Limping: Evaluation, Diagnosis, and Management in the Pediatric ED

A 6 year-old male is brought to the pediatric ED for evaluation of limping that has worsened over the last month. He has complained of intermittent right-sided hip pain with occasional limping over the last 6 months. The parents do not recall any history of trauma. They report that he had a cold during the last 6 months, but nothing out of the ordinary. He has had no fever and no weight loss. He has been seen by his physician several times for the pain and limping. He was previously diagnosed with transient synovitis and muscle strain. Treatment consisted of rest and ibuprofen. He reported temporary relief of the pain with ibuprofen. However, the parents are concerned that the limping is more noticeable, and the child is unable to play like he used to. They want to know when he will walk normally again.

As you evaluate this child, several questions run through your head: How do I make a diagnosis in a problem that has been ongoing for 6 months? Will lab tests help me? Should I bother with plain films or get an MRI? What part of the leg do I image? Is this a tumor?

Children often present to the ED with a limp. When there is a history of trauma, the management is often straightforward. Without a history of trauma, the differential can be overwhelming. The causes of limping or leg pain in a child can be as benign as “growing pains” or as malignant as a tumor. To avoid a “shot gun”

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CME Objectives
Upon completing this article you should be able to:
1. Review the evidence on the evaluation of a child with a non-traumatic limp.
2. Manage and evaluate septic arthritis vs. transient synovitis.
3. Evaluate the resources available that are helpful for diagnosing the limping child.
4. Determine the potential diagnoses and treatments for the limping child.

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approach in the evaluation of a child with a non traumatic limp, the emergency physician should be knowledgeable in the history and physical examination findings of the common etiologies of the limping child to avoid unnecessary tests and radiographs. In this issue of Pediatric Emergency Medicine Practice, we will review the available evidence on the evaluation of a child with a non traumatic limp.

**Abbreviations Used in this Article**

- AP – Antero-posterior
- CBC – Complete Blood Count
- CRP – C Reactive Protein
- CT – Computed Tomography
- ED – Emergency Department
- ESR – Erythrocyte Sedimentation Rate
- HSP – Henoch Schölein Purpura
- JRA – Juvenile Rheumatoid Arthritis
- LCPD – Legg-Calve-Perthes disease
- MRI – Magnetic Resonance Imaging
- NSAID – Nonsteroidal anti-inflammatory drug
- ROC – Receiver Operator Characteristic
- SCFE – Slipped Capital Femoral Epiphysis
- WBC – White Blood Cell

**Critical Appraisal of the Literature**

While limping has been reported and studied for over 100 years, the past 10 years have yielded very little new literature in support of the ED approach to the diagnosis and treatment of limping. While there are several review articles discussing the evaluation and management of the child with a limp, there is a lack of methodologically sound studies examining this broad topic, specifically regarding the overall approach to the limping child. Most studies relate to the management of specific disorders once the diagnosis is already made. The key, of course, is getting to the correct diagnosis. In general, the history and physical examination will help narrow the focus in the extensive differential diagnosis and help guide the ED physician in the initial work-up and management.

**Epidemiology, Etiology, and Pathophysiology**

**Epidemiology**

The literature on the epidemiology of the child with a limp presenting to the ED is quite limited. One study reported up to 4% of pediatric ED visits are for evaluation of limping or refusal to walk. Limping was more common in males than females (1.7:1) with a median age of 4.3 years. Toddlers are very active but have immature gaits leading to frequent falls. Infections are common in this age group since the bony cortex is developing and there is little resistance to bacterial invasion. School-aged children are more ambulatory and rambunctious which increases their risk of injuries. Jumping off objects, such as bunk beds, trampolines, and trees can lead to injuries such as fractures, dislocations, and ligamentous injuries. In this age group, the bony architecture is more mature and resilient. Muscle strength has also increased dramatically. A SCFE is an example of how bone maturation, strength, and weight-matches can result in problems.

**Etiology**

Abnormal gait in children may be due to a wide variety of causes including infectious, inflammatory, musculoskeletal, and malignant. In a prospective study conducted in a pediatric ED during a 6 month period, Fischer et al found an incidence of acute atraumatic limp of 1.8/1000. Of the 243 subjects studied, 193 (80%) presented with pain; the hips and knees were the most common locations of pain, occurring in 33.7% and 19.3% of the subjects, respectively. The most common diagnosis was transient synovitis or “irritable hip,” comprising approximately 40% of the subjects. Of note, 63 of the 243 subjects (26%) had no definitive diagnosis.

Studies on septic arthritis and osteomyelitis have shown a tremendous decline in Haemophilus influenza b as a pathogen in pediatric septic arthritis in the late 1990’s compared to the 1980’s and earlier, largely due to widespread immunization programs. Most recent studies report Staphylococcus aureus as the predominant organism isolated in bacterial septic arthritis and osteomyelitis in all age groups, accounting for up to 53% of the cases. In Moumile’s study, Kingella kingae was the second most common organism, occurring in 14% of the total isolates. This was followed by Streptococcus pyogenes and Streptococcus pneumoniae. In Luhmann’s study, Staphylococcus aureus, Streptococcus pyogenes, and Enterobacter were the common organisms, followed by Kingella, Neisseria meningitides, Streptococcus pneumoniae, Neisseria gonorrhoeae, Candida, and Staphylococcus epidermidis. The pathogens involved may also exhibit some geographic variability. In a study conducted in Israel from 1988-1993, Kingella and Haemophilus influenza b...
were the two most common organisms isolated in patients less than 2 years of age with septic arthritis. Among neonates, *Staphylococcus aureus* remains the most common pathogen, followed by *Escherichia coli* and Group B *Streptococcus*. *Salmonella* was found to be the predominant organism causing osteomyelitis in patients with sickle cell disease, though *Staphylococcus aureus* is also a common pathogen.

**Pathophysiology**

Walking is comprised of two distinct phases, the stance and the swing. In order for gait to be smooth and fluid, joint flexibility, pelvic rotation, pelvic tilt, balance, and strength all have to be unimpaired. Any aberration of the cycle will be noticed as a limp. The type of limp can help determine the cause. Limps have been divided into three types: antalgic, trendelenburg, and short leg. The antalgic or “quick step” gait is a painful limp with a shorter stance on the affected or painful leg. It is commonly seen with traumatic injuries (fractures, sprains, or strains), tumors, or infectious etiologies. The Trendelenburg or “lurch gait” is a painless limp primarily due to musculoskeletal weakness. The affected hip drops down during the swing phase of the contralateral leg. The pelvis tilts into the affected side when standing. This may be seen with LCPD, SCFE, developmental dysplasia of the hip, and neuromuscular diseases (poliomyelitis).

The developmental status of the child must be taken into consideration when assessing a gait disorder. Limping cannot be diagnosed until the infant can stand. Infants generally pull to a stand by nine months of age and start to “cruise” around while holding onto furniture or other items. Most children older than one year can walk unassisted. Toddlers initially have a wide-based gait. Intrinsic hip abductor weakness leads to a mild Trendelenburg gait and a noticeably shorter stance phase. By age three, children have assumed adult gait characteristics.

