A Diagnostic Imaging Algorithm for Children with Hip Pain

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Purpose

- Since November 2012, General Practitioners (GPs) in Australia have been able to request Medicare-eligible hip MRIs for patients under 16 years with suspected septic arthritis, suspected slipped capital femoral epiphysis or suspected Perthes disease (1).

- Extending MRI requesting rights to GPs is aimed at avoiding exposure of children to unnecessary radiation associated with other types of diagnostic imaging (1).

- Analyses of GP MRI requests in UK institutions reported large variations in requesting patterns between GPs suggesting the need for increased communication between GPs and imaging departments to optimise use of the service (2).

- We aimed to develop a diagnostic imaging algorithm for the investigation of hip pain in paediatric patients to be used as a clinical decision support tool for GPs and other medical practitioners.

Methods and Materials

- A search of MEDLINE and the Cochrane Database of Systematic Reviews identified a list of relevant articles.

- Original articles, systematic reviews and evidence-based guidelines were included; non-human studies and articles not published full-text in the English language were excluded.

- Articles were ranked according to the Oxford Centre for Evidence-Based Medicine Levels of Evidence.(3)

- An evidence-based pathway was produced, reviewed and approved by Diagnostic Imaging Pathways Expert panel members, in consultation with the Editor, Editorial Panel and the Paediatric Imaging Reference Group of RANZCR.(4)

- A final pathway was produced for publication.

Results
The resultant pathway (Fig. 1 on page 6) provides imaging recommendations for clinically suspected diagnoses.

Fig. 1: Diagnostic imaging pathway for child with hip pain.  
**References:** Diagnostic Imaging Pathways, Royal Perth Hospital / Perth 2013

**Imaging in Legg-Calve Perthes Disease** (Fig. 2 on page 7)

- Form of idiopathic osteonecrosis with peak incidence at 5-6 years, ~3 times more common in boys than girls.(5)
- Diagnosis of exclusion. Other causes of avascular necrosis include sickle cell disease, leukaemia, steroids and Gaucher’s disease.(6)
- Early diagnosis is important for joint preservation.(7)

**Radiography**

- AP pelvis and frog leg lateral radiographs are the initial modality of choice for both diagnosis and follow-up.(8)
- Bilateral hip involvement occurs in ~15% of patients. Both hips should be imaged.(5, 9)
- Changes of Perthes disease can take 3-4 months to become apparent on radiographs.(8)
Magnetic resonance imaging or bone scan

- MRI is generally regarded as the preferred advanced imaging modality but if the child is less than 6 years a general anaesthetic or sedation will likely be required. Bone scan is an alternative in these cases to avoid sedation.
- Using a combination of unenhanced and post gadolinium MRI sequences the diagnosis of Perthes disease can be confidently made, even in the presence of normal or equivocal radiographs.(6)
- The normal critical upstroke of enhancement occurs in the first 2 minutes following contrast administration so rapid image acquisition is essential, as is coronal plane acquisition to allow easy comparison with the other hip. After the early vascular phase, the disparity between normal and abnormal is less apparent.(10)
- Dynamic gadolinium enhanced subtraction MR also allows assessment of revascularisation patterns.(11)
- MRI can distinguish Perthes disease from other epiphyseal conditions such as Meyer dysplasia and can find other causes of hip pain such as apophyseal injury or fracture.(6)
- When the complication of progressive subluxation is suspected MRI can substitute for arthrography which usually requires general anaesthesia.(8)
- In the past, pin hole scintigraphy (bone scan) was considered the gold standard for assessing prognosis as it could assess the degree and type of revascularisation.(12)
- Diffusion weighted imaging MRI may be a way of distinguishing between Perthes disease with favourable and unfavourable prognosis.(13)

Imaging in slipped capital femoral epiphysis (SCFE) (Fig. 3 on page 8)

- SCFE is a Salter Harris I fracture through the proximal femoral growth plate. (14)
- Can be mechanically stable, where a patient can still bear weight, or mechanically unstable which typically presents as an acute physeal fracture and inability to weight-bear.(15)
- Early symptoms can be subtle and the diagnosis is easily overlooked. A dull ache that is exacerbated by exercise is a common early symptom. The diagnosis may only become apparent when a stable slip progresses to an unstable one.(15)
- High rate of bilateral involvement, with over 20% at the time of diagnosis and over 50% overall in one study.(16)
- Patients with SCFE are at risk of avascular necrosis, chondrolysis and premature osteoarthritis.(17, 18)

Radiography
• AP and frog leg or lateral radiographs are the first investigation of choice. (17)
• ~13% of slipped capital femoral epiphyses may not be visible on AP radiographs.(19)
• A line drawn along the lateral aspect of the femoral neck should intersect 20% of the femoral epiphysis and, if not present, indicates medial displacement of the epiphysis.(20)
• Other findings on an AP radiograph include loss of epiphyseal height and variable physeal widening and irregularity.(21)

