Bone & joint infections

Lecture outline

- Septic arthritis
- Osteomyelitis
    - Acute
    - Chronic
- Spondylodiskitis and Epidural Abscess
- Infections with Prostheses in Bones and Joints

Infectious arthritis

- Infectious arthritis of native Joints caused by any of a number of **diverse microorganisms**
- **Bacterial arthritis**, (suppurative, pyogenic, or septic arthritis) is the **most common**
- **Viral arthritis** often involves **multiple joints** as a component of a systemic infection and generally does not lead to long-term morbidity.
- Joint infection due to **mycobacteria** and **non-Candida fungi** usually present as **chronic**, slowly progressive **monoarticular arthritis**

Infectious arthritis

- In addition to direct joint infection by microbes, a **reactive** or **sterile arthritis** is occasionally associated with systemic or local infection at a site re **remote to the joint.**

Septic arthritis (native joints)

- Considered as a **rheumatologic emergency**

  because of its potential for rapid joint

  destruction with irreversible loss of function.

Acute Bacterial Arthritis

- The **extremely vascular synovial membrane** of the joint lacks a **limiting basement membrane** and is particularly susceptible to the deposition of bacteria.

Acute Bacterial Arthritis

- Increasing because of a larger number of **risk patients** and **surgical joint procedures**
- Usually, **hematogenously** acquired during overt or **occult bacteremia**, including that due to **endocarditis**.
- **Normal**, **diseased** and **prosthetic joints** are all susceptible to infection
- **Abnormal joint architecture** greatly increases the risk.

Acute Bacterial Arthritis

- Other routes of infection include **direct inoculation** of bacteria into the joint through surgery, trauma, percutaneous puncture (such as from a nail, needle, or thorn)

or

from **contiguous spread** from adjacent infected soft tissue or bone.

Acute Bacterial Arthritis

Predisposing host factors

- Joint disease (RA, Osteoarthritis etc)
- Advanced age
- Chronic systemic disease (DM, CRF. CLD, CA)
- Immunosuppression

Acute Bacterial Arthritis

Predisposing host factors

- Trauma

  Surgery (including arthroscopic), Penetrating injury

  Intraarticular injection (e.g., glucocorticoids)

  Prosthetic joint

- Intravenous drug use
- Endocarditis

Microbiology (Organism Isolates, number (% of total))

Gram-positive

- ***Staphylococcus aureus* 1066 (46)**
- Staphylococci, co negative 84 (4)
- **Streptococci 512 (22)**
- *Streptococcus pyogenes* 183 (8)
- *Streptococcus pneumoniae* 156 (7)
- *Streptococcus agalactiae* 69 (3)
- Other streptococci 104 (5)

Gram-negative

- *Escherichia coli* 91 (4)
- *Haemophilus influenzae* 104 (5)
- *Neisseria gonorrhoeae* 77 (3)
- *Neisseria meningitidis* 28 (1)
- *Pseudomonas aeruginosa* 36 (2)
- *Salmonella* spp. 25 (1)
- Other gram-negative rods 110 (5)

Microbiology …….

- For patients with **rheumatoid arthritis**, the proportion of septic arthritis due to **S. aureus** has been reported to be higher (approximately **75%**).
- Methicillin-resistant *Staphylococcus aureus* (MRSA) is increasingly isolated

- Bacterial arthritis of the third proximal interphalangeal joint.

Microbiology …….

- **Streptococcus** spp. are the bacteria **next most** frequently isolated from adults with native joint septic arthritis.
- Streptococcus pyogenes and other β hemolytic streptococci from Lancefield groups C, F, and G are important pathogens
- **Group B streptococci** are an increasing cause of **bacterial arthritis in adults** with diabetes, malignancy, and genitourinary structural abnormalities
- **Gram-negative bacilli** (5% to 20%) (increasingly multiple-drug resistant). Common in

  neonates

  elderly patients

  intravenous drug users

  immunocompromised hosts

Microbiology …….

- ***Pseudomonas aeruginosa***

  important pathogen in **intravenous drug users**

- ***Haemophilus influenzae***

  - once an important pathogen in **young children**
  - **now rarely causes** septic arthritis as H. influenzae type B vaccine is widely employed.