<table>
<thead>
<tr>
<th>Table 1. Differential for the limping child</th>
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<tbody>
<tr>
<td><strong>Congenital</strong></td>
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<tr>
<td>Developmental dysplasia of the hip</td>
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<td>Coxa vara</td>
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<td>Congenital short femur</td>
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<td>Spinal dysraphism</td>
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<td>Meyers dysplasia</td>
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<td>Multiple epiphyseal dysplasia</td>
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<td>Leg length discrepancy</td>
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<td><strong>Inflammatory/Rheumatologic</strong></td>
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<td>Juvenile rheumatoid arthritis</td>
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<td>Ankylosing spondylitis</td>
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<td>Rheumatic fever</td>
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<td>Psoriatic Arthritis</td>
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<td>Systemic lupus erythematosis</td>
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<td>Scleroderma</td>
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<td>Dermatomyositis</td>
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<td>Henoch Schonlein Purpura</td>
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<td>Mixed Connective Tissue Disease</td>
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<td>Inflammatory Bowel Disease</td>
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<tr>
<td><strong>Infectious</strong></td>
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<td>Transient synovitis</td>
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<td>Septic arthritis</td>
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<td>Osteomyelitis</td>
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<td>Cellulitis</td>
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<td>Diskitis</td>
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<td>Lyme Disease</td>
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<td>Tuberculous arthritis</td>
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<td>Postinfectious reactive arthritis</td>
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<td>Ingrown toenail</td>
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<td><strong>Degenerative</strong></td>
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<td>Legg-Calve-Perthes</td>
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<td>Kohler’s disease</td>
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<td>Sever’s disease</td>
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<td>Osgood Schlatter’s disease</td>
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<tr>
<td>Slipped capital femoral epiphysis</td>
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<td>Osteochondritis dissecans</td>
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<td><strong>Trauma</strong></td>
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<td>Toddler’s fracture</td>
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<td>Fractures</td>
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<td>Accidental or Inflicted</td>
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<td>Stress fracture</td>
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<td>Spondylolisthesis</td>
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<td>Ruptured plantaris tendon</td>
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<td>Knee strain</td>
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<td>Meniscal injuries</td>
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<td>Sprains and Strains</td>
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<td>Herniated nucleolus pulposis</td>
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<td>Torn plantaris tendon</td>
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<td>Patellofemoral disorders</td>
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<td>Overuse syndromes</td>
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<td>Drugs</td>
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<td>Rickets</td>
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<td>Scurvy</td>
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<td>Hyperparathyroidism</td>
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<tr>
<td><strong>Neuromuscular</strong></td>
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<tr>
<td>Muscular dystrophy</td>
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<td>Cerebral palsy</td>
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<tr>
<td>Guillain-Barre</td>
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<tr>
<td>Tick paralysis</td>
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<tr>
<td><strong>Other</strong></td>
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<tr>
<td>Sickle cell disease</td>
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<td>Hemophilia</td>
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<tr>
<td>Blount’s disease</td>
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<td>Tarsal coalition</td>
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<td>Conversion reactions</td>
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<td>Referred pain</td>
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<td>Abdominal or genital</td>
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Differential Diagnosis

The differential diagnosis of limping is extensive. (See Table 1 on page 3). There may also be some variations in the common diagnoses based on the age of the patient. (See Table 2). The following is a description of the various etiologies of limping in children.

Congenital

Hip dysplasia has previously been called “congenital hip dislocation.” The current accepted term of developmental dysplasia of the hip illustrates that the infant hip may be abnormally developed but not actually dislocated. The diagnosis is not always made in the nursery. It may not come to attention until the child becomes ambulatory, at which time a Trendelenburg gait may be noted. An ultrasound is used for diagnosis in early infancy, while plain films are more useful in the older child. Orthopedic referral is needed for further treatment.

Inflammatory/Rheumatologic

Numerous rheumatologic illnesses have arthritis as a significant symptom. Therefore, they can present with limping as the primary complaint. Initially, it may be difficult to make the diagnosis, particularly if only one joint is involved. In these cases, it may be confused with a septic arthritis. Other systemic signs and symptoms, and chronicity of the arthritis may help make the correct diagnosis. For instance, an associated rash, eye abnormalities, recurrent fever, or other joint pain in the past may lead the physician toward a diagnosis of JRA. Psoriasis and inflammatory bowel disease may have arthritis associated with their other findings. Ironically, the arthritis can precede the skin changes in psoriatic arthritis. HSP may also present with joint pain and limping before the typical purpuric rash in 15% of the cases.22

Historical and examination findings with HSP include abdominal pain, palpable purpura (usually localized to the lower extremities and buttocks), joint pain, hematuria, hematoochezia, hematemesis, headaches, and peripheral edema. Approximately 40% of patients may have had a preceding illness such as an upper respiratory tract infection.23, 24

Infectious

Many infectious diseases include a component of arthritis or arthralgias either as an acute finding, or as a post-infectious or reactive arthritis. These include post-streptococcal arthritis, as well as viral illnesses such as hepatitis and Coxsackie virus.

A more serious bone and joint infection can be easily missed and result in permanent sequelae if the diagnosis is delayed. Findings include swelling, erythema, and tenderness near the area of infection. Osteomyelitis in the pediatric population is commonly spread hematogenously. Staphylococcus aureus and Streptococcus pyogenes (group A beta-hemolytic streptococcus) constitute the major pathogens. In some circumstances, other pathogens need to be considered. Neonates are susceptible to group B Streptococcus and Escherichia coli, adolescents to

<table>
<thead>
<tr>
<th>Table 2. Common etiologies of the limping child by age groups</th>
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<tr>
<td><strong>Toddlers (1 – 3 years)</strong></td>
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<tr>
<td><strong>Infectious</strong></td>
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<tr>
<td>Septic arthritis</td>
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<tr>
<td>Transient synovitis</td>
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<tr>
<td>Osteomyelitis</td>
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<tr>
<td><strong>Trauma</strong></td>
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<tr>
<td>Toddler’s fracture</td>
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<tr>
<td>Stress fracture</td>
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<tr>
<td>Child abuse</td>
</tr>
<tr>
<td><strong>Congenital</strong></td>
</tr>
<tr>
<td>Developmental dysplasia of hip</td>
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<tr>
<td><strong>Neuromuscular</strong></td>
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<tr>
<td>Cerebral Palsy</td>
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Neisseria gonorrhea, and sickle cell patients to Salmonella. In addition to examining the involved extremity, a complete evaluation should include the spine and pelvis to rule out a diskitis or sacroiliac disease.

Transient synovitis may present in a similar manner to septic arthritis. It is a self-limited inflammation of the synovial lining, usually resolving within 3 to 10 days of the onset of symptoms. It is the most common cause of painful limp in childhood, accounting for up to 40% of non traumatic limps. Although the cause is unknown, it is hypothesized that transient synovitis is due to a post-infectious phenomenon. It often presents following a viral illness or upper respiratory infection.

Lyme disease, a tick-borne infection due to Borrelia burgdorferi, also includes arthritis as a characteristic feature. Lyme arthritis can be classified according to the number of joints involved and duration. Episodic arthritis involves 1 to 4 joints for a duration of <1 week with recurrence at least 2 weeks later. Acute and chronic pauciarticular arthritis involves 1 to 4 joints with chronic form lasting >4 weeks. The disease includes the typical expanding target lesion (erythema migrans), involvement of central and peripheral nervous systems, and migratory arthritis. Bilateral Bell’s Palsy can be seen with Lyme disease.

Traumatic
When a clear history of trauma precedes the limp, the diagnosis is often much easier to make. However, toddlers can present without a history for injury, or with a trauma or fall that is thought to be insignificant. Such a scenario is often found in children who have a fracture of the tibia, known as the toddler’s fracture. (Please see Figure 1 on page 6.) The toddler’s fracture is a spiral, oblique, non-displaced fracture of the distal tibia, typically seen in children <3 years of age. Sometimes the fracture is only picked up on oblique views of the tibia, follow-up radiographs done weeks later, or by bone scan. Halsey et al found the most common symptoms of a toddler’s fracture to be point tenderness and refusal to bear weight. The sensitivity and specificity of point tenderness (59% and 53%, respectively) and refusal to bear weight (82% and 30%, respectively) were found to be poor. In the same study, patients with a presumptive diagnosis of toddler’s fracture were placed in a long leg cast or splint. However, 21 of the 59 patients did not have evidence of fracture even on follow-up x-rays. The final diagnosis in these patients is not known, and the inconvenience of taking care of a toddler in a long leg cast or splint is not discussed. Also, the question of what would have happened if these children were not splinted still remains unanswered.

