Acute osteomyelitis

Acute osteomyelitis is **a purulent process in bone caused by a pyogenic organism** . This inflammation takes place in a limited space given by the boundaries of the mineral bone matrix, which will not allow tissue expansion typical of every inflammation. The classic division of osteomyelitis is **acute, subacute and chronic** .

According to the method of origin, we distinguish:

- hematogenous osteomyelitis;
- osteomyelitis arising from transfer from another infectious site;
- osteomyelitis resulting from direct introduction of a microorganism during trauma or surgery.

While hematogenous osteomyelitis is more common in the youngest children, the other types are more common in older patient groups. 50% of osteomyelitis cases are found in preschool children.

Pathogenesis

- Hematogenous spread: the presence of at least temporary **bacteremia** (primary infection is usually in the area of the mouth, umbilical cord , cannulated vessel). The hematogenous route in young children is related to the rich blood supply of their growing bones,
- the settlement of bacteria in the bone - the predilection area is **the metaphysis of long bones** , where the blood flow is blocked,
- inflammatory exudation and increased pressure → spread of infection to the surrounding bone,
- penetration under the periosteum creates **a subperiosteal** abscess ,
- if the metaphysis is located intra-articularly (e.g. at the hip joint), the infection can spread to the joint and **purulent arthritis** develops .
- physis = growth cartilage, represents a relatively good barrier against the spread of infection, therefore purulent masses from the metaphysis tend to expand either inwards into the medullary cavity or up under the periosteum. In the newborn and infant age, however, capillaries penetrate through the growth cartilage , and apparently this is also why purulent osteomyelitis at this age is often complicated by purulent arthritis.
- In untreated osteomyelitis, there is necrosis of variously extensive areas of the metaphysis and diaphysis, which are separated from the living bone by granulation tissue. These are so-called **sequestrations** . The newly formed living bone from the periosteum envelops these dead areas, we are talking about the so-called **encapsulation of the sequestrum** . These layers are intermittently perforated by accumulated pus, which is released through the fistula to the surface. The repetitive process of sequestration and encapsulation creates spaces in the bone containing bacteria, granulation tissue , and dead bone. Because they are separated from the blood supply, they are beyond the reach of the immune system and generally administered drugs. **Chronic osteomyelitis** occurs , characterized**sequestrations, intermittent or permanent drainage of pus from fistulas .**
- **Brodi's abscess** is a subacute intraosseous abscess that has not extended subperiosteally, and is classically located in the distal part of the tibia.

Osteomyelitis most often affects **the distal femur and proximal tibia** , another frequent localization is the proximal femur and distal metaphyses of the radius and humerus.

Etiology

- In newborns – **Staphylococcus aureu**s , **group B streptococci and gram-negative bacteria** .
- In children under 3 years of age – **Staphylococcus aureus** , **then** S**treptococcus pneumoniae and** pyogenes .
- Community-associated **MRSA** (CA-MRSA = community-associated methicillin resistant S. aureus) infections are a growing problem in some regions.
- In the immunocompromised - various bacteria and fungal agents, a specific place is occupied by Salmonella enteritidis in patients with sickle cell anemia and other hemoglobinopathies .
- *Kingella kingae* , a gram-negative strain, can cause osteoarticular involvement, especially in children < 2 years of age, following a respiratory infection.
- Rare agents are anaerobic bacteria - Bacteroides, Fusobacterium, Clostridium and Peptostreptococcus.

Clinical signs

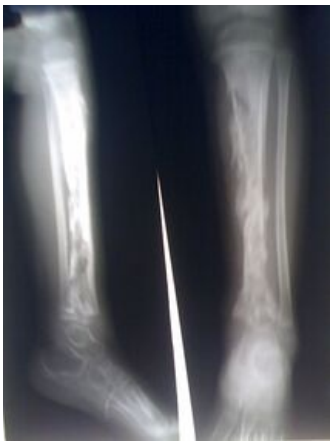
Symptoms of acute hematogenous osteomyelitis vary according to the extent, location and duration of infection, age and resistance of the pathogen, but are usually quite urgent. On the other hand, antibiotic therapy used for an unclear febrile condition can mask these symptoms and make diagnosis difficult (**mitigated infection**).

