

Periosteal reactions in African children

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Abstract

There is a wide differential for periosteal reactions in the paediatric age group. In addition to the common causes for periosteal reactions seen in first world communities, African children present with dramatic radiological images of various nutritional and infective diseases. Those that are encountered in third world communities include congenital syphilis, nutritional rickets, tuberculosis and scurvy. Diagnosis is aided by grouping periosteal reactions according to various conventional film features. These features include anatomical site of

involvement, whether the periosteal reactions are unifocal or multifocal, and if multifocal, whether they are bilaterally symmetrical or asymmetrical. These features must be considered in conjunction with the patient's age and clinical history. This pictorial review demonstrates a range of these conditions and concentrates on those encountered in the African setting while highlighting their differentiating features.

Introduction

There is a wide differential for periosteal reactions in the paediatric age group. In addition to the common causes of periosteal reactions seen in first world communities, African children present with dramatic radiological images of various nutritional and infective diseases that are endemic in third world communities. This pictorial review demonstrates a variety of these periosteal reactions and lists features to allow differentiation based on the conventional radiography, the age of the child and the clinical history.

Discussion

A periosteal reaction seen on conventional radiographs is the new bone formation occurring in response to a stimulus. It may either be due to a generalised metabolic condition or from local elevation of the periosteum

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From seeing to understanding

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by trauma, infection or neoplastic cells. Since it is a non-specific reaction to various causes, the differential diagnosis is potentially large. Diagnosis is aided by grouping periosteal reactions according to various conventional radiograph features. These features include site of involvement and whether the periosteal reactions are bilaterally symmetrical, asymmetrical or focal. (Tables 1-3). The patient age and clinical history is also useful in narrowing the differential diagnosis down.¹ There are also associated local and distant conventional radiograph features that allow for aetiological differentiation.

Table 1 : Causes for bilaterally symmetrical periosteal reactions

Bilaterally Symmetrical

1. Normal infant
2. Congenital syphilis
3. Rickets
4. Scurvy
5. Acute leukaemia
6. Hypertrophic oosteoarthropathy
7. Juvenile chronic arthritis
8. Caffey's disease
9. Prostaglandin E₁ therapy

Table 2 : Causes for bilaterally asymmetrical periosteal reactions

Bilaterally Asymmetrical

1. Multifocal osteomyelitis
2. Non-accidental injury
3. Metastases (neuroblastoma)
4. Tuberculosis
5. Sickle-cell dactylitis (hand-foot syndrome)
6. Bleeding diatheses (haemophilia)

Table 3 : Causes for focal periosteal reactions

Focal

1. Trauma (including stress fractures)
2. Osteomyelitis
3. Neoplasm (Ewing's sarcoma, osteosarcoma, eosinophilic granuloma, osteoid osteoma)

Bilaterally symmetrical periosteal reactions: Table 1 lists the causes for bilaterally symmetrical periosteal reactions. A single lamellar diaphyseal periosteal reaction may occasionally be seen in *normal infants* with no pathological cause attributable.¹ In *congenital syphilis* (Figures 1 and 2), the metaphyseal lucent band is the commonest reported finding. The epiphysis is generally spared. Up to 95% of infants with congenital syphilis have bone changes. These are often not seen at birth but increase in inci-



Figure 1: Congenital syphilis. Bilaterally symmetrical periosteal reactions and Wimberger's 'rat bite' sign (arrowheads) on medial proximal tibial metaphysis are demonstrated.

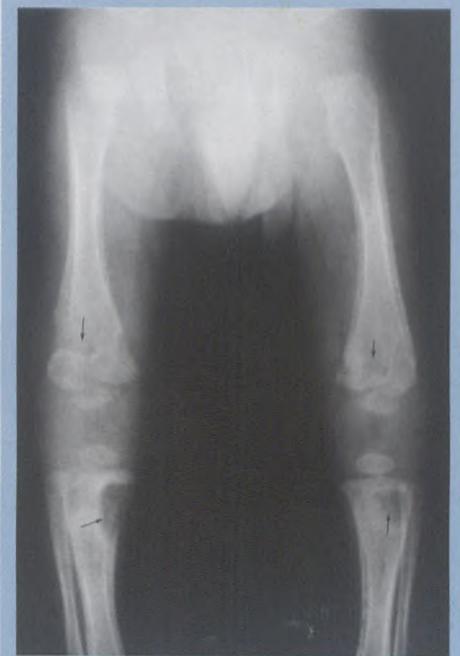


Figure 2: Congenital syphilis. More severe changes with lucent osteolytic lesions (arrow) of the diaphysis are demonstrated.

