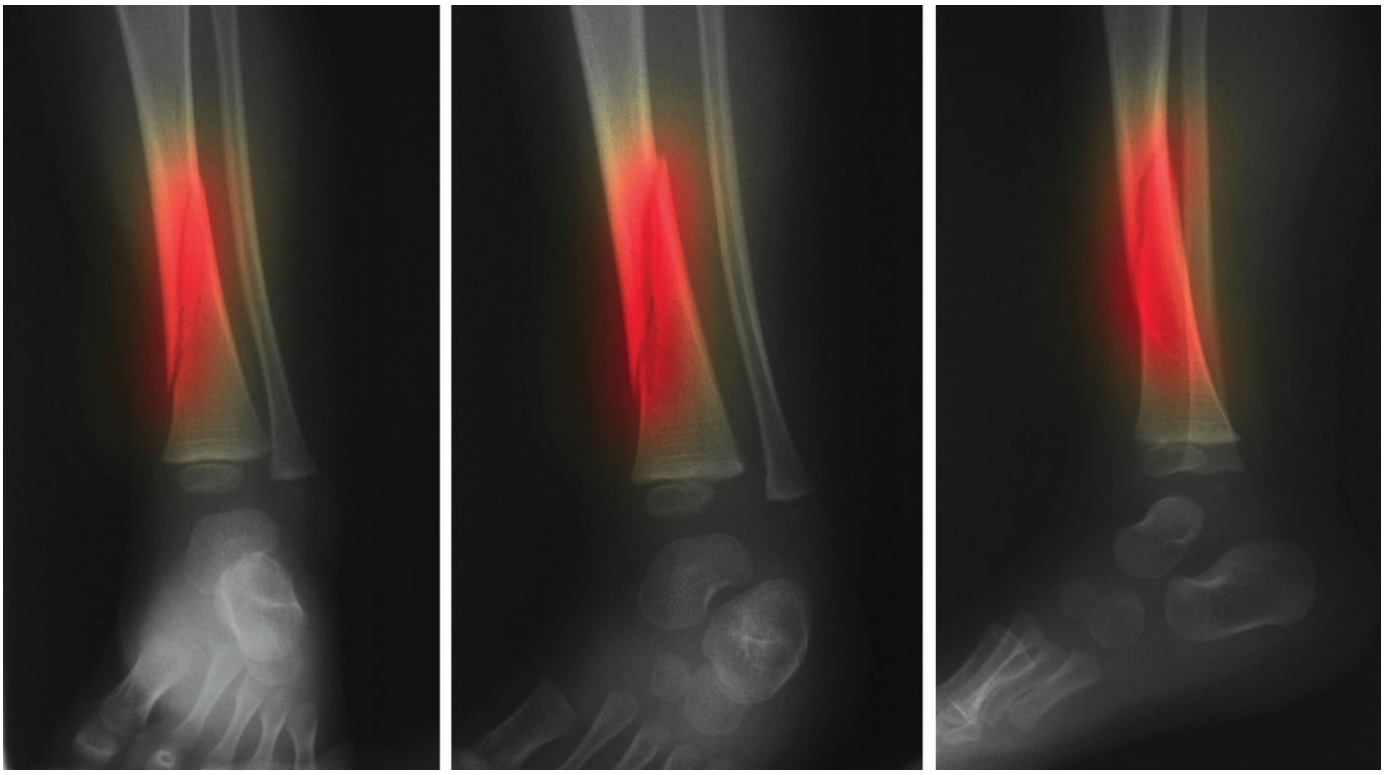

Radiographs showing a long spiral fracture of the tibia in a 2½-year-old boy.

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Evaluation of the Limping Child

A common problem in children, limp has numerous etiologies, such as infection, inflammation, trauma, and developmental issues. A thorough examination helps the urgent care physician determine the treatment course and whether child abuse is a possible factor.

Limp is a relatively common presenting symptom in children.[1] Defined as "any deviation from a normal gait pattern for the child's age"[2] or an "uneven, jerky, or laborious gait, usually caused by pain, weakness, or deformity,"[3] pediatric limp has multiple etiologies (Table 1).[1-17]

Certain factors are particularly helpful in distinguishing the cause of a limp: patient age, whether the limp is acute or chronic, whether the limp is painful or painless, and whether there are any associated systemic symptoms or a preceding trauma. Although some conditions may appear at any age (eg, fracture, osteomyelitis, septic arthritis), many conditions

typically present in a particular age range (Table 2).[17] For instance, slipped capital femoral epiphysis (SCFE) typically presents in preadolescence or adolescence. An acute onset of limp suggests trauma or infection, whereas gradual progression suggests a neuromuscular disorder, Legg-Calvé-Perthes disease (LCPD), SCFE, rheumatologic disease, or malignancy. Nocturnal pain and associated systemic complaints should raise suspicion for malignancy. It is often difficult to elicit a history of trauma or even pain, and it should be noted that referred pain is not uncommon in children. Thus, hip pathology may present as knee pain, and pain from the lower back may be referred to the lateral thigh.

