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# PEDIATERIC OSTEOMYELITS: ROLE OF MRI

Radiodiagnosis

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## ABSTRACT

Osteomyelitis is an infection of the bone, bone marrow and surrounding soft tissue. Pediatric osteomyelitis can be a challenging problem to both the clinician and the radiologist as the clinical presentation can be variable in severity, and laboratory results are relatively unsupportive in the diagnostic workup. Radiology plays an important role in its diagnosis and can also be helpful to guide treatment and intervention.

## KEYWORDS

Pediatric Osteomyelitis, Mri.

**INTRODUCTION:**
Osteomyelitis is an infection of the bone and bone marrow. Estimated incidence of pediatric osteomyelitis vary, but pediatric osteomyelitis is generally considered rare, with one group of investigators reporting an incidence of 6.0 per 1000 admissions in a children's hospital (1). Because of its rarity and several other unique features of pediatric osteomyelitis, imaging this infection can be challenging.

Plain radiograph is always an initial investigation; but it is often negative in early disease. MRI has been found useful in the diagnosis of clinically suspected osteomyelitis in both adults and children [2–12]. It has become a primary advanced imaging technique for the diagnosis of osteomyelitis after initial radiographs have been obtained. MRI has the advantages of excellent tissue characterization and high resolution, depicting the presence of both osteomyelitis and its complications, which include soft-tissue and bone abscesses, physeal involvement, and septic arthritis [5, 13]. This added information can alter clinical management, such as determining the need for percutaneous or surgical drainage in addition to antibiotic therapy [13].

**OBJECTIVE:** This article discusses the pathophysiology of childhood osteomyelitis, imaging protocol and significance of each sequence, and imaging findings of childhood osteomyelitis.

**REVIEW OF LITERATURE:**
**1.Pathophysiology:**
Osteomyelitis is defined as an infection of the bone. In childhood the most common route of infection is haematogenous spread of a microorganism. Secondary spread by contiguity and direct spread of infection [11, 14].

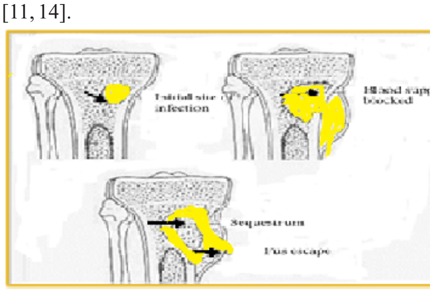
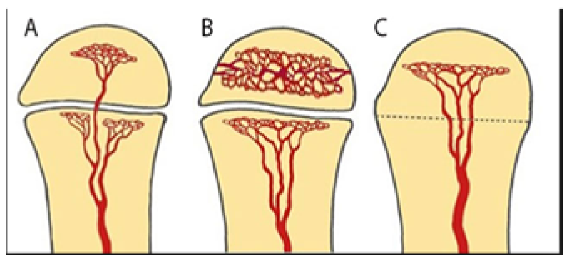


**Image 1**
In growing bone the diaphysis and metaphysis share the same nutrient arteries and veins. These arteries and veins form a fine network of arterioles and venules in the metaphysis, which leads to the formation of so-called sinusoidal lakes. In contrast to the adult situation, in young children the epiphysis has its own nutrient vessels. After 12 to 18 months of age, these transphysial vessels disappear. As a result, the physis acts as a natural border and prevents the spread of osteomyelitis from the metaphysis to the epiphysis. Spread to the epiphysis and joints is less common. Neonates are more prone to osteomyelitis. Because of a less developed immune system, osteomyelitis can be caused by less virulent agents and tends to present fewer clinical signs. The combination of unclear symptoms in neonates and the presence of transphysial vessels can lead to indolent infections that are often discovered at a late stage [11, 15].




A - In children, capillaries of metaphysis turn sharply without penetrating growth plate.
B - In infants, some metaphyseal vessels penetrate growth plate, ramifying the epiphysis.
C - In adults, with closure of growth plate a vascular loop between meta and epiphysis is seen.

**Image 2**
The reported annual incidence of childhood osteomyelitis is 3 to 20 per 100,000. The incidence is higher in children below 3 years of age, with a peak incidence in children below 1 year of age. Acute osteomyelitis occurs more often in boys, with a reported male-female ratio of 1.9 to 1.0 [14, 11, 16–18].

