Diagnosis of hip pain in children

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Hip pain is uncommon in children and imaging plays a central role in diagnosis and follow-up. The commonest cause of hip pain is acute transient synovitis. Other causes, which vary according to the age group of the child, include Perthes' disease and slipped capital femoral epiphyses. This review discusses the differential diagnosis and imaging pathways required.

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Hip pain is an uncommon experience for children and is a source of concern for parents and physicians. There are many causes and therefore a systematic approach is needed for diagnosis. The diagnostic considerations are limited by the age of the child (*Table 1*), which in turn provides a useful framework for selecting the appropriate imaging modality.

WHAT IMAGING MODALITIES ARE AVAILABLE?

Many modalities are available for diagnosis and each has its advantages and disadvantages. The most efficient and cost-effective modality should be selected for each case.

TABLE 1.
Causes of hip pain by age groups

Age group	Category	Cause
1–4 years	Inflammatory	Acute transient synovitis — commonest
		Septic arthritis/osteomyelitis
		Cellulitis
	Trauma	Soft tissue injuries
		Fractures
		Non-accidental trauma
5–9 years	Inflammatory	Transient synovitis
		Septic arthritis
		Juvenile chronic arthritis
		Rheumatic fever
	Trauma	Soft tissue injuries
		Fractures (including stress fractures)
	Others	Perthes' disease and tumours
> 9 years and adolescent		Slipped capital femoral epiphysis
		Juvenile chronic arthritis
		Trauma
		Neoplasia

Plain radiographs

These should always be obtained first. They often establish the diagnosis, obviating further imaging. Anteroposterior (AP) and frog lateral views of both hips are needed. A frog lateral provides a view of both femoral capital epiphyses (FCE) in lateral profile. A hip joint effusion may be the only abnormality present and is seen as displacement or effacement of the pericapsular fat planes (psoas, obturator and gluteal) and an increase in the inferomedial joint space (*Figure 1*).

Ultrasound

Hip joint effusions are reliably diagnosed by high frequency (7–10 MHz) ultrasound (US) and show up as a collection of hypoechoic fluid anterior to the proximal diametaphyseal area of the femur (*Figure 2*). US is non-invasive, widely

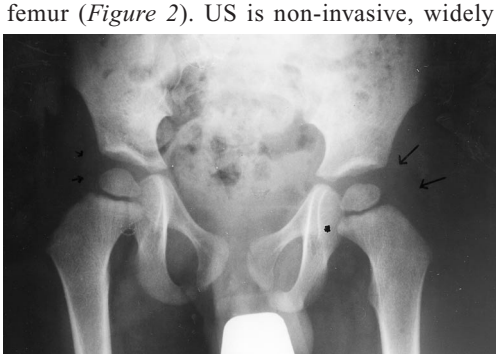

Figure 1. Anteroposterior radiograph of the pelvis in a 4-year-old child with acute transient synovitis of the left hip showing bulging of the pericapsular fat planes (large arrows) and an increase in the inferomedial joint space (asterisk) as a result of a joint effusion. Note the preserved pericapsular fat planes on the right side (small arrows).

available, does not involve the use of ionizing radiation and is repeatable. The procedure, however, can be technically difficult in a child with a flexed and acutely painful hip and is highly operator dependent.

Bone scintigraphy
Technetium 99m-labelled methylene diphosphonate (MDP) is injected intravenously. Areas of increased activity are seen as a result of tracer accumulation in sites of increased vascularity and osteoblastic activity. Photopenic areas are suggestive of ischaemia.

Computed tomography
The strength of computed tomography (CT) lies in its ability to image cortical bone and therefore it is a useful modality to image and perhaps guide percutaneous therapy for an osteoid osteoma of the proximal femur. A disadvantage of CT is that it involves ionizing radiation and some children will need either sedation or a general anaesthetic.

Magnetic resonance imaging
The lack of ionizing radiation, superb soft tissue contrast and multiplanar capabilities are important advantages of magnetic resonance imaging (MRI). MRI is just as sensitive as bone scintigraphy for the early detection of avascular necrosis of the femoral head when radiographs are frequently normal. A disadvantage of MRI, similar to CT, is the need for sedation or anaesthesia in some young children.