CASE PRESENTATIONS

Case 1

A 2-year-old boy presents with a 2-day history of fever, refusal to walk, and decreased activity. On examination, the child is irritable, has a fever of 39°C, and cries when the physician's examining hand reaches toward his right hip. Plain films demonstrate no abnormalities. The patient's white blood cell (WBC) count is 15,000 cells/mm^3, erythrocyte sedimentation rate (ESR) is 60 mm/h, and C-reactive protein (CRP) level is 4 mg/dL (40 mg/L); hip ultrasound is pending.

Septic Arthritis

After the knee, the hip joint is the second most commonly infected joint in children with septic arthritis.[4] Bacteria may infect the hip either hematogenously or by direct extension from osteomyelitis of the femoral head. The physis of the hip is intracapsular; thus, infection of the proximal femoral metaphysis can easily spread to invade the joint space. Due to the potential for rapid joint destruction and long-term morbidity, it is critical to rapidly recognize and diagnose septic arthritis.[18] The most common organisms involved are streptococci and *Staphylococcus aureus*. The bacterial enzymes and products of the inflammatory cells can destroy the joint or the growth plate. Increased pressure from an effusion within the capsule may impede blood flow, resulting in avascular necrosis and consequent limb length discrepancy and decreased joint mobility.[19] Delayed treatment of septic arthritis can result in osteonecrosis of the femur, femoral osteomyelitis, and sepsis.[20]

Children with septic arthritis typically are febrile and appear ill. Weight bearing and movement of the hip are usually resisted in all age-groups. Only 8% of septic arthritis is multifocal or polyarticular; classically, it is monoarticular.[21] Importantly, prior antibiotic use (eg, in partially treated septic arthritis) may alter the presentation. Septic arthritis may also be a presentation of Lyme disease; thus, in endemic regions, children should be evaluated with antibody titers and serology.[22]

Since septic arthritis can be a challenging diagnosis, decision algorithms have been developed to identify predictors of disease. One large retrospective study demonstrated a less than 1% risk of septic arthritis in the absence of all the following: fever greater than 38.5°C within 1 week of presentation, refusal to bear weight, ESR greater than 40 mm/h, and WBC count greater than 12,000 cells/mm^3.[23] These findings were later validated.[24] Additionally, a CRP level greater than 2 mg/dL (>20 mg/L) was prospectively found to be an independent predictor of septic arthritis.[25]

The diagnosis of septic arthritis is confirmed by ultrasound-guided aspiration of inflammatory hip fluid with positive identification of a causative organism in a culture of synovial fluid or blood. A joint aspirate showing a WBC count of greater than 50,000 cells/mm^3 along with neutrophil predominance or the demonstration of bacteria by Gram stain is the diagnostic threshold for septic arthritis.[23] Immediate aspiration of the hip joint is recommended in the patient with an irritable hip to expedite diagnosis and treatment.[26]

Therapy consists of IV antibiotics and urgent drainage of the hip fluid to avoid buildup of intra-articular pressure that may impede the arterial supply. Empiric antibiotic regimens should cover gram-positive and gram-negative organisms, such as *S aureus* (often methicillin-resistant) and *Kingella kingae*; ceftriaxone or cefazolin with vancomycin may be the best choice prior to availability of culture results.[27]

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Delayed treatment of septic arthritis can result in osteonecrosis of the femur, femoral osteomyelitis, and sepsis.

TABLE 1. Etiologies of Limp in Children

Infection

Septic arthritis

Osteomyelitis

Discitis

Psoas abscess

Inflammation

Transient synovitis

Psoriatic arthritis

Systemic lupus erythematosus

Juvenile idiopathic arthritis

Spondyloarthropathy

Trauma

Toddler's fracture

Foot fractures (eg, calcaneus, cuboid)

Child abuse

Overuse injuries

- Chondromalacia patellae
- Stress fractures
- Sever disease—calcaneal apophysitis at the Achilles tendon insertion
- Sinding-Larsen-Johansson syndrome or "jumper's knee"—apophysitis of inferior pole of the patella at the patellar tendon insertion
- Osgood-Schlatter disease—osteochondrosis of the tibial tuberosity