Acute Bacterial Arthritis - Pathogenesis

Adherence & colonization of organisms to the **synovial membrane**

bacterial **proliferation** in synovial fluid

- in some cases by joint disease or injury (traumatic or surgical) that results in an increased amount or exposure of host-derived extracellular matrix proteins such as fibronectin, collagen, laminin, elastin, and hyaluronic acid that promote bacterial attachment

Acute Bacterial Arthritis - Pathogenesis

influx of acute and chronic **inflammatory cells**

↓

purulent inflammation of the joint and its synovial fluid

↓

Leukocyte-derived **proteases** and inflammatory **cytokines** (IL-1, IL-6, -α (TNF-α)

↓

cartilage degradation, inhibition of cartilage synthesis, and subchondral bone loss.

↓

- Intraarticular cartilage destruction may be seen in 3 days
- Although certain bacterial products or toxins may directly increase tissue damage in the infected joint, it is the **host inflammatory rresponse** to infection that is responsible for much of the joint injury.

Pathogenesis -----

inflammatory joint infusion **increases intra-articular pressure**

↓

Restrict capillary blood flow to the joint

↓

cartilage and synovial ischemia and **necrosis** & destruction

↓

joint space narrowing and further erosive damage to the cartilage and underlying bone

↓

infection **spread** from the joint to **surrounding soft tissue**

↓

disrupt **ligaments**, **tendons**, and other periarticular structures

↓

Form **sinus tracts**

TABLE 102-3 Clinical and Epidemiologic Features Associated with Selected Bacterial Causes of Septic Arthritis

Clinical or Epidemiologic Feature	*Etiologic Agent*
Rheumatoid arthritis	*Staphylococcus aureus*
Intravenous drug use	*S. aureus, Pseudomonas aeruginosa*
Diabetes, malignancy	*S. aureus,* Group B streptococci
Immunocompromised hosts	*S. aureus,* streptococci, enteric gram-negative bacilli, *Listeria monocytogenes*
Neonates, children less than 4 years age	Gram-negative bacilli, *Kingella kingae*
Young adults, menstruating females, associated skin lesions	*Neisseria gonorrhoeae*
Fibrocartilaginous joints (e.g., pubic symphysis)	*S. aureus, P. aeruginosa*
Cat or dog bite	*Pasteurella multocida, Capnocytophaga* spp., anaerobes
Human bite	*Eikenella corrodens,* anaerobes, other oral flora (e.g., viridans streptococci)
Rat bite	*Streptobacillus moniliformis*
Postpartum women	*Mycoplasma hominis*
Ingestion of unpasteurized dairy products, residents or travelers from endemic areas	*Brucella* spp.
Residents or travelers to Southeast Asia	*Burkholderia pseudomallei* (Melioidosis), *Streptococcus suis*
Following plant thorn injury	*Pantoea agglomerans, Nocardia* spp.

Laboratory diagnosis

- **Frequently shows an elevated**

  peripheral blood white cell count (WBC)

  erythrocyte sedimentation rate

  C-reactive protein

Laboratory diagnosis……

Arthrocentesis

- **Antimicrobial therapy** should be **delayed** until arthrocentesis and appropriate diagnostic cultures are obtained unless the patient shows signs of sepsis

- **Purulent** , low-viscosity synovial fluid with elevated polymorphonuclear neutrophil count.

50,000 cells/mm3 has been used to suggest septic arthritis

Laboratory diagnosis……

Synovial fluid Ix

- **Culture** yield bacterial growth up to **80%** to **90%** of the time
- **Gram stain** is diagnostic in only **50%** of these
- In cases with a **subacute** or **chronic** presentation, **fungal** and **mycobacterial** smear and culture is indicated.