The most common site of infection is the long bones, especially the femur and tibia. Most infections are mono-ostotic, but polyostotic involvement of up to 6.8 % is reported in infants, and even 22 % in neonates [17].

The most common organism causing acute haematogenic osteomyelitis is Staphylococcus aureus (up to 95 %), followed by β-haemolytic Streptococcus, Streptococcus pneumoniae, Escheria coli and Pseudomonas aeruginosa. Paediatric tuberculous osteomyelitis is uncommon as compared to skeletal tuberculosis, which mainly affects spine and joints. Tubercular osteomyelitis may show soft tissue swelling, minimal periosteal reaction, osteolysis with little or no reactive change, periarticular osteoporosis, and erosions. Sclerosis is less frequently seen. Sequestration in tuberculous osteomyelitis is relatively uncommon and less extensive than with pyogenic osteomyelitis. The spread of infection across the epiphyseal plate, less likely in pyogenic osteomyelitis.

**2. Risk factors:**
Risk factors for osteomyelitis include trauma, sickle cell disease, immunodeficiency, sepsis and minor trauma in combination with bacteremia, an indwelling vascular catheter and chronic vascular lines [15, 17].

**3. Clinical presentation:**

Clinical presentation can be diverse and therefore confusing. Usually pain and reluctance to move limbs are present. Also fever, swelling and tenderness can be present. Acute osteomyelitis is defined as the presence of complaints for fewer than 14 days, whereas the sub-acute form persists longer than 14 days.

**4. Complication:**

Complications of osteomyelitis can be the development of an abscess, development of sequesters, fistulas and sinus tract lesions. Other complications are septic arthritis, slipped epiphysis, damage of the physis causing early closing of the physis and eventually leading to growth retardation, or angulation deformation in the long bones.

**5. Imaging**

Initial investigation for pediatric osteomyelitis is plain radiograph. From 10-21 days, an osseous lesion becomes visible on conventional radiography. CT can be better in appreciation of sequestrum, cortical breach, periosteal reaction and air. Also it provides better guidance for biopsy. MRI is modality of choice. MRI has the advantages of excellent tissue characterization and high resolution, depicting the presence of both osteomyelitis and its complications, which include soft-tissue and bone abscesses, Physeal involvement, and septic arthritis.

**Table:1**

| SEQUENCE | SIGNIFICANCE |
|---|---|
| T1 SE / FSE | Anatomy, bone marrow, fat content, haemorrhage, calcifications, fracture, tumour margins. |
| T2 FSE with FS / STIR | Sensitive for edema, bone marrow, effusion and soft tissue edema. |
| PD SE/FSE (FS) | Anatomy as well as edema. |
| Contrast-enhanced T1 FS | FS technique in combination with gadolinium-to see the enhancement. |
| Gradient Echo FS | Excellent for cartilage, with 3D T1 or T2* being the best sequence for blood products. |

Confirmation of diagnosis is biopsy with pathological correlation.

**Differential diagnosis:**

1. **Ewing sarcoma**-onion peel type of periosteal reaction and main involvement of diaphysis is characteristic. Osteomyelitis abscesses demonstrate peripheral rim enhancement whereas tumors usually enhance heterogeneously.
2. **Neuropathic joint**-Neuropathic arthropathy usually affects multiple bones in a periarticular distribution, whereas osteomyelitis affects single bones in weight-bearing areas. Marrow edema adjacent to soft tissue inflammation is also typical of osteomyelitis.
3. **Osteoid osteoma**—an osteoid osteoma is a benign tumor appears as an oval lytic lesion with a dense sclerotic center. It may appear like a sequestrum; however Osteoid osteomas are usually round whereas sequestra are irregularly shaped. On post-contrast, osteoid osteomas will enhance avidly where as sequestra do not enhance. Osteoid osteomas are not associated with bone destruction or inflammatory changes in soft tissue.
4. **Stress injuries**—bones which undergo repetitive stress can show marrow edema with periosteal reaction, same as osteomyelitis. But; unlike osteomyelitis, the signal abnormality is confined to bone in stress injuries with no surrounding soft tissue inflammation.

