Paediatric Infection Update - Sticks and stones may break my bones, but infection makes me sicker

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A six-month-old baby is brought to the Children's Emergency Department by their parent. They report that for the last 24 hours, the infant has not been using their right arm and it has become 'limp'. The parents have recorded a low-grade fever with a home thermometer and report that the baby has 'gone off' their feeds. There is no history of trauma. The child was born at term with an unremarkable birth and developmental history.

This is a fairly common presentation to the orthopaedic on call team. Often trauma or injury is considered first when a child has an acutely irritable upper limb. This differs from the limping child, whereby our colleagues in the emergency department will tend to consider a potential infection. However, osteomyelitis or septic arthritis (SA) can affect any limb or joint. Incidence figures vary, but it is estimated the shoulder is affected in 2%-12% of cases of SA, compared to the hip in 32%-39% and knee in 26%-47%[1].

Bone and joint infection (BJI) in children has changed noticeably in the post-COVID-19 western world. It is a fascinating, challenging area of paediatric orthopaedic care that should always quicken the pulse and incite heightened clinical suspicion. This editorial utilises this clinical case in order to illustrate various aspects of investigation and management of acute bone, and joint infection in children, including:

1. The new BOAST paediatric infection guidelines
2. Imaging in BJI and the PICBONE study
3. An update on what orthopaedic surgeons should understand about the organisms implicated in BJI

On examination, the infant is unsettled and has a temperature of 39°C. There is no obvious erythema, warmth or deformity around the shoulder girdle. They seem irritable with movement of their right shoulder and abduction is limited to 90 degrees. They have a warm hand and a strong radial pulse. Their ear, nose, throat, abdominal and cardiovascular examination are unremarkable. Radiographs of their right humerus are shown in Figure 1. Bloods demonstrate a CRP of 26 and WCC of 7 × 109/L with a normal neutrophil count. Blood cultures are taken.

Examining a listless infant is challenging. They are unable to give a history and sometimes the clinical signs can be subtle. A 'pseudo paralysis' of a limb may be the only clue of an underlying BJI. Differentials include first presentation of juvenile idiopathic arthritis (JIA), a humeral or clavicle fracture, chronic recurrent multifocal osteomyelitis (CRMO), brachial plexus injury, or, rarely, malignancy. As always, vigilance is required for the potential of non-accidental injury and a top-to-toe examination is indicated. CRP may not be significantly elevated even in acute SA, especially in the infant population[2].

The next question that maybe reasonably asked is whether to commence antibiotic therapy.

A new British Orthopaedic Association Standard (BOAST) on the Management of Children with Acute Musculoskeletal (MSK) Infection was published in May 2022. It gives clear, comprehensive guidelines on how to assess, investigate and treat children with suspected MSK infection. It touches on the importance of agreed referral pathways to specialist centres, to support local hospitals and transfer complex cases. It acknowledges the diagnostic