Magnetic resonance imaging

• There is limited evidence for routine screening with MRI although cases of 'pre-slip' have been described that were only detectable with MRI.
• The earliest imaging finding, evident only on MRI, is focal widening of the physis, with or without synovitis, but without slippage of the femoral head (pre-slip).(21, 22)
• The MRI diagnosis of an early SCFE relies on recognition of a morphologic change at the head/neck junction and abnormal signal intensity centred at the physis, indicative of oedema.(14)

Imaging in septic arthritis and osteomyelitis

• Osteomyelitis and septic arthritis should be considered in the differential diagnosis of any child with limb pain, even if there is a history of trauma. It is most common in young infants, is usually monoarticular and is frequently localised to the hip or knee joints. It can be a difficult diagnosis to make and with potentially severe consequences and for these reasons referral to a paediatric tertiary centre is generally recommended.(23, 24)
• Osteomyelitis can be present even in a well looking afebrile child. (25)
• Septic arthritis is a medical emergency and can result from a penetrating injury, haematogenous spread or spread from adjacent sites of infection. Haematogenous spread is more common in neonates and infants, when vessels cross the growth plate and can seed infection from the adjacent metaphysis.(18)

Radiography and ultrasonography

• In one study less than one third of patients with septic arthritis had any abnormality on radiographs with changes of osteomyelitis and septic arthritis sometimes taking up to 7-10 days to become apparent.(24)
• Hip ultrasound is quick, free of ionising radiation and can evaluate for a hip joint effusion or soft tissue collection (Fig. 4 on page 9). However it is not specific and generally can't distinguish between a transient synovitis or
septic arthritis. Other aetiologies such as Perthes disease can also result in a hip joint effusion. A negative hip ultrasound does not exclude the presence of septic arthritis.(26)

*Magnetic resonance imaging or bone scan*

- With negative radiographs and ultrasound and continued suspicion of infection, MRI and bone scan are options. MRI has the advantage of no ionising radiation but often requires general anaesthesia in very young children. Bone scan is an alternative to avoid sedation.
- Whilst MRI cannot reliably distinguish between septic arthritis and transient synovitis, the findings of signal abnormality in the bone marrow and signal alterations and enhancement of surrounding soft tissue suggest the diagnosis of septic arthritis.(27) Bone scan is of limited value in distinguishing transient synovitis from septic arthritis.(28)

**Other causes of hip pain in children and adolescents include:**

- Aneurysmal bone cyst *(Fig. 5 on page 9)*
- Giant cell tumour *(Fig. 6 on page 10)*
- Langerhans cell histiocytosis *(Fig. 7 on page 10)*
- Anterior inferior iliac spine avulsion fracture *(Fig. 8 on page 12)*

*Images for this section:*
Fig. 1: Diagnostic imaging pathway for child with hip pain.
**Fig. 2:** Perthes disease, left hip, AP radiograph view. There is a relatively small, sclerotic epiphysis with subcortical lucency (crescent sign) and joint space widening.
Fig. 3: Slipped capital femoral epiphysis, left hip, AP radiograph view.

Fig. 4: Septic arthritis, longitudinal ultrasound view through hip joint demonstrating complex effusion.
Fig. 5: Aneurysmal bone cyst, left proximal femoral metaphysis (A, B). Sharply defined, osteolytic lesion with thin sclerotic margin, complicated by pathological fracture (arrows).

Fig. 6: Giant cell tumour, right proximal femoral epiphysis/metaphysis, MRI coronal T1-weighted (A), STIR (B) and T1-weighted fat-saturated post-gadolinium (C) views. MRI shows demarcation on T1 between fatty marrow and tumour, with enhancing solid components. The tumour abuts the articular surface and subchondral bone.
**Fig. 7:** Langerhans cell histiocytosis, right proximal femur, AP radiograph (A), axial STIR MRI (B) and sagittal post-gadolinium T1-weighted (C) views. Well-defined intramedullary
lytic lesion (arrows) with overlying cortical thinning and destruction and periosteal reaction.

**Fig. 8:** Anterior inferior iliac spine avulsion fracture (white arrow), left hip, AP radiograph view. This injury typically occurs in adolescent athletes involved in kicking sports due to eccentric contraction of the rectus femoris muscle.
Conclusion

This diagnostic imaging algorithm is an evidence-based clinical decision support tool that provides recommendations on the investigation of children with hip pain. It aims to improve requesting Physician knowledge and reduce inappropriate imaging requests.

Generally, initial imaging is plain radiography and/or ultrasonography. Where initial imaging is equivocal or negative with continued clinical suspicion, MRI is an accurate advanced imaging modality but requires sedation in young children. Bone scan may be an alternative in these cases. If septic arthritis or osteomyelitis is highly suspected, urgent tertiary orthopaedics referral is indicated.

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References


2. Gough-Palmer AL, Burnett C, Gedroc WM. Open access to MRI for general practitioners: 12 years' experience at one institution - a retrospective analysis. Br J Radiol 2009; 82(980):687-690


25. Ferguson LP, Beattie TF. Osteomyelitis in the well looking afebrile child. BMJ 2002;324:1380-1

