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

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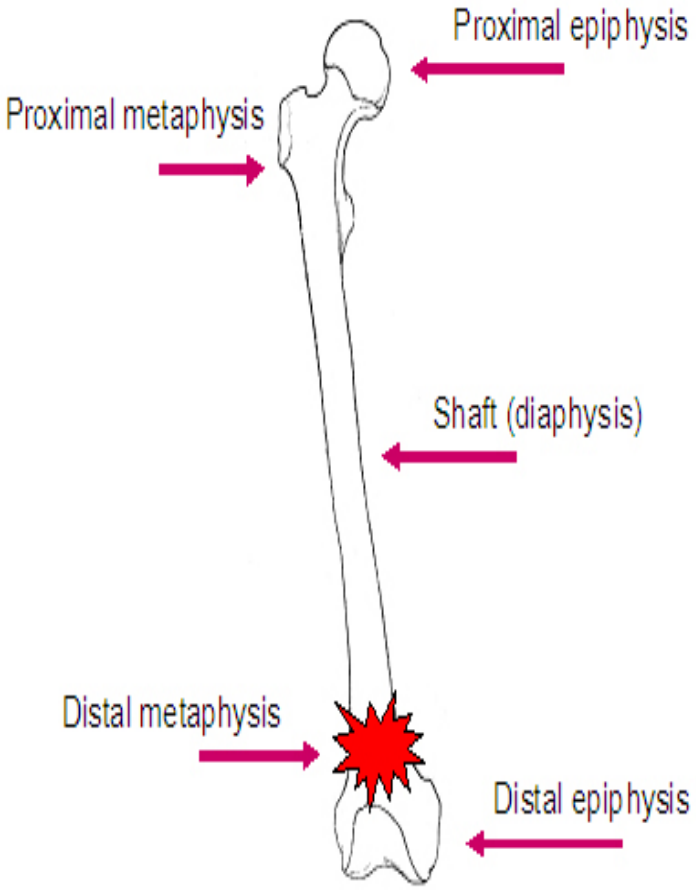
Objectives

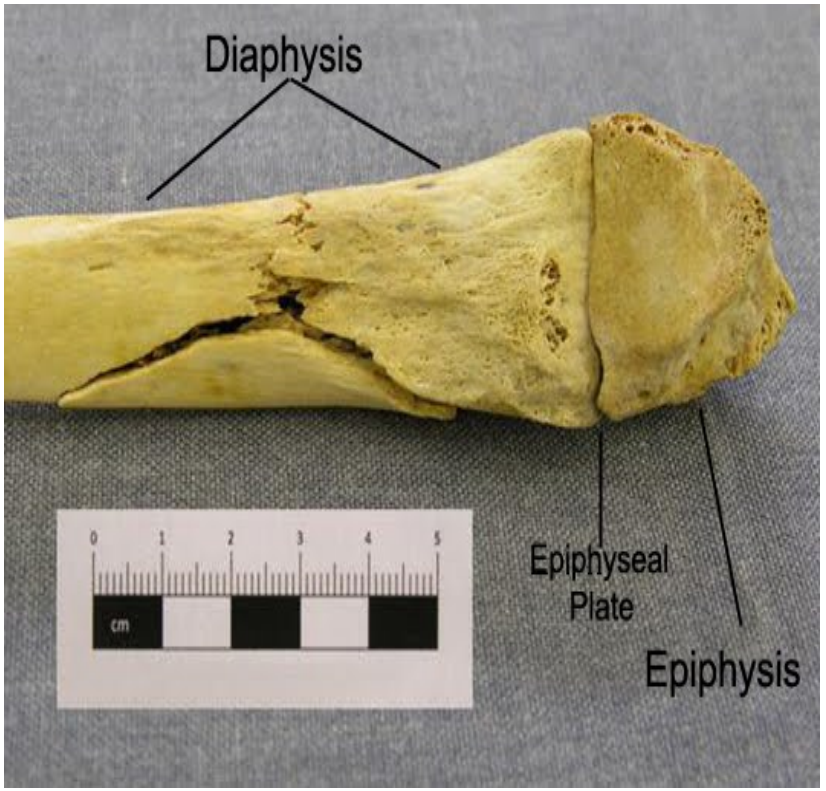
- Recognize the differences between osteomyelitis and arthritis.
- Recall the route of infection of bone and joint.
- Describe how infections reach the bone /joint.
- Discuss the epidemiology, risk factors and pathogenesis of both osteomyelitis and arthritis
- Recall the commonest causative organisms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


