



Bone and Joint Infection

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Objectives:

→ No Objectives were provided for this lecture.

Color Index:

Original text | **Doctor's notes** | Text book
Important | **Golden notes** | Extra

Overview:

- 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, Polysaccharides Biofilm that forms commonly around artificial joints and prevents ABx from reaching, 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.
 - Involucrum: New bone formed at site of infection and trapping a cavity of bone.

Bone infection

❖ Osteomyelitis:

- Infection of bone and bone marrow.
- Route of infection:
 - direct inoculation → Open fractures
 - blood-borne organisms → hematogenous
- Determination of the offending organism is not a clinical diagnosis, but depends on deep culture which it is essential. The deep culture is taken from deep bone not soft tissue unless there was pus for example.



Bone infection

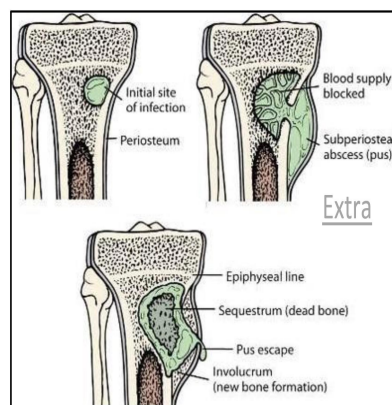
1 Acute Hematogenous Osteomyelitis

Clinical Features:

- Caused by blood-borne organisms.
- 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:

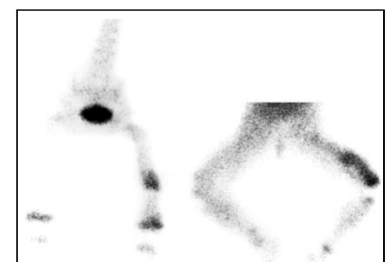
- Early: Soft tissue swelling. **No changes visible on x-ray**
- (10-14 days): Bone demineralization = **decreases bone density. 2 weeks to see bone changes on X-ray**
- Later (in chronic stage):
 - **Sequestrum** (indication of OM) dead bone with surrounding granulation tissue. **(appears as a dense sclerotic lesion)**
 - **Involucrum** periosteal new bone formation.
- 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.



1 Acute Hematogenous Osteomyelitis

Diagnosis

- ↑ **WBC** count mainly neutrophils
- ↑ **ESR** *not specific (better in TJA infection)*
- **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.
- **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 T1-weighted* bone marrow signal intensity.
 - Increased post-gadolinium (contrast) fat-suppressed T1-weighted signal intensity.
 - Increased T2-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”*
- **Nuclear medicine studies** → may help when not sure *of the course or source of infection.*
 - 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”.



Treatment

1

Identify the organisms

3

Deliver antibiotics to the infected site.

2

Select appropriate antibiotics.

4

Halt tissue destruction

Empirical Treatment

Is initiated **before definitive cultures become available**, based on patient’s age and other circumstances.

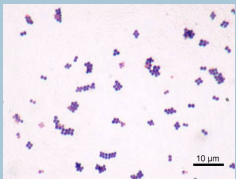
NEVER START THE ANTIBIOTIC BEFORE OBTAIN THE CULTURE

1 Acute Hematogenous Osteomyelitis

Treatment

Empirical Treatment:

Newborn (up to 4 months of age)



- The most common organisms:
 - 1. **Staphylococcus aureus**. most common organism in bone infection.
 - 2. **Gram-negative bacilli**.
 - 3. **Group B streptococcus**. after URTI
- Newborns: crying, pain, swelling, stiffness (loss of function)
 - - May be afebrile. weak immunity هذه المشكلة إنهم بدون حرارة
 - - 70% positive blood cultures.
- Primary empirical therapy includes:
 - **Oxacillin** (penicillin) specific for staph. for group (+)
 - **3rd generation cephalosporin** for other groups. for group (-)

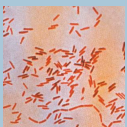
Children 4 years of age or older

- The most common organisms:
 - **Staphylococcus aureus**.
 - **Group A streptococcus**.
 - Coliforms (uncommon).
- Empirical therapy includes:
 - **Oxacillin or cefazolin** 1st gen cephalosporins
 - If suspecting gram-negative organisms → 3rd-generation cephalosporin.
- Haemophilus influenzae bone infections almost completely eliminated due to vaccination.

