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HISTOLOGICAL CHANGES IN BONES IN OSTEOMYELITIS

Annotation: this article presents histological changes in the bones in osteomyelitis. the article is written in the case of using internet resources.

Key words: bone, osteomyelitis, infection.

Healthy intact bone is resistant to infection. The bone becomes susceptible to disease with the introduction of a large inoculum of bacteria, from trauma, ischemia, or the presence of foreign bodies because bone sites to which microorganisms can bind are exposed. Certain bacteria such as *Staphylococcus aureus* adhere to the bone by expressing receptors, called adhesins, for some components of the bone matrix, including laminin, collagen, fibronectin, and bone sialoglycoprotein. *S. aureus* expresses a collagen-binding adhesin, which permits its attachment to bone cartilage while the fibronectin-binding adhesin's role in attachment of bacteria to surgically implanted devices in bone was recently discovered. Also interesting to note is that *S. aureus* can survive intracellularly after being internalized by cultured osteoblasts. Some bacteria create a protective biofilm coating around themselves and underlying surfaces. This characteristic of some bacteria to adhere to the bone and surgically implanted devices following which they express phenotypic resistance to antibiotic therapy and their ability to survive intracellularly may explain the persistence of bone infections and high failure rates of shorter courses of antimicrobial treatment

Bone can get infected via the hematogenous route of infection through bacteremic seeding of bone from a distant source of infection, contiguous spread from surrounding tissue and joints, or direct inoculation of bone from trauma or surgery. Hematogenous osteomyelitis occurs more frequently in children compared to adults, and long bones are usually affected. In adults, hematogenous osteomyelitis affects the vertebrae most commonly. Contiguous osteomyelitis in young adults usually occurs in the setting of trauma and related surgery, while in older adults, infection is typically related to decubitus ulcers and infected joint arthroplasties. osteomyelitis associated with vascular insufficiency frequently occurs in the presence of underlying diabetes mellitus.

In patients with diabetes, osteomyelitis usually results from compromised blood supply to the lower extremities, which contributes to impaired local immunity and skin healing, promoting the spread of infection. Sensory neuropathy in the setting of diabetes mellitus predisposes to the formation of skin ulceration at pressure and trauma points, complicating matters even worse.

Contiguous osteomyelitis frequently develops in debilitated patients who are wheelchair or bedbound and are predisposed to pressure-related skin ulcerations, especially in the sacrum, buttock, hips, and heel. These ulcers are typically colonized by polymicrobial flora from the skin and gastrointestinal tract such that soft tissue infection can quickly spread to the underlying bone. Other sources of contiguous osteomyelitis are trauma leading to infected, exposed skin, and soft tissue. Osteomyelitis with direct inoculation of bacteria may occur in the setting of open fractures, bone reconstructive surgery, or with placing orthopedic hardware. The well-perfused metaphyses, which have scarce functioning phagocytes, are the most common site of infection in hematogenous osteomyelitis affecting the long bones. The blood supply to the long bones penetrates the bone at the mid-shaft then

splits into two traveling to both metaphyseal endplates. Slowing of blood flow in vascular loops at the metaphysis encourages the deposition of microbes and the establishment of infection. To contain the disease, phagocytes release enzymes that lyse bone, creating an inflammatory response. This inflammatory response forms pus (a protein-rich exudate containing dead phagocytes, tissue debris, and microorganisms) and causes increased intramedullary pressure. The inflammatory exudate can rupture through the cortex to the periosteum if left unchecked. Disruption of the periosteum impairs the periosteal blood supply leading to bone ischemia then necrosis. Separated pieces of necrotic bone are called sequestra, which occasionally contain pus. New bone formation over the injured periosteum is called involucrum, and it may partially surround a sequestrum. Discharge from a sequestrum can lead to sinus tract formation.

The main histopathological finding in acute osteomyelitis are microorganisms, congested or thrombosed blood vessels, and infiltrates of neutrophils. On the other hand, the hallmark histopathological finding in chronic osteomyelitis is necrotic bone. Other features of chronic osteomyelitis include a predominance of mononuclear cells, replacement of osteoclast resorbed bone by granulation, and fibrous tissue leading to bone loss and the formation of sinus tracts, which is pathognomic.