Blood culture

- Positive in **50% to 70%** of patients

Additional cultures

- from any wound **contiguous** with the afflicted joint and skin lesions

Gonococcal arthritis

- During the 1970s and 1980s Neisseria gonorrhoeae was the predominant cause of bacterial arthritis
- However, the prevalence of gonococcal arthritis has **markedly decline**

Gonococcal infection. Pustular lesion overlying the
fifth toe in a patient with disseminated gonococcal infection

Management

- The management of acute bacterial arthritis requires **prompt joint drainage** & **antimicrobial therapy**.
- **Antimicrobial therapy** for native joint bacterial arthritis should be **initiated without delay** to limit articular destruction (Refer guideline)
- IV antimicrobials usually are continued for 2 to 4 weeks, although infections due to S. aureus, including MRSA and gram-negative bacilli generally require 4 weeks of treatment

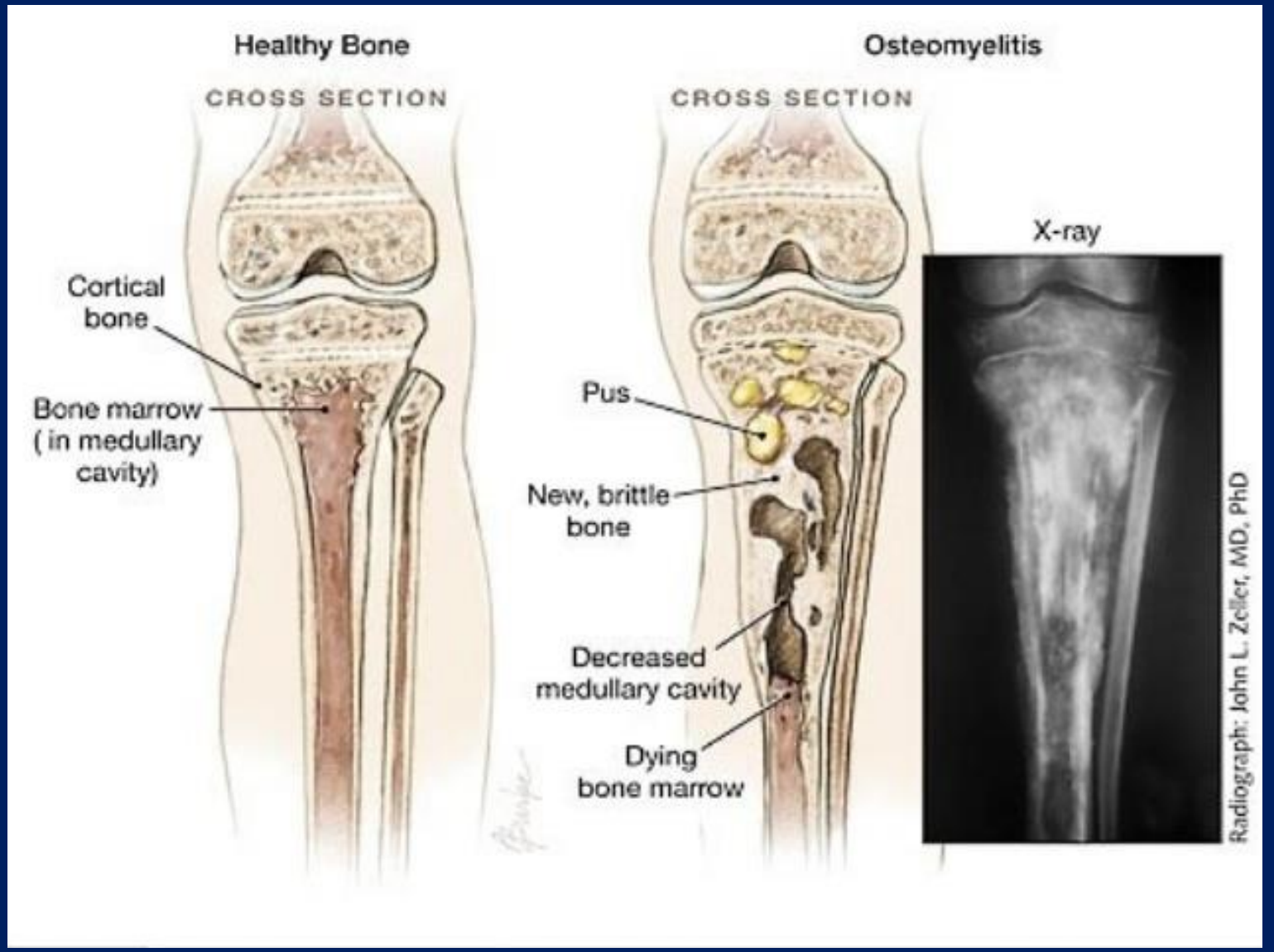
TABLE 102-6 Infectious Causes of Chronic Monoarticular or Oligoarticular Arthritis