EVALUATION OF HIP PAIN IN TODDLERS (1–4 YEARS)

Acute transient synovitis or irritable hip
Acute transient synovitis (ATS) can be described as a non-specific, short-term inflammatory synovitis with a synovial effusion of the hip joint in children (Gershuni et al, 1983) (*Table 1*). It is the most common cause of a limp in children once trauma is excluded (Ryöppy, 1994). The diagnosis is based on a history of acute onset of hip pain and limp which are short lived (Jacobs, 1971). The pain may be referred to the knee.

The hip is usually held in flexion with slight abduction and lateral rotation, but the child is otherwise healthy (Koop and Quanbeck, 1996). There may be mild elevation of the erythrocyte sedimentation rate (ESR) but the white blood cell (WBC) count is normal (Blumhagen, 1994). The peak age of presentation is between 3 and 6 years. ATS is more common in boys (Illingworth, 1983).

Imaging: The diagnosis is often made on clinical grounds without the need for any imaging (Myers and Thomson, 1997). However, radiography is indicated to exclude osseous pathological conditions (Marchal et al, 1987) and should be done first. In ATS the radiographs may be normal or may show signs of a joint effusion (*Figure 1*). Ultrasonography of the hips is very sensitive in detecting a hip joint effusion (*Figure 2*) but cannot differentiate between different kinds of arthritis (Marchal et al, 1987). Joint aspiration and examination of the synovial fluid are not indicated if pyogenic infection is not suspected. Bone scans and MRI are not primary examinations, but may be of use in prolonged cases (Ryöppy, 1994).

Septic arthritis
This condition is an emergency and is an important differential of ATS. Half of the patients are less than 2 years old (Blumhagen, 1994). Modes of spread include haematogenous (commonest) from a focus of metaphyseal osteomyelitis and direct innoculation from femoral venepuncture. *Haemophilus influenzae* type B and *Staphylococcus aureus* are common causative agents (Barton et al, 1987). The clinical picture is that of an ill child with fever, limp and pain on passive motion of the hips (Volberg et al, 1984). The WBC count and ESR are elevated.
Diagnosis and imaging: Prompt diagnosis is important as any delay can result in a poor outcome: destruction of the femoral head, degenerative arthritis and permanent deformity. Plain radiographs may show the presence of an effusion, osteopenia, soft tissue swelling and associated osteomyelitis with or without subluxation (*Figure 3*). They are not completely reliable, especially in infancy, because

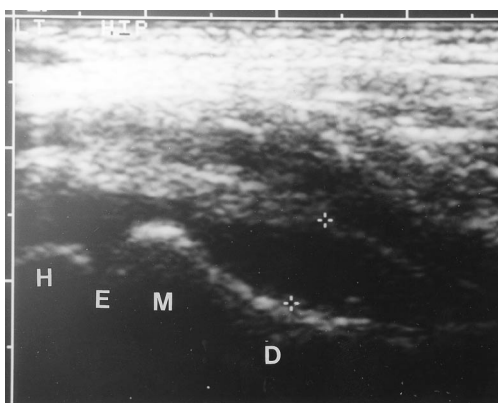

Figure 2. Longitudinal ultrasound of the left hip in the patient in Figure 1 *shows an effusion as a hypoechoic collection anterior to the proximal femur (H = femoral head, E = epiphyseal plate, M = metaphysis, D = diaphysis).*

Figure 3. Plain film of the pelvis shows a subluxed right hip secondary to septic arthritis.

ossification of the proximal femur is minimal. In the older child a hip radiograph is not sufficiently sensitive to be used as a screening test as it is uncommon for a hip to sublux (Volberg et al, 1984), although other signs may be present.

