OSTEOMYELITIS

Osteomyelitis is an infection involving the bone. It can be classified according to the duration of illness as **acute** (lasting days or weeks) or **chronic** (lasting months or years). In cases of osteomyelitis, sequestra (pieces of necrotic bone that separate from viable bone) are usually present. This condition is a consequence of bone ischemia and necrosis from blood vessel compression, often associated with bone marrow inflammation. A sinus tract may be present, which is pathognomonic for osteomyelitis. In osteomyelitis, the infection can spread to the periosteum, leading to periosteal seeding of the infection. The infection can also involve the metaphyseal vessels beneath the periosteum, leading to the formation of an abscess. Within the abscess, sequestra (pieces of necrotic bone) may form. Sinus formation can occur in osteomyelitis, leading to the formation of passages called cloacae. These cloacae can discharge pus and bone fragments. Involucrum refers to the new bone formation around the area of infection as a response to the infection.

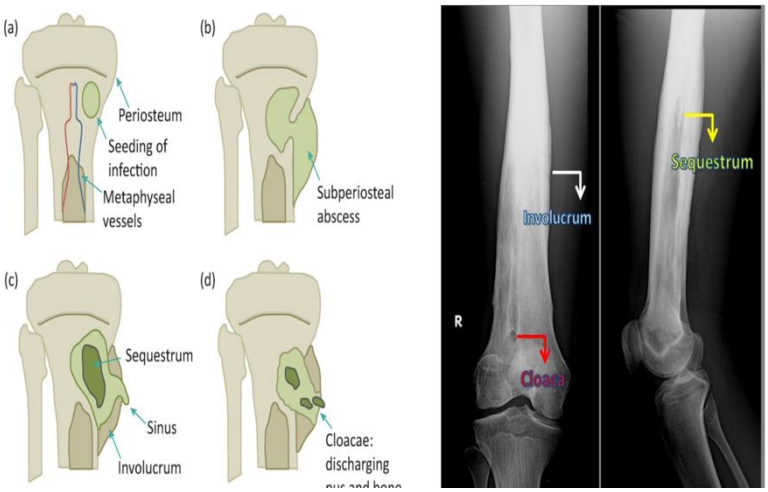


Fig.1

Osteomyelitis can be classified according to the source of infection:

- **Haematogenous osteomyelitis**: This type of osteomyelitis occurs when bacteria enter the bloodstream (bacteremia) and spread to the bone, causing an infection.
- **Non-haematogenous osteomyelitis**: This type of osteomyelitis involves the contiguous spread of infection from surrounding soft tissues or joints to the bone, or through direct inoculation of bacteria into the bone.

Epidemiology and Risk Factors

Non-hematogenous osteomyelitis:

- Younger adults are more commonly affected due to trauma and related surgeries.

- Older adults may develop osteomyelitis through spread from soft tissues and joints, such as diabetic foot wounds or decubitus ulcers.

- Risk factors include poorly healing soft tissue wounds (including decubitus ulcers), presence of orthopedic hardware, diabetes, peripheral vascular disease, and peripheral neuropathy.

Hematogenous osteomyelitis:

- More common in children, while vertebral osteomyelitis is more common in adults.

- Risk factors include age 50 years and older, intravenous drug use (age under 40), endocarditis, indwelling intravascular devices (such as leg or vascular catheters, cardiovascular devices), orthopedic hardware, hemodialysis, and sickle cell disease.

Microbiology

Non-hematogenous osteomyelitis

- Involves either polymicrobial or monomicrobial infections

-Most common pathogens include Staphylococcus aureus (including MRSA), coagulase-negative staphylococci, and aerobic gram-negative bacilli

- Rare pathogens may include corynebacteria, fungi, and mycobacteria

Hematogenous osteomyelitis:

- Usually monomicrobial

- Most common pathogens include Staphylococcus aureus (potentially multifocal) and aerobic gram-negative bacilli (30%)

- Less common pathogens may include Pseudomonas aeruginosa and Serratia marcescens in intravenous drug users, Aspergillus in immunocompromised hosts, beta-hemolytic streptococci, Mycobacterium tuberculosis, Candida species.

Clinical Presentation of Osteomyelitis

- Non-hematogenous osteomyelitis:

- Acute presentation: gradual onset of dull pain, may have local findings such as tenderness, warmth, erythema, and swelling, and systemic symptoms like fever. In some cases, especially in the hip, vertebrae, or pelvis, there may be few signs or symptoms.

- Chronic presentation: pain, which may be intermittent, erythema, swelling, and the presence of a draining sinus tract. Fever is usually absent. Deep or extensive ulcers that fail to heal after several weeks of appropriate care, particularly overlying bony prominences, or non-healing fractures. Patients with diabetes may present with atypical findings.

- Hematogenous osteomyelitis

- Clinical presentation may vary but often includes symptoms similar to non-hematogenous osteomyelitis, such as pain, swelling, erythema, and systemic signs of infection.

Specific Forms of Hematogenous Osteomyelitis

1. **Vertebral Osteomyelitis**: Infection of the vertebrae, which can lead to back pain, spinal deformities, and neurological symptoms if the infection affects the spinal cord or nerves.

2. **Sternoclavicular and Pelvic Osteomyelitis**: Sternoclavicular osteomyelitis involves infection of the sternum and clavicle bones, while pelvic osteomyelitis involves the infection of the pelvic bones. These forms of osteomyelitis are not uncommon in intravenous drug users (IVDUs) due to the risk of bacteremia from contaminated needles.

3.**Long bone osteomyelitis** : very rare and more commonly seen in children that in adults. Typically involves the infection of the bone marrow in long bones.