Bacteria	*Mycobacteria*
Borrelia burgdorferii	*M. tuberculosis*
Tropheryma whippleii	*M. kansasii*
Treponema pallidum	*M. marinum*
Nocardia spp.	*M. avium-intracellulare* complex
Fungi	*M. terrae*
Candida spp.	*M. fortuitum, M, chelonae, M. abscessus*
Cryptococcus neoformans	*M. haemophilum*
Blastomyces dermatitidis	*M. leprae*
Coccidioides spp.	***Parasites***
Paracoccidioides brasiliensis	Helminths
Sporothrix schenckii	Filariae
Aspergillus spp.	
Scedosporium, Fusarium	

Septic Bursitis

- Septic bursitis is common, usually affecting the subcutaneous olecranon, prepatellar, or infrapatellar bursae
- Bacteria are most often introduced through trauma or accidental percutaneous punctures and
- very rarely through hematogenous dissemination.
- Infection of deep bursae is rare
- More than 80% of septic bursitis is due to S. aureus with the remainder due to Streptococcus spp., and various gram-negative bacteria, mycobacteria, and fungi.

Osteomyelitis



Microbiology of Osteomyelitis

Common (>50% of Cases)

- ***Staphylococcus aureus***
- Coagulase-negative staphylococci

Occasionally Encountered (>25% of Cases)

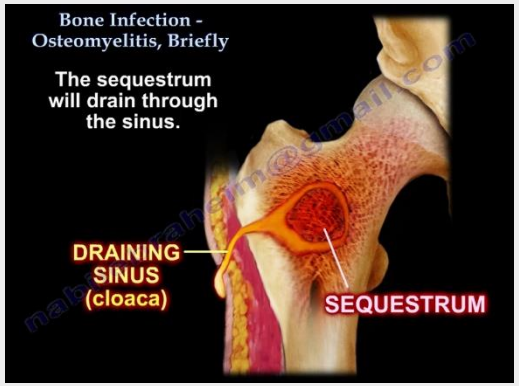
- **Streptococci**, Enterococci
- Pseudomonas spp.
- Enterobacter spp, Proteus spp., *E. coli*
- Anaerobes

Rarely Encountered (<5% of Cases)

- ***Mycobacterium tuberculosis***
- Mycobacterium avium complex
- Candida spp.
- Aspergillus spp.
- Actinomyces