Developmental

Slipped capital femoral epiphysis

Developmental dysplasia of the hip

Tarsal coalition

Aseptic necrosis

Legg-Calvé-Perthes disease

Osteochondrosis

Kohler disease—osteochondritis of the tarsal navicular

Freiberg disease—osteochondritis of the second, third, and fourth metatarsal

Tumors

Benign—osteoid osteoma, unicameral bone cysts, aneurysmal bone cysts, fibrous dysplasia, eosinophilic granuloma

Malignant—osteogenic sarcoma, Ewing sarcoma, leukemia, lymphoma, neuroblastoma

Neuromuscular causes

Peripheral neuropathy

Muscular dystrophy

Cerebral palsy

Other systemic causes

Gastrointestinal causes—appendicitis

Genitourinary causes—testicular torsion, epididymitis, ovarian cysts, pelvic inflammatory disease

Data extracted from Singer[1]; Leung and Lemay[2]; Brady[3]; Krogstad and Smith[4]; Taylor and Clarke[5]; Alexander et al[6]; Halsey et al[7]; Wenger et al[8]; Weinstein[9]; Lehmann et al[10]; Ledwith and Fleisher[11]; Aronsson et al[12]; Loder et al[13]; Gunner and Scott[14]; Flynn and Widmann[15]; Barkin et al[16]; Leet and Skaggs.[17]

Case 2

A 4-year-old boy is brought to urgent care by his mother because of a 1-day history of left hip pain. He recently had a viral upper respiratory tract infection, although he has no fever upon presentation. On examination, he appears well and holds his hip in external rotation and abduction. He walks upon request, but he has an antalgic gait. His radiographs are normal, WBC count is 8,000 cells/mm^3, ESR is 3 mm/h, and CRP level is 0.3 mg/dL.

Transient Synovitis

Characterized by pain and limited motion of the hip, transient synovitis, once called *toxic synovitis*, is relatively common, with an annual incidence of 0.2% and a cumulative lifetime incidence of 3%.[28] It is the most common cause of hip pain in children ages 3 to 10 years, with a 2:1 male predominance.[28,29] The etiology of transient synovitis is unknown, although it frequently occurs after a bacterial or viral infection, and symptoms

generally resolve within 1 week. Typically, children with transient synovitis are afebrile, appear well, and present with unilateral hip pain. The child usually prefers to keep the hip in external rotation and abduction and may refuse to walk or may walk with an antalgic gait. However, some children present with a high fever, and up to 5% may have bilateral symptoms. Furthermore, 25% of children presenting with unilateral symptoms have bilateral hip effusions on ultrasound.[30] Some children present with medial thigh or knee pain.

For children presenting with possible transient synovitis, the differential diagnosis of concern is septic arthritis. Unfortunately, there is no single test that clearly distinguishes septic arthritis from transient synovitis. Although ultrasound accurately detects an effusion, it does not determine the cause of this condition and is best used to guide hip aspiration. The aspirate may also assist the physician in differentiating transient synovitis from septic arthritis. A study by Lee et al proposed that MRI may be used to help distinguish transient synovitis from septic arthritis due to signal intensity alterations in the bone marrow[31]; however, more studies are needed to confirm this. Urgent care physicians should note that expensive tests, such as MRI, are not necessary to rule out septic arthritis in a child who has no fever and has a normal WBC count and inflammatory marker levels.

Management of transient synovitis is conservative with NSAIDs, heat, massage, and weight-bearing activities, as tolerated. The reported recurrence rate is as high as 15%.[5] Although rare, long-term complications of transient synovitis include coxa magna, which is an overgrowth of the femoral head that may be seen on radiographs, and degenerative disease of the femoral head.

Case 3

A 20-month-old otherwise healthy girl is brought to urgent care by her father due to a 1-day history of limp. He reports that the child fell while playing vigorously with her older brothers on the playground the previous day. On examination, the child is afebrile, appears well, and has mild tenderness to palpation along the distal right tibia. There is no ecchymosis or deformity. The radiographs demonstrate a faint oblique distal tibial fracture.

TABLE 2. Etiologies of Limp by Age in Toddlers and Children

Ages 1 to 3 years
Septic arthritis
Osteomyelitis
Fractures
Developmental dysplasia of the hip
Congenital limb length discrepancy
Ages 4 to 10 years
Septic arthritis
Osteomyelitis
Transient synovitis
Fractures
Kohler disease
Legg-Calvé-Perthes disease
Juvenile idiopathic arthritis
Leukemia
Ages 11 to 18 years
Septic arthritis
Sprains/fractures
Slipped capital femoral epiphysis
Osgood-Schlatter disease
Overuse syndromes
Tumors
Osteomyelitis

Data extracted from Leet and Skaggs.[17]