Lower extremity fractures in non-ambulatory children should also raise suspicion for non-accidental trauma. Look for bucket handle fractures or corner fractures that are suggestive of child abuse. While spiral fractures are traditionally thought of as being suspicious for non-accidental trauma and are more likely to be investigated, they are not pathognomonic for abuse. Scherl et al found equal numbers of transverse and spiral femur fractures among cases with positive results of investigations for abuse. Mellick also found that isolated spiral tibial fractures are most commonly accidental. The history surrounding the event and other evidence of injury or neglect help determine whether child protective services investigation is warranted.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Classic historical or physical findings</th>
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<tbody>
<tr>
<td>HSP</td>
<td>Palpable purpuric rash (lower extremity), abdominal pain</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>Tick bite, erythema migrans, migrating arthralgia</td>
</tr>
<tr>
<td>Guillain-Barre</td>
<td>Ascending weakness/paralysis, lack of DTR*</td>
</tr>
<tr>
<td>Systemic Lupus Erythematosis</td>
<td>Malar rash, discoid rash, photosensitivity</td>
</tr>
<tr>
<td>JRA</td>
<td>Uveitis, iridocyclitis, fever, painful nodules on extensor surfaces, salmon colored evanescent rash</td>
</tr>
<tr>
<td>Dermatomyositis</td>
<td>Proximal muscle weakness, heliotrophic rash</td>
</tr>
<tr>
<td>Osgood Schlatter’s Disease</td>
<td>Pain on tibial tuberosity, increased pain with repeated activity</td>
</tr>
<tr>
<td>Leukemia/lymphoma</td>
<td>Weight loss, fever, pallor, petechiae</td>
</tr>
<tr>
<td>Rheumatic fever</td>
<td>Erythema marginatum, subcutaneous nodules, Sydenham’s chorea, carditis</td>
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</table>

* deep tendon reflexes
Toxic/metabolic
Toxic/metabolic causes include drugs, rickets, scurvy, and hyperparathyroidism. Surprisingly, some drugs can cause limb pain and present as limping. Vitamin A intoxication and carbamazepine have been implicated.

Corticosteroids, ergotamine, phenothiazines and thiazides may cause muscle cramps. Hypercalcemia can cause bone pain. Rickets, the most common form of which in the U.S. is vitamin D deficient rickets, may also be associated with fractures and pain. Other metabolic diseases that affect the skeletal system include the mucopolysaccharidoses. All of these disorders usually involve some type of spinal deformity, with kyphosis being the most common.

Neoplasia
Neoplastic causes of limping include benign bone tumors (unicameral and aneurysmal bone cysts), malignant bone tumors (Ewing’s sarcoma, osteosarcoma), metastatic bone disease, and leukemia or lymphoma. Several case studies are reported with children presenting with limping and bony pain in which a subsequent diagnosis of a malignancy is made. Concurrent systemic signs and symptoms of fever, weight loss, lymphadenopathy, or hepatosplenomegaly should prompt further investigation with laboratory studies, particularly a CBC to evaluate cell lines, and radiographs as indicated by the examination.

Primary malignant bony tumors such as osteosarcoma or Ewing’s sarcoma commonly involve the long bones, and thus may be seen in the lower extremity. Growing children are affected most often, with the peak incidence occurring in the pre-teen and early teen years. Spinal tumors, such as sacrococcygeal teratoma or bony tumors of the axial skeleton may also cause lower extremity weakness, back pain, and limping.

Benign bone lesions such as osteochondromas and osteoid osteomas may be found in the limping child. Osteoid osteomas are a common benign bone tumor that may occur in the lower extrem-

Figure 1. A nondisplaced oblique spiral fracture suggestive of a toddler’s fracture
ity or back, causing limping and pain. It is common in early adolescence, with pain characteristically worse at night, and relieved by NSAIDs. Radiographs usually confirm the diagnosis.

**Degenerative**

Degenerative causes of limping include avascular necrosis of the femoral head, LCPD. LCPD is caused by osteonecrosis of the proximal epiphysis of the femoral head. LCPD is most likely the result of repeated trauma to the hip in active boys which may impair the blood supply to this area. It is most commonly seen in children ages 4 to 10 years. Patients typically present with chronic limping. While it is classically known as a “painless limp,” there may be associated hip pain and referred pain to the ipsilateral knee or groin. Swelling and tenderness on examination are rare. Patients may also keep the hip externally rotated with limited abduction and internal rotation. Avascular necrosis of the femoral head has also been reported to be increased in children with renal failure. In one study, it was noted to occur in 1 out of 15 children with renal failure, which is a significantly higher rate than the general pediatric population. Children who are being treated with corticosteroids may be at a higher risk, although avascular necrosis has been noted to occur in the absence of steroid use. Patients with sickle cell disease may also be at increased risk for developing avascular necrosis of the femoral head. Laboratory tests are generally normal, and plain radiographs of the hips make the diagnosis once significant necrosis has occurred.

Osgood Schlatter’s disease is characterized by pain over the tibial tuberosity. This disease is felt to be a result of repeated microtrauma to the insertion of the patellar tendon, similar to Sever’s disease, which is pain in the area of the insertion of the Achilles tendon to the calcaneus. It is more common in adolescent boys, and may be bilateral 25-50% of the time. The diagnosis is made based on the presence of tenderness to palpation over the tibial tuberosity. In addition, pain is exacerbated with repeated activity, particularly jumping or knee extension against resistance. Resolution occurs when the secondary ossification center fuses to the proximal tibia, which occurs with maturation. Treatment consists primarily of limiting activity, immobilization, and NSAIDs.

SCFE is a medial or posterior slipping of the femoral capital epiphysis. The typical patient with SCFE is an overweight adolescent male. Manoff et al studied the association between body mass index and SCFE. They retrospectively reviewed 106 subjects with radiographically confirmed SCFE to 46 normal controls. In the SCFE group, 81.1% had a body mass index greater than 25. The authors concluded that obesity is an important risk factor for SCFE, especially in adolescent males.
index greater than the 95th percentile, compared to 41.3% in the control group (p< 0.0001). However, it is also seen in tall, thin adolescents who have undergone a recent growth spurt, resulting in shearing stress on the weakened epiphysis. SCFE will often present with a painful limp, hip or groin pain, or referred knee pain. Knee pain was found to be the primary presenting symptom in 15% of the patients with SCFE. Physical examination finds the hip externally rotated with painful range of motion, especially internal rotation, abduction, and flexion. Plain radiographs are generally the initial step in the diagnosis. Up to 60% of patients may develop bilateral SCFE, with about 23% having bilateral slips at the time of initial presentation. There is also an association of SCFE with endocrine abnormalities such as hypothyroidism, panhypopituitarism, and hypogonadism. Such abnormalities should be suspected and evaluated in a younger child with SCFE, short stature, and hypogonadism. These children are also more likely to have bilateral SCFE. A delay in diagnosis of SCFE results in increased slip severity and potentially higher risk of long-term complications. Treatment involves emergent orthopedic consultation for internal fixation. Osteochondritis dissecans is a disease in which a small island of bone dies and is then sloughed. Typically, the child complains of poorly localized knee pain. Osteochondritis dissecans commonly presents in the preteen or early adolescent period. Pain with full flexion is usually found. If there is a piece of sloughed bone, one may find an effusion. Locking of the knee can occur while in flexion. Typically involving the distal femur, osteochondritis dissecans can be easily identified on plain AP radiographs of the femur. Treatment includes immobilization, isometric exercises to retain quadriceps tone, and pain control. Arthroscopic surgery is indicated for continued pain. (Please see the May 2006 issue of Pediatric Emergency Medicine Practice of pain management.)