Adults 21 years of age or older

- **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**

Sickle cell anemia



- **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**

Hemodialysis and IV drug abuser

- Common organisms:
 - 1. **Staphylococcus aureus**
 - 2. **S. epidermidis**
 - 3. **Pseudomonas aeruginosa**
- #Treatment of choice is **penicillinase-resistant synthetic penicillins (PRSPs¹) + ciprofloxacin**.
- Alternative treatment: Vancomycin **with ciprofloxacin** (allergy)

1- PRSPs include: Oxacillin, Cloxacillin, Dicloxacillin, Methicillin, and Nafcillin

1 Acute Hematogenous Osteomyelitis

Treatment

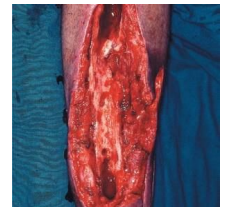
Operative Treatment:

- Empiric therapy 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. **(we use nuclear scan for this case) In case of presence of sequestrum it must be removed (Sequestrectomy)**

2 Acute Osteomyelitis

Clinical feature

- Usually comes 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 **"pain, swelling, loss of function and fever"**
- **Most common offending organisms are:**
 - S. aureus
 - P. aeruginosa
 - Coliforms
- **Complications:**
 - 1- Septicemia and distant abscesses.
 - 2- **Septic arthritis**
 - 3- Chronic osteomyelitis.
 - 4- Growth disturbance in skeletally immature and deformity
 - 5- Pathological fracture



Treatment

- **Empirical therapy: oxacillin + ciprofloxacin**
- **Treatment:**
 - Radical Incision & Drainage. **"Radical means you take everything out, bone, soft tissue and even the skin"**
 - Removal of orthopedic hardware **"device, screws or plates"** 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 → muscles + soft tissue + skin) for open wounds if needed.

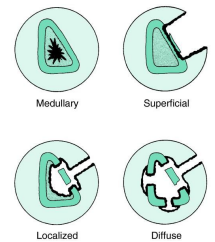
3 Chronic Osteomyelitis

Clinical feature

- **Common in:**
 - Inappropriately treated acute OM. **presences of sequestrum (requires urgent intervention)** “source of bacteria” antibiotics cannot reach it.
 - Trauma.
 - Immunosuppressed. **They will present with sinus discharging pus without fever**
 - **Diabetics.**
 - IV drug abusers.
- **Most common organisms:**
 - - S. aureus - Enterobacteriaceae (**mainly with IV drug abuse**) - P. aeruginosa
- **Features:**
 - Skin and soft tissues involvement.
 - Sinus tract may occasionally develop squamous cell carcinoma.
 - Periods of quiescence followed by → acute exacerbations.

Anatomical classification:

- 4 Types:
 - **Medullary.** **Can erode internal blood vessels and aid in forming sequestra**
 - **Superficial.** **Only surface (part of 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**



Diagnosis:

- **Best test to identify the organisms → Operative sampling of deep specimens from multiple foci.**
- Nuclear medicine → activity of the disease. E.g. Bone scan, gallium scan to tell if the lesion is old, remission, reactive and show us if infection is expanded and destruction more tissue.
- Anything that wasn't useful in acute is useful here: plain x rays, CT scans

Treatment

- **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
- **IV antibiotics** must be **based on** deep cultures. **NOT THE SUPERFICIAL CULTURE**
- **Surgical debridement:**
 - **Complete removal of compromised bone and soft tissue**
 - 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**