Proximal epiphysis
Proximal metaphysis
Shaft (diaphysis)
Distal metaphysis
Distal epiphysis


Diaphysis
Epiphyseal Plate
Epiphysis

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	Common causative organisms
• Infants	• *S.aureus, group B Streptococcus,Gram* negative rods (eg. *E.coli, Klebsiella*).
• Children	• *S. aureus*, group A *Streptococcus* & *H. influenzae*
• Adults • Sickle cell disease • Infection after trauma ,injury or surgery	• *S.aureus* • *S.aureus, S. pneumoniae, Salmonella* species • *S.aureus*, group A S*treptococcus*,Gram negative rods, anaerobes.
• Infection after puncture wound of foot.	• *Pseudomonas aeruginosa, S.aureus*
• AIDS patients	• *Mycobacterium tuberculosis* or *M. avium.*

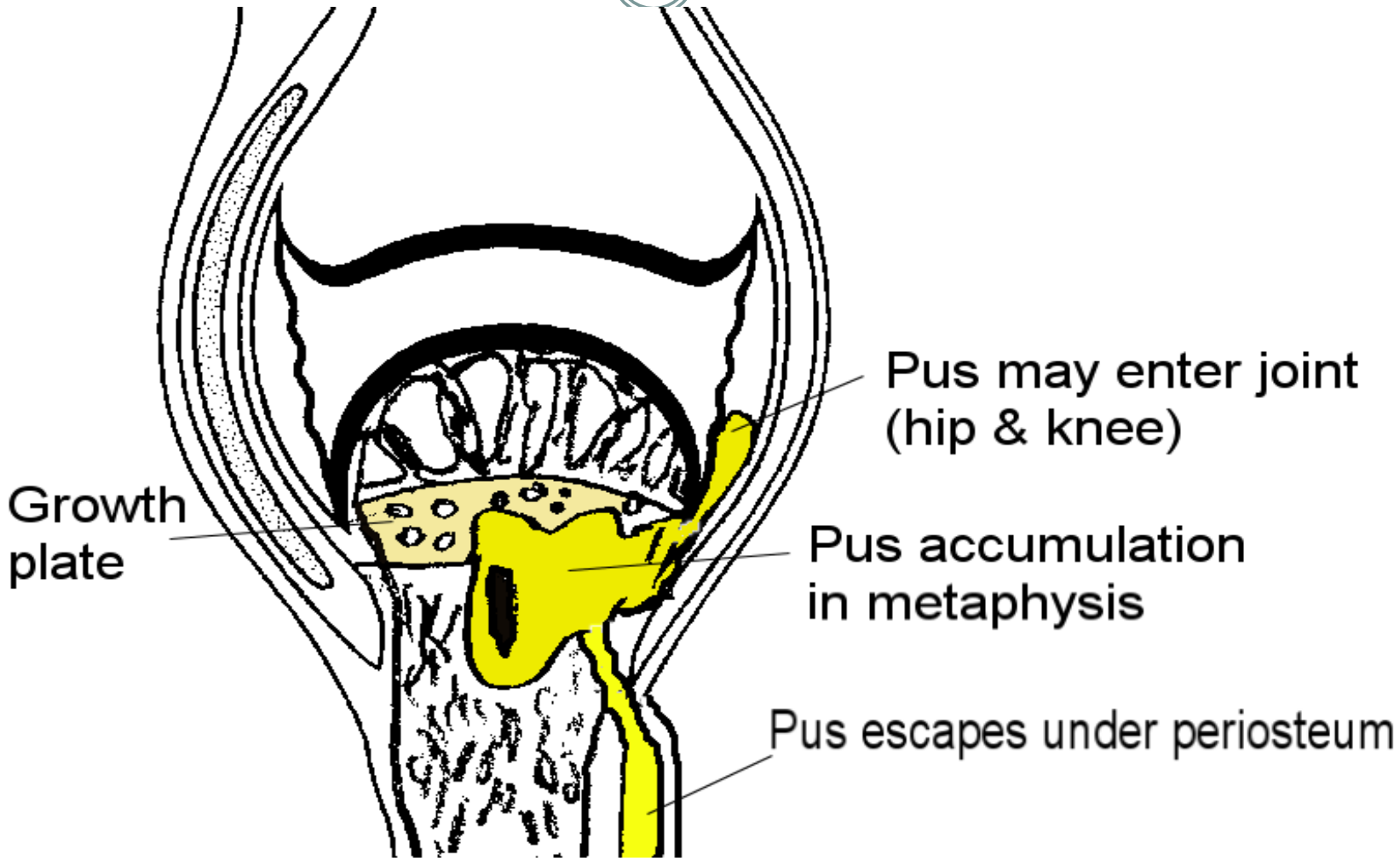
Clinical presentation & investigation

- 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.

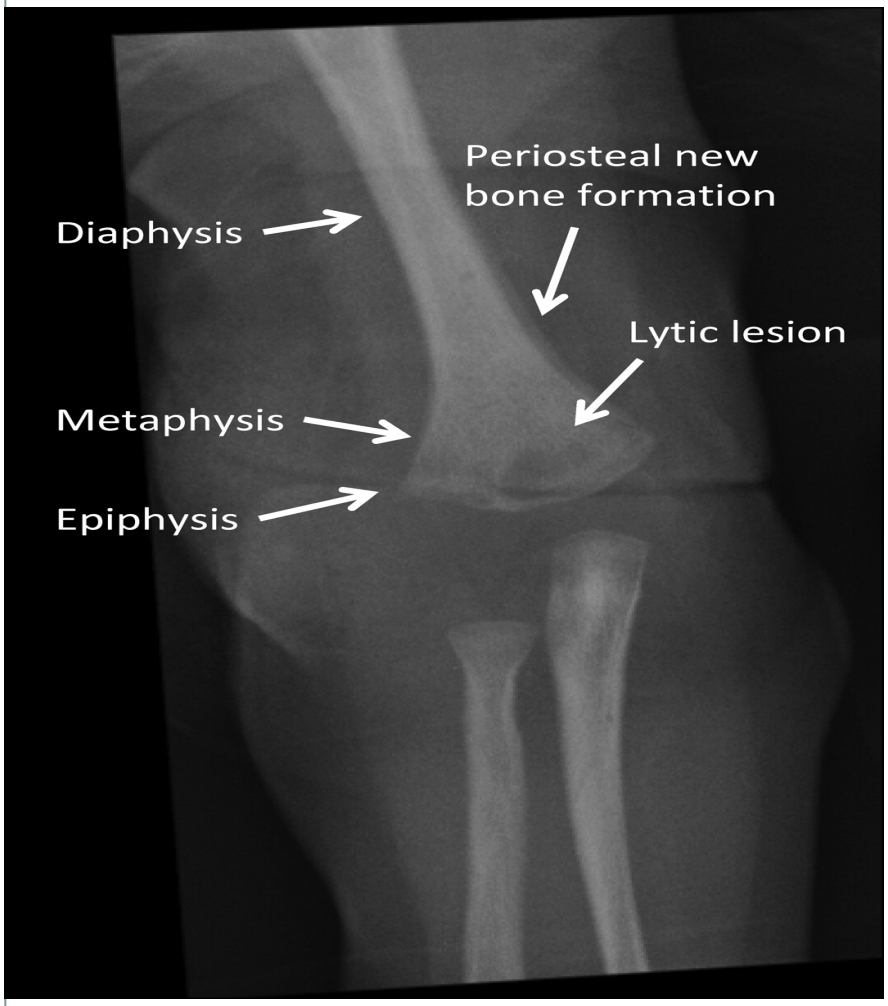
Clinical presentation & investigation

- 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, *Enterobactericae, 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 haemtogenous spread from lung foci or as an extension from a caseating lymph bone (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 caused by bacteria or viruses.