Neuromuscular
Neuromuscular conditions which cause weakness in the hip girdle, lower spine, or extremities can present as limping. These include muscular dystrophies, myelitis or myositis, neuropathies, demyelinating disorders, or disorders involving the neuromuscular junction. A thorough discussion of these disorders is beyond the scope of this review article.

Pre-Hospital Care
The role for pre-hospital care for non traumatic limping is limited. In cases of an obvious traumatic injury, the affected extremity should be immobilized and splinted in a position of comfort until further evaluation and management can be completed in the ED.

Emergency Department Evaluation
Given the broad differential diagnosis of the child with a limp, the emergency physician must rely a great deal on the history and physical examination findings to help narrow the possible range of diagnoses, and thus guide the appropriate evaluation and management of the patient.
**History**

When evaluating a child with a limp, a complete and comprehensive history is first and foremost in helping to make the correct diagnosis. Some typical characteristics of the history or examination in certain diseases can help narrow the differential diagnosis. (See Table 3 on page 5.) A history of associated symptoms such as joint edema, erythema, and pain may be suggestive of an infectious etiology such as a septic joint or osteomyelitis, or of a rheumatologic condition if the symptoms are recurrent or chronic.

Constitutional symptoms such as fever, pallor, easy bruising, chills, and weight loss with limping or bony pain should prompt an investigation for malignant causes of limping. Chronic limping or pain with a lack of other associated symptoms are more likely to occur with degenerative causes such as LCPD or SCFE. Also, a preceding illness such as an upper respiratory tract infection, pharyngitis, or scarlet fever is often noted with transient synovitis or post-infectious (post-strep) reactive arthritis. A history of abdominal pain, rash, travel history, or tick bite may also be useful in determining the etiology of the limp.

**Physical examination**

The physical examination of the child with a limp should be done in a systematic, head to toe manner. Specific examination findings may be suggestive of the etiology of the limp. Fever noted on the vital signs should lead one to suspect infectious etiologies. Certain rashes or skin findings can also help lead to the diagnosis. A palpable purpuric rash over the lower extremities with joint pain or limping suggests HSP. Erythema nodosum can be seen with inflammatory bowel disease which occasionally has associated arthritis causing limping. In addition, a target lesion (erythema migrans) is seen with Lyme disease. Localized erythema, warmth, edema, and pain are indicative of infectious causes such as osteomyelitis or septic arthritis. Ophthalmic abnormalities, such as iritis, in conjunction with arthritis can be seen with rheumatologic diseases. Also, lymphadenopathy or hepatosplenomegaly in the limping child is certainly concerning for malignancy as a possible etiology.

Back pain, or pain with palpation over the spine may be elicited in discitis.

Evaluating lower extremity muscle bulk, strength, sensation, and deep tendon reflexes are also key aspects of the physical examination. Lack of deep tendon reflexes suggests Guillain-Barre syndrome, with limping due to weakness. Calf muscle hypertrophy may be seen with certain muscular dystrophies. The position that the legs are held in may also help localize the abnormality. For instance, patients with SCFE or LCPD often keep the affected hip externally rotated and slightly flexed. A positive Galleazzi test, with asymmetric knee heights with the patient supine, hips and knees flexed, is suggestive of developmental dysplasia of the hips. This test is more appropriate in an older child, as opposed to the Ortolani-Barlow maneuvers done on the neonate.

(continued on page 12)
Clinical Pathway: Approach To The Acutely Limping Child With Fever

1. Limping Child
   - YES
   - Fever >100.4
     - NO
     - Go to the “Limping Child Without Fever” clinical pathway on the next page
   - YES
     - History suggestive of leukemia or rheumatologic pathology (see text)
       - YES
       - Further work up as recommended by consultants
       - NO
       - Physical examination with signs of septic knee or ankle
         - NO
         - Obtain ultrasound of hips Positive for effusion?
           - YES
           - Consult for joint aspiration and admit for IV antibiotics
           - NO
           - Obtain ESR and/or CRP
             - ESR >50 mm/h or CRP >2.0 mg/dL
               - YES
               - Admission for further work up (i.e. bone scan, MRI)
               - NO
               - Follow up with primary physician or return to the ED for worsening symptoms
             - NO
             - Consult and admit for IV antibiotics
Clinical Pathway: Approach To The Acutely Limping Child Without Fever

Limping child with no fever

**YES**

Typical characteristic history or physical examination

**YES**

See Table 3 on page 5

**YES**

Work up and treat as appropriate

**NO**

Physical examination with localized pain

**NO**

History concerning for rheumatologic or septic arthritis without fever

**YES**

Obtain plain radiograph. * Positive finding?

**YES**

Treat as appropriate

**NO**

Obtain ESR and/or CRP

ESR >50 mm/h

CRP >2.0 mg/dL

**YES**

Admit for further work up

**NO**

Complete radiograph from hip to feet. Positive finding?

**NO**

Follow up with primary physician or return to the ED for worsening symptoms

**YES**

Treat as appropriate

* Consider radiograph of hip if patient complains of knee pain
Local tenderness, masses, or swelling can be seen with osteomyelitis or bony tumors. Tenderness over the tibial tuberosity in an otherwise well child is diagnostic for Osgood Schlatter’s disease. An evaluation of range of motion of the hips, knees, and back can also help localize the source of limping. Of course, observing the child’s gait is a key part of the exam. The physician should determine if there is an antalgic gait, a Trendelenburg gait, or if it is actually ataxia, which would lead to an entirely different set of diagnostic considerations, such as cerebellar tumors. The child’s shoes, socks, and, if possible, pants should be removed for the examination of gait.

Diagnostic Studies

Laboratory studies
Generally, laboratory studies are not a key component in the evaluation of the limping child. Laboratory tests may help to support a diagnosis already made on clinical grounds. Imaging studies can be more useful, depending on the etiology of the limp. Much of the literature on the usefulness of laboratory studies in the evaluation of the child with a limp centers around the WBC count, ESR, and CRP, and their use with septic arthritis, osteomyelitis, and transient synovitis. In general, studies have shown a high sensitivity but low specificity for the use of CRP and ESR. However, many of the studies have small sample sizes, poorly designed methodology, and varying standards for what are considered normal values.

Complete Blood Count
The total WBC count has been studied to determine its usefulness in predicting septic arthritis versus transient synovitis. Eich et al found that leukocytosis (defined by age ranges) was not significantly different between patients with septic arthritis and transient synovitis. Del Beccaro and Zawin found similar overlap in the WBC count between these groups. However, many of the studies have small sample sizes, poorly designed methodology, and varying standards for what are considered normal values.

CRP
CRP is an acute phase protein that generally rises rapidly, reaching a peak value around the second day of illness, then normalizing by 7-10 days with certain support the diagnosis of a malignancy. In addition, in a child in whom HSP is suspected, a CBC should be done to rule out thrombocytopenia as a cause of the purpura.

ESR
The ESR has consistently been found to be higher among patients with septic arthritis versus those with transient synovitis. However, there is no agreement as to a cut-off value above which one can make the diagnosis of septic arthritis. For instance, Eich et al found a mean ESR of 103 mm/h among patients with septic arthritis. However, they recommend using a value >20 mm/h to suggest septic arthritis. Yet, their own data shows that 25% of the patients with transient synovitis also have an ESR >20 mm/h. This illustrates that while patients with septic arthritis have a statistically significantly higher ESR than those with transient synovitis, the value is not very specific but can be highly sensitive depending on the cut-off value chosen.