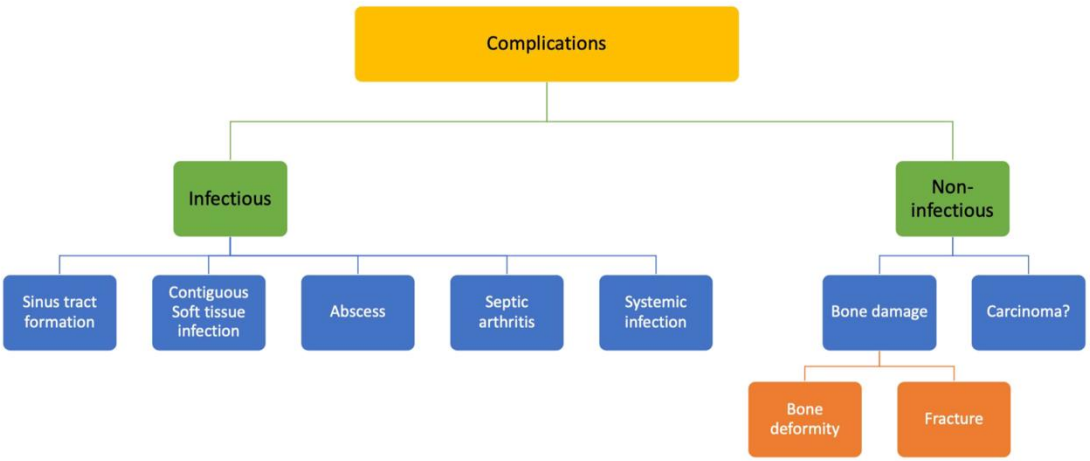


Fig. 2. Professor just read the table

Diagnosis of Osteomyelitis:

- Non-hematogenous osteomyelitis:

- Laboratory findings are often nonspecific.

- In acute cases, high white blood cell count (WBC) and elevated erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels may be observed.

- In chronic cases, WBC count may be normal, and ESR/CRP levels may be normal or elevated.

- Diagnosing osteomyelitis can be challenging in cases involving prosthetic material, extensive skin or soft tissue ulceration, or ischemic changes due to vascular insufficiency.

- Hematogenous osteomyelitis:

- Hemocultures may be negative in cases of hematogenous osteomyelitis, particularly if there is clearance of bacteremia by the time of diagnosis. This can make the diagnosis more challenging, as blood cultures may not always yield positive results.

1. History and Physical Examination:

- Consider predisposing factors such as trauma, surgery, or underlying conditions.

- Perform a thorough physical examination looking for signs of infection, such as localized pain, tenderness, erythema, warmth, and swelling.

2. Blood Tests:

- Blood tests may include complete blood count (CBC) to check for elevated white blood cell count (WBC) and inflammatory markers like erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP).

3. Imaging:

- If symptoms have been present for less than two weeks, consider imaging with CT or MRI.

- For symptoms lasting longer than two weeks, X-rays may be sufficient for initial evaluation.

- For diabetic foot infections, MRI may be the imaging modality of choice.

- In cases involving metal hardware, nuclear imaging techniques may be used.

4. Hemocultures:

- Blood cultures may help identify the causative organism, especially in cases of hematogenous osteomyelitis.

5. Bone Biopsy:

- In some cases, a bone biopsy (open or percutaneous) may be necessary for definitive diagnosis. This procedure can provide samples for gram staining, culture, and histological examination.

- Bone biopsy may not be necessary if radiological findings and blood cultures are conclusive for the diagnosis of osteomyelitis.

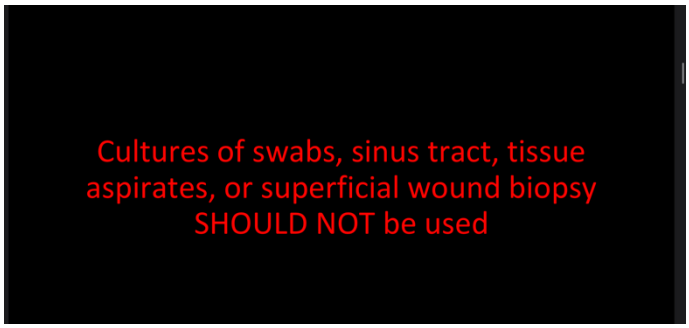


Fig.3

It is important to note that cultures obtained from swabs, sinus tracts, tissue aspirates, or superficial wound biopsies should generally **not be used** for the diagnosis of osteomyelitis. These samples may not provide accurate results for identifying the causative organism in bone infections. For accurate diagnosis and identification of the pathogen causing

osteomyelitis, bone biopsy samples (open or percutaneous) are preferred. These samples provide direct access to the infected bone tissue, allowing for more reliable culture and sensitivity testing. Additionally, blood cultures can be beneficial for detecting bacteremia associated with hematogenous osteomyelitis. While swabs, sinus tract cultures, tissue aspirates, or superficial wound biopsies may be useful in other types of infections, they are not typically recommended for diagnosing osteomyelitis due to the risk of false-negative results and the potential for contamination from surrounding tissues

Antibiotic Treatment after Surgery for Osteomyelitis

- Non-hematogenous Osteomyelitis

- In cases where residual infected bone is present or hardware retention is necessary, a prolonged duration of antibiotic therapy is often required.

- Following surgery, intravenous or highly bioavailable oral antibiotic therapy is initiated and guided by antimicrobial susceptibility data for the specific pathogen involved. This treatment typically lasts for over 6 weeks.

- After the initial treatment period, a switch to antibiotic suppression therapy may be considered until fracture union is achieved or no residual infected bone is detected. This may involve a lower dose of antibiotics to prevent recurrence.

- If there is no residual infected bone or soft tissue involvement, amputation or complete hardware removal may be considered.

- In cases where hardware removal is indicated, a shorter duration of antibiotic therapy (typically 5 days, but may be extended to 10-14 days in the presence of extensive soft tissue involvement) is often prescribed, guided by antimicrobial susceptibility data.

- Hematogenous osteomyelitis

In cases of hematogenous osteomyelitis, the duration of antibiotic treatment can vary based on several factors, including the presence or absence of surgical debridement. There is some uncertainty regarding the optimal duration of antibiotic therapy for hematogenous osteomyelitis

. 1**. If no surgical debridement is performed**

- Antibiotic therapy may be prescribed for a duration of approximately 4 weeks.

- The decision to initiate antibiotic therapy without surgical debridement may be based on factors such as the patient's clinical condition, imaging findings, and the presence of systemic symptoms of infection.