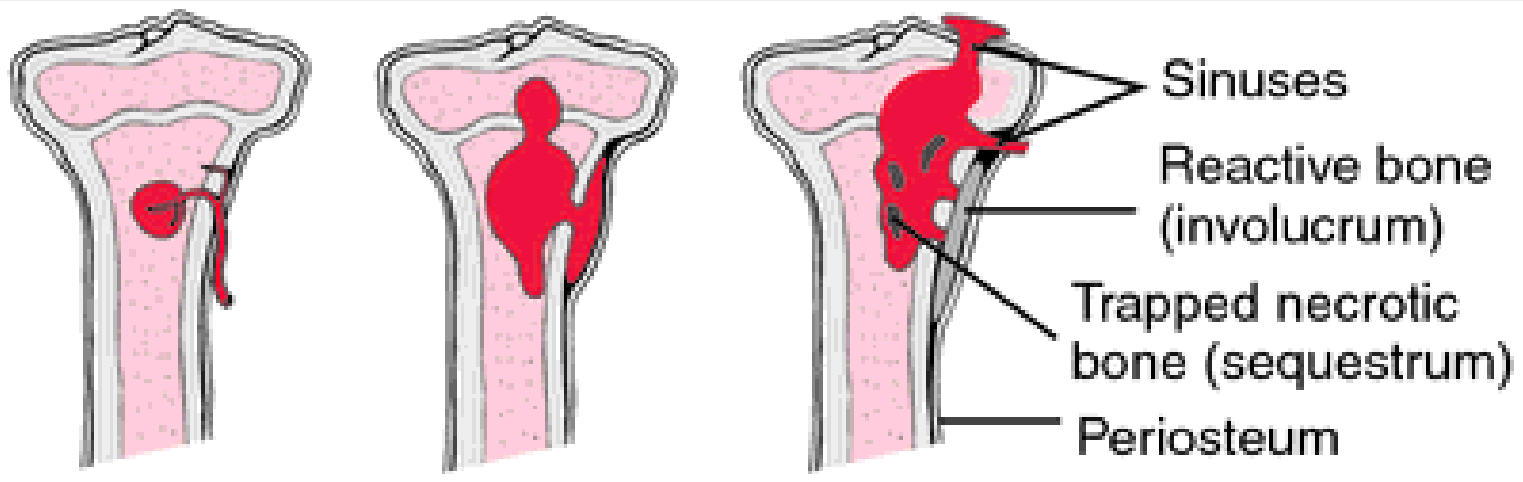
Osteomyelitis

- Osteomyelitis can be **haematogenous** or **contiguous** to a soft tissue infection or **direct inoculation** of microorganism into the bone as a result of trauma or surgery.
- Bacteria produce a **local inflammatory reaction**
- promotes **bone necrosis** and the formation of **sequestra**
- Progressive destruction of the bone and the formation of sequestra are characteristics of this disease



Microbiology….

- **Hematogenous** long bone osteomyelitis - usually **mon**obacterial



- **Contiguous** infection - usually **poly**microbial

Laboratory diagnosis

- Erythrocyte sedimentation rate (**ESR**) **and C-reactive protein** are often **elevated**.
- **White blood cell count** can be **normal or elevated**.

Laboratory diagnosis…..

Identification of causative agent

- **All antimicrobials** should be **withheld** if possible until percutaneous aspirate or surgical deep cultures have been obtained, **unless** there is concomitant soft tissue infection or **sepsis** syndrome.
- Antimicrobials are usually started **immediately** after **surgical debridement**.

Laboratory diagnosis

Identification of causative agent

- The identification of a causative microorganism is **crucial**.
- The type of organism and ABST **optimize** medical **therapy**.
- **best samples** for bacterial and anaerobic culture

  surgical sampling

  or

  needle aspiration under radiologic guidance

Laboratory diagnosis……

- **Contrary to common belief**, **swab cultures** from draining wounds and sinus tracts can be of **diagnostic benefit** for two main reasons.

  1. identification of certain **resistant microorganisms** (e.g., MRSA, VRE) indicates the need for **infection control measures**.

  2. Isolation of ***S. aureus*** from **superficial cultures** has a high degree of correlation with **deep cultures**.

  The recovery of **other microorganisms correlates poorly** with deep cultures

Management

- The **goal** of therapy of osteomyelitis is to **eradicate the infection** and to **restore function**.
- Most cases - require a **combination** of **medical** and **surgical** therapy for successful eradication of the infection.

Rx - antibiotics over a long period of time is mandatory

- Antimicrobials are usually **started immediately after surgical debridement**.

- Antibiotics over a long period of time - **lessen** the amount of **discharge**, but it will not cure the disease because it **cannot sterilize dead bone or cavities** with **necrotic content** and rigid walls.”