Toddler's Fracture

Occurring in children aged 9 months to 3 years, toddler's fracture was once thought to be an oblique undisplaced fracture of the distal third tibial shaft; however, it is now known to occur also in the distal half of the tibia. Toddler's fracture is considered a subset of childhood accidental spiral tibial fractures and involves an indirect twisting or rotational force applied to the foot.[32] Radiographs of the tibia may demonstrate a hairline fracture (Figure 1). Less than half of patients have a his-

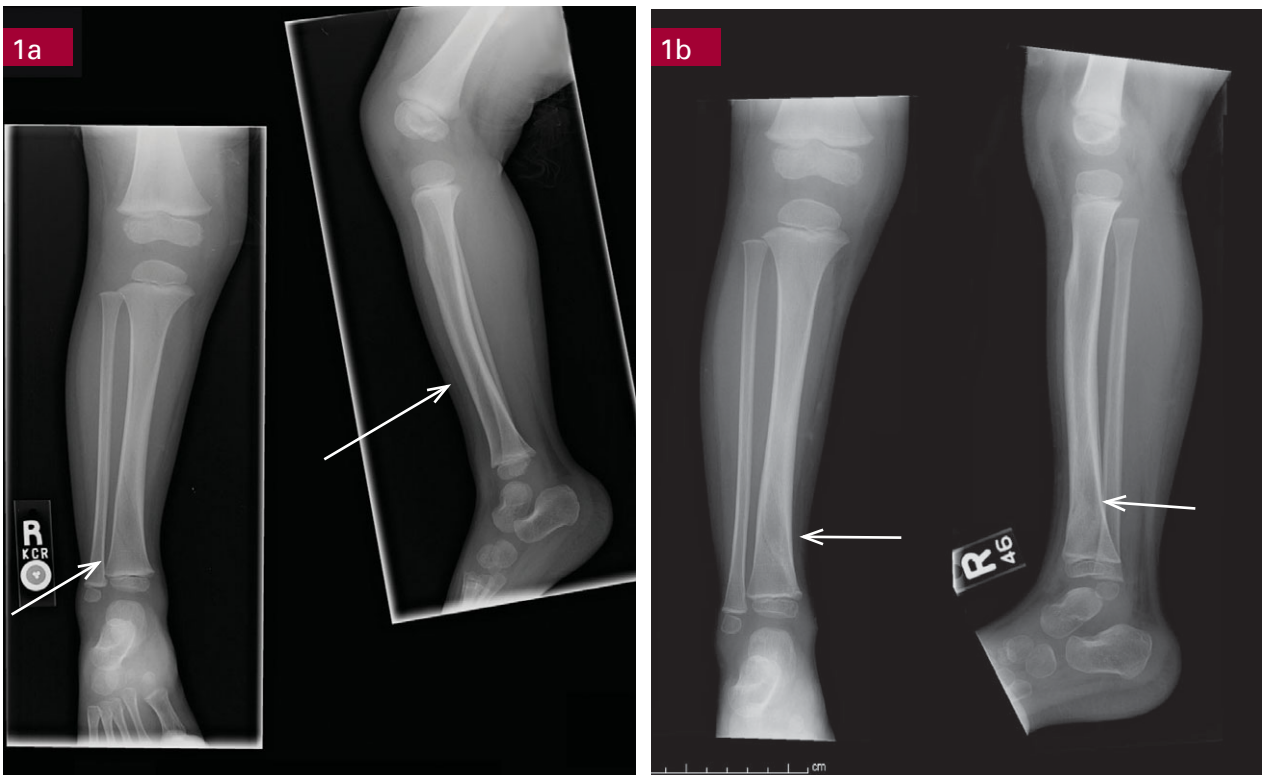


FIGURE 1. Toddler's Fracture. 1a. AP radiograph of the tibia revealing a toddler's fracture. **1b.** Lateral radiograph of the tibia revealing a toddler's fracture.

tory of obvious trauma, and the mechanism for the responsible injury may be trivial. The chief presenting symptom is typically a limp or refusal to bear weight.[33] Physical examination findings are often subtle with no apparent bruising or deformity, although there may be some local tenderness. Additionally, radiographs are completely normal in up to 43% of cases[32] or show only elastic bowing or periosteal calcification of the bone. The fracture may be seen only on the internal oblique view, but if all views are normal and a toddler's fracture is still suspected, a nuclear bone scan should be considered.

Though most spiral fractures suggest child abuse, spiral fractures of the mid and lower tibia have no such connotation.[6] However, if a child has a midshaft transverse tibial fracture, child abuse should still be considered in the differential diagnosis. Accidental fractures are rare in children younger than 12 months.[34] Table 3[35] outlines other injury patterns or signs that should raise the suspicion of child abuse. Children with a toddler's fracture require a short leg walking cast for 3 to 6 weeks.[7,35]

Case 4

A 6-year-old boy is brought to urgent care by his parents because of a gradual onset of limp, first noticed by his teacher. The child, who is afebrile, does not complain of pain but does walk with a Trendelenburg gait and holds his left hip in an internally rotated and abducted position. The plain radiographs demonstrate a radiolucent area in the anterolateral epiphysis of the left femoral head, and the radiologist reports a positive crescent sign (Figure 2).