2. **If surgical debridement is performed:**

- The duration of antibiotic therapy may start from the time of surgical debridement.

- In cases where surgical debridement is performed to remove infected tissue and bone, the antibiotic therapy may be initiated post-surgery and continued for a duration as determined by the healthcare provider based on the specific circumstances of the infection.

Spondilodyscitis

Spondylodiscitis, also known as vertebral osteomyelitis or spondylitis, is an infection that affects the intervertebral disc space and typically involves two or more adjacent vertebral bodies. This condition can lead to inflammation and destruction of the intervertebral discs and adjacent vertebral bones.

Radiological Classification

- **Discitis:** Refers to inflammation and infection of the intervertebral disc itself.
- **Spondylodiscitis**: Involves infection of both the intervertebral disc and adjacent vertebral bodies, leading to disc and vertebral involvement.
- **Vertebral Osteomyelitis or Spondylitis**: Indicates infection and inflammation of the vertebral bodies themselves, which may extend from the disc space.

Epidemiology

It is more common in adults, with most cases occurring in patients over the age of 50. The incidence of spondylodiscitis increases with age, which is likely due to factors such as decreased immune function and the presence of other comorbidities. Men are affected approximately twice as often as women, although the reasons for this gender difference are not fully understood. Spondylodiscitis can also occur in children, although it is less common than in adults. The overall incidence of spondylodiscitis has been increasing in recent years in countries such as the US and France, with rates ranging from 5 to 11 cases per 100,000 person-years. There are several factors contributing to the increasing incidence of spondylodiscitis, including the rising rates of bacteremia due to the use of intravascular devices and other forms of instrumentation in healthcare settings. The aging population, increasing number of patients on dialysis, and the growing use of immunosuppressive medications also play a role in the increasing incidence of spondylodiscitis.

Pathogenesis – routes of infection

The pathogenesis of spondylodiscitis involves several routes of infection:

1. **Hematogenous spread**: In many cases, the infection reaches the spine through the bloodstream from a distant site or focus of infection in the body. Common sources of hematogenous spread include urinary tract infections, skin and soft tissue infections (such as those seen in intravenous drug users), respiratory tract infections, infections related to intravascular devices, wound infections, infective endocarditis, dental infections, and direct spread from other abscesses or infected lesions.

2. **Direct inoculation**: Spondylodiscitis can also occur through direct inoculation of infectious agents into the spine. This can happen as a result of trauma to the spine, invasive spinal diagnostic procedures (such as lumbar punctures, myelography, or discography), spinal surgeries, or other interventions involving the spine (such as translumbar aortography,

chemonucleolysis, facet joint injections, epidural catheter placement, or epidural corticosteroid injections).

3**. Contiguous spread**: In some cases, the infection can spread to the spine from adjacent soft tissue infections. For example, infections in the soft tissues surrounding the spine can extend into the vertebral bodies and intervertebral discs, leading to spondylodiscitis.

Pathogenesis – extension of infection

1. Posterior extension:

- Epidural abscess
- Subdural abscess
- Meningitis: Infections can spread to the meninges, the protective membranes covering the brain and spinal cord, leading to inflammation and infection.

2. Anterior or lateral extension:

- Paravertebral abscess
- Retropharyngeal abscess
- Mediastinal abscess
- Subphrenic and retroperitoneal abscesses
- Psoas abscess: An abscess can develop in the psoas muscle, which is located in the lower back and can cause pain and difficulty moving.

3. Thoracic vertebral infections:

- Thoracic vertebral infections can extend into the pleural space, potentially leading to the development of an empyema (collection of pus) in the pleural cavity surrounding the lungs.

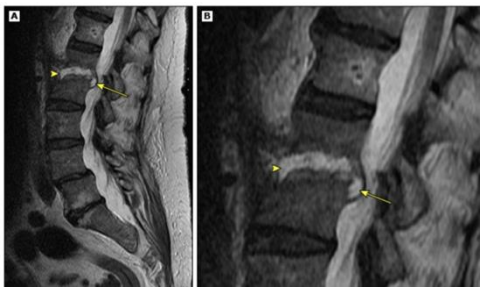


Fig. 4

Pathogenesis-risk factors

Risk factors for spondylodiscitis include:

1**. Injection drug use:** Intravenous drug use can introduce infectious agents into the bloodstream, increasing the risk of hematogenous spread of the infection to the spine.

2. **Infective endocarditis**: Patients with infective endocarditis, an infection of the heart valves, are at increased risk of developing spondylodiscitis. In a retrospective study, approximately 31% of patients with spondylodiscitis were found to have infective endocarditis.

3. **Degenerative spine disease**: Conditions such as degenerative disc disease or osteoarthritis of the spine can weaken the spinal structures, making them more susceptible to infection.

4. **Prior spinal surgery**: Previous spinal surgeries can disrupt the normal anatomy of the spine and increase the risk of infection.

5. **Diabetes mellitus**: Diabetes weakens the immune system and impairs the body's ability to fight off infections, making individuals with diabetes more susceptible to spondylodiscitis.

6**. Corticosteroid therapy**: Long-term use of corticosteroids can suppress the immune system, increasing the risk of infections, including spondylodiscitis.

7. **Immunocompromised state**: Patients with conditions that weaken the immune system, such as HIV/AIDS, organ transplant recipients, or those on immunosuppressive medications, have a higher risk of developing spondylodiscitis due to their compromised ability to fight off infections.

Aetiology

The etiology of spondylodiscitis involves various pathogens, with the majority of cases being caused by a single microorganism. **Staphylococcus aureus** is the most common pathogen responsible for spondylodiscitis, followed by MRSA, which is increasingly prevalent in both community and healthcare settings. Other causative organisms include enteric Gram-negative bacilli, streptococci (both pyogenic and non-pyogenic species), Pseudomonas aeruginosa, coagulase-negative staphylococci, and Candida. In some cases, spondylodiscitis can be caused by Mycobacterium tuberculosis, nontuberculous mycobacteria, Brucella melitensis, Burkholderia pseudomallei, Salmonella species, and Entamoeba histolytica.