dence after the neonatal period. The bone changes usually resolve by nine months of age.¹⁻³

Rickets (Figures 3 and 4) in southern Africa is most commonly due to vitamin D deficiency and is usually only seen beyond four months of age when maternally derived stores have been depleted. It affects multiple sites (including skull and chest) but is most evident at sites of rapid bone growth i.e. wrists and knees.^{1,4} *Scurvy* (Figures 7 and 8) rarely occurs prior to four months of age due to maternally derived stores of vitamin C, but may present after this period with limb pain mimicking osteitis or arthritis in infants fed with unsupplemented cows milk.^{1,5,6}

Acute Leukaemia (Figure 9) is associated with osteopaenia and prominent metaphyseal bone resorption with or without a dense zone of provisional calcification.^{1,7} *Hypertrophic oosteoarthropathy* (Figure 10) in children occurs most commonly with

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Figure 3 : Rickets
Before treatment this patient demonstrates ill-defined/absent epiphysis, a splayed, cupped and frayed metaphysis; a widened growth plate due to uncalcified osteoid; osteopaenia and a bilaterally symmetrical apparent periosteal reaction (arrowheads) due to uncalcified subperiosteal osteoid. After treatment there is better definition of the metaphyseal ends due to calcification of the previously uncalcified osteoid (open arrows).

bronchiectasis following measles or pulmonary tuberculosis. Periosteal reactions in *juvenile chronic arthritis*

after more than a month of therapy. It is very seldom seen as surgical repair is usually undertaken before the bone changes occur.^{1,9}

Bilaterally asymmetrical periosteal reactions: Table 2 lists the causes for a bilaterally asymmetrical periosteal reactions. *Non-accidental injury* (Figure 11) typically manifests as multiple fractures in varying stages of healing which are not accounted for by a plausible history or by underlying causes such as a bone dysplasia or a metabolic disorder. Besides corner and bucket handle fractures

(Figure 14) are commonly in the periarticular regions of the phalanges, metacarpals and metatarsals.¹ *Caffey's disease* (Figure 15) occurs before 5 months of age. It typically involves the mandible, clavicles and ribs. Asymmetric involvement of ribs and long bones may occur.⁸ *Prostaglandin E₁ therapy* for patent ductus arteriosus may lead to periosteal reactions



Figures 5 and 6 : Tuberculous osteitis
Both patients demonstrate aggressive appearing lucent lesions of the tibia (arrowhead) with associated local lamellated and solid periosteal reactions respectively.

through the metaphyses, fractures involving the posterior ribs, scapulae, spine and small bones of the hand and feet are highly specific for NAI. Skull fractures with or without intracranial injuries and visceral injuries are also frequently seen.¹ *Tuberculous osteitis* (Figures 5 and 6) in young children may involve multiple sites including the diaphyses of long bones and the small bones of the hands and feet. The features of cortical breakthrough,

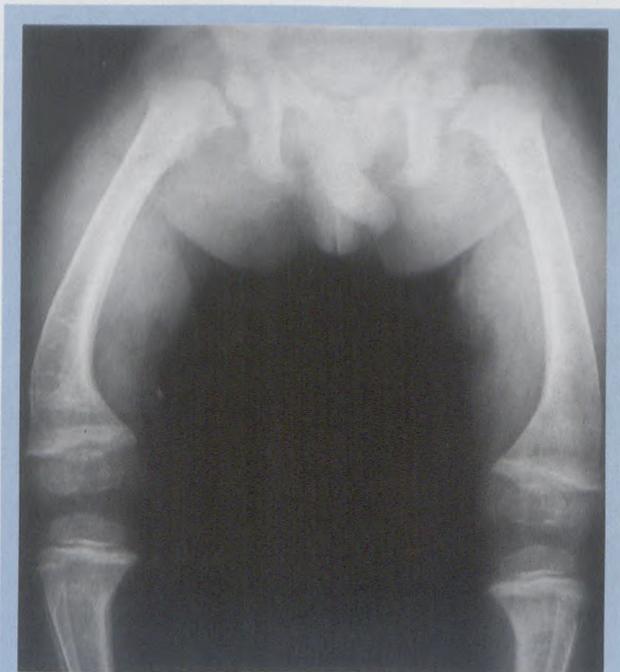
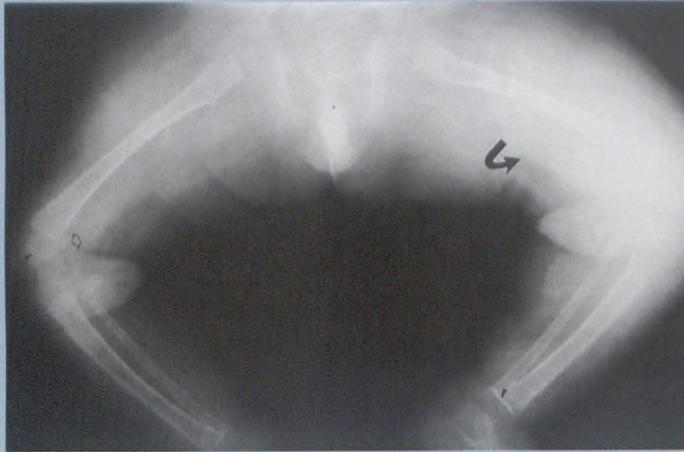
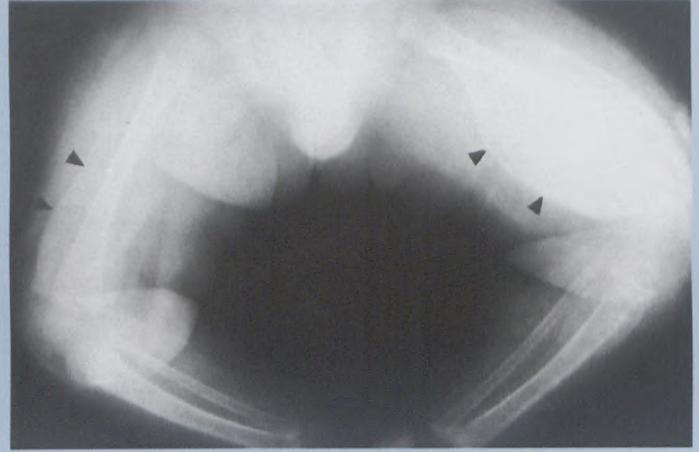