Legg-Calvé-Perthes Disease

Most commonly occurring in children between ages 3 and 12 years, LCPD results from idiopathic avascular necrosis of the femoral head.[8] Although the definite etiology is unknown, an association has been found with secondhand smoke, low so-

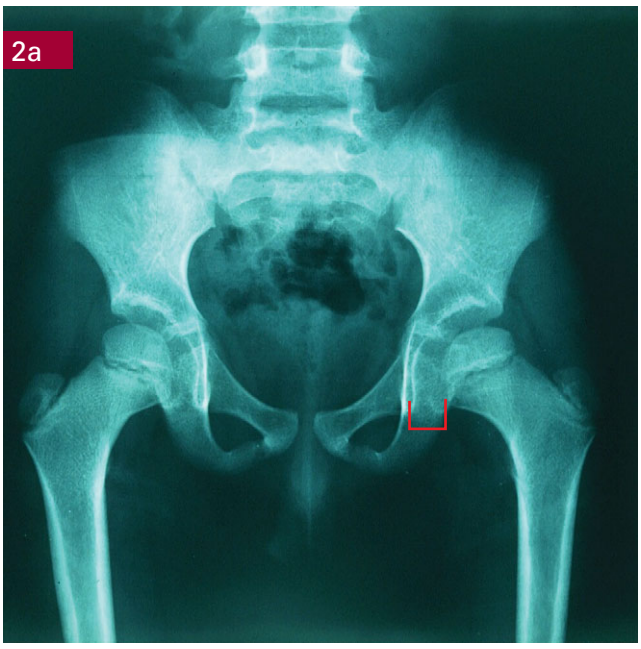
cioeconomic status, and transient synovitis.[36] There is a 4:1 male predominance, and while the majority of cases are unilateral, up to 10% are bilateral.

Onset is usually insidious, and children will classically demonstrate a Trendelenburg gait. Physical examination may reveal an internally rotated and abducted hip, as well as atrophy of the affected thigh muscles.[9] Anteroposterior (AP) and lateral hip radiographs, along with frog-leg views, are helpful in diagnosis; however, the diagnosis can be difficult, as the initial radiographs may be normal. Subtle findings in the early stages include a smaller, dense-appearing epiphysis and widening of the medial joint space, associated with an irregular physis. The crescent sign, a subchondral radiolucent zone in the anterolateral epiphysis representing a subchondral fracture, may be present. Five sequential radiographic stages have been described and include (1) smaller femoral head epiphysis and articular space widen-

TABLE 3. Presentation Patterns and Fracture Types Suggestive of Child Abuse

Presentation Patterns
Fractures inconsistent with the developmental age of the child
History inconsistent with physical injuries
Repeated health care visits for different injuries
Multiple fractures or fractures in different stages of healing
Delay in seeking medical attention
Fracture types
Metaphyseal-epiphyseal fractures
Rib fractures
Vertebral fractures
Finger fractures in nonambulatory children
Midshaft humerus fractures in children younger than 3 years

Data extracted from Carty.[35]



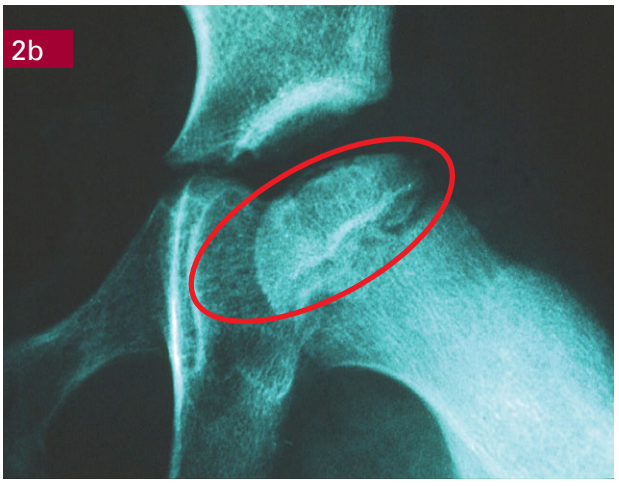


FIGURE 2. Radiographic Indications of Legg-Calvé-Perthes Disease. **2a.** Widening of the left hip joint. **2b.** Subchondral collapse along with the crescent sign.