Clinical presentation

The clinical presentation of spondylodiscitis typically includes localized pain in the infected disc space area that worsens with physical activity or percussion. The pain may radiate to other areas such as the abdomen, leg, scrotum, groin, or perineum. Symptoms often have a subacute onset with progressive worsening over time, with an average duration of symptoms before diagnosis being around 48 days. Pain may be more severe at night, even after initially improving. Patients may experience reduced mobility and spasms of the paravertebral muscles. In cases where an epidural abscess is present, symptoms can include severe back pain, radiculopathy, motor weakness, sensory changes (such as loss of bowel and bladder control and loss of perineal sensation), and potential paralysis. Fever is not always present but can be seen in a significant proportion of cases. Local tenderness to gentle spinal percussion is a common clinical sign, although it is not specific. In some instances, cold tender masses in the back, known as "cold abscesses," may be present, particularly in infections caused by tuberculosis (TB) and non-tuberculous mycobacteria (NTM). Sources of hematogenous spread leading to spondylodiscitis can include infections from various sites such as the urinary tract, skin and soft tissue, respiratory tract, intravascular devices, wounds, infective endocarditis, dental infections, or direct spread from other abscesses or infected lesions

Diagnosis

The diagnosis of spondylodiscitis involves a comprehensive approach, starting with a detailed history and physical examination to assess symptoms, risk factors, and clinical findings. Laboratory tests, including ESR, CRP, and blood and urine cultures, are performed to evaluate inflammation markers and identify potential pathogens. Imaging studies, such as MRI or CT scans, are used to visualize the affected area and confirm the diagnosis. Obtaining samples for culture through CT-guided needle biopsy or pus aspiration helps in identifying the causative pathogen, guiding targeted antibiotic therapy. In cases where initial cultures are negative but suspicion remains high, a second biopsy may be considered for a definitive microbiological diagnosis. Surgical consultation is recommended for patients with neurologic deficits, epidural or paravertebral abscesses, or signs of cord compression, as they may require surgical intervention. Understanding the diagnostic process for spondylodiscitis is essential for accurate identification and appropriate management of this condition.

Diagnosis-additional radioniucid scans

In cases where radiographic changes on plain films or CT scans are inconclusive or absent, additional radionuclide scans may be considered for the diagnosis of spondylodiscitis, particularly when there is a high suspicion for osteomyelitis. However, labeled-leukocyte scans or three-phase bone scintigraphy are not typically recommended due to their high rates of false-positive and false-negative results.

Alternative radionuclide imaging modalities that may be used include:

1**. Gallium imaging**(*fig.5a)*: Gallium scans can be employed to detect areas of infection or inflammation and are useful in cases where spondylodiscitis is suspected but not clearly visualized on other imaging modalities.

2. **FDG-PET**(fig.5b): Fluorodeoxyglucose-positron emission tomography (FDG-PET) imaging has a high negative predictive value close to 100% for detecting spondylodiscitis. It offers good specificity, but caution is needed as PET scans can be positive in conditions such as tumors, degenerative spinal disease, or in the presence of spinal implants.

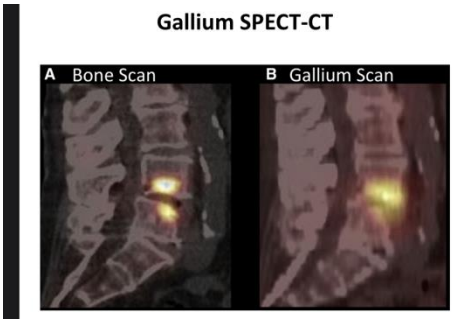


Fig.5a

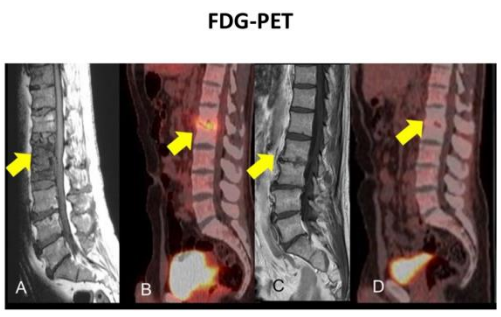


Fig.5b

Treatment - principles

The treatment of spondylodiscitis follows key principles:

- Antimicrobial therapy tailored to the identified pathogen once a microbiologic diagnosis is confirmed, along with percutaneous drainage of paravertebral abscesses if necessary.

- Delaying antibiotic initiation until a microbiologic diagnosis is confirmed, unless there are urgent situations like neurologic compromise or sepsis where empiric antibiotic treatment is warranted.
- Initial use of intravenous (IV) antibiotics to ensure systemic distribution and efficacy during the acute phase of treatment.
- Antibiotic treatment duration of several weeks, with longer courses (8 to 12 weeks) required for cases with undrained abscesses, drug-resistant organisms, or extensive bone destruction.
- Routine follow-up imaging studies are generally not needed initially, as imaging findings may worsen before showing improvement.

Initial IV antibiotics

When initiating intravenous (IV) antibiotic therapy for spondylodiscitis, the choice of antibiotics should ideally be guided by the identified pathogen through microbiological diagnosis. However, in cases where a specific pathogen has not been identified (no diagnosis), empiric antibiotic treatment may be initiated based on common causative organisms and local resistance patterns.

