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Understanding Chronic Osteomyelitis: Causes, Diagnosis, and Challenges

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Abstract: ***Osteomyelitis is an important cause of morbidity and mortality in children and adults. Imaging plays a crucial role in establishing a timely diagnosis and guiding early management, with the aim of reducing long - term complications. Recognition of the imaging features of osteomyelitis requires a good understanding of its pathogenesis. In this review, the key imaging findings in osteomyelitis are correlated with the underlying pathological processes. There is a particular emphasis on magnetic resonance imaging (MRI), which is the best available imaging modality owing to its high sensitivity for detecting early osteomyelitis, excellent anatomical detail and superior soft tissue resolution. However, other modalities such as nuclear medicine and computed tomography (CT) are also useful in many clinical contexts, and will also be described in this review.***

Keywords: Musculoskeletal, infection, radiology, magnetic resonance imaging (MRI)

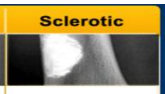
1. Introduction

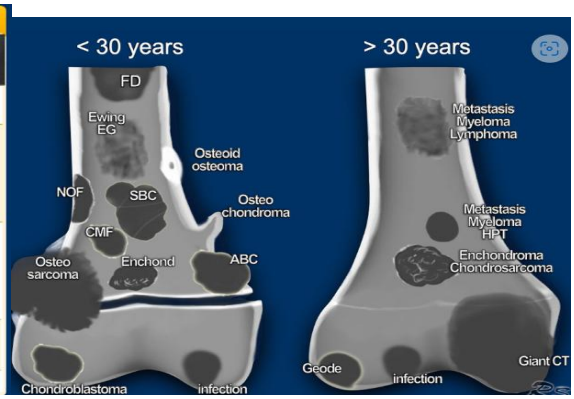
Osteomyelitis is inflammation of the bone marrow secondary to infection, which can progress to osteonecrosis, bone destruction and septic arthritis. It is an important cause of permanent disability in both children and adults worldwide. Osteomyelitis has a bimodal age distribution with peak incidences in children under 5 and adults over 50 years of age. Two epidemiological studies conducted in the United States within the last decade have demonstrated an increase in the incidence and severity of acute osteomyelitis in children, linked to the increasing prevalence of methicillin - resistant Staphylococcus Aureus (MRSA).

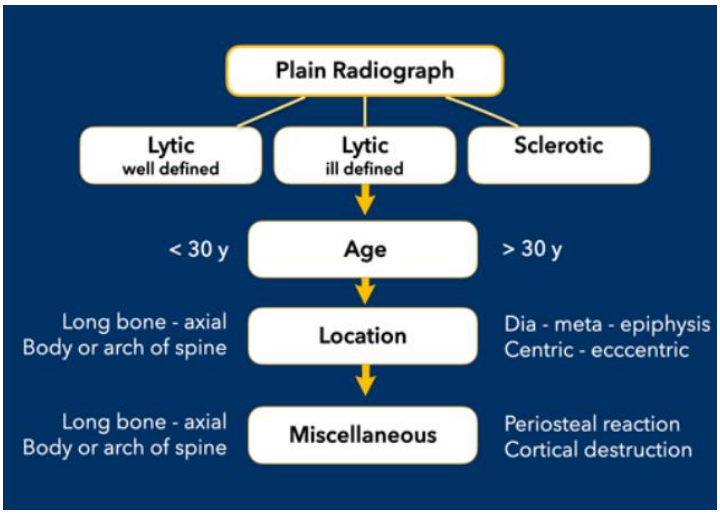
The typical clinical presentation of osteomyelitis with pain, erythema and oedema of the affected part is non - specific and can be caused by a multitude of other diseases. Poor feeding and irritability may be the only symptoms present in infants. Serum inflammatory markers may be normal, especially in neonates and patients with chronic osteomyelitis (6). For these reasons, imaging plays an integral role in establishing the diagnosis of osteomyelitis and characterising the extent of disease spread. The importance of imaging goes beyond making the initial diagnosis as radiologists are able to perform image - guided abscess aspirations and bone biopsies to direct further management, and follow - up scans are often required during the course of treatment to ensure resolution of infection.