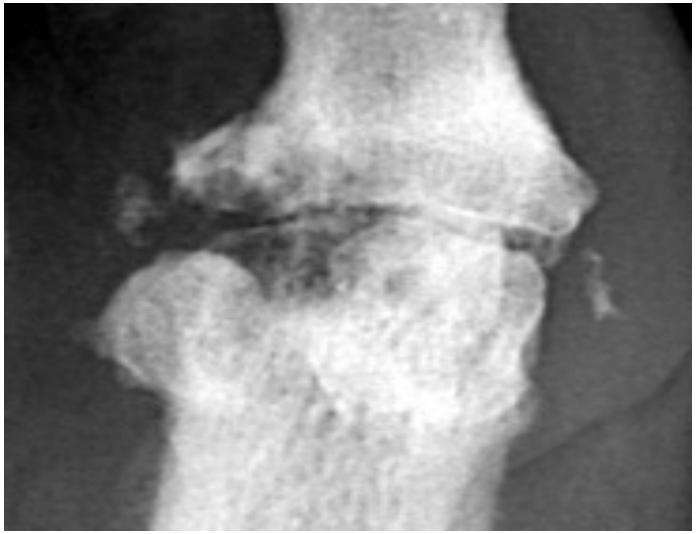
Haematogenous seeding of joint is most common.

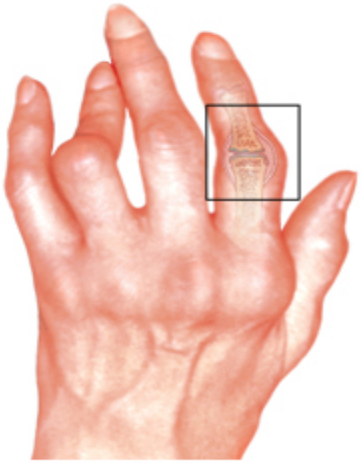
Common symptoms :pain, swelling, limitation of movement.

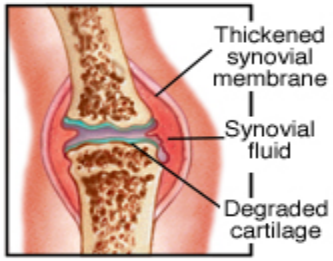
Diagnosis by **Arthrocentesis** to obtain synovial fluid for analysis; Gram stain, culture & sensitivity

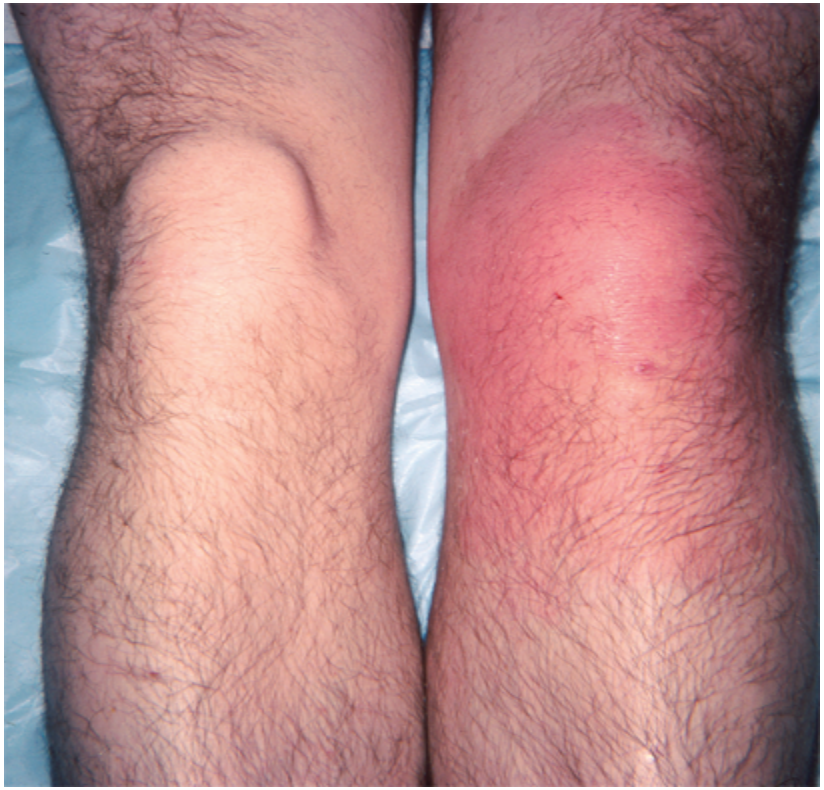
Drainage & antimicrobial therapy important management.