Several studies found a mean ESR among patients with septic arthritis to be approximately 50 mm/h. In a study of 26 patients, Klein reported a sensitivity of 91% for an ESR >30 mm/h, and 95% for an ESR >20 mm/h. However, specificities were not given. Del Beccaro et al showed an increased relative risk of 4.96 and 5.52 for having septic arthritis versus transient synovitis with an ESR of >20 mm/h and >30 mm/h, respectively. When calculating the relative risk of septic arthritis versus transient synovitis with an ESR of >20 mm/h and/or temperature >37.5 °C, the relative risk was found to be 22.48. However, in all these cases, the 95% confidence intervals were wide, likely due to the small sample sizes. In addition, Levine et al calculated an area under the ROC curve of 0.61 for ESR. Likelihood ratios for having septic arthritis did not have significant 95% confidence intervals with different ESR values, even with an ESR >75 mm/h. The ESR alone cannot make the diagnosis of septic arthritis, but may be useful in conjunction with other historical and examination findings that are suggestive of septic arthritis.
1. “I didn’t think that a febrile child with a normal CBC could have a serious cause for his limp, so I discharged him home.”

Studies to date have not shown the CBC alone to be a reliable predictor for septic arthritis. Although not adequately validated, a history of fever, non weight-bearing, an ESR >40 mm/h, and a serum WBC of >12,000 /mm³ can be predictive of septic arthritis.

2. “Although the child with fever and pallor didn’t have a source for his limp, an ESR was found to be elevated so I started him on steroids for a presumptive rheumatologic disease.”

In the presence of concurrent systemic signs and symptoms of fever, pallor, weight loss, lymphadenopathy, or hepatosplenomegaly, a CBC should be ordered to evaluate cell lines to rule out leukemia. Steroid use prior to a thorough evaluation by a hematologist/oncologist can alter management of a child with leukemia.

3. “The patient complained of knee pain and had a normal plain radiograph of the knee. Since he walked with a limp, I placed him in a knee immobilizer and discharged him home with instructions to follow up with his primary doctor within a week.”

Caution should be taken when evaluating a child with complaints of knee pain. If a patient presents with knee pain with a normal examination of the knee, consider further evaluation of the hip as a source of the limp.

4. “The history was concerning for a hip disorder but the AP and lateral radiograph of the hips were found to be normal.”

The addition of a frog leg lateral view is usually recommended. In the possible diagnosis of SCFE, a sensitivity rate of 66% was found with plain AP radiographs. The addition of a frog leg lateral view increased the sensitivity rate to 80%.

5. “I did not want to get social work involved as the parents seemed genuinely concerned for their child. But in the presence of a spiral fracture to the tibia without a clear history, I called child protective services.”

This scenario is often found in children who have a non-displaced fracture of the tibia, known as the toddler’s fracture. The toddler’s fracture is a spiral, oblique non displaced fracture of the distal tibia, typically seen in children <3 years of age.

6. “I was uncertain whether this patient had transient synovitis or septic arthritis until an ESR was found to be 26 mm/h. Now I know he has septic arthritis.”

No study to date has clearly shown a cut off value to predict septic arthritis in children. Using a cut off value of 20 mm/h has shown a high sensitivity for the diagnosis of septic arthritis, but a low specificity. Currently, the gold standard remains synovial fluid culture.

7. “The child has sickle cell disease and fever with a limp. No obvious swelling was noted on examination, so I treated him with narcotics to manage his pain.”

If a patient with sickle cell disease presents with symptoms that are not consistent with their pain crisis, caution must be taken to ensure that they do not have osteomyelitis or a septic joint. A common pathogen to consider in a child with sickle cell disease is Salmonella or Staphylococcus aureus.

8. “I obtained a plain radiograph of the right hip due to pain and limping in an overweight male. I was surprised to find it normal as I was highly suspicious of SCFE.”

Obtaining bilateral hip films can be useful in the diagnosis of SCFE. A “Klein line” may appear to be normal, but in comparison to the contralateral hip, it may show a mild medial slip as evidenced by a difference in the “Klein line” intersecting the femoral head.

9. “The child had a limp with a normal examination. Since there was no focal area to radiograph, I discharged the patient home.”

If no clear source is found for the limp, obtaining a radiograph of the hips to the feet can identify a fracture in 1/5 of children.

10. “I was considering a diagnosis of a septic hip in this patient, but since the plain radiographs showed no evidence of an effusion, I diagnosed her with transient synovitis.”

Plain radiographs rarely have evidence of effusion in septic arthritis. Most effusions can be detected by ultrasonography; however, effusions do not differentiate septic arthritis from transient synovitis. A joint aspirate should be obtained in all cases of suspected septic arthritis.
appropriate therapy. Among patients with septic arthritis, Kallio found a mean CRP of 8.5 mg/dL. Eich’s study showed a mean CRP of 9.9 mg/dL. In that study, while all patients with septic arthritis had a CRP of >2.0 mg/dL, 14% of patients with transient synovitis also had a CRP of >2.0 mg/dL.

In a retrospective study on 278 children with multiple different etiologies of arthritis, Kunnamo found that a CRP of >2.0 mg/dL had a sensitivity of 94% and a specificity of 92% for the 18 patients with septic arthritis. Yet the positive predictive value was only 57%, with a negative predictive value of 99%. A higher CRP of >4.0 mg/dL had a lower sensitivity of 71%, but higher specificity of 98%. Levine et al found sensitivities of 41-90%, with specificities of 29-85%, depending on the cut-off value chosen. The area under the ROC curve for CRP was 0.72, compared with 0.61 for the ESR. This study also concluded that the CRP may be a better negative predictor than a positive predictor of septic arthritis, with a NPV of 87% if the CRP is <1.0 mg/dL.

Synovial Fluid
If septic arthritis is suspected, then fluid from the appropriate joint should be aspirated for cell count and culture. While synovial fluid culture is the current accepted gold standard for diagnosing septic arthritis, studies have shown that 30-70% of cases have no growth on culture. In general, nucleated cells of >50,000/mm³ in the joint aspirate is concerning for septic arthritis.

Urinalysis
A urinalysis is recommended as part of the evaluation for patients suspected of having HSP. Renal involvement can persist long term and is a major cause of long-term morbidity among patients with HSP. Evidence of nephritis may not be evident until several weeks after initial presentation. Urinalysis may also be done as part of the evaluation for abdominal pain that may be causing a change in gait, as in appendicitis, testicular pain, urinary tract infections, or nephrolithiasis.

Supplemental tests
Additional serum testing may be indicated based on the history and physical findings of the patient. Among patients with HSP, checking stool for occult blood may be warranted, particularly in cases with severe abdominal pain. Gastrointestinal bleeding and intussusception are known complications of HSP. If positive, the patient should be admitted, or at least observed for a longer period of time for serial examinations and further management, if needed. In addition, a chronic history of recurrent arthritis with other systemic features such as fever, anemia, serositis, and/or rash, may prompt investigation for rheumatologic causes of limping. These tests include antinuclear antibodies (ANA), rheumatoid factor (RF), and anti-double stranded DNA. Also, evidence of proximal muscle weakness with other characteristic findings of rash may warrant checking creatinine kinase (CK) and aldolase levels for dermatomyositis. In areas endemic for Lyme disease, with a history of a tick bite, Lyme titers may be indicated as well. These tests might best be done by the primary care physician or with the guidance of a rheumatologist, as results generally will not be readily available to the emergency physician and follow-up will be indicated.