FIGURE 3. Slipped Capital Femoral Epiphysis Demonstrated on Lateral Radiograph. **3a.** Pelvis widening of the physis on the right. **3b.** The epiphysis slipping posteriorly and inferiorly.

ing, (2) subchondral fracture, (3) resorption of bone, (4) ossification of new bone and, finally, (5) a healed stage.[8] Early on, before changes are evident on plain films, a bone scan will demonstrate decreased perfusion to the femoral head and MRI may reveal marrow changes.[37]

LCPD does not require emergent inpatient treatment. In fact, in children younger than 6 years it may necessitate only observation with bed rest and instructions for abduction stretching exercises, as a younger age at onset is associated with a better prognosis. An orthopedic consultation should be obtained for further management. Treatment for LCPD aims to maintain the femoral head in the acetabulum with external splints. Surgery may be required if there are gross de-

formities of the femoral head.[38] The long-term outcome of LCPD depends on the age at onset and the degree of involvement of the femoral head.[39] A younger age at onset is associated with a better prognosis; children older than 10 years have a high rate of osteoarthritis.

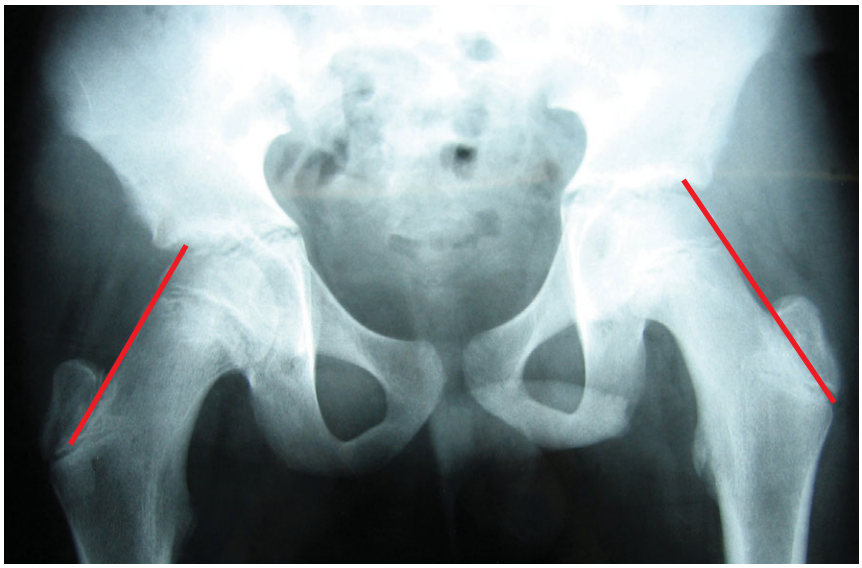


FIGURE 4. Klein's Line Drawn Along the Greater Trochanter.
Note, the line does not cross the epiphysis on the side with slipped capital femoral epiphysis, unlike on the normal side, where the line clearly intersects the epiphysis.

Case 5

A 13-year-old obese boy presents with right anterolateral thigh pain and a limp, which he says began after playing soccer in physical education class earlier in the day. He notes that he fell several times during the game but was able to bear weight through the end of the game. On examination, he is afebrile and appears well. He has no tenderness to palpation of his right thigh, but he has decreased internal rotation and flexion mobility of the affected hip. When the clinician asks him to flex his hip, the patient attempts to externally rotate and abduct the hip. The lateral plain radiographs demonstrate slipped capital femoral epiphysis (Figure 3).

Slipped Capital Femoral Epiphysis

This condition results when the femoral epiphysis slips posteriorly, causing impaired internal rotation of the hip. The classic presentation of SCFE involves an obese adolescent, with a mean age of 12 years in girls and 13.5 years in boys and a male-to-female ratio of 1.5:1. In one series, the relative incidence of SCFE was reported as nearly four times higher in black children and 2.5 times higher in Hispanic children than in white children.[10] The slipped epiphysis is bilateral in 20% to 40% of cases. Although some patients report a history of acute pain or minor trauma, there typically is a gradual onset of chronic hip or knee symptoms associated with an antalgic or Trendelenburg gait; however, the presentation is quite variable. Some patients may not have any pain or may have pain referred to the knee or the anterior thigh.[11] Physical examination may demonstrate decreased flexion of the affected hip, and patients may attempt to externally rotate and abduct the hip when flexing the hip. Internal rotation of the hip is decreased and usually painful.