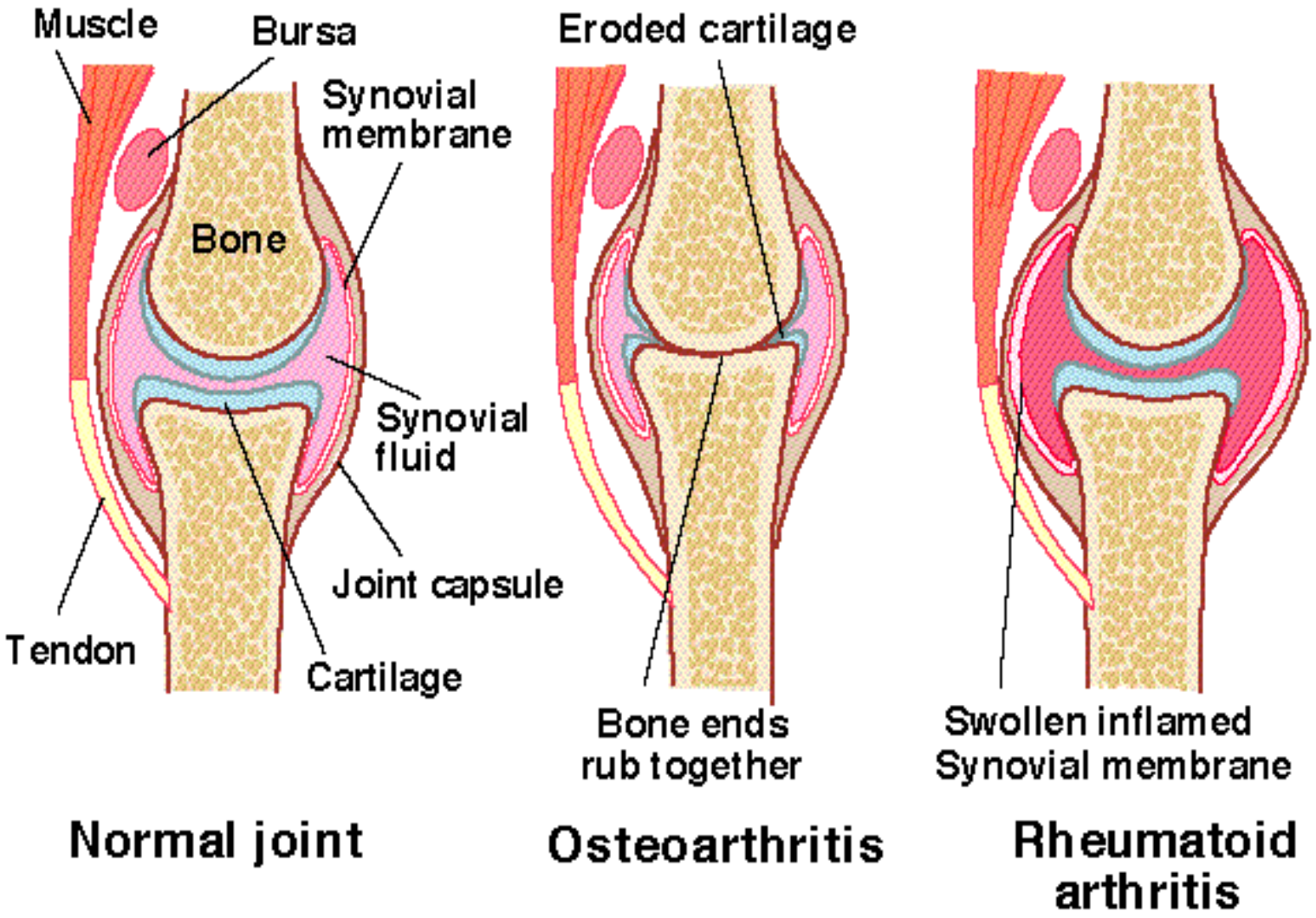
Septic Arthritis











NORMAL and ARTHRITIC JOINTS

A Bonsall

Common causes of septic arthritis

Age/special conditions	Common organism
• Neonates	• *S.aureus*, group B *Streptococcus*, Gram negative rods (eg. *E.coli, Klebsiella, Proteus, Pseudomonas)* .
• Infants /children	• *S.aureus*, group A *Streptococcus, S.pneumoniae, H. influenzae* type *b*
• Adults	• *S.aureus, Neisseria gonorrheae*
• Sickle cell disease	• *Salmonella* species, *S.aureus*
• Trauma /surgical procedure	• *S.aureus*
• Chronic arthritis	• *Mycobacterium tuberculosis* , Fungi
• Prosthetic arthritis	• Skin flora

Other causes of septic arthritis

Viruses:

Include: Rubella, Hepatitis B, mumps, Parvovirus B19,Varicella,EBV,Adenoviruse,..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 gonorrheae* . 