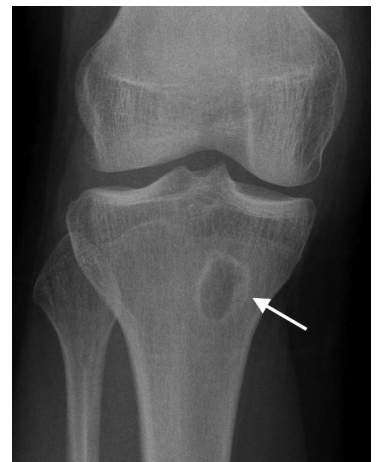
4 Subacute Osteomyelitis

Clinical feature

- May occur in:
 - Partially treated acute osteomyelitis.
 - Occasionally in fracture hematoma.
- Painful limp. **not severe like acute**
- **No** systemic and often no local signs or symptoms.
- Signs and symptoms on plain radiograph.

Diagnosis

- 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**¹
 - **Pic:** 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 won't spread



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

❖ Route of infection:

- 1** | Hematogenous spread.
- 2** | Extension of metaphyseal/diaphyseal osteomyelitis in children
- 3** | Complication of a diagnostic or therapeutic joint procedure "like aspiration, steroid injection" **IATROGENIC**

❖ Most common in:



infants & children → hip joint



in adults → knee joint"

1: (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 infection and tumour

Septic arthritis

❖ Metaphyseal osteomyelitis can lead to septic arthritis in:

01

Proximal femur → **most common** in this category. It may go up to the hip and cause septic arthritis

02

Proximal humerus. goes to shoulder joint

03

Radial neck. goes to elbow joint

04

Distal fibula. goes to ankle joint

❖ 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.

Treatment

Empirical therapy

Newborn (up to 3 months of age)	Children (3 months to 14 years of age)
<ul style="list-style-type: none"> • Most common organisms almost same as acute OM newborn: <ul style="list-style-type: none"> ○ S. aureus ○ Group B streptococcus • Less common organisms: <ul style="list-style-type: none"> ○ Enterobacteriaceae ○ Neisseria gonorrhoeae • 70% with adjacent bony involvement. • Blood cultures are commonly positive. • Initial treatment: PRSP + 3rd-generation cephalosporin. 	<ul style="list-style-type: none"> • Most common organisms: <ul style="list-style-type: none"> ○ S. aureus ○ Streptococcus pyogenes ○ S. pneumoniae ○ H. influenzae > markedly decreased with vaccination ○ gram-negative bacilli • Initial treatment: PRSP + 3rd-generation cephalosporin. • Alternative treatment vancomycin + 3rd-generation cephalosporin.

Septic arthritis

Treatment

Acute monoarticular (One joint is involved) septic arthritis in Adults

- 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

Polyarticular septic arthritis

Most common organisms:

1. Gonococci,
2. B. burgdorferi,
3. Acute rheumatic fever
4. Viruses.

Chronic monoarticular septic arthritis (Cartilage damage)

Most common organisms:

1. Brucella most common
2. Nocardia
3. Mycobacteria
4. Fungi

Surgical treatment:

- Mainstay of treatment:
 - Surgical drainage → open or arthroscopic تنظيف المفصل. Clean and wash with a scope but if it's difficult you can open
 - Daily aspiration.
- Tuberculosis infections lead to pannus (soft tissue granuloma) [Inflammation and proliferation of the synovium leads to formation of pannus.] similar to that of inflammatory arthritis (Rheumatoid Arthritis). Pannus "hypertrophied synovium" has to be removed.
- Late sequelae of septic arthritis → soft tissue contractures → may require soft tissue procedures (such as a quadricepsplasty [corrective surgical procedure on the quadriceps femoris muscle and tendon to release adhesions and improve mobility]). The quads become short and you can't extend the knees anymore so we have to do surgery to make it more elongate

Infected Total Joint Arthroplasty

❖ Most common pathogen:



S. epidermidis
Most common with any foreign body



S. aureus



Group B streptococcus

Diagnosis

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

Prevention

- Perioperative intravenous antibiotics most effective method for decreasing its incidence.
- Good operative technique. Laminar flow avoiding obstruction between the air source and the operative wound.¹
- 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**



1: ([Video Explains Laminar Flow](#)) air suction mechanism

Infected Total Joint Arthroplasty

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 antibiotic) 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 gentamicin
 - Antibiotic spacers/beads.
 - You could do both Abx-impregnated cement and antibiotic spacers/beads

SAQs

A 45 year old diabetic lady presents to your clinic complaining of a discharging wound in her foot. She reports having this issue for the past 3 years as it started soon after she had developed a calcaneal comminuted fracture. .