**MATERIAL AND METHOD:**

The following observational study was conducted during a period of two years (August 2015-August 2017). All patients of age group of 0-18 years old; presenting in the pediatrics and orthopedic outpatient and inpatient Department with complaints and clinical findings and plain x ray were pointing towards bone pathology are referred to Department of Radiology for evaluation by MRI.

**Inclusion criteria-**

1. An age range of 0–18 years.
2. Studies ordered for suspicion of osteomyelitis with or without h/o trauma.
3. Consent for the study.
4. Normal s. creatinine level (for contrast study)

**Exclusion criteria-**

1. Patient in which any surgical intervention has been done.
2. Patients with other comorbidity as hematological abnormality (sickle cell anemia or thalassemia), malignancy, congenital skeleton abnormality.
3. Any C/I for MRI.

**IMAGING PROTOCOL**

1. T1 SE / FSE
2. T2 TSE
3. STIR or T2 FSE
4. PD SE/FSE (FS)
5. Contrast-enhanced T1 FS
6. Gradient Echo FS

**IMAGE ANALYSIS**

Diagnostic criteria's of osteomyelitis & its complications were centered on those described in the literature [1, 2, 4, 5, 12, 15].

*Osteomyelitis* is considered by reduced marrow signal intensity on T1-weighted imaging and increased marrow signal intensity FS T2-weighted and STIR images. In contrast study, osteomyelitis was described as abnormal bone marrow enhancement on fat-suppressed T1-weighted images.

*Intraosseous, subperiosteal, and soft-tissue abscesses* **(figure 1)** were defined as well-circumscribed areas of focally increase signal intensity on T2 & STIR weighted images with reduced signal in T1 sequences and peripheral enhancement post contrast images.

*Septic arthritis* was described as joint effusion with synovial thickening.

*Physeal involvement* **(figure 3)** was characterized as increased signal intensity or widening of the growth plate on T2/ STIR and enhancement on contrast-enhanced images.

**RESULTS:**

**1.Age group:**

**Table 2**

| Age | No. Of patient |
|---|---|
| <1 Yrs. | 03 |
| 1-5 Yrs. | 09 |
| 6 to 18 Yrs. | 25 |

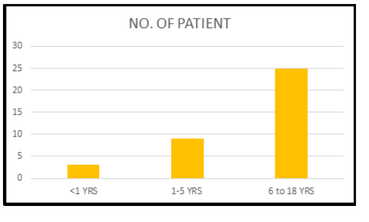



**Image 3'**

**2. Gender:**

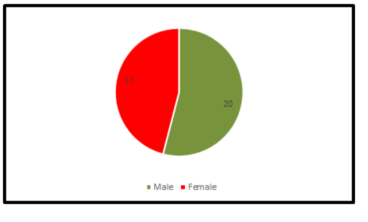



**Image 4**

**3. Prior h/o trauma:**

**Table 3**

| History of trauma | Yes | No |
|---|---|---|
| | 8 | 29 |

**4. Periosteal thickening:**

**Table 4**

| Periosteal thickening | Present | Absent |
|---|---|---|
| | 35 | 2 |

**5. Complications:**

(a.) Intraosseous/ subperiosteal/ soft tissue abscess (figure 1):

**Table 5**

| Intraosseous/ subperiosteal/ soft tissue abscess: | Present | Absent |
|---|---|---|
| | 11 | 26 |

(b.) Septic arthritis (figure 3):

**Table 6**

| | Present | Absent |
|---|---|---|
| | 6 | 31 |

Epiphysis involvement (figure 3):

**Table 7**

| | Present | Absent |
|---|---|---|
| | 10 | 27 |

(d.) Sinus tract formation (figure 2):

**Table 8**

| Sinus tract | Present | Absent |
|---|---|---|
| | 8 | 29 |

## DISCUSSION:

### Age group:

In our study; range of patients age was 37 with number of patients with age group of <1years was 3; 1-5 years was 9 and >5 years was 25.

This result is in agreement with that reported by *Zaoutis et al (17),* who studied children aged 2 months to 17 years and found an incidence of 42% and 58% for the same age groups.