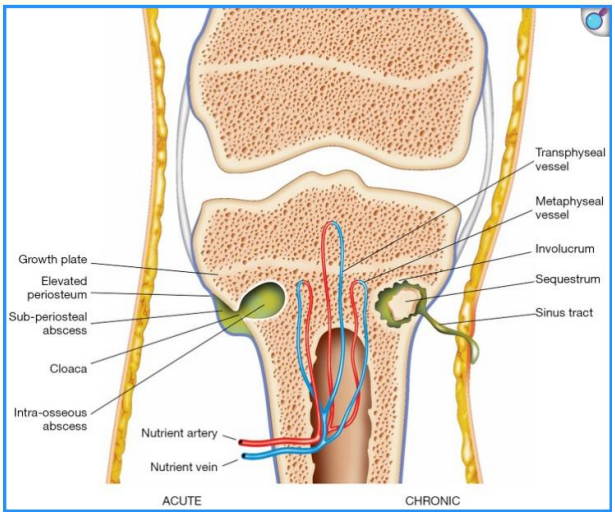
2. Osteomylitis: Anatomy

ANATOMY:

Age	Well-defined	ill-defined	Sclerotic
			
0-10	EG SBC	EG -Ewing Osteosarcoma Leukemia	Osteosarcoma
10-20	NOF Osteoblastoma Fibrous dysplasia EG SBC ABC Chondroblasoma CMF	Ewing Eosinphilic Gran Osteosarcoma	Osteosarcoma Fibrous dysplasia Eosinphilic Gran Osteoid osteoma Osteoblastoma
20-40	Giant CT Enchondroma Chondrosarcoma (low grade) HPT - Brown tumor Osteoblastoma	Giant CT	Enchondroma Osteoma Bone island Paroseteal Osteosarc Healed lesions: · NOF, EG · SBC, ABC · Chondroblastoma
40	Metastases Myeloma Geode	Metastases Myeloma Chondrosarcoma (high grade)	Metastases Bone island
All ages	Infection	Infection	Infection







Pathogenesis

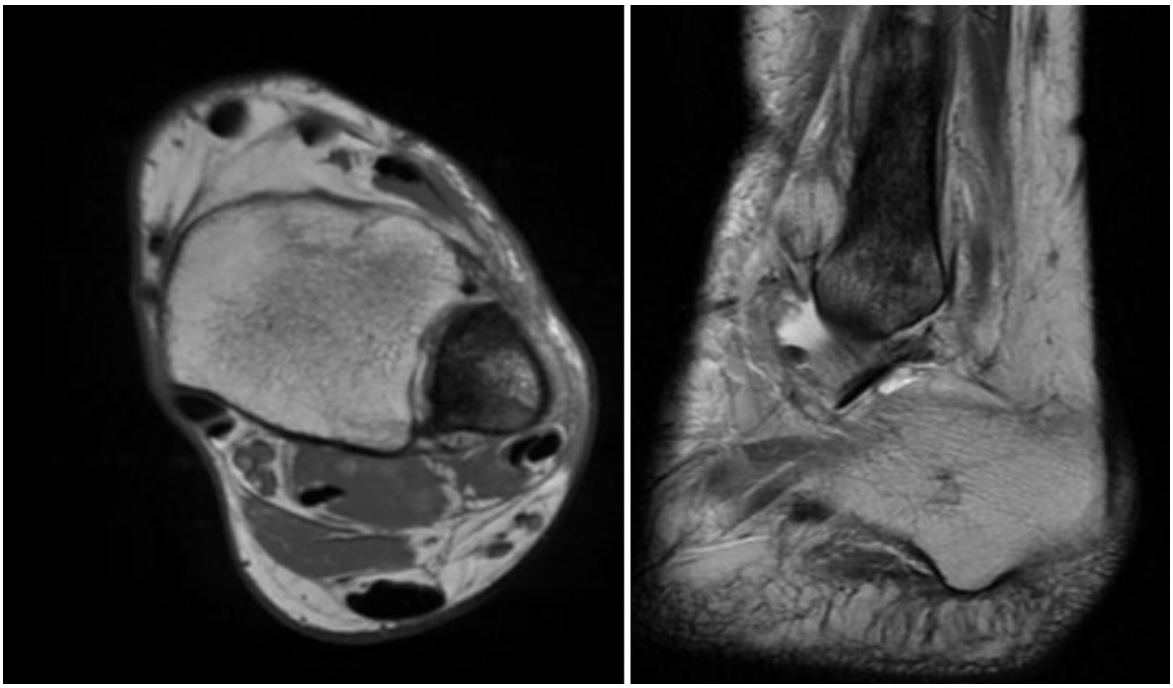
The pathogenesis of osteomyelitis. Metaphyseal vessels contain slow - flowing blood, predisposing to bacterial proliferation. Hence, the metaphysis is a common site for haematogenous osteomyelitis. The growth plate forms a barrier between the metaphyseal and epiphyseal vessels in children over 18 months of age. However, in infants under 18 months and in adults, transphyseal vessels are present which provide a route for infection to communicate between the metaphysis and epiphysis. In acute osteomyelitis, a collection of pus becomes surrounded by granulation tissue and reactive bone, forming an intraosseous abscess. Raised intramedullary pressure secondary to accumulation of pus leads to rupture of the cortex, creating a defect known as a cloaca, which drains pus from the bone to the surrounding tissues. This can cause a subperiosteal abscess with elevation of the periosteum, as well as soft tissue abscesses. In chronic osteomyelitis, disruption of the intraosseous and periosteal blood supply leads to formation of a necrotic bone fragment, known as a sequestrum, which is surrounded by pus and granulation tissue. A reactive shell of new bone forms around the sequestrum and is known as an involucrum. A sinus tract, which drains pus from bone to the skin surface, may be present in both acute and chronic osteomyelitis.