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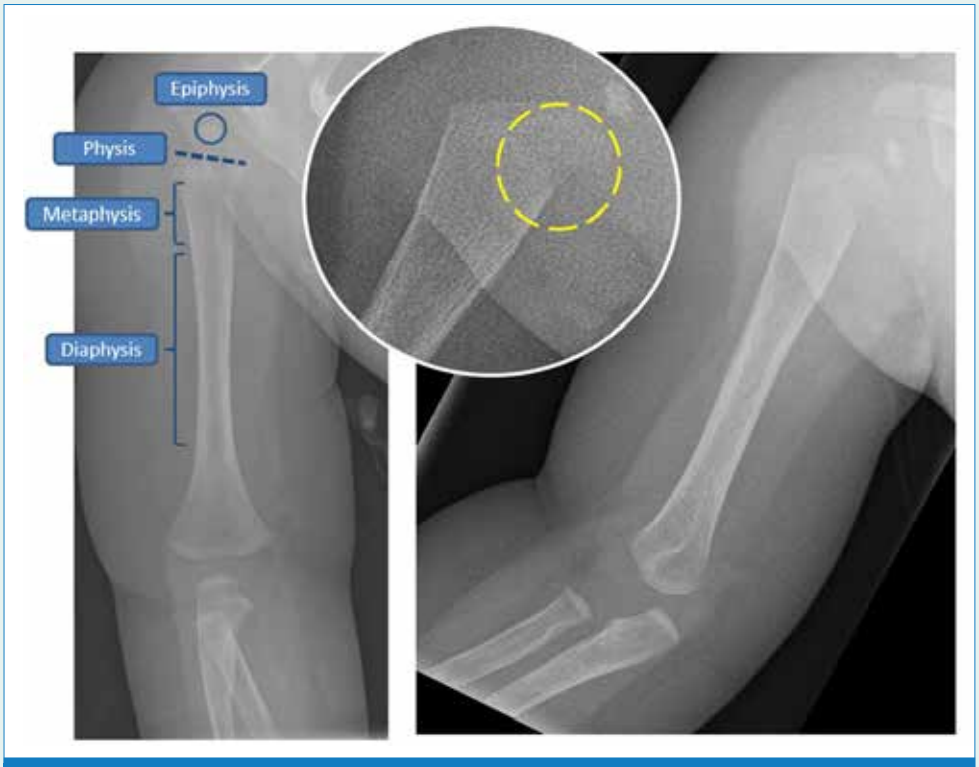

Figure 1: Annotated anterior-posterior and lateral radiographs of the right humerus and shoulder. The enhanced image of the shoulder shows lucency in the proximal humerus (yellow circle).

uncertainty in these cases in that no single investigation algorithm is completely reliable. It supports empirical antibiotic treatment in children who meet the NICE high-risk sepsis criteria, but acknowledges that treatment can be delayed until tissue sampling in stable children.

Radiographs (Figure 1) are reported as showing no fractures, but possible osteomyelitis due to the lucency seen in the proximal humerus which may represent a Brodie's abscess or subperiosteal collection.

In acute osteomyelitis there are often no radiological changes initially and this should lead to consideration of further imaging. Ultrasound (USS) is quick, requires no irradiation or sedation and in many centres, can be performed out of hours in the Emergency Department[3]. USS can identify the presence and volume of a joint effusion, any tissue inflammation and may even identify a subperiosteal collection. The disadvantages are that it cannot accurately distinguish between sterile, purulent and haemorrhagic effusions, and that it is user-dependent in nature[1]. Magnetic resonance imaging (MRI) with contrast may be the gold standard diagnostic imaging modality, but it can be a logistical challenge to perform in young children that often require sedation or anaesthesia.

The PICBONE study started recruitment in December 2022. It is a multi-centre cohort study from Oxford to understand the diagnostic accuracy of MRI and USS in acute haematogenous osteomyelitis in children. Their study also aims to create a BJI diagnostic pathway for use in the Emergency Department.

A USS (Figure 2) showed general inflammation around the proximal humerus. A 6-10mm deep joint effusion was identified with a small quantity of fluid seen along the cortex of the proximal humeral metadiaphysis. Collectively, appearances were concerning for SA with or without osteomyelitis of the proximal right humerus. A MRI (Figure 3) showed appearances in keeping with right shoulder septic arthritis with small subperiosteal collection.

Blood cultures grow *Staphylococcus aureus*. Is this the most common causative organism?

S. aureus remains the most common organism in paediatric BJI, but others should be considered. It can be infamously difficult to identify the organism causing a BJI. Around 20% to 50% of children with BJI remain culture negative[4]. *Staphylococcus aureus* is the most commonly cultured organism. Other common pathogens are *Kingella kingae*, *Streptococcus pyogenes* and *Streptococcus pneumoniae* and *Salmonella*[1,5]. *Kingella* tends to affect children under 2 years old and often behaves in an indolent manner, although is one of the only organisms that will cause an abscess in the epiphysis. It is notoriously difficult to culture, but can be detected by polymerase chain reaction (PCR). Where available, a prompt request for PCR may aid in diagnosis and help tailor antibiotic therapy[5]. >>

Figure 2: Annotated USS of right shoulder showing glenohumeral joint effusion.