### Sex distribution:

In our study, male to female ratio 1.17: 1. We did not found any significant difference in incidence of pediatric osteomyelitis. Another study done by *Riise et al (16)* also did not find any difference between sexes in the incidence of osteomyelitis, most studies (1,13-15) effectively demonstrated a predominance of male sex.

### Past h/o Trauma

In our study 10 out 37 (approx.27%) had past h/o trauma followed with onset of trauma.

The role of trauma is important, as highlighted by the fact that one-third of children with osteomyelitis have a history of a recent injury (19).

### Acute v/s chronic osteomyelitis

Out of 37 patients; 26 had imaging features of acute osteomyelitis, rest 11had features of chronic osteomyelitis with associated complication.

Out of 37; in 10 patients epiphysis was involved. Among those 10 patients 3 patients were below 1year age and 6 were between 2 to 18 years.

Involvement of epiphysis in children more than 1 year could be due to poor immune status of patient or separate involvement of epiphysis.

### Summary:

The total number of patients included in our study were 37. These patients were referred for evaluation.

1. These patients were in the age group of 1 to 18 years, of which 54% were males and were 45% females.
2. The main presenting chief complaint in our study group was pain in involved limb; approximately 1/3 of patients were having prior history of trauma.
3. Out of 37; 26 patients were having imaging features of acute osteomyelitis rest 11 patients had associated complication.
4. Out of 37; in 10 patients epiphysis was involved. Among those 10 patients 3 patients were below 1year age and 6 were between 2 to 18 years.
5. Involvement of epiphysis in children more than 1 year could be due to poor immune status of patient or separate involvement of epiphysis.
6. Although biopsy or culture specimens are still needed to yield the definitive diagnosis for etiology (pyogenic v/s tuberculosis), however involvement of epiphysis with adjacent joint, minimal to no periosteal reaction and no sequestrum and cloaca formation go in favour of tuberculous osteomyelitis in clinically suspected cases.

## CONCLUSION

Osteomyelitis in childhood can be a challenging diagnosis. Delay in diagnosis can lead to growth and developmental disturbances of the affected bone, including malformations of the joints. Although biopsy or culture specimens are still needed to yield the definitive diagnosis, it is important for radiologists and clinicians alike to understand the spectrum of imaging features of paediatric osteomyelitis to aid in making an early diagnosis with reasonable confidence.

**FIGURE 1**

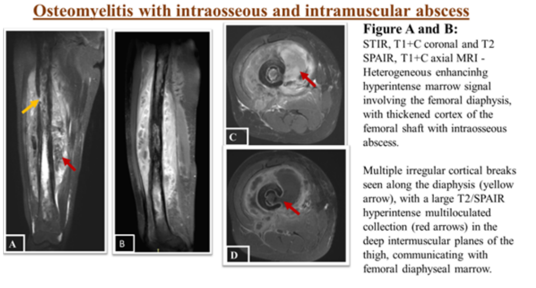



**FIGURE 2**

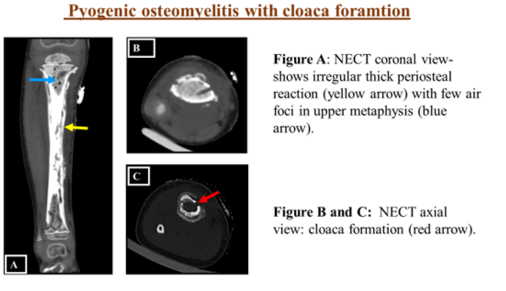
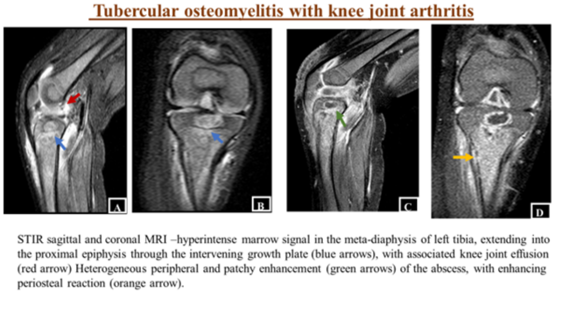



**FIGURE 3**

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