3. Case Report:

A 32 year old female presented to Orthopedic OPD with complains of pain and swelling around left ankle since 3 days associated with difficulty walking.
No H/O trauma.
On examination: CNS study was unremarkable.
CVS study was unremarkable
RS study was unremarkable
PA: soft and non tender

MRI LEFT ANKLE with CT CUT was performed.

MR LEFT ANKLE (PLAIN + CONTRAST):



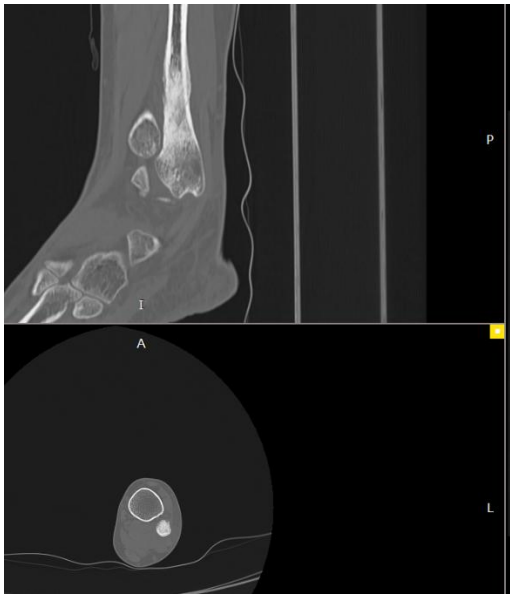


Figure 1: Axial T1w

Figure 2: SAG T2W

CT Cut Images

4. Report

An area of abnormal intra medullary altered signal intensity is noted involving the visualized distal diaphysis and meta - diaphysis of the fibula. It measures approximately 4.9 x 1.4 x 1.5 cm (CC x TR x AP). It appears hypointense on T1W images and T2W images with mild heterogeneous hyperintensity on PDFS images - - - - suggestive of sclerosis with adjacent edema.

An area of abnormal signal intensity which appears T2W and PDFS hyperintense and shows restriction diffusion on Diffusion weighted images with associated subtle drop on ADC map, is seen extending into the periosteal region, measuring approximately 2.3 x 1.3 x 0.3 cm (AP x TR x CC), suggestive of a suspicious area of abscess. No extension to the skin surface or sinus tract formation is noted.
There is adjacent thick periosteal reaction seen. Few areas of cortical breach are seen involving the antero - medial cortex, largest measuring 2.5 mm in the region of the visualized distal diaphysis which shows focal areas of irregular cortical margins with periosteal elevation (As confirmed on CT - cuts). Diffuse cortical thickening with adjacent T1W hypointensity is seen within the visualized medullary cavity, suggestive of sclerosis.