- Because it takes **6 weeks** for the **debrided bone** to be **covered by vascularized soft tissue**, and because of a higher relapse rate occur with a short duration of therapy need total duration of **4 to 6 weeks** of parenteral antimicrobial therapy

Chronic Osteomyelitis

- Often the **consequence** of an **open**, **comminuted fracture** and inadequately treated infection of the fracture site.
- **Internal fixation** devices may have remained in place.
- **Systemic symptoms** (fever or chills) are typically **lacking**
- A chronic **draining sinus** is often present.
- **Sequestra** (fragments of dead bone) are usual and act as a **foreign body** within the lesion.
- **Cultures** from **surgery** are needed to guide prolonged antimicrobial therapy

Vertebral Osteomyelitis, Spondylodiskitis, and Epidural Abscess

- ***S. aureus*** and **coagulase-negative staphylococci** are the most common microorganisms encountered in vertebral osteomyelitis.
- ***Mycobacterium tuberculosis*** is common in endemic regions

Laboratory diagnosis

- An **elevation** of the **ESR** is present in more than **90%** of cases
- **White blood cell** count is elevated in less than **50%** of patients.
- **Best** sample for microbial ID - Bone chips taken **during surgical debridement**
- Blood cultures may be positive, and if they are, infective endocarditis may be present

Management

- Despite important medical and surgical advances in management of patients, osteomyelitis remains **extremely difficult to treat**.
- The **relapse** rate can be **20%**.
- Treatment of chronic osteomyelitis usually requires **aggressive surgical debridement** and **prolonged antimicrobial therapy**.

Infections with Prostheses in Bones and Joints

- Prosthetic joints become infected by two different pathogenetic routes

  locally introduced

  hematogenous

- The locally introduced form of infection is the result of **wound sepsis** contiguous to the prosthesis or operative contamination.
- Any factor or event that **delays wound healing** increases the risk of infection.

  Ischemic necrosis, **infected** wound hematomas, wound infection (with or without identifiable cellulitis), and **suture abscesses** are common preceding events

Causative microorganisms

- The spectrum of microbial agents - unlimited
- **Coagulase-negative staphylococci** - the **most common** causative agent
- **Streptococci** and **gram-negative bacilli** - responsible for 20% to 25% each
- **Anaerobes** - represent 10% of these infections.
- Includes organisms ordinarily considered "**contaminants**" of cultures, such as corynebacteria, propionibacteria, and Bacillus spp. emerged as a more prominent

Bacteriology of Prosthetic Joint Infection

Pathogens & Frequency (%)

- **Coagulase-negative staphylococci 22**
- Staphylococcus aureus 22
- α-Hemolytic streptococci 9
- β-Hemolytic streptococci groups A, B, G 5
- Enterococci 7
- Gram-negative aerobic bacilli 25
- Obligate anaerobes

Clinical Presentation

- The pattern of **clinical presentation** is determined largely by three factor

  the **virulence** of the infecting pathogen

  the **nature of the host tissue** in which the microorganism grows

  the **route of infection**.

- ***S. aureus*** is a particularly virulent pathogen in this setting and usually produces a **fulminant infection**.

- **β-Hemolytic streptococci** and **aerobic gram-negative bacilli** are also capable of causing this clinical picture.

- Avirulent but persistent **coagulase-negative staphylococci** are associated with **indolent course**.

Diagnosis

- Clinical manifestations
- Infection must be **differentiated** from aseptic and **mechanical problems**
- Elevated

  peripheral **leukocyte** counts

  erythrocyte sedimentation rates

  C-reactive protein levels

  although suggestive, also are inadequate to diagnose sepsis in this clinical setting

Diagnosis

- Analysis of **joint fluid often reveals** a **high leukocyte count** (mainly polymorphonuclear cells), **high protein** content, and **low glucose** concentration

Microbial identification

- Isolation of the pathogen by **aspiration** of joint fluid or by culture of tissue obtained at **arthrotomy**
- Operative cultures are used to diagnose prosthetic joint infection definitively; therefore, the **patient should not receive antimicrobial** therapy before **surgery**.
- Optimally **several (five to seven) specimens** of tissue and fluid should be submitted for culture.

Treatment

- The most effective treatment for prosthetic joint infection involves **complete removal of all foreign materials** (metallic prosthesis, cement, and any accompanying biofilm)
- Followed by a **6-week course of bactericidal antibiotic therapy** chosen on the basis of quantitative in **vitro susceptibility studies**.
- **Reimplantation** is performed at the conclusion of the **6-week antibiotic course**