AP and frog-leg radiographs are often diagnostic. The degree of slippage and radiographic classification is determined by the amount of femoral head displacement off the femoral neck. Type I involves less than 33% displacement; type II, 33% to 50% displacement; and type III, more than 50% displacement. Normally, on an AP radiograph, Klein's line, which is a line that is drawn along the superior aspect of the femoral neck, intersects the epiphysis (Figure 4). If it does not, SCFE is likely. Likewise, on the frog-leg radiograph, a line drawn through the center of the proximal femur should intersect the center of the epiphysis, but if the line falls anterior to the epiphysis, SCFE is likely. MRI, CT, and bone scan-

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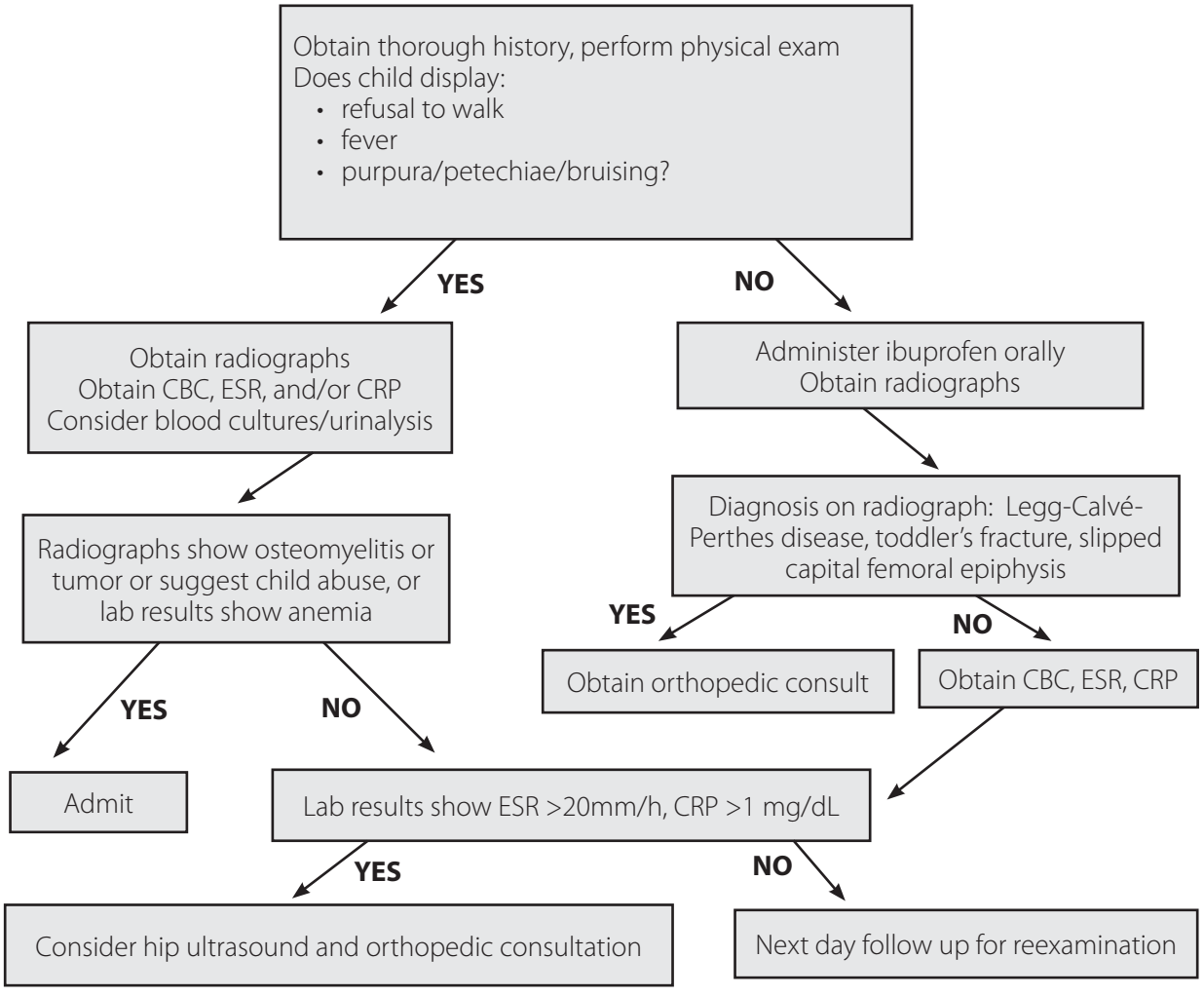
Unstable SCFEs have an increased risk for osteonecrosis and, if untreated, can lead to degenerative joint disease.

FIGURE 5. Algorithm for the Evaluation and Management of the Limping Child



CBC = complete blood count; ESR = erythrocyte sedimentation rate; CRP = C-reactive protein level

ning may help confirm the diagnosis of SCFE and assess the degree of displacement and arterial perfusion. While there may be no changes on plain radiographs early in the disease, MRI findings are diagnostic.