- *General symptoms* are a manifestation of a septic condition – **high fever, shivering, vomiting, dehydration** . However, they may not be fully expressed in newborns and young infants.
- *Local symptoms* include **bone pain** , often accentuated even by minimal movement . The absence of active movement of the limb is therefore typical = so-called **pseudo-paralysis** . When the lower limb is affected, the child refuses to walk or attacks the affected side (**antalgic walking**). In the smallest children,

asymmetric movements of the limbs should be noted.
- The area is **warmer, swollen and tender to palpation** . Redness is not usual. However, it can occur in areas where the bones are located just under the skin (clavicle, tibia). The limbs are usually held in an antalgic position, but usually less rigidly than in septic arthritis. After a few days, however, the adjacent joints are filled with reactive sterile exudate, and this then makes differential diagnosis difficult.

Diagnostics

- Elevation of **inflammatory parameters** – FW , CRP , procalcitonin ,
- **leukocytosis** with a shift to the left
- repeated examination **of blood cultures** , where we often find the etiological agent of inflammation,
- **X-ray** image:



  - In the first days, only swelling of the surrounding soft tissues can be noted,
  - with a delay of 7–12 days – bone changes – irregularities in the X-ray structure of the metaphysis and later the diaphysis – osteopenia, osteolysis, periosteal changes.
  - Subperiosteal formation of new bone already proves the penetration of the infection through the cortex.
  - X-ray, however, is of great importance in differential diagnosis, as it allows to rule out fractures, possibly tumors. *A negative X-ray finding does not exclude the diagnosis of acute osteomyelitis.*

- radioisotope examination – **three-phase scintigraphy of the skeleton** (Technetium 99m labeled diphosphonates). Typically, the affected area shows increased uptake of the radionuclide, which signals *increased osteoblastic activity* . **Allows a distinction between osteomyelitis and a deep form of cellulitis, fractures, tumors or orthopedic procedures also present increased uptake of the radionuclide.
  - On the other hand, scintigraphy can be falsely negative in the first few days.
- During the **ultrasound examination**, we detect a non-specific infiltration of the soft tissues, later a subperiosteal abscess. USG is also useful in ruling out deep thrombosis, which can be found in patients with osteomyelitis caused by CA-MRSA. Doppler imaging is the method of choice in this indication. However, routine screening for deep vein thrombosis as part of the diagnosis of osteomyelitis is not recommended.
- **MRI** – early demonstrates bone changes, marrow swelling and subperiosteal abscess. However, this examination is not always available. In addition, in childhood, it requires general anesthesia.
- **scan with indium labeled leukocytes** . Its evidence is low in the lowest age groups (newborns, infants) and in patients with neutropenia.
- **puncture** - must always be performed. We aspirate pus from a subperiosteal abscess, from a bone or from an affected joint. But we have to puncture the joint with another needle to prevent possible introduction of infection into the hitherto sterile joint. This is followed by a culture examination to detect the infectious agent.
- We demonstrate the etiological agent from blood cultures and aspiration punctures. A negative X-ray finding does not exclude the diagnosis of acute osteomyelitis.

Differential diagnosis

- **Purulent arthritis** (in later stages this may be present as a complication of osteomyelitis).
  - In purulent arthritis, however, scintigraphy does not show too much accumulation of the radiopharmaceutical. If accumulation takes place, it is more likely in the soft tissues and not in the bone.
- **Febris rheumatica** – in older children, very rare,
- juvenile idiopathic arthritis ,
- acute leukemia ,
- malignant tumors,
- discitis.
  - The patient usually reports local pain or we can observe spine deformity in the sense of gibbousness. The etiology of discitis is not sufficiently understood.
  - Discitis is treated with anti-staphylococcal antibiotics for 4-8 weeks until the aspirate culture is negative.
- Birth injuries that lead to limited movement of the limb, especially fractures or birth palsy of the brachial plexus.

Therapy

- Antibiotics that we administer for a long enough time and in a sufficient dose. Before deployment, we collect blood cultures and bone aspirate for cultivation!
  - Staphylococcus aureus – **oxacillin or clindamycin** ,
  - MRSA or Penicillin Resistant Pneumococcus – **Vancomycin** . The severity of infections caused by Staphylococcus aureus also lies in the increasing incidence of Panton-Valentine leukocidin production.
  - **Hemophilus influenzae is already rare (Hib vaccination), empirically, a combination of 3rd generation cephalosporins** (cefotaxime, ceftriaxone) **with oxacillin or clindamycin** is recommended for children < 3 years of age . (Monotherapy with 3rd generation cephalosporins is not optimally effective on Staphylococcus aureus.)