Initial iv antibiotics

Infectious agent	Antibiotic regimen	Dosing
Staphylococci, methicillin susceptible	oxacillin	2 g x 6
	cefazolin	2 g x 3
Staphylococci, methicillin resistant (or allergy to penicillins and no desentization)	vancomycin	20-35 mg/kg load and then 15-20 mg/kg x 2 (+TDM adjusted)
	daptomycin	6-10 mg/kg x 1
Gram negative bacteria (according to local resistance patterns)	ceftriaxone	2 g x 1
	ceftazidim	2 g x 3
	cefepime	2 g x 3
	ciprofloxacin	400 mg x 2
Penicillin-sensitive streptococci and *Cutibacterium*	ceftriaxone	2 g x 1
	penicillin G	12-24 M units continuous infusion
Empiric treatment	Vancomycin plus Cefotaxime Ceftazidime Ceftriaxone Cefepime Ciprofloxacin	See above 2 g x 4 2 g x 3 2 g x 1 2 g x 3 400 mg x 2

Fig.6

Treatment-presence of hardware

The prognosis of spondylodiscitis is generally favorable with appropriate therapy, but there are potential complications and factors that can impact outcomes:

- Most patients experience gradual improvement in back pain with the initiation of therapy, and pain typically resolves after bone fusion occurs.
- Complications may include neurologic impairment due to abscess formation or bony collapse, with a prevalence of 16%.
- Relapse occurs in approximately 14% of cases, with a higher rate associated with Staphylococcus aureus infections.
- Residual symptoms, mainly back pain, persist in about 31-32% of patients post-treatment, and major depression can also be a complication.
- Delay in diagnosis is a significant risk factor for poor outcomes.

In retrospective studies, all-cause mortality was reported at 11%, with 43% of patients undergoing surgery (successful in 79%). Risk factors for death or residual symptoms included neurologic compromise at diagnosis, nosocomial infection acquisition, and delay in diagnosis. Morbidity and mortality tend to increase with age, delayed diagnosis, multiple comorbidities, frailty, and concomitant infective endocarditis. Overall mortality is low, with less than 5% reported (pre-antibiotic era rates were around 25%), and residual neurological deficits are seen in 7% of cases. In a large retrospective study, in-hospital mortality was 6% and largely influenced by comorbidities such as diabetes, end-stage kidney disease, cirrhosis, and malignancy.

TB spondylitis – Pott's disease *fig.7*

Tuberculous spondylitis, also known as Pott's disease, typically affects the dorsal (thoracic) vertebrae, although it can also involve the lumbar region. It is a slow but destructive disease characterized by vertebral fractures leading to kyphosis, a forward curvature of the spine. Patients may present with cold abscesses in the back, a collection of pus formed as a result of the tuberculosis infection. The diagnosis of TB spondylitis is often confirmed through biopsy or drainage of paravertebral abscesses. These procedures help identify the presence of Mycobacterium tuberculosis, the causative agent of tuberculosis, and guide appropriate treatment strategies. Early detection and management of Pott's disease are crucial to prevent complications such as spinal deformity and neurological deficits .Historically, the treatment of Pott's disease included heliotherapy (sunlight exposure) and bed rest as part of the management strategy. Sunlight exposure, specifically ultraviolet (UV) light, was believed to have beneficial effects on tuberculosis infections, as UV light has antimicrobial properties that can help in the treatment of the disease. Additionally, bed rest was commonly prescribed to patients with Pott's disease to reduce spinal stress and prevent further damage to the affected vertebrae. Resting in bed was thought to promote healing and alleviate pain associated with the condition

Fig.7

Discitis

Discitis, or inflammation of the intervertebral disc, is a condition that can occur in children but is less common than in adults. The intervertebral disc consists of the nucleus pulposus,

which is a semigelatinous material containing a high percentage of water (70-90%), and the annulus fibrosus, which has a hyaline circular surface. The disc is avascular from around 30 years of age, making microinfarctions more frequent in adults and potentially leading to more severe disease. In children, discitis is often seen in those younger than 4 years of age and is typically associated with fever. In adults, the exact incidence is unknown, and discitis is sometimes grouped with spondylodiscitis. Lumbar disc involvement is common in discitis and may occur as a metastatic localization of sepsis originating from sources such as urinary tract infections, skin and soft tissue infections, or following urinary tract interventions. Risk factors for discitis in adults may include intravenous drug use, obesity, and diabetes. The treatment of discitis, particularly in post-surgical cases, may involve similar approaches to those used for spondylodiscitis, with a focus on antimicrobial therapy and appropriate management of associated complications.

Prosthetic Joint infections

Definition

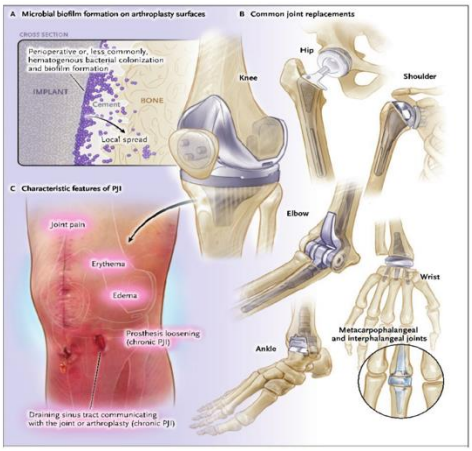
Prosthetic joint infection refers to an infection involving a joint prosthesis, with the **hip**, **knee,** and **shoulder** being the most commonly affected joints. PJI is typically classified based on the time of onset following joint replacement surgery, although there is some controversy regarding the classification criteria. The classification of prosthetic joint infections often includes the following categories:

1. **Early-onset PJI**: Infections that occur within the first three months after joint replacement surgery are classified as early-onset PJI.

2. **Delayed-onset PJI**: Infections that occur between three to twelve months after the initial joint replacement surgery are categorized as delayed-onset PJI.

3. **Late-onset PJI**: Infections that occur more than twelve months after the joint replacement surgery are considered late-onset PJI.

Fig.8



Epidemiology

The epidemiology of prosthetic joint infections (PJI) is influenced by several factors, including the increasing number of arthroplasties performed worldwide. In the United States alone, approximately 1 million hip and knee arthroplasties are conducted each year. The risk of developing a prosthetic joint infection varies based on the location of the joint replacement, with higher rates observed in the first two years following surgery. The incidence of PJI is generally reported to be around 0.5-2% for knee arthroplasties, which are at greater risk due to their increased mobility and less soft tissue protection. For hip arthroplasties, the incidence is typically in the range of 0.5-1%, while shoulder arthroplasties have an incidence of less than 1%. The specific bacteria responsible for prosthetic joint infections in different joint replacements may vary. However, there are conflicting results in the literature regarding the overall incidence trends of PJI, with some studies suggesting a stable incidence rate while others report increasing or decreasing trends over time.