Imaging Studies

Plain Radiographs
Plain radiographs are often obtained as the initial evaluation of a child with a limp. When an area of pain or swelling is localized, both AP and lateral films should be obtained. When the pain cannot be localized, as in a nonverbal child, plain radiographs from the hips to feet can identify a fracture in 1/5 of patients presenting with a limp. When considering a diagnosis of SCFE, LCPD, or fracture, plain radiographs are usually adequate in the initial ED evaluation of the child. If a child presents with knee pain as a possible site for the limp, obtain films above and below the joint in question (i.e. the ankle and the hip). If the plain films are inconclusive, it may be beneficial to repeat the films in 10 – 14 days. Follow-up films may reveal a healing fracture that was not evident on initial presentation.

LCPD is usually diagnosed by plain radiographs with AP and frog leg lateral views. Typically the radiograph shows sclerosis, flattening, or fragmentation of the femoral head. Early in the illness, a small femoral head with a possible widened medial joint space is seen, especially in comparison with the contralateral side. As the disease progresses, a crescent-shaped radiolucent line, the crescent sign, appears along the proximal femoral head. Later in the disease progression, the femoral head can become more radiopaque with subsequent fragmentation...
and collapse of the epiphysis. (See Figure 2 on page 7). No recent studies have evaluated the diagnosis of LCPD. Instead, most studies have focused on outcome and management of LCPD by different radiographic methods including plain films, bone scan, ultrasound, CT, and MRI.54-60

The key to the diagnosis of SCFE is obtaining the appropriate radiographs and interpreting them correctly. Obtaining an AP view and a special frog leg lateral view is usually recommended because the AP view may fail to show the displacement in 14% of cases.61 (See Figure 3 on page 8). Also, radiographs of bilateral hips can aid in the diagnosis with the unaffected hip serving as a comparison view. On an AP view, the “Klein line” is drawn along the lateral cortex of the femoral neck and should intersect a portion of the lateral femoral head. If it does not, then a medial slip of the femoral epiphysis is indicated.62,63 (See Figure 4 on page 9). Comparison to the contralateral hip may also reveal a smaller portion of the femoral head above the “Klein line” that can also suggest an early slip of the involved hip. On a frog leg lateral view, the slip may be more obvious. On a lateral view, if a line passing through the center of the femoral neck does not intersect the center of the femoral head, a posterior slip is suggested. A subtle finding of an early SCFE may be a physis that is widened or blurred (Bloomberg’s sign) compared to the contralateral hip.64,65

Plain radiographs have a limited role in the emergent evaluation of septic arthritis. It has also been found to be unreliable for the diagnosis of a septic hip.66 In the presence of a widened joint space, the likelihood of septic arthritis is raised, but most plain radiographs are found to be normal even in the presence of a joint effusion. In a small retrospective study of children diagnosed with septic arthritis, Gandini showed that 12% of plain radiographs were found to be abnormal, in contrast to 83% of ultrasonographic studies showing an effusion.67 Marchal also found that, of 21 children with transient synovitis, a joint effusion was detected on 20 patients with ultrasonography. But only 8 (42%) were found to have an increased joint space on plain radiographs.68

Ultrasonography
Ultrasonography examination of the hip has been

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Key Points

- A thorough history and examination of a child with a limp will help focus and guide the ED evaluation.
- Consider referred pain from the hip in a child with complaints of limping with knee pain.
- Plain radiographs are generally the first step in the evaluation of a limping child without a fever.
- Plain radiographs are generally adequate in determining the etiology of limping in a child without a fever.
- The ESR and CRP are not specific to the diagnosis of septic arthritis, but can be useful in conjunction with the historical and physical examination findings.
- In a non-ambulatory child with a lower extremity fracture, consider non accidental trauma.
- The gold standard for the diagnosis of septic arthritis remains joint aspirate.
- In a well-appearing child without a definitive diagnosis for limping and without concern for an infectious etiology, outpatient follow-up and re-evaluation can be appropriate therapy.
shown to identify most cases of painful hips. In Germany, ultrasonography was able to make a diagnosis in 90% of children; 53 children with transient synovitis, 47 with LCPD, 28 with SCFE, and 3 with septic arthritis. They concluded that ultrasonography is a useful tool for the diagnosis of a child with a painful hip.69 No studies have been conducted comparing ultrasonography to plain radiographs in the ED evaluation of LCPD. Few studies have compared other radiographic modalities to plain radiographs in the diagnosis of SCFE. Billing et al believed that ultrasonography had not been proven to add much to the definitive diagnosis of SCFE.70 In contrast, in a small study of 21 symptomatic overweight children with a possible diagnosis of SCFE, Magnano et al showed a sensitivity rate of 66% for the diagnosis of SCFE with plain AP radiographs. With the addition of a frog leg lateral view, the sensitivity rate increased to 80%. Ultrasonography and MRI revealed a higher sensitivity in the detection of SCFE, 95% and 88%, respectively. They recommended that ultrasonography be considered for the early detection of slipped capital femoral epiphysis.71

Most studies on ultrasonography have been focused on detecting an effusion in children with hip pain and septic arthritis. In a study conducted by Miralles, 500 children were prospectively evaluated by plain films and ultrasonography. Only 58 plain films were found to be abnormal when ultrasonography detected a hip effusion in 235 children.72 Gordon et al carried out ultrasonography in 132 children with hip pain. Follow up to determine the absence or presence of septic arthritis was conducted with 73 of the patients. Only four patients were found to have no effusion on initial ultrasonography but were later determined to have septic arthritis. Two had inadequate initial studies, and the other two had symptoms for <24 hours.73 Tien et al found 31 of 40 patients with suspected septic arthritis had an ultrasound confirmed joint effusion. Of these patients, 22 were found to have confirmed septic arthritis by needle aspiration of the joint.74

Another cause of hip effusions is transient synovitis. Marchal found that, of 21 children with transient synovitis, a joint effusion was detected on 20 patients with ultrasonography.75 Distinguishing between septic arthritis and transient synovitis is difficult as the two share many clinical and laboratory features. Several studies investigating the echogenicity of the effusion to differentiate septic arthritis from transient synovitis have had conflicting results. Dorr and colleagues found that 13 patients with confirmed septic arthritis had effusions on ultrasonography that were non-echofree. Of 58 patients with transient synovitis, 42 were echofree, 12 had a low level of echogenicity, and four had a very small amount of effusion that could not be classified confidently.75 In a prospective controlled study, Zieger also found that transient synovitis had effusions to be echofree, whereas septic arthritis showed non-echofree effusions.76 In contrast, Marchal found increased echogenicity in the effusion of patients with transient synovitis, but no echogenicity in the one patient with a final diagnosis of septic arthritis.80 In 235 patients with a hip effusion, Miralles also found that no sonographic signs served to differentiate sterile, purulent, or hemorrhagic effusions.72 In an animal study of rabbits, Strouse et al demonstrated increased synovial vascularity in approximately 50% of septic arthritis cases by Doppler ultrasonography.77 In clinical practice, hypervascularity proved to be less useful showing only 1 of 11 patients with a positive finding on Doppler ultrasonography.78 Thus, while ultrasonography may be useful in detecting joint effusion, the specifics of the findings are conflicting and would be operator and viewer dependent.

**Bone scan**

When the history and physical examination do not localize a source of a child’s limp and plain radiographs do not show any evidence of pathology, a bone scan may help to localize the site in question. A bone scan uses IV technetium 99m-labeled methylene diphotonate that accumulates in areas of increased cellular activity and blood flow. Choban and Killian reviewed the records of 60 children aged less than five years with limp. 35 bone scans were performed that led to 18 definitive diagnoses including synovitis, osteomyelitis, LCPD, JRA, soft tissue infection, and discitis.89 In another prospective series of 50 limping toddlers that had no clear diagnosis, a bone scan localized the lesion in 27 patients (54%) with no infections being missed.90 Goergens showed that 88% of bone scans were found to be positive in a series of patients with a diagnosis of septic arthritis.81

**Computed tomography**

CT is rarely needed in the emergency evaluation of a child with a non traumatic limp. It can be useful for a more detailed evaluation of a possible bony etiology for the limp. Most studies on CT scans and limp-
ing children have been centered on the severity and long term management of children.\textsuperscript{82-85} No studies were directed at the ED evaluation of a child with a non traumatic limp.