SCFEs are classified as *stable* if the patient can walk with or without the aid of crutches and *unstable* when the patient cannot walk. Stable SCFEs are optimally treated with a single-screw fixation in situ, while an unstable SCFE is treated with urgent joint aspiration, followed by closed reduction and single- or double-screw fixation.[12] Unstable SCFEs have an increased risk for osteonecrosis and, if untreated, the condition is associated with the risk for progression and degenerative joint disease.[13] There is evidence that surgical intervention within 24 hours of SCFE onset leads to significantly fewer complications.[40] Thus, emergent orthopedic consultation and hospitalization are indicated. In the event of a suspected SCFE, the patient should immediately be restricted from bearing weight.

OTHER POSSIBLE ETIOLOGIES

Systemic Rheumatologic Diseases

The most common rheumatologic diseases that present with isolated hip arthritis are the spondyloarthropathies, especially psoriatic arthritis. This condition is often difficult to diagnose, as classic skin changes sometimes do not manifest until after the onset of arthritis. Juvenile idiopathic arthritis, previously known as juvenile rheumatoid arthritis, rarely presents with isolated hip disease, and when it does involve the hip, it is usually in the setting of a systemic inflammatory state involving other joints.[14]

Tumors and Malignancies

Osteoid osteoma is a benign bone tumor that may present with hip pain, as its most common site of occurrence is the proximal femur. Typically, patients present with nocturnal, aching bone pain relieved by NSAIDs. On plain radiography or CT, the lesion may be visible as a lucency with surrounding cortical thickening.

Leukemia, specifically acute lymphoblastic leukemia, is the most common malignancy to present as bone pain in children. The pain is due to leukemic infiltration of the bone. Other neoplasms that can involve joints include neuroblastoma, lymphoma, Ewing sarcoma, and other soft-tissue sarcomas. Warning signs of possible malignancy include nocturnal bone pain, pain that is localized away from a joint, or laboratory findings of anemia, thrombocytopenia, or elevated levels of lactate dehydrogenase or uric acid.[2]

OVERALL APPROACH TO LIMP IN CHILDREN

When a child comes to urgent care with refusal to walk or a limp, a complete history and physical examination, including evaluation of the abdominal and genitourinary systems, should be performed to assess for systemic symptoms or signs, evaluate for child abuse, and assist in directing the diagnostic process (Figure 5). Hip pathology should always be considered in a child presenting with knee pain, as the former often presents with referred pain to the knee; in other words, "knee pain equals hip pain." Leg and foot bones should be palpated and all joints should be taken through the full range of motion.

Gait analysis is helpful in narrowing the differential diagnosis. Ideally, the child should be observed walking while barefoot and unclothed, walking and, if possible, running down a hallway to allow the physician determine the type of limp. A normal gait consists of symmetric motions involving two sequential phases: swing and stance.[15] Typically, the stance phase is longer than the swing phase. With an antalgic gait, the stance phase is shortened to decrease the period of pain during walking on the affected side. A Trendelenburg gait is a downward pelvic tilt away from the affected hip, resulting from a weakened gluteus medius muscle on the affected side[16]; the patient may lean toward the affected side to balance the pelvis. A steppage gait results from exaggerated hip and knee flexion during the swing phase due to an inability to actively dorsiflex the foot; this is sometimes seen in children with neuromuscular diseases, such as cerebral palsy. Children with a leg length discrepancy may have a vaulting gait in which the knee is hyperextended and locked at the end of the stance phase.

For most well-appearing toddlers, consider the following plan: Provide oral ibuprofen and order plain films of the affected leg, making sure to request more than one view of the limb. If the patient easily ambulates and has a normal physical exam and normal x-rays, close follow-up with the primary care physician may be all that is warranted. In these patients, transient synovitis is by far the most common diagnosis. Older patients may also be evaluated for LCPD and SCFE.

In patients with any systemic signs or symptoms or continued refusal to walk after administration of ibuprofen, additional laboratory testing is needed, including a complete blood count and ESR and CRP measurement. If septic arthritis is suspected due to physical exam findings or laboratory abnormalities, ultrasound of the hip may be ordered to evaluate for an effusion. If an effusion is present, diagnostic hip aspiration is warranted. If the aspirate indicates septic arthritis, the patient should

>>FAST TRACK<<

Gait analysis is helpful in narrowing the differential diagnosis. Ideally, the child should be observed walking while barefoot and unclothed.

be hospitalized for parenteral antibiotic therapy. Additionally, any patient with a limp should be admitted for further evaluation if serious conditions, such as septic arthritis, child abuse, or SCFE, remain in the differential diagnosis.

Although a diagnostic challenge, limp in a child should be approached with a management algorithm based on age, history, and physical examination findings, as well as directed radiographic and laboratory evaluation. □

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