Native vertebral osteomyelitis (NVO) is usually a hematogenous infection affecting two adjacent vertebral endplates. This presentation is explained by the blood supply of the vertebrae as segmental arteries typically bifurcate to supply two adjacent endplates of contiguous vertebrae. Venous drainage from Batson's plexus may explain spondylodiscitis metastasizing from a urinary tract focus, especially in senior men.

The categorization of osteomyelitis as acute or chronic is based on the histopathological findings rather than the duration of illness. Acute osteomyelitis refers to infection occurring before the development of sequestra and usually takes place within two weeks of disease onset. However, the development of sequestra may be slow in some settings, such as vertebral osteomyelitis, and rapid in others as when associated with prosthetic devices or open fractures. Following the development of necrotic bone and the formation of sequestra, the infection is considered chronic.

There are two major classification schemes for osteomyelitis. The first is by Lew and Waldvogel, while the other is by Cierny and Mader. Lew and Waldvogel classified osteomyelitis based on the duration of illness as acute or chronic and by the mechanism of infection (either hematogenous or contiguous infection). Contiguous infection is further classified based on the presence or absence of associated vascular insufficiency.

The Cierny and Mader scheme provides guidance in patient management. In this scheme, the classification of osteomyelitis is by anatomic stage and the host health status.

The categories and corresponding anatomic types are:

- Stage 1: Disease confined to the medullary of the bone
- Stage 2: Superficial disease
- Stage 3: Localized spread
- Stage 4: Diffuse disease

The local and systemic factors which define host health status are:

- A: Normal host
- Bs: Host with systemic compromising factors
- Bl: Host with local compromising factors
- Bsl: Host with both local and systemic compromising factors
- C: Host for whom treatment of the osteomyelitis is worse than the disease itself.

Causes of systemic host compromise are malnutrition, renal and hepatic failure, diabetes mellitus, chronic hypoxia, neoplasm, and immunodeficiency disease. Local compromising factors of the host health status are chronic lymphedema, venous stasis, major and small vessel disease, arteritis, peripheral neuropathy, and tobacco use.

The clinical presentation of osteomyelitis depends on the etiology. Sometimes diagnosis in adults can be tricky, and it requires a high index of suspicion. A good history and physical is always the right place to start and are essential parts of the initial evaluation. Some patients are at high risk for osteomyelitis, and these include those with bacteremia, endocarditis, intravenous drug use, trauma, and open fractures. Also, patients with chronic poorly healing wounds in the setting of diabetes mellitus, peripheral vascular disease, peripheral neuropathy, or orthopedic hardware are at increased risk. Acute osteomyelitis may present gradually with onset over a few days but usually manifests within two weeks. Patients may have local symptoms such as erythema, swelling, and warmth at the site of infection. There may be a dull pain with or without motion and sometimes constitutional symptoms such as fever or chills. In subacute presentations, some patients may have generalized malaise, mild pain over several weeks with minimal fever, or other constitutional symptoms. Acute osteomyelitis may also present as septic arthritis, especially if the metaphyses of the bone is within the infected joint capsule. Septic arthritis of the elbow, shoulder and hip joints may complicate osteomyelitis of the proximal radius, humerus, and femur, respectively. New or worsening neck or back pain in a patient with fever, elevated inflammatory markers (CRP, erythrocyte sedimentation rate [ESR]), bacteremia, or endocarditis should raise the suspicion for native vertebral osteomyelitis (NVO).

In chronic osteomyelitis, symptoms may occur over a longer duration of time, usually more than two weeks. As with acute osteomyelitis, patients may also present with swelling, pain, and erythema at the site of infection, but constitutional symptoms like fever are less common. Patients who have deep or extensive ulcers that do not heal after several weeks of appropriate therapy, especially in people with diabetes or debilitated patients, should raise the suspicion for osteomyelitis. Physical examination should focus primarily on finding a possible nidus of infection, assessing sensory function, and peripheral vasculature. Tenderness to palpation over vertebral bone may be a significant finding in vertebral osteomyelitis. The ability to probe an ulcer to the bone with a blunt sterile instrument is highly suggestive of osteomyelitis. The probe to bone test is a screening tool in conjunction with the patient's pretest probability for osteomyelitis to determine whether additional diagnostic tests such as radiographic imaging or bone biopsy are required for therapeutic decisions.

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