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/mm3,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.gonorrheae*. 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 infectiuos arthritis**:

1. MSSA: Cloxacillin or Cefazolin
2. MRSA: Vancomycin
3. Streptococci: Penicillin or Ceftriaxone or Cefazolin
4. *Enterobacetriacae*: Ceftriaxone or Fluroquinolone
5. *Pseudomonas*: Piperacillin and Aminoglycoside
6. Animal bite : Ampicillin-Sulbactam

- **Lyme disease arthritis**: Doxycycline for one month.

Prognosis & Complications

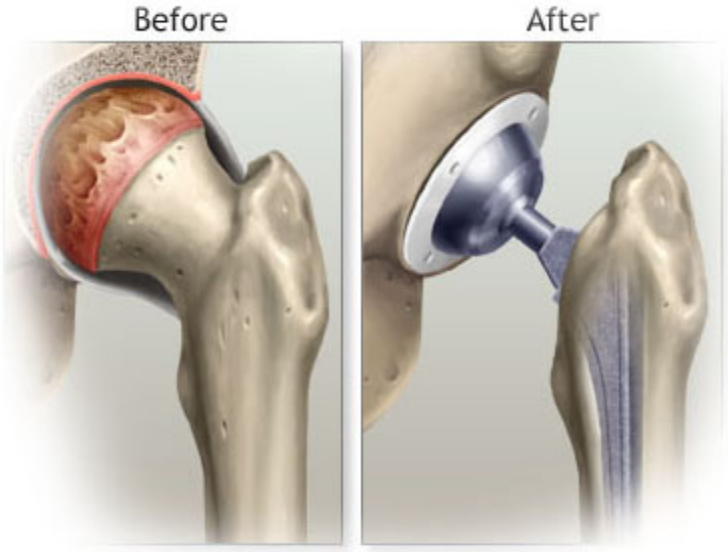
- Gonococcal arthritis has an excellent outcome .
- Non-Gonococcal arthritis: can result in scarring with limitation of movement, ambulation is affected in 50% of cases.
- Risk factors for long term adverse sequelae include:

  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



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 eduction