Minimal ankle joint and subtalar joint effusion is seen.

T2W and STIR hyperintensities are seen in the adjacent soft tissues including muscles and subcutaneous plane, predominantly involving lateral malleolus s/o edema.

There is thickening seen of the anterior and posterior tibio - talar ligament.

5. Treatment

The treatment of **chronic osteomyelitis**—a persistent or recurring bone infection—typically requires a **multimodal approach** involving both medical and surgical interventions. Here's a structured outline of the standard treatment:

1) Antibiotic Therapy

a) **Long - term antibiotics** (usually 4–6 weeks or more) are essential.
b) **Empirical therapy** may start broad - spectrum, then tailored based on:
- Bone biopsy cultures (gold standard)
- Sensitivity testing

c) **Common antibiotics** (depending on the organism): vancomycin, ceftriaxone, ciprofloxacin, rifampin (for biofilms), etc.
d) **IV antibiotics** are often used initially, sometimes followed by oral options.

2) Surgical Management

a) **Debridement**: Removal of necrotic bone and infected tissue.
b) **Sequestrectomy**: Removal of dead bone (sequestrum).
c) **Drainage**: Abscesses or sinus tracts must be drained.
d) **Stabilization**: May involve orthopedic hardware if the bone is unstable.
e) **Reconstruction**: May require bone grafts or flaps after infection control.

3) Local Antibiotic Delivery

Antibiotic beads or spacers (e. g., gentamicin - impregnated cement) are sometimes used during surgery for local high - dose antibiotic delivery.

4) Management of Comorbidities

Control of diabetes, peripheral vascular disease, or immunosuppression is critical for healing and infection control.

5) Chronic Suppressive Therapy

In select cases where eradication isn't possible (e. g., non - operable patients), **long - term suppressive oral antibiotics** may be used.

6) Monitoring and Follow - up

a) Clinical signs: pain, drainage, fever.
b) Labs: ESR, CRP, WBC count.
c) Imaging: serial X - rays, MRI, or CT for monitoring response.

6. Conclusion

The consensus statements are intended to improve and standardize the care and management of patients with suspected chronic osteomyelitis by helping providers determine when to perform a percutaneous image - guided biopsy. These statements represent the collective opinions and perspectives of experts in radiology, infectious diseases, vascular surgery, and orthopedic surgery, who collaborate to care for this patient population. Imaging with radiography and MRI, when feasible, is the first step in the workup of patients with suspected chronic osteomyelitis, except in the setting of a necrotic and extensive decubitus ulcer, for which surgical debridement and intraoperative cultures are recommended. Negative MRI results can rule out osteomyelitis, and positive MRI results help determine how to proceed with management. Cultures from sinus tracts may offer a noninvasive alternative to percutaneous image - guided bone biopsies. If a biopsy is required, then it is recommended that antibiotics be avoided or discontinued for an optimal period of 2 weeks. In the case of septic arthritis, joint aspirations are usually adequate unless negative, in which case a percutaneous image - guided biopsy may be necessary. Finally, it is crucial to note that research was limited to some topics. Thus, some statements were generated using suboptimal evidence and should be considered in the context of the entire clinical scenario. Additionally, adherence to the recommendations presented will not always ensure an accurate diagnosis or a successful outcome for every patient, and providers should follow a reasonable course of action based on the most up - to - date evidence, available resources, and the responsibility to deliver safe and effective medical care. The panel strongly encourages additional high - quality research that further sheds light on the best practices for treating patients with suspected chronic osteomyelitis.

7. Discussion

Chronic osteomyelitis is a persistent and challenging infection of the bone that often arises from untreated or inadequately treated acute infections, open fractures, or surgical complications. It is characterized by long - standing inflammation, necrotic bone (sequestrum), and recurrent flare - ups. Management requires a combination of prolonged antibiotic therapy, surgical debridement, and close monitoring to prevent recurrence. Early diagnosis and a multidisciplinary approach are essential for improving outcomes and minimizing complications such as bone deformity or systemic infection.

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