    - A good choice to cover both methicillin-sensitive staph and Hib is **a 2nd generation cephalosporin** (cefuroxime).
    - neonates combination **of oxacillin and 3rd generation cephalosporins** – Enterobacteriacae and GBS .
- **debridement** – if the cause of osteomyelitis is penetrating trauma (removal of foreign bodies and necrotic tissue) and consider coverage with antipseudomonas antibiotics.
- The minimum duration of ATB administration is set at 4 weeks, most patients require 4-8 weeks of administration. It depends on the sensitivity of the pathogen, the clinical course and the values of inflammatory markers.
    - We switch from iv therapy to po when the clinical condition improves and inflammatory parameters decrease. Studies have been conducted that confirmed the effectiveness of a four-day course of antibiotics in uncomplicated osteomyelitis followed by a 30-day administration of antibiotics after Before changing to the after form, we must have proven good sensitivity of the pathogen to the selected antibiotics. It is advantageous if the laboratory is able to perform a serocidal assay = Schlichter test. The oral antibiotic must be able to provide a sufficient serum level, usually 2–3 times the usual oral dose. Peak serocidal levels must be kept at a value of 1:8 or higher. At the same time, the patient must not have GIT intolerance (vomiting, diarrhea) to ensure sufficient absorption, there must be good compliance with the family. If the patient does not meet the above criteria, intravenous antibiotic treatment must be continued,
- If there is no clinical improvement within 48-72 hours from the start of treatment (recession of temperature, pain and swelling), we perform **repeated aspiration of bone tissue** for culture and proceed to **surgical drainage** . Another indication for drainage is a delayed diagnosis or the presence of a subperiosteal abscess.
- **immobilization of the limb** (plaster splints, traction) and adequate analgesia
- After stabilization – **rehabilitation treatment**
- If the course is uncomplicated, we check **inflammatory markers, liver tests and blood counts weekly** to monitor treatment response, possibly adverse effects of antibiotics (hepatopathy, neutropenia).

Complications

- Arthritis,
- pathological fracture,
- deformities and shortening of limbs due to destruction of the physis,
- chronic osteomyelitis with the formation of sequestrations and the necessity of a surgical solution.

Neonatal osteomyelitis

- Gram-negative enterobacteria, Staphylococcus aureus and Group B Streptococcus (agalactiae, GBS).
- Intravenous inputs and punctures are predisposed.
- Diagnosis often delayed because erythema and swelling may be absent and pseudoparalysis of the limb may be the only symptom. Around 50% of newborns with osteomyelitis have multiple bone involvement. Often the adjacent joint is also affected.
- In contrast to older children, in newborns, a plain X-ray image that reveals a lytic area at the time of diagnosis tends to be very early sensitive.
- More frequent damage to the growth of the limb.

Other bone infections

Osteomyelitis of the vertebrae and pelvis

- Rare in childhood.
- Symptomatology is often non-specific and delays early diagnosis.
- The causative agents are Staphylococcus aureus and gram-negative enterobacteria.

Salmonella infection

- Different strains of Salmonella can cause acute osteomyelitis even in the localization of vertebrae.
- Joint and bone infection with Salmonella must always lead to the suspicion of *immunodeficiency or hemoglobinopathy* , especially sickle cell disease. In these cases, we consider performing a bone biopsy to rule out bone infarction.

TB osteomyelitis

- Rare in childhood.
- The diagnosis is based on epidemiological contexts, histopathological findings and the Mantoux test.
- The treatment is specific and long-term - antituberculosis.

Chronic recurrent multifocal osteomyelitis

- Unclear etiology,
- subfebrile and swelling over the affected bones,
- flat bones,
- bone scintigraphy shows increased uptake in several bones, but blood cultures and bone aspirates tend to be negative,
- it is necessary to distinguish histiocytosis from Langerhans cell leukemia or neuroblastoma.

Subacute form of osteomyelitis

- Under the picture of a fever of unknown origin and we find no signs of a local finding.
- Sometimes we find erythema nodosum at the same time and the search for the cause leads us to the diagnosis of subacute osteomyelitis.
- The number of leukocytes and other inflammatory markers may not be increased. X-rays and scintigraphy are helpful in diagnosis.
- Again, aspiration of bone tissue is necessary to identify the causative agent (Mycobacterium tuberculosis, mycoses or other unusual pathogens may figure here) before starting antibiotic treatment. The duration of treatment is usually 2–3 months and depends on the clinical course, or signs of healing according to X-ray findings.

Links

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