Progressive disease causes cortical disruption, periosteal reaction and bone destruction (*Figure 4*). US demonstration of joint effusion in a child with fever, leucocytosis and raised ESR suggests septic arthritis and joint aspiration should be performed (Zavin et al, 1993). The purpose of aspiration is two-fold:

1. To obtain fluid for microbiological analysis

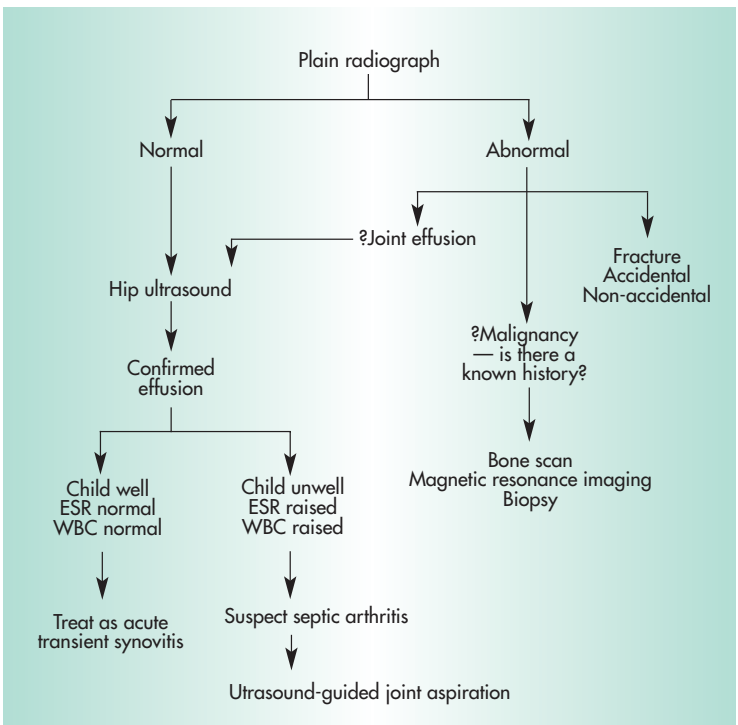

Figure 5. Flow chart for workup of hip pain in toddlers. ESR = erythrocyte sedimentation rate; WBC = white blood cell.

Figure 4. A lateral view of the left hip in an ill child with fever and hip pain shows a focus of osteomyelitis in the metaphysis of the femur.

2. To decompress the joint (Zavin et al, 1993).

The absence of fluid on US excludes septic arthritis (Jaramillo et al, 1995b). In suspected cases, bone scintigraphy may show generalized increased uptake in the joint but MRI has little role in evaluation in acute septic arthritis (Mize and Bissett, 1996).

Differential diagnosis and work-up

Septic arthritis must be differentiated from ATS (*Figure 5*). Clinical parameters including fever, leucocytosis and raised ESR may suggest the correct diagnosis, but substantial overlap exists. Controversy exists about aspirating hips in all cases with a joint effusion. The procedure is invasive, not without complications and can be emotionally traumatic for both the child and parents. Joint aspiration therefore is only performed in patients with hip effusions if there is clinical concern about infection. If the child is clinically well and has undergone evaluation by an orthopaedic surgeon, a diagnosis of ATS is made and the child closely monitored (Strouse et al, 1998).

Other osseous pathologies, e.g. fractures, are frequently revealed on plain radiographs. For older children the history of trauma and site of injury are usually obvious. When non-accidental trauma is suspected clinically a full skeletal survey is warranted.

EVALUATION OF HIP PAIN IN CHILDREN 5–10 YEARS

The same inflammatory conditions that affect toddlers also occur in children in this age group and ATS is still the commonest cause, but Perthes' disease (PD) has to be excluded (*Table 1*).

Perthes' disease

PD is a disorder of unknown aetiology and affects the femoral head. It is characterized by ischaemic necrosis, collapse and subsequent repair of the FCE (Skaggs and Tolo, 1996). The disorder is commoner in boys and 80% of cases occur in children between 4 and 9 years of age. Affected children have a delayed bone age.

Clinical presentation: PD is usually unilateral. Asymmetric bilateral disease occurs in 13% of cases (Ozonoff, 1992). The initial ischaemic event is clinically and radiologically silent. The repair response of the bone leads to symptoms of pain and limitation of movement, and to the abnormal radiographical findings (Myers and Thomson, 1997). The condition may initially be indistinguishable from ATS and pain may be referred to the knee (Koop and Quanbeck, 1996).