**Magnetic Resonance Imaging**

MRI has become increasingly important in the evaluation of possible infectious etiologies in children with a limp. The utility of MRI in the ED evaluation of a child with a limp has a limited role, as further diagnostic evaluation can be completed non-emergently either on an inpatient or outpatient basis. The MRI is useful for the detection of bone marrow and soft tissue lesions as well as joint effusions. The sensitivity and specificity of detecting a joint effusion was found to be 100% and 77%.\textsuperscript{86} Lee et al attempted to describe any differential findings on MRI between septic arthritis and transient synovitis. Nine patients with septic arthritis and 14 patients with transient synovitis were evaluated and there was significantly increased signal intensity in patients with septic arthritis (p = < 0.001).\textsuperscript{87} In a prospective study of 45 children with acute hip pain, Ranner compared plain radiographs, bone scan, and MRI. The study found that the MRI provided more morphologic information than the other techniques.\textsuperscript{88} In a small study of 13 children with SCFE, Umans et al compared radiographs and CT with MRI in the diagnosis of early physeal lesions for a “pre slip.” Of the one child with a pre slip of the femoral head, only the MRI clearly delineated the physeal changes of the pre slip.\textsuperscript{89} Pinto et al noted that, in two patients suspected of having LCPD, the plain radiograph and bone scan were found to be normal. An MRI was obtained and the diagnosis of LCPD was made by showing definite avascular necrosis of the affected hip.\textsuperscript{90}

**Treatment**

Treatment for the child who presents with a limp is, of course, dependent on the ultimate etiology of the limp. Some primary considerations are pain control, antibiotic therapy if indicated (i.e. for septic arthritis or osteomyelitis), splinting, or need for further subspecialty consultation, such as with orthopedics, rheumatology, or oncology.

Analgesic medication may include acetaminophen, NSAIDs, and narcotics, depending on the severity of the pain. In a randomized, blinded, placebo controlled study, Kermond et al found that NSAIDs shortened the duration of symptoms in children with a clinical diagnosis of transient synovitis of the hip.\textsuperscript{91}

If a diagnosis of SCFE or LCPD is suspected, the patient should be non-weight bearing, and an urgent orthopedic referral should be made. Goals of therapy for LCPD include resolving the hip joint inflammation and positioning the femoral head in such a way as to promote healing. If 50% or more of the femoral head can be seen, therapy is aimed at maintaining the range of motion until healing occurs. When more than 50% of the head is involved, orthopedists will place the hip in an abduction brace or hip spica cast, or perform an osteotomy of the proximal femur to position the femoral head well into the acetabulum. Usually the brace is used for children under seven, and osteotomy reserved for the older patient. Ultimately, the outcome for those who present with less than 50% of their femoral head involved is good. Children under six do very well, but those over 10 or those with flattening of the femoral head do not. Treatment for SCFE involves in situ pinning to prevent further slippage.

The use of glucocorticoids has been studied for patients with HSP. In general, the routine use of prednisone in HSP is not recommended. Patients may be treated with steroids to relieve abdominal pain. However, Rosenblum and Winter showed that abdominal pain in patients with HSP is largely self-limited.\textsuperscript{92} By 72 hours, there was no difference in the number of patients still complaining of abdominal pain between the group treated with prednisone and the group not treated with steroids. Huber et al conducted a randomized, placebo-controlled trial of prednisone in early HSP.\textsuperscript{93} They found no significant reduction in the risk of renal involvement or gastrointestinal complications with early prednisone therapy when compared to placebo. However, the total study population of 40 patients may be too small to detect relatively rare events such as intussusception. Mollica et al did find a significant difference in reduction of the development of nephropathy among patients treated with corticosteroids.\textsuperscript{94} However, this study was not randomized or blinded. Most other studies are retrospective studies, with mixed results. Other studies have shown improvement in the progression of nephritis in more severe cases of HSP, where there is already evidence of significant nephropathy among patients treated with corticosteroids.\textsuperscript{95-97} The studies on the prevention of intussusception with the use of corticosteroids are generally limited by their retrospective nature and small number of patients.
Antibiotic therapy for suspected or proven infectious causes of limping such as osteomyelitis or septic arthritis should be guided by the age group, the common pathogens in the geographic area for that age group, and susceptibility patterns of the area. In general, therapy should include anti-staphylococcal coverage such as nafcillin, oxacillin, clindamycin, or vancomycin. Broader, gram-negative coverage with, for instance, a third-generation cephalosporin, may also be appropriate pending culture results.

In June 2003, an interdisciplinary expert committee in Boston set a clinical practice guideline for the treatment of septic arthritis of the hip in children to try to improve the process of care and the outcome of these children. They retrospectively reviewed the medical records of 30 children with septic arthritis as a control group and prospectively applied the clinical guideline in 30 consecutive patients seen at their hospital. The clinical guideline recommended that if a previously healthy patient between 6 months and 18 years of age is found to have a history and physical examination suggestive of a septic arthritis, the patient was to follow a set clinical guideline. Initial labs included CRP, ESR, CBC with differential, blood culture, throat culture and anti-streptolysin O antibody titers, along with radiographs of the hip. If the labs or radiographs suggested septic arthritis, then aspiration of the joint was done. However, the authors failed to define their laboratory or radiographic definitions for septic arthritis. If the joint aspirate showed WBC >50,000 /mm³ or a positive gram stain, then the patient was admitted for possible operative drainage or intravenous antibiotics. Once patients showed clinical improvement after 72 hours of treatment, they could be discharged home if able to tolerate oral antibiotics. Although this study showed a lower rate of bone scanning, lower rate of presumptive drainage, and a shorter hospital stay, there was no difference with outcome, readmission, or recurrent infection.

**Special Circumstances**

Children with special needs and chronic illnesses present additional challenges to the emergency physician. For instance, patients with sickle cell disease may have limping due to pain from vaso-occlusive crisis. They are also at risk for avascular necrosis. If the pain is not a usual site for their pain crisis, radiographs may be indicated. In addition, as noted earlier, the pathogens involved in septic arthritis for sickle cell patients may be different. Hemophiliacs with hemarthrosis may also present with acute limping. These patients need recombinant factor VII replacement. In some cases, families can do this therapy in an outpatient basis. However, a discussion with the hematologist may be helpful in determining which cases should be admitted for closer observation and therapy. Finally, wheelchair bound patients often develop osteopenia. Caretakers may report crying with movement or difficulty with physical therapy. Diagnosis in this case is particularly difficult, as the etiology can range from constipation to urinary tract infection to fracture.

**Controversies/Cutting Edge**

**Procalcitonin**

In recent years, procalcitonin has been studied as a marker to differentiate between inflammatory conditions and more serious bacterial infections. One prospective study has found elevated procalcitonin levels >0.5ng/ml to have a sensitivity of 43.5% and a specificity of 100% in identifying patients with skeletal infections (osteomyelitis and septic arthritis) from those with other causes of fever and limping (reactive arthritis, JRA, soft tissue infection). None of the patients with a diagnosis other than skeletal infection had an elevated procalcitonin level. In this study, there was no significant difference between the CRP, ESR, and WBC count among patients with skeletal infection vs. those with “other” diagnoses for their fever and limp. Another study found similarly low sensitivity with high specificity for procalcitonin in identifying patients with bacterial septic arthritis (55% and 94%, respectively). This study also showed that a CRP value of >5.0 mg/dL had a 100% sensitivity, but only 40% specificity. These are early studies with small sample sizes. Nonetheless, they do represent an interesting area of possible future research.