Pathogenesis-risk factors

The pathogenesis of prosthetic joint infections involves various risk factors that contribute to the development of these infections. Some important risk factors associated with an increased likelihood of PJI include:

1**. Presence of comorbidities**: Conditions such as rheumatoid arthritis, diabetes mellitus, malignancy, chronic kidney disease, obesity, lymphedema, and immunosuppression can weaken the immune system and predispose individuals to infections, including PJI.

2**. Use of certain medications**: The use of prednisone, tumor necrosis factor inhibitors, and other biologic disease-modifying antirheumatic drugs can impact immune function and increase the risk of infections.

3**. History of prior arthroplasty or prior infection at the surgical site:** Previous joint replacement surgeries or infections at the surgical site can increase the risk of subsequent PJI.

4. **ASA score ≥3**: A higher American Society of Anesthesiologists (ASA) score, which reflects the overall health status and comorbidities of a patient, is associated with an increased risk of PJI.

5**. Prolonged duration of surgery:** Lengthy surgical procedures can increase the risk of PJI due to prolonged exposure of the surgical site to potential pathogens.

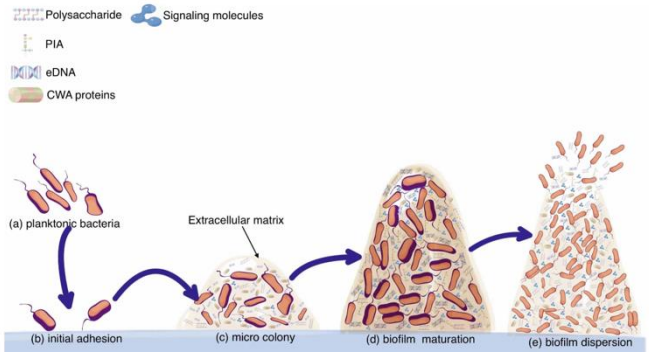
6. **Postoperative complications**: Complications such as hematoma formation or wound dehiscence following surgery can create an environment conducive to infection and increase the risk of PJI.

7**. Staphylococcus aureus bacteremia**: Bacterial bloodstream infections, particularly caused by Staphylococcus aureus, can lead to seeding of the joint prosthesis and subsequent development of PJI.

Pathogenesis-biofilm

Prosthetic joint infections present challenges in treatment due to factors that affect antibiotic efficacy and the development of antibiotic resistance. The establishment of biofilms on prosthetic surfaces can alter antibiotic mechanisms and hinder their penetration, limiting their effectiveness in eradicating the infection. Additionally, there is a logarithmic decline in antibiotic susceptibility once the biofilm forms, leading to reduced antibiotic efficacy over time. Although patients with PJI may initially respond to antibiotic treatment, there is a risk of relapse within days or months after stopping antibiotics, unless the infected hardware (prosthesis) is removed. The biofilm acts as a reservoir for bacteria, contributing to recurrent or persistent infections.

Fig.9



Aetiology

The etiology of prosthetic joint infections (PJI) is diverse, with pathogens often originating from the skin flora, which is typically considered sterile.

Aetiology

Early onset (<3 months)	Delayed onset (3-12 months)	Late onset (>12 months)
S. aureus	CONS	*S. aureus*
Gram- bacilli	*Cutibacterium**	Gram- bacilli
*Cutibacterium**	Enterococci	Streptococci
polymicrobial		

*shoulder

Rare cases:
•MTB
•NTM
•Candida

Fig.10

Clinical Presentation – early onset (< 3 months)

In early-onset prosthetic joint infections (PJI) occurring within the first three months after implantation, patients may present with clinical signs and symptoms indicative of infection shortly after the surgical procedure. Common manifestations of early-onset PJI include

surgical site issues like wound dehiscence, hematoma, or superficial necrosis at the incision site. Joint-related symptoms such as pain, warmth, erythema, induration, and edema at the incision site may also be observed. Additionally, patients may experience wound drainage or dehiscence, joint effusion (fluid accumulation), and fever as systemic signs of infection.

Clinical Presentation – delayed onset (3-12 months)

In delayed-onset prosthetic joint infections (PJI) occurring between 3 to 12 months after implantation, the clinical presentation tends to be insidious and challenging to distinguish from other causes of joint symptoms. Patients may experience a more gradual onset of symptoms, including persistent joint pain and potential early signs of implant loosening. Fever, though present in about half of cases, can indicate a systemic response to the infection. The development of a sinus tract, a draining channel from the infected joint to the skin surface, is a characteristic feature that aids in diagnosing PJI. Physical examination findings may be minimal, complicating the differentiation between infection and aseptic failure of the joint prosthesis

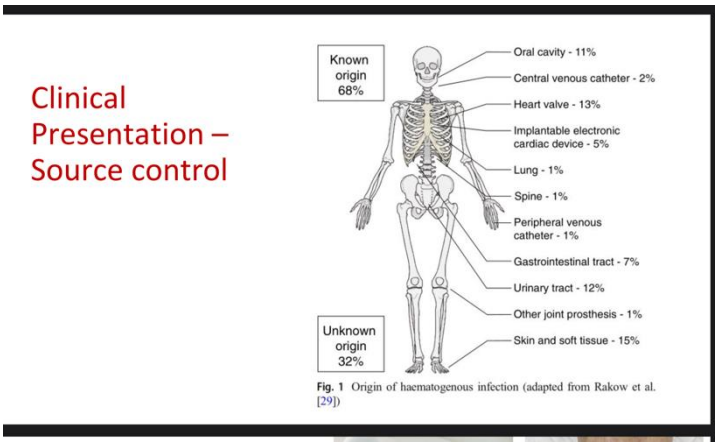
Clinical Presentation – late onset (>12 months)

In cases of late-onset prosthetic joint infections (PJI) occurring more than 12 months after implantation, approximately 50% of cases are associated with hematogenous spread from infections at other sites, such as central venous catheters, urinary tract infections, or skin and soft tissue infections. The clinical presentation of late-onset PJI typically includes an acute onset of symptoms, with patients experiencing a sudden onset of symptoms despite having had a previously well-functioning joint. Common manifestations include joint pain, warmth, erythema at the incision site, induration, and edema, along with joint effusion contributing to joint symptoms. Systemic symptoms like fever can also be present as part of the body's response to the infection. Late-onset PJI may lead to joint instability and potential dislocation, indicating advanced stages of infection. Recognizing the acute presentation of symptoms, the joint-related signs, and the history of hematogenous spread from another infection site is crucial for diagnosing late-onset PJI.