Imaging: ***Plain radiographs:*** These are the only useful imaging modalities available for both initial diagnosis and longer-term follow-up of the disease. Abnormalities are detectable at approximately 5 months after the initial insult and are caused by repair and absorption of the dead bone as revascularization of the femoral head occurs (Ozonoff, 1992). Initially the FCE is smaller and denser compared to the other side. The cartilage space is widened. A subchrondral lucency appears and later the FCE fragments (*Figure 6*). If the radiographs are normal, MRI or bone scintigraphy are more sensitive.

Bone scintigraphy: Reduced uptake of tracer is seen initially (*Figure 7*) and as revascularization occurs, tracer begins to accumulate in the lateral portion of the femoral head (Laor et al, 1998).

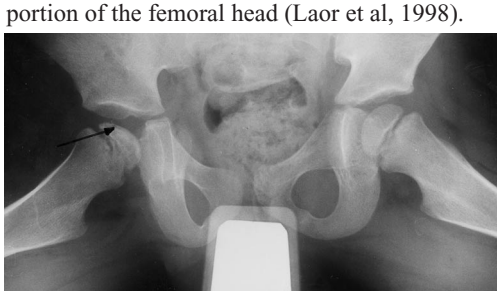

Figure 6. Frog lateral view of the pelvis shows a small and dense right femoral capital epiphysis with a subchondral lucency (arrow) and an increased superior hip joint space.

Diagnostic workup: In the uncomplicated case of PD, plain radiographs are sufficient to make the diagnosis (*Figure 8*). In suspected and

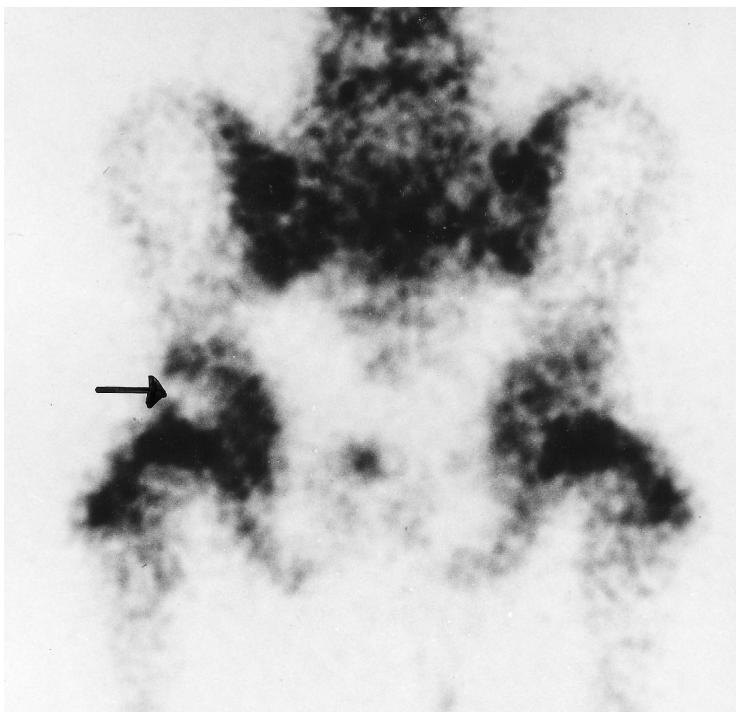

Figure 7. Radioisotope bone scan (posterior view) showing a photon deficient area at the lateral aspect of the left femoral head (arrow) in a child with Perthes' disease.