Figure 4 : Rickets
Long-term sequelae with bowing deformities and attempted remodelling of the long bones are seen.

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Figures 7 and 8 : Scurvy
The pre-treatment image demonstrates generalised osteopaenia, the characteristic Wimberger's ring (pencil thin epiphyseal cortex) (small arrow), Frankel's line (dense zone of provisional calcification) (arrowhead) and Pelkan spurs (metaphyseal corner



fractures) (open arrow). The soft tissue mass surrounding the diaphysis represents a subperiosteal haematoma (curved arrow). After treatment the periosteum and haematoma calcify showing its bilaterally symmetrical nature (big arrowheads).

poor zone of transition and lamellated periosteal reaction are indistinguishable from a malignant neoplasm and without a suggestive chest radiograph or positive skin test, biopsy may be the only means of differentiation. Tuberculous bone infection in older children

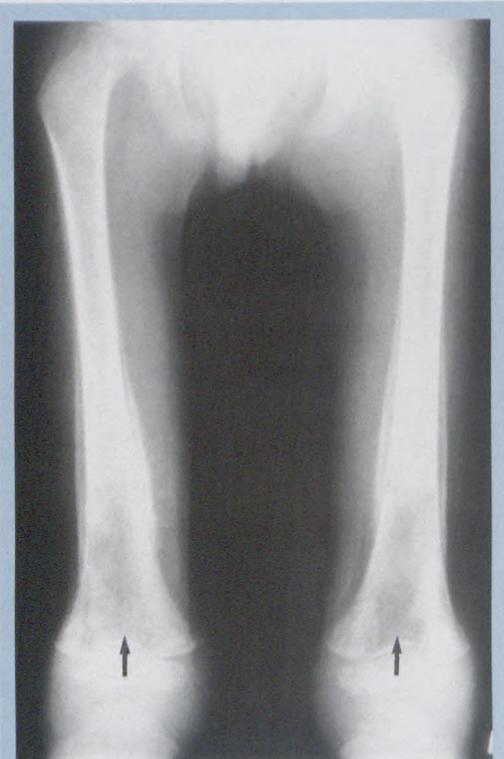


Figure 9 : Leukaemia
The lucent metaphyseal bands (arrows) are characteristic of leukaemic infiltration as are the accompanying periosteal reactions.

