Musculoskeletal infections in children

Infection is one of the primary pathologies encountered in children, and musculoskeletal infection must be considered in any child presenting with a pyrexia of unknown origin.

This article will discuss the most common musculoskeletal infections in children, some of the more common and uncommon clinical presentations, the organisms involved and the optimum imaging techniques used.

**Osteomyelitis**

The term osteomyelitis is derived from the Greek words osteon (meaning bone) myelo (meaning marrow) and itis (meaning inflammation) and literally means inflammation of the bone and marrow.

The most common form of musculoskeletal infection is acute osteomyelitis. This is primarily a disease of young children with 30% cases occurring before two years of age and more than 50% occurring before five years of age. There is a reported incidence of 1:3,1000 in neonatal units and an incidence of 1:5000 in children under 13 years of age. It appears also to be more frequent in males.

Osteomyelitis may occur as a result of haematogenous or contiguous spread from an adjacent soft tissue infection or as a result of direct implantation following trauma.

The organism involved varies according to the age of the patient. Bacterial infection with Staphylococcus aureus is most common in both neonates and young children, but in neonates infection with group B streptococcus and Escherichia coli also occurs. Rarer microorganisms include tuberculosis, and salmonella must be considered in at-risk groups such as immunocompromised patients or patients with underlying pathologies such as sickle cell disease.

Osteomyelitis most commonly affects the lower limb (two-thirds of patients), in particular the hip or knee, and may present with local swelling or tenderness or with pseudoparalysis of the limb. In neonates, the clinical symptoms and signs are more likely to be minimal, but the disease is more likely to be multifocal and extensive.

The more extensive nature of the disease in the younger child is explained by the presence of transphyseal vessels in children under the age of 18 months. These vessels cross the growth plate and allow the spread of infection from the highly vascular metaphysis to the growing epiphysis, leading to epiphyseal damage and joint involvement (figure 1).

Beyond the age of 18 months the vessels no longer cross the physis into the epiphysis, but travel up to the growth plate and then loop back into the metaphysis. As a result, osteomyelitis is predominantly seen at the metaphysis in the growing child and epiphyseal involvement is rare beyond the age of 18 months.

**Imaging osteomyelitis**

All imaging modalities have a role in the diagnosis and management of osteomyelitis.

**X-ray**

In a child presenting to the accident and emergency department with a painful or swollen limb or with pseudoparalysis, the initial investigation of choice is the plain radiograph. Although this has very low sensitivity and specificity for detecting acute osteomyelitis, it has the advantage of excluding other pathologies such as a fracture or tumour.

It is well recognised that the radiographic features of osteomyelitis occur later in the course of the disease and that the initial plain film may be normal, but subtle lucency or periosteal reaction can be seen within the bone as early as seven days. It is worth noting that studies have shown that the plain x-ray is normal in as many as 80% of patients in the first two weeks of the disease (figure 2).

**CT**

It is important to be aware of the use of ionising radiation in children and the need for dose limitation so, in general, the use of CT is confined to those children with a known bony abnormality that requires further assessment prior to radiological or orthopaedic intervention, ie for identification of a sequestrum.
In most centres MRI is the cross-sectional imaging modality of choice for imaging osteomyelitis in children.

MRI
The earliest feature of acute osteomyelitis is oedema within the marrow. Fluid sensitive sequences (T2 weighted sequences or short tau inversion recovery (STIR) sequences) are highly sensitive and allow optimum visualisation of these changes, where marrow oedema will be seen as high signal.

The use of gadolinium in children is controversial, but is of value in the identification of an associated abscess.

- Gadolinium enhancement does not increase the sensitivity or specificity of osteomyelitis.
- If fluid sensitive images are normal gadolinium enhancement is of no value.
- If fluid sensitive images are abnormal gadolinium enhancement may be of value in identifying the presence of an abscess.
- If the abscess is confined to the epiphyseal cartilage the unenhanced scans may be normal.

MRI is highly sensitive but not specific and it is essential to correlate any imaging findings with the clinical scenario.

In the absence of clear clinical signs of infection in a child, the presence of marrow oedema, often associated with signal changes within the adjacent soft tissue, should be intensively investigated to exclude more sinister pathology such as primary bone tumour or haematological malignancy.

Ultrasound
Ultrasound is an ideal imaging tool in paediatrics due to the lack of ionising radiation and the absence of the need for sedation or general anaesthesia, but it is universally recognised that ultrasound is entirely operator dependent.