**Clinical Practice Guidelines**

An evidence based clinical prediction algorithm was developed by Kocher et al in an attempt to differentiate septic arthritis from transient synovitis. They retrospectively reviewed the medical records of 82 patients with septic arthritis and 86 patients with transient synovitis. Multiple logistic regression identified history of fever, non weight-bearing, an ESR >40mm/h, and a serum WBC of >12,000 /mm³ to be independent predictors for differentiating septic arthritis from transient synovitis. An algorithm
based on the number of predictors found that having all four predicted 99.6% of those with septic arthritis, three predicted 93.1%, two predicted 40.0%, one predicted 3.0%, and having none of the four predicted <0.2%. When all four parameters were met, they also found excellent diagnostic performance of this algorithm on a receiver operating characteristic curve with an area under the curve of 0.96.41

Follow up studies of this clinical prediction rule have shown mixed results. In a follow up validation study by Kocher, applying the prediction rule prospectively to 51 patients with septic arthritis and 103 patients with transient synovitis revealed the same four predictors on multivariate analysis. Applying the algorithm with the same four predictors found the predicted probability of septic arthritis was 93.0% with four predictors, 72.85% with three predictors, 35% with two predictors, 9.5% with one predictor, and 2% with no predictor. The area under the receiver operating characteristic curve was 0.86. Although the clinical prediction rule did not perform as well as the initial study, they concluded that it maintained very good diagnostic performance in a new patient population.101

When applying the clinical algorithm to 163 patients, another validation study on a different study population found the four predictors proposed by Kocher had a predicted probability of a patient having septic arthritis of 59%, compared to the initial 99.6% published by Kocher.41,42

### Disposition

The majority of children who present to the ED with a chief complaint of limping have a minor, self-limited disease. These children can be safely discharged home with instructions for pain control if needed, and instructions to follow-up with their primary care physicians. Discharge instructions should include recommendations to return for re-evaluation if symptoms worsen, or new symptoms develop in addition to limping that may be concerning for a more serious etiology. These include fever, joint edema and erythema, new rash, weight loss, or hematemesis and/or hematochezia.

Some cases will require admission for further therapy and consultation. Among patients with suspected septic arthritis or osteomyelitis, the patient should be admitted for IV antibiotics, and, if needed, surgical drainage and debridement. In cases where pain is not adequately controlled with standard oral analgesics, admission for pain control and serial exams may be indicated. Suspected cases of neoplasm also warrant admission for further diagnostic evaluation, such as bone marrow biopsy or bony tumor biopsy. In addition, in traumatic cases where the history is not consistent with the injuries, and abuse is suspected, the child should be admitted for further investigation.

### Summary

The differential diagnosis of patients who present to the ED with a complaint of a painful hip or a limp is extensive. Evaluating a child with a limp may be quite challenging if one does not use a systematic approach. The approach to narrowing the differential should begin with a thorough history and physical exam. When more serious conditions are suspected or cannot be ruled out, then further evaluation such as laboratory testing or further consultation is warranted. Selection of laboratory studies and imaging should be guided by the history and physical examination. Ultimately, the goal of the clinician is to exclude the more serious, life-threatening diseases and to prevent permanent impairment in function.

### References


29. Postovsky S, Bialik V, Keider Z, et al. Large cell lym-


51. Narchi H. Risk of long term renal impairment and duration of follow up recommended for Henoch-Schönlein purpura with normal or minimal urinary findings: a systematic review. Arch Dis Child. 2005; 90(9): 916-20. (Case reports)


17. All the following statements regarding the treatment of a limping child are true except:
   a. a patient with SCFE requires an urgent orthopedic consultation
   b. transient synovitis is treated with NSAIDs and rest
   c. LCPD does not require any treatment as it is self limiting
   d. HSP can be managed with outpatient follow up
   e. anti staphylococcal antibiotics are the treatment of choice for septic arthritis

18. A spiral fracture of the lower extremity is pathognomonic for child abuse.
   a. True
   b. False

19. Osgood Schlatter’s disease:
   a. refers to an abnormality of the insertion of the Achilles tendon
   b. can be diagnosed clinically with pain on palpation at the tibial tuberosity
   c. is most frequently seen in obese adolescent males
   d. requires immediate surgical intervention
   e. is a common newborn hip abnormality

20. The most common bacteria found in septic arthritis is:
   a. Haemophilus influenza b
   b. Kingella kingae
   c. Neisseria meningitides
   d. Staphylococcus aureus
   e. Streptococcus pneumoniae

21. Transient synovitis is a self limited disease that is a diagnosis of exclusion.
   a. True
   b. False

22. All of the following regarding radiographic studies with SCFE are true except:
   a. early slips may not be evident on initial plain radiographs
   b. an AP view of the hips are adequate to diagnose SCFE
   c. comparison with the contralateral hip may help detect an early slip
   d. the Bloomberg sign suggests an early slip by showing a blurred physis
   e. MRI can detect an early slip that may not be evident on plain radiographs

23. A Klein line:
   a. is drawn along the lateral femoral neck and should intersect the femoral head.
   b. refers to growth arrest in the physis in the patient with leukemia
   c. aids in the diagnosis of tarsal coalition
   d. is a radiographic sign of avascular necrosis of the femoral head
   e. represents a joint space widening to suggest an effusion on plain radiographs

24. SCFE is only found in obese adolescent males.
   a. True
   b. False

25. Avascular necrosis of the femoral head can be associated with:
   a. idiopathic causes such as LCPD
   b. sickle cell disease
   c. chronic steroid use
   d. complication of SCFE
   e. all the above

26. The addition of a frog leg lateral view on plain radiographs increases the sensitivity of detecting hip abnormalities.
   a. True
   b. False

27. An 8-year-old male presents with purpuric lesions on his legs, with abdominal pain and bilateral leg pain. The most likely diagnosis is:
   a. disseminated intravascular coagulation
   b. Henoch-Schonlein Purpura
   c. Lyme disease
   d. meningitis
   e. viral exanthem

28. Ultrasonography has been shown to be useful for the detection of:
   a. a bony cyst in the diagnosis of HSP
   b. an effusion of the knee in Lyme disease
   c. an effusion of the hip in septic arthritis
   d. a Klein line in SCFE
   e. sickled cells in the joint space in children with sickle cell disease

29. A 4-year-old with a previous history of an upper respiratory infection now presents with a two day history of refusal to walk.
The vital signs are normal and the examination shows no obvious joint swelling, but limited range of motion is noted with flexion and rotation of the right hip. The most likely diagnosis is:

- a. Guillain-Barre syndrome
- b. LCPSD
- c. osteomyelitis
- d. SCFE
- e. transient synovitis

30. A child presents with fever, weight loss, pallor, and leg pain. The most appropriate diagnostic laboratory test would include:

- a. a CBC with a manual differential
- b. a blood culture
- c. an electrolyte panel
- d. a urine analysis
- e. Lyme titers

31. An adolescent female presents with a swollen knee and fever. Aspiration of the joint reveals >50,000/mm³, the likely pathogen is:

- a. Candida
- b. Kingella kingae
- c. Neisseria meningitides
- d. Neisseria gonorrhoeae
- e. Staphylococcus epidermidis

**Class Of Evidence Definitions**

Each action in the clinical pathways section of Pediatric Emergency Medicine Practice receives a score based on the following definitions.

**Class I**
- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

**Level of Evidence:**
- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

**Class II**
- Safe, acceptable
- Probably useful

**Class III**
- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

**Level of Evidence:**
- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

**Indeterminate**
- Continuing area of research
- No recommendations until further research

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