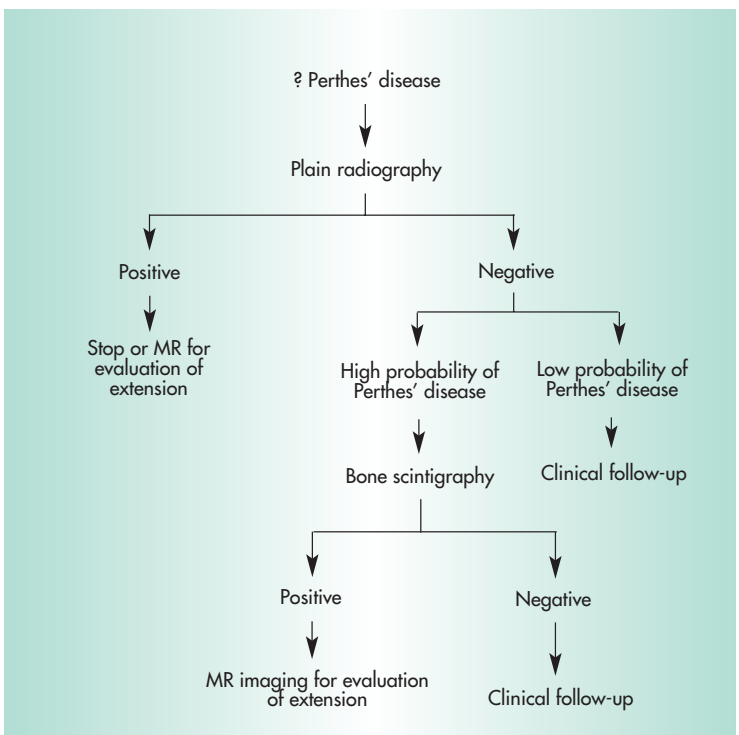

Figure 8. Flow chart for workup of hip pain in children between 5 and 10 years of age. MR = magnetic resonance.

complicated cases, MRI shows previously unsuspected abnormalities and provides added anatomical detail that would not be provided by a bone scan (Myers and Thomson, 1997). The MRI findings of avascular necrosis are characteristic and include a low signal area at the superior and lateral aspect of the femoral head on T1-weighted images and an area with a surrounding double line of low and high signal intensity on proton density images (*Figure 9*) (Jaramillo et al, 1995a).

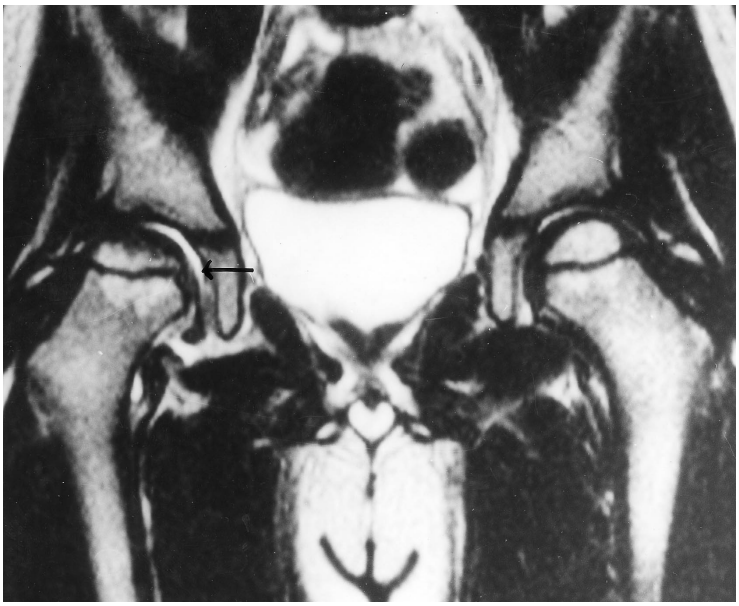

Figure 9. Perthes' disease. Coronal image demonstrates flattening and deformity of the right femoral head. Note the low signal area (black) at the superior and lateral aspect of the femoral head and a small joint effusion (arrow).