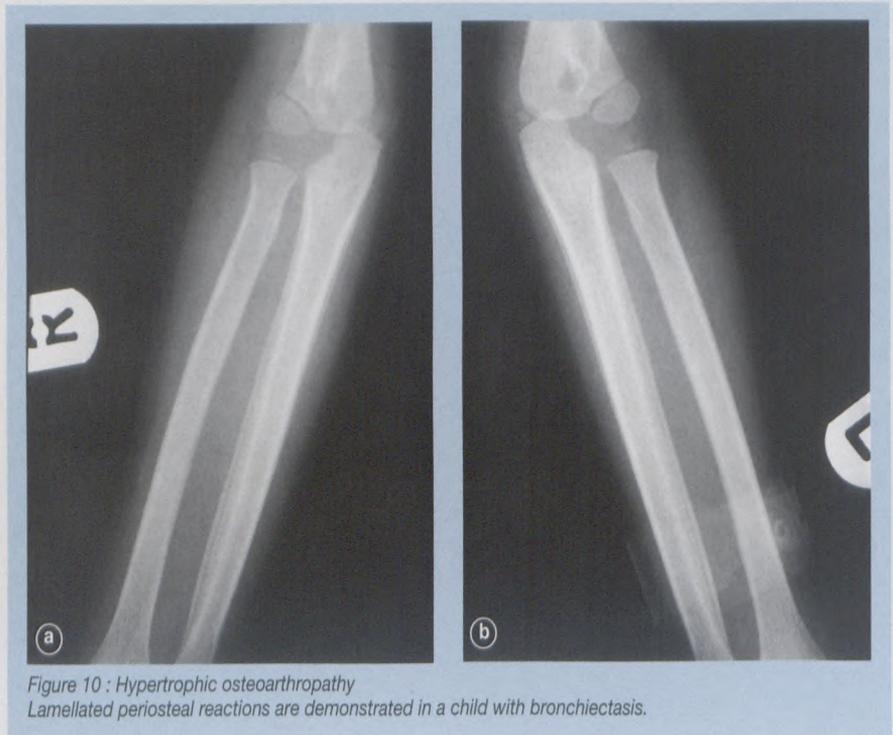


Figure 10 : Hypertrophic osteoarthropathy
Lamellated periosteal reactions are demonstrated in a child with bronchiectasis.

more commonly affects the spine and joints.^{10,11} *Sickle-cell dactylitis* (hand-foot syndrome) occurs in children aged six months to two years of age (Figure 13). Soft tissue swelling with patchy lucency and sclerosis of the metacarpal, metatarsal and phalangeal shafts can be seen. Marrow hyperplasia leads to widening of the skull

diploic space. Sickling leads to vascular infarcts - square-shaped compression infarcts of the vertebral endplates are diagnostic. *Bleeding diatheses* have other features involving the joints and bones which aid in this diagnosis. *Metastases* (Figure 12) may produce periosteal reactions with or without associated bone lesions.¹

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Figure 11 : Non-accidental injury
The combination of multiple fractures in different stages of healing, corner (short arrow) and bucket handle (thin arrow) fractures and multifocal periosteal reactions are highly suggestive of non-accidental injury.

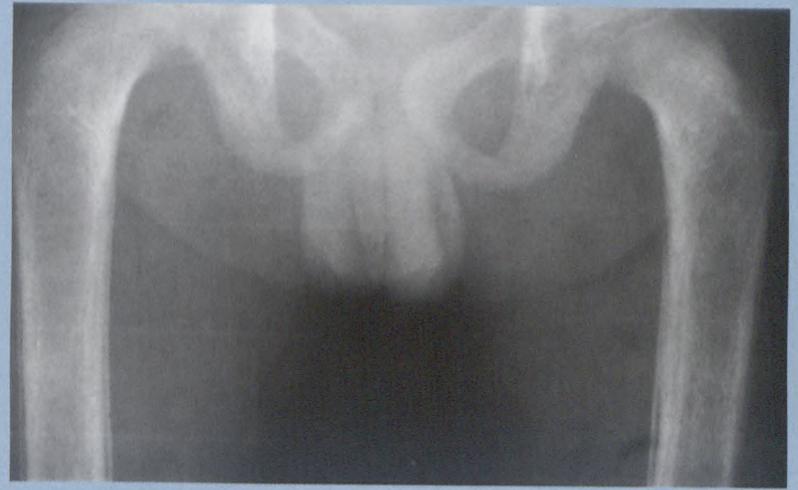


Figure 12 : Neuroblastoma metastases
These may cause periosteal reactions with or without lytic bone lesions.



Figure 13 : Sickle-cell anaemia
Typical changes of sickle cell disease are present in the hands with 'egg-in-cup' epiphysis in metaphyses (thin arrow), widened medullary cavities (open arrows), coarse trabecular and an associated periosteal reaction in the right radius and ulna (arrowheads).