Invasive Group A Strep (iGAS) infection has caused significant anxiety in recent months. iGAS infection rates in the 1 - 9 year age group have increased fourfold this year compared to pre-pandemic. Fortunately, there have only been five recorded deaths within seven days of iGAS diagnosis in children aged less than 10 years old[6].

The infant was taken to theatre for an open washout of the right glenohumeral joint. Turbid fluid was drained and purulent material in biceps tendon sheath was incised. Tissue samples sent for microbiology also grew *S. aureus*. Histopathology showed necro-inflammatory debris with no evidence of malignancy. They were treated with two weeks of intravenous (IV) flucloxacillin and ceftriaxone via a central line, before being discharged on six weeks of oral co-trimoxazole. They made an excellent recovery and rapidly regained full painless use of the right arm. They will remain under close clinical and radiographic follow up to monitor for growth arrest of the proximal humerus, a recognised complication after SA[7].

Increasingly, shorter courses of intravenous therapy are given with an 'early oral switch'. In many units, outpatient antibiotic therapy services allow IV antibiotics to be given in the community. If surgical intervention is required, and facilities and skill mix allow, consideration should be given to insertion of mid-term IV access under the same general anaesthetic. Shared decision-making will guide empirical and definitive antibiotic choice, duration and when to switch to oral therapy.

Musculoskeletal infection in children remains a diagnostic challenge, particularly in the upper limb. It is our experience that new-onset pseudoparalysis in the upper limb of a child is likely to be due to infection if the clinical signs and appropriate investigations support this. It is important to consider other diagnoses such as non-accidental injury and when sending samples to microbiology, send tissue for histopathology to aid the diagnosis of synovitis in the setting of JIA or CRMO. A multi-disciplinary approach to management involving our paediatric infectious disease and microbiology colleagues is essential. ■

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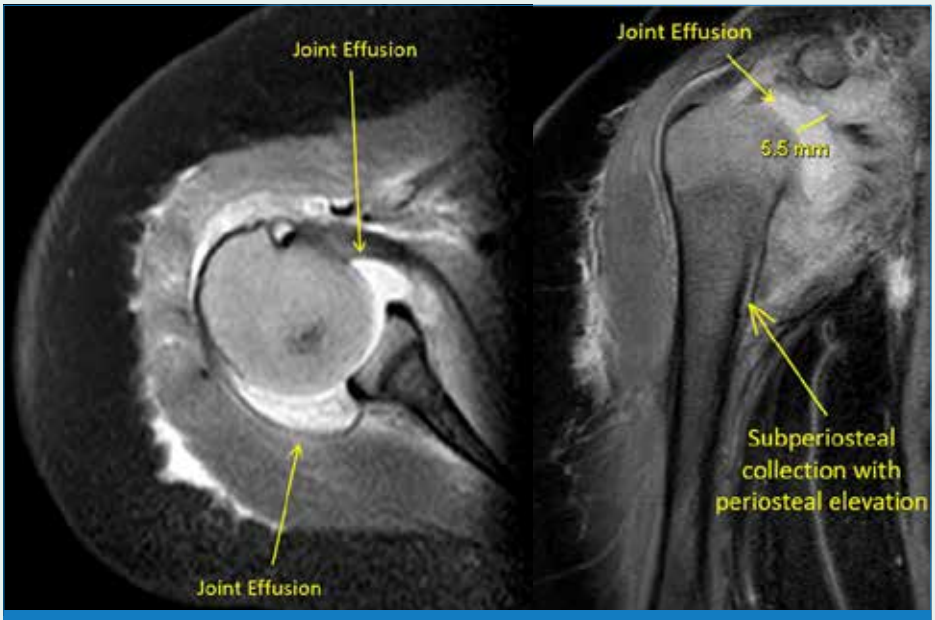

Figure 3: Annotated coronal and axial MRI sections of the right shoulder. This shows a joint effusion and subperiosteal collection of fluid tracking down the proximal humeral diaphysis anteromedially measuring up to 2mm in depth.