** Penicillin or Ceftriaxone or Cefazolin
 4. ***Enterobacteriaceae:*** Ceftriaxone or Fluroquinolone
 5. ***Pseudomonas:*** Piperacillin and Aminoglycoside
 6. **Animal bite :** Ampicillin-Sulbactam
- **Lyme disease arthritis:** Doxycycline for one month.

Prognosis & Complications



- Gonococcal arthritis has an excellent outcome .
- Non-Gonococcal arthritis: can result in scarring with limitation of movement, ambulation is affected in 50% of cases.
- Risk factors for long term adverse sequelae include:
 - Age, prior rheumatoid arthritis, polyarticular joint involvement, hip or shoulder involvement, virulent pathogens and delayed initiation or response to therapy.

Infections of Joint Prosthesis



- Occur in 1 - 5 % of total joint replacement.
- Most infections occur within 5 years of joint replacement.
- Often caused by skin flora.
- Diagnostic aspiration of joint fluid necessary .
- Result in significant morbidity and health care costs.
- Successful outcomes results from multidisciplinary approach.

Joint Prosthesis



Before



After



Before



After



Diagnosis of Prosthetic Arthritis



- Aspiration & surgical exploration to obtain specimen for culture , sensitivity testing & histopathology.
- **Skin flora regarded as pathogens if isolated from multiple deep tissue cultures.**
- **Plain X-ray** may not be helpful.
- **Arthrography** may help define sinus tracts.
- Bone scan-not specific for infection.
- ESR and C-reactive protein(CRP) may be high.

Management & Treatment



- Surgical debridement and prolonged antimicrobial therapy
- **Surgery: removal of prosthesis**
- Antibiotic –impregnated cement during re-implantation
- **Antimicrobial for 6 weeks:**
- Begin empiric IV antibiotic to cover MRSA and Gram negative rods (Vancomycin, Cefepime, Ciprofloxacin, or Aminoglycoside)
- **Chronic therapy with oral drug if removal of prosthesis not possible.**

Reference book



Ryan, Kenneth J. Sherris Medical Microbiology.
Seventh edition.

Mc Graw –Hill education