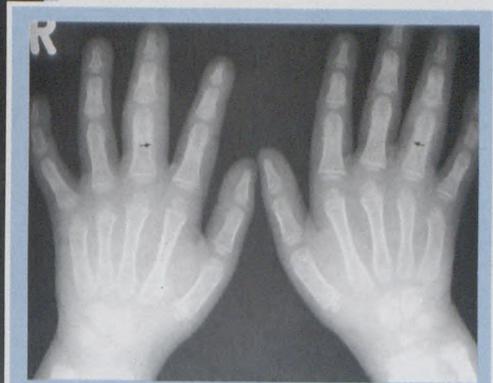


Figure 14 : Juvenile chronic arthritis
Soft tissue swelling and a periosteal reaction are present over the proximal phalanges of right middle and left ring fingers (arrows). There is associated generalized osteopaenia but no periarticular erosions.

Focal periosteal reactions: Table 3 lists the causes for a focal periosteal reaction. In these cases the cause is often an obvious history as in subacute (Figure 16)¹² or acute *trauma* or on assessment of the radiograph as in *primary bone neoplasms* (Figure 18).¹³ The bone changes of *osteomyelitis* (Figure 17) occur late in the disease and the diagnosis is preferably made on technetium bone scan and biopsy.¹⁴

Conclusion

Important differentiating features of periosteal reactions include:

- Age of child
- Associated clinical history

- Whether unifocal or multifocal
- If multifocal, whether bilaterally symmetrical or asymmetrical
- Anatomical and geographic location of periosteal reaction
- Associated specific bone changes

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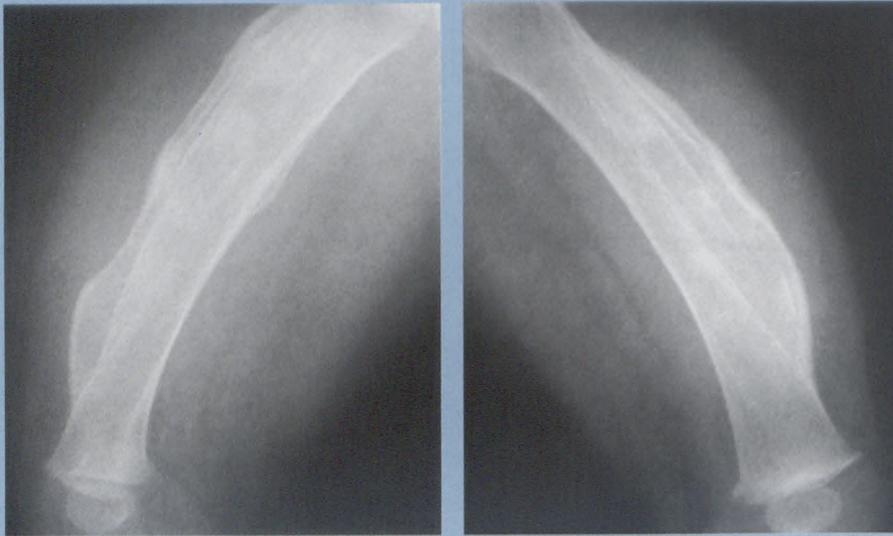


Figure 15 : Caffey's Disease
A florid diaphyseal periosteal reaction with bony bowing deformities, expansion and remodelling of both femurs is seen in a child with Caffey's Disease.



Figure 17 : Pyogenic osteomyelitis
Ill-defined patchy lucencies (arrowheads) of the distal tibial metaphysis and diaphysis with cortical breakthrough (curved arrow) and a periosteal reaction are demonstrated in this case of pyogenic osteomyelitis.

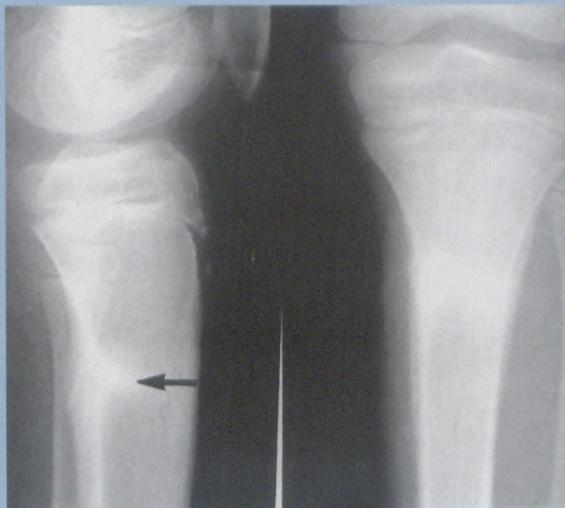


Figure 16 : Trauma
The transverse sclerotic band (arrow) in the proximal tibia represents a healing stress fracture with an associated periosteal reaction.

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Figure 18 : Osteosarcoma
The extensive periosteal reaction is associated with the aggressive malignancy involving the left femur.

Acknowledgements

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