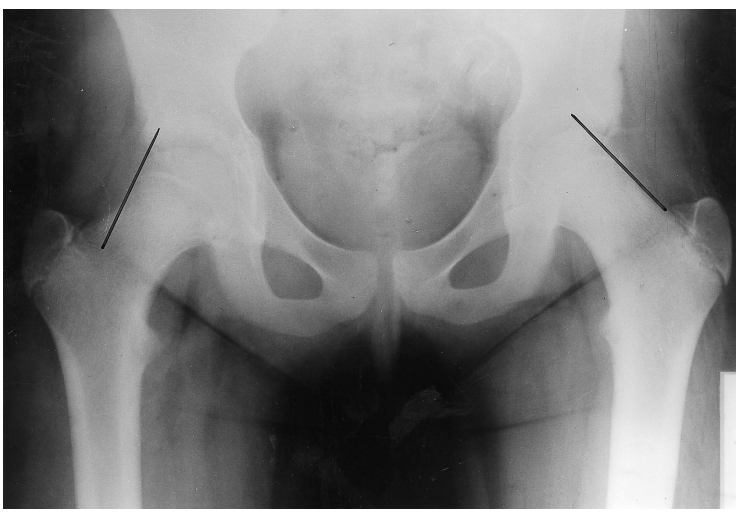

Figure 10. Right slipped capital femoral epiphyses. Anteroposterior view of the pelvis showing slight widening of the growth plate, mild osteopenia of the femoral head and neck and almost no femoral head lying lateral to the femoral neck cortical line. At least a sixth of the femoral head lies lateral to the femoral neck cortical line on the left side (normal).

EVALUATION OF HIP PAIN IN CHILDREN OVER 9 YEARS AND ADOLESCENTS

The commonest cause of hip pain in adolescents is slipped capital femoral epiphysis (SCFE) (Blumhagen, 1994).

Slipped capital femoral epiphysis

SCFE is a disorder in which there is a gradual or acute disruption through the capital epiphyseal plate (Carney et al, 1991). It affects overweight adolescents who are tall for their age. The peak incidence age for girls is 11.5 years and for boys 13 years (Carney et al, 1991). SCFE is twice as common in boys as girls, but this incidence is changing as more girls are taking part in athletic sports. Hip pain and altered gait are present with knee pain occurring in 25% of patients.

Imaging: The epiphysis remains in a normal position within the acetabulum, while the remainder of the femur displaces from the epiphysis, usually anterolaterally and superiorly, causing the epiphysis to appear to be displaced posteriorly and inferiorly (Koop and Quanbeck, 1996). Early findings on plain films are growth plate widening and osteopenia of the involved femoral head and neck. A line drawn tangential to the lateral border of the femoral head neck normally transects the epiphyseal ossification centre so that approximately one-sixth of the femoral head lies lateral to this line (*Figure 10*). In SCFE less of the femoral head lies lateral to this line (Laor et al, 1998). SCFE is best seen on a frog lateral view (*Figure 11*) and therefore AP and frog lateral views are recommended in all children over age of 9 years with hip pain.

Diagnostic work-up in adolescent: Plain films will usually reveal the diagnosis of SCFE. If these are normal, other causes of hip pain in this age group, e.g. neoplasia or trauma, should be excluded, and a bone scan is usually the next mode of investigation. An osteoid osteoma of the proximal femur may present as hip pain and shows up as a focal hot area and this may be revealed on the plain films (*Figure 12*). A CT scan is normally done to confirm findings and to guide percutaneous therapy for the tumour (Goldman et al, 1993).

CONCLUSION

The causes of hip pain in children are many and the diagnosis is based on the age group of the child, although overlap frequently occurs.

Many imaging modalities, e.g. US and MRI, are available to aid and occasionally to confirm the diagnosis but plain films remain the main-

stay of diagnosis and follow-up in these patients. They are the most cost effective and should be obtained in all cases. HM

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Figure 12. An osteoid osteoma of the left proximal femur. Note the sclerotic lesion (small arrow) surrounded by a lucency (large arrow) and a marked local periosteal reaction overlying the tumour (arrowheads).

Figure 11. A frog lateral view confirms that posteromedial and inferior displacement of the right capital femoral epiphyses.

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KEY POINTS

- The three common causes of hip pain in childhood are acute transient synovitis, Perthes' disease and slipped capital femoral epiphyses.
- Acute transient synovitis is the commonest cause of hip pain in children in the 2–7 years age group.
- Differentiation of acute transient synovitis from septic arthritis is clinical but if the diagnosis is in doubt, ultrasound-guided joint aspiration should be done.
- Plain films remain the mainstay for diagnosis and follow-up.
- Magnetic resonance imaging and bone scintigraphy show osseous abnormalities before plain film findings become evident in Perthes' disease.
- Trauma and tumours are important diagnostic differentials in all age groups.