Clinical presentation-source control (*fig.11)*

The source of infection plays a critical role in determining the clinical presentation and management. The origin of PJI can be categorized into known and unknown sources, with varying percentages attributed to different locations. Here, the professor only pointed out the oral cavity (13 %) and the urinary tract (12%).

Fig. 11



Diagnosis-initial assessment

The diagnostic approach involves an initial assessment that includes plain radiography and serum markers like ESR (erythrocyte sedimentation rate) and CRP (C-reactive protein). If a sinus tract is not evident, diagnostic arthrocentesis is performed to analyze synovial fluid, including WBC (white blood cell count), LE (leukocyte esterase), crystal analysis, alpha-defensin levels, and microbial cultures (Gram stain and culture). In cases of chronic, indolent, or refractory infections, previously culture-negative infections, or immunosuppressed patients, additional testing such as mycobacterial and fungal cultures may be necessary to identify the causative pathogens accurately. This comprehensive diagnostic approach helps clinicians determine the presence of PJI, differentiate between infectious and non-infectious causes of joint symptoms, and guide appropriate treatment strategies for optimal patient outcomes

Treatment options

1. **DAIR (Debridement, Antibiotics, and Implant Retention)**: This is a procedure where the infected joint is debrided, antibiotics are administered, and the prosthetic components are retained. This is typically used for early, acute infections.

2. **DAPRI (Debridement, Antibiotics, and Prosthesis Retention with Irrigation**): Similar to DAIR, but with the addition of thorough irrigation of the joint. This may be used for more established infections.

3. **One-stage revision:** This involves removing the infected prosthetic components and replacing them with new components in a single surgery. This may be considered for certain cases of prosthetic joint infection.

4. **Two-stage revision**: This involves removing the infected prosthetic components, placing a temporary spacer with antibiotics, treating the infection, and then replacing the components in a second surgery. This is often used for chronic or difficult-to-treat infections.

5. **Arthrodesis:** This involves fusing the joint together to eliminate movement. This may be considered in cases of severe infection or failed joint replacement.

6. **Girdlestone procedure**: This involves removing the prosthetic components and leaving the joint un-replaced. This may be considered in cases of severe infection or poor bone quality.

7. **Amputation**: In severe cases of infection or failed joint replacement, amputation may be necessary to control the infection and improve quality of life.

8. **Suppressive antibiotic treatment**: In cases where complete eradication of the infection is not possible, long-term suppressive antibiotic therapy may be considered to control the infection and prevent further complications.

Diabetic foot

Epidemiology

The epidemiology of diabetic foot complications is significant, with a high prevalence and associated risks. Individuals with type 1 or type 2 diabetes have a lifetime risk of developing diabetic foot issues of up to 34%. This high risk is reflected in the annual incidence of approximately 18.6 million cases per year, indicating a substantial number of individuals affected by diabetes globally. Diabetic foot complications are associated with a range of risks, including a high likelihood of hospitalization, re-admission, amputation (up to 20% of cases), and a mortality risk 2.5 times higher than individuals without diabetic foot problems. These risks underscore the severity and impact of diabetic foot issues on individuals with diabetes. Foot ulcers are a common complication, affecting around 50% of individuals with diabetes. These ulcers can lead to further complications such as osteomyelitis (bone infection), cellulitis (skin infection), sepsis (systemic infection), and gangrene (tissue death). These complications can result in long-term disability and significantly impact the quality of life of affected individuals. Overall, diabetic foot complications pose a serious health concern, contributing to morbidity, mortality, and reduced quality of life in individuals with diabetes.

Risk factors

Risk factors include :

1**. Previous foot ulceration**: Individuals with a history of foot ulcers are at a higher risk of recurrence, with more than 50% experiencing recurrences within 5 years.

2. **Neuropathy**: Neuropathy is present in up to 80% of patients with diabetic foot complications. It leads to the loss of sensation of pain and pressure, making individuals more susceptible to minor traumas. Additionally, neuropathy causes impaired microcirculation and compromised skin integrity.

3. **Foot deformity**: Foot deformities, such as hammer toes and Charcot's foot, are associated with neuropathy and increase the risk of diabetic foot issues.

4. **Vascular disease (peripheral artery disease**): Peripheral artery disease results in reduced blood flow to the feet, leading to poor wound healing and increased risk of complications.

5. **Medications**: Some medications, such as SGLT2 inhibitors, may have potential associations with diabetic foot complications. For example, certain medications may increase the risk of urinary tract infections.

6. **Age and ethnicity**: In the United States, younger individuals from black, Native American, or Hispanic populations may be at higher risk of diabetic foot complications. Social factors, access to healthcare, nutrition status, and overall health care access can contribute to these disparities.

7. **Rural or low-income areas**: Individuals living in rural or low-income areas may face challenges accessing medical care, leading to delays in diagnosis and treatment of diabetic foot issues.

Clinical assessments

Clinical assessments for diabetic foot complications may include:

1**. Ankle-brachial index (ABI)**: The ABI is a non-invasive test that compares the blood pressure in the ankle to the blood pressure in the arm. A low ABI may indicate peripheral artery disease (PAD), which can affect blood flow to the legs and feet.