Musculoskeletal ultrasound in children can be very useful in identifying subperiosteal collections and joint effusions that may be associated with osteomyelitis, but in order to be able to identify areas of pathology it is important to be able to recognise the sonographic appearances of the growing skeleton.

Unossified cartilage is hypoechoic on ultrasound with fine focal echoes throughout. This can be seen in the region of the epiphyses, carpal and tarsal bones and in the region of the patella and must not be misinterpreted as purulent fluid.

Nuclear medicine
Although technetium-labelled MDP bone scans have been largely superseded in many centres by MRI, they do have a role in the diagnosis of osteomyelitis.

In the young child, where MRI may require sedation or general anaesthesia, a 99mTc MDP bone scan may be of value in excluding underlying bone infection in the presence of soft tissue inflammation or joint swelling.

Interpretation of nuclear medicine imaging requires correlation with the plain radiograph and it is important to recognise that relatively increased uptake in the region of the metaphyses is normal and should not be misinterpreted.

Positivity in the presence of osteomyelitis is seen between 24 and 72 hours and is seen as a focal or regional area of increased uptake representing an area of increased bone turnover (osteoblastic activity). In addition, it is worthwhile including the whole skeleton on the static views in order to exclude multiple sites of pathology.

Although 99mTc MDP bone scans are highly sensitive they have a low specificity. Clinical and radiological correlation is therefore essential in narrowing the differential of infection, fracture healing or tumour.

Brodie’s abscess
This is a subacute pyogenic infection of the bone, most commonly caused by Staphylococcus aureus. This condition is named after Sir Benjamin Collins Brodie, a former president of the Royal College of Surgeons who identified and managed a tuberculous abscess in the proximal tibia in the early 19th century.

As with acute osteomyelitis, Brodie’s abscess is more common in children and has a male preponderance. The abscess is typically located at the metaphysis, but may cross the open physis and can be found in the epiphysis.

The most common site is the tibial metaphysis (proximal or distal) and the ends of the long bones, but carpal and tarsal bones may also be affected.

An untreated Brodie’s abscess may persist for many months.
Imaging Brodie’s abscess

**X-ray**

The lesion is seen on the plain radiograph as a focal lucency surrounded by a margin of sclerosis. This may be associated with periosteal reaction along the shaft of the bone, but the presence of a lucent channel extending from the abscess towards the growth plate is said to be pathognomonic of Brodie’s abscess.

**MRI**

Brodie’s abscess is seen as a well defined, focal area of high signal on T2 weighted with a margin of low signal surrounded by a further rim of high signal.

### Septic arthritis

As with osteomyelitis, infection of the joint is most commonly caused by Staphylococcus aureus and the most commonly affected joints are the hip and the knee.

In neonates and infants group D streptococcus should be considered and in children under four years of age the spectrum of infectious organisms includes Haemophilus influenzae and Streptococcus pyogenes. In some cases rarer organisms such as gonorrhea, brucellar and salmonella should also be considered.

It is essential to make an early diagnosis in septic arthritis to avoid irreversible damage to the joint.

**X-ray**

Depending on the joint affected the plain film may be normal (septic arthritis of the hip) or may show a joint effusion (septic arthritis of the knee), but the main contribution of the plain film is in excluding other pathology.

**Ultrasound (figure 6)**

Although examination of a painful joint in a child may be challenging, with adequate pain relief, parental support and distraction techniques ultrasound is the modality of choice for imaging septic arthritis.

In most centres ultrasound is readily available and does not require sedation or general anaesthesia.

It is not possible to distinguish between septic arthritis and inflammatory arthritis with imaging alone and the definitive diagnosis is typically made by analysis of the fluid following joint aspiration.

It is important not to confuse unossified cartilage with the changes seen on imaging may be aggressive and many musculoskeletal infections the plain film may be normal in discitis. If there are clinical concerns, a 99mTc MDP bone scan will show increased uptake at the site of pathology (figure 5). An MRI scan of the spine will show abnormal signal within the disc and adjacent vertebral endplates and will also show any associated collection at the site of the infection (figure 7b). In these cases gadolinium enhanced scans can be helpful in delineating any local soft tissue collections.

Treating the discitis leads to a resolution of all clinical symptoms.

### Summary

Investigating musculoskeletal infection in children involves a multidisciplinary team and multimodality imaging approach, starting with the plain film.

The changes seen on imaging may be aggressive and extensive and if there is clinical concern or symptoms and signs fail to resolve with appropriate treatment, other aggressive bone pathologies must be considered and if necessary a bone biopsy may be required.

### References