1. What is the most likely diagnosis?
1- Chronic Osteomyelitis 2- infected wound
2. Name the 3 most possible organisms?
- S. Aureus - Enterobacteriaceae - P. Aeruginosa
3. How would you manage this patient (2 investigations and 3 modalities of treatment)?
1- Nuclear Scan 2- Deep specimen culture 3-IV antibiotics based on the culture
4- Complete removal of compromised bone and soft tissue 5- Hardware removal



Quiz

MCQ

Q1: An 8-year-old girl comes to the emergency department with her mother because of right ankle pain. Her mother states that the pain started two weeks earlier and subsequently became worse. She also reports fever for the last week, and pain around the joint. Physical examination shows the right ankle is erythematous, warm, swollen and tender to palpation over the lateral malleolus. Radiographs of the ankle show soft tissue edema and a large radiolucency in the distal fibula. Which of the following is the most likely organism involved?

- A. Staphylococcus aureus.
- B. Group A streptococcus.
- C. Salmonella
- D. E.coli

Q2: A 12-year-old girl comes to the emergency department with her father because of right wrist pain. She states that the pain began 17 days ago and has continued to worsen. She reports being ill with a fever and an upper respiratory illness prior to the onset of the wrist pain. Her temperature is 38.5°C (101.3°F), pulse is 92/min, respirations are 22/min, and blood pressure is 132/76 mm Hg. Physical examination shows the right wrist is erythematous, warm, swollen, and tender to palpation over the distal radius. Radiographs of the wrist show soft tissue edema and a large radiolucency in the distal radius. Which of the following is the most definitive treatment for this condition?

- A. Excision of the bone lesion
- B. Iv antibiotics
- C. Irrigation and debridement of the bone lesion
- D. Iv antibiotics with Irrigation and debridement of the bone lesion

Q3: A 32-year old man comes to the emergency department because of fever, worsening pain, and impaired range of motion in his right knee for 3 days. He states that he often has to clear small nails or glass splinters from the rough pavement of his construction site before kneeling to do work-related tasks. He has never had a prosthetic implant, there is no family history of rheumatoid arthritis or gout, and that he does not have unexplained skin lesions. Examination shows there is an obvious effusion in his right knee. It is visibly red and swollen, and warm and painful to touch. He refuses to bend it. His left knee is unaffected. Which of the following would be the most helpful test in establishing a diagnosis?

- A. CBC and cultures
- B. Joint fluid analysis and culture
- C. Right knee film
- D. Polarizing microscopy of synovial fluid for crystals

Q4: A 72-year-old who underwent a total knee replacement 3 weeks ago, presents with increasing knee pain and swelling, with raised inflammatory markers. An aspiration of the joint cultures coagulase-negative staphylococcus. The next most appropriate step in management is?

- A. Two-stage revision, with cement spacer plus intravenous antibiotics.
- B. Intravenous antibiotics.
- C. Open washout/debridement, polyethylene exchange and intravenous antibiotics.
- D. Arthroscopic washout/debridement and intravenous antibiotics.

Q5: A 71-year-old patient presents with increasing knee pain 6 weeks after having a total knee replacement. Which of the following would be most reliable in the diagnosis of infection?

- A. Erythrocyte sedimentation rate.
- B. C-reactive protein.
- C. Microscopy and culture of joint aspirate.
- D. Triple phase isotope bone scan.
- E. Magnetic resonance imaging.

Answers

Q1	Q2	Q3	Q4	Q5
A	D	B	C	C

THANK YOU

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