2. **Resistance Toe Pressure**: It assesses the pressure required to compress the toe and can provide information about the blood flow in the foot. Low resistance toe pressure may indicate compromised vascular health

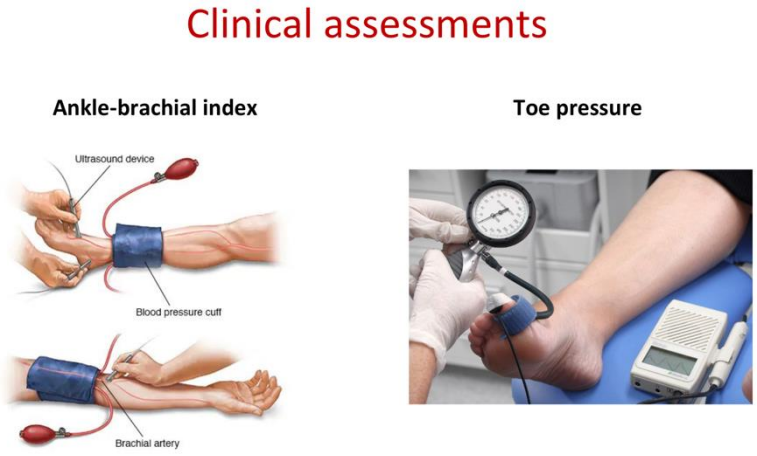
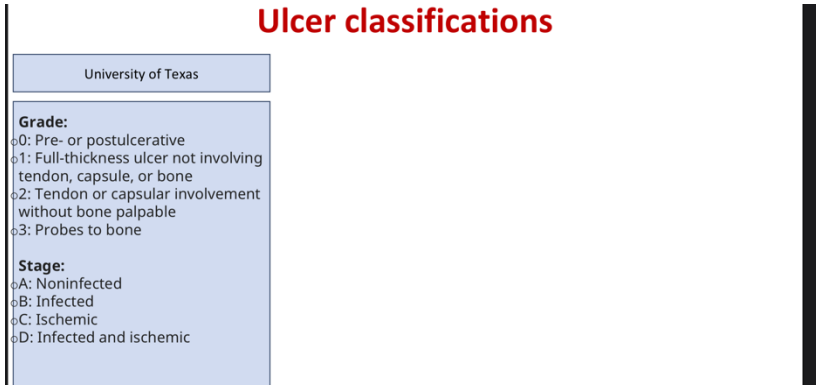


Fig.12

Ulcer classifications

Professor skipped the slide mentioning only that there are many ulcer classifications.

Fig.13



Management

Some key management strategies include:

1. **Complete evaluation**: A thorough assessment of the individual with diabetic foot complications is essential. This evaluation may include assessing nutrition status, consulting with vascular surgeons to address vascular issues, and identifying any underlying risk factors that may contribute to foot problems.

2**. Sharp debridement**: Debridement involves the removal of dead or infected tissue from the wound to promote healing and prevent infection. Sharp debridement is a common technique used to clean and prepare the wound for proper healing.

3. **Proper, personalized wound coverage**: Wound care plays a crucial role in managing diabetic foot ulcers. Proper wound coverage, such as dressings or advanced wound care products, helps create a conducive environment for healing and prevents infection.

4. **Pressure reduction**: Mechanical offloading techniques, such as using casts, orthotic devices, or specialized footwear, can help reduce pressure on the affected foot and prevent further damage to the wound. Offloading is an essential component of diabetic foot ulcer management.

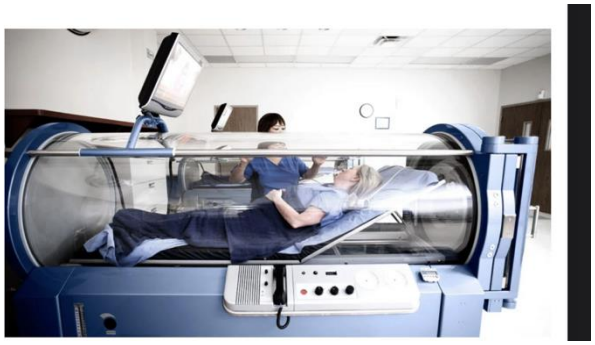
5. **Prevention of relapses**: Preventing the recurrence of diabetic foot complications is crucial. This may involve patient education on foot care, regular monitoring of foot health, and implementing preventive measures to reduce the risk of future ulcers or complications.

Local care

Local care for diabetic foot ulcers is essential in promoting wound healing and preventing complications.It includes **debridement**, which involves the removal of dead or infected tissue from the wound bed, plays a crucial role in creating a clean environment for healing and reducing the risk of infection. Different debridement methods, such as sharp debridement or enzymatic debridement, may be employed based on individual wound characteristics. **Proper wound dressings** are vital for managing diabetic foot ulcers as they help maintain a moist healing environment, protect the wound from contaminants, and support the healing process. Various types of dressings, including hydrocolloid, foam, or alginate dressings, are used depending on the wound's specific needs. **Adjunctive local**

therapies, such as Negative Pressure Wound Therapy (NPWT) or Vacuum-Assisted Closure (VAC), can further enhance wound healing. NPWT applies negative pressure to the wound, promoting fluid removal, reducing edema, and stimulating tissue granulation. Skin grafts and substitutes may be considered for non-infected, non-ischemic wounds to support wound closure. Additionally, Hyperbaric Oxygen Therapy and local oxygen therapy can improve oxygen delivery to the tissues, aiding in the healing process.

Fig.14



Treatment of Diabetic foot infection

The prevention and treatment of diabetic foot infections require a collaborative approach involving surgeons and infectious disease specialists.To prevent diabetic foot infections, individuals with diabetes should practice proper foot care, including regular foot inspections, keeping the feet clean and dry, and wearing suitable footwear. Maintaining optimal blood sugar levels through glycemic control is essential to reduce the risk of diabetic complications, including foot infections. Regular foot exams by healthcare providers can help detect any issues early and prevent infections from developing. In the treatment of diabetic foot infections, obtaining tissue samples for culture and sensitivity is crucial before initiating empirical therapy. This allows for targeted antibiotic treatment based on the specific pathogens identified in the wound. Diabetic foot infections can be caused by various pathogens, including Gram-positive cocci, Gram-negative bacilli, anaerobes, and polymicrobial organisms, often exacerbated by impaired immunity in individuals with diabetes. The duration of antibiotic therapy for diabetic foot infections depends on factors such as the extent of tissue involvement (soft tissues, bone), presence of ischemia, and the risk of relapses. Tailoring the duration of treatment to these factors is essential for successful management and resolution of the infection.