Diagnostic Approach to Limp in Children

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Abstract

“Limp” is a common complaint of children presenting to the emergency department or physician’s office. For most patients presenting with limp, the diagnosis and management can be completed in the physician’s office or emergency department by gathering a detailed history, performing a careful physical examination, and requesting a few laboratory and imaging studies. This article reviews common causes of atraumatic limp in children and discusses the evaluation and management of these conditions. [Pediatr Ann. 2015;44(12):548-550, 552-554, 556.]

ILLUSTRATIVE CASES

Case 1
A 3-year-old boy presented to the emergency department (ED) with complaint of a limp for the past 10 days noted by the parents. His family denied any trauma, fever, or recent upper respiratory infection symptoms. The child had normal vital signs and physical examination so that unnecessary laboratory and imaging studies are not performed. In this article, we discuss the common causes and management of atraumatic limp in children.

Case 2
An 11-month-old healthy boy presented to the ED with refusal to stand or crawl. His parents noted a low-grade fever and a rash. On examination, the child was afebrile and had an erythematous rash that was target-shaped over the anterior chest and extremities. Both knees were mildly swollen; however, the joints were nonerythematous.
not warm, and had full range of motion without any discomfort. What will your approach be for this patient?

**Case 3**

A 2-year-old healthy girl presented to the ED with refusal to walk since the morning. She had a runny nose and cough for a few day prior. She had a normal physical examination but refused to bear weight on her right side. There was no joint erythema, swelling, tenderness, or signs of trauma in the lower extremity. What tests will aid in the diagnosis?

**EPIDEMIOLOGY**

“Limp” represents a common complaint in children presenting to the ED. Although the majority of limping is related to trauma, atraumatic limp is reported in 1.8 per 1,000 children younger than age 14 years. The average age of presentation is 4 years, and it typically affects boys more commonly than girls. Most children present with a unilateral limp that is painful. Slightly less than half of these patients have a preceding illness. The differential diagnosis for limp is expansive and it is important to discern the benign from life-threatening conditions that cause an atraumatic limp in children (Table 1). Ultimately, for most patients presenting with limp, the diagnosis and management can be completed in the physicians’ office or ED.

**ANATOMY OF GAIT**

To understand what causes a child to limp, it is necessary to understand the anatomy of a normal gait. A child develops a mature gait pattern at age 3 years and it consists of a stance phase and swing phase. Disordered gait can be classified as antalgic and nonantalgic. An antalgic gait results from pain in the affected extremity, resulting in a shortening of the stance phase and an increase of the swing phase. This type of gait results typically from trauma or an infection. Types of nonantalgic gait include a Trendelenburg gait, in which the pelvis exhibits a downward tilt toward the unaffected side during the swing phase because of weakness in the contralateral gluteus medius muscle. This type of gait is usually seen in disorders of the hip such as developmental dysplasia of the hip (DDH), Legg-Calvé-Perthes (LCP) disease, or slipped capital femoral epiphysis (SCFE). A steppage gait results from excessive flexion of the hip and knee joints during the swing phase due to an inability to dorsiflex the foot. A vaulting or circumduction gait occurs due to hyperextension and locking of the knees at the end of the stance phase and the child must vault over the affected extremity. This gait is usually associated with a limb-length discrepancy or a mechanical disorder leading to abnormal knee mobility.

**TABLE 1. Differential Diagnosis of Atraumatic Limp**

<table>
<thead>
<tr>
<th>Category</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious</td>
<td>Septic arthritis, Osteomyelitis, Discitis, Lyme disease, Psoas abscess, Gonococcal arthritis</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>Transient synovitis, Serum sickness, Henoch-Schonlein purpura, Rheumatic fever, Ankylosing spondylitis, Systemic lupus erythematosus</td>
</tr>
<tr>
<td>Vascular</td>
<td>Legg-Calvé-Perthes disease, Osteonecrosis, Sickle cell disease</td>
</tr>
<tr>
<td>Neoplastic</td>
<td>Leukemia, Tumors such as osteoblastoma or osteosarcoma</td>
</tr>
<tr>
<td>Congenital</td>
<td>Developmental dysplasia of the hip</td>
</tr>
<tr>
<td>Other</td>
<td>Intraabdominal, Inguinal hernia, Appendicitis, Pyelonephritis, Pelvic inflammatory disease, Intracranial pathology, Intracranial space occupying lesion (eg, tumor or abscess)</td>
</tr>
</tbody>
</table>
NEW-ONSET LIMP

Evaluation of a limping child should begin with a thorough history elicited from both the child as well as the caregiver. The age of the child at onset of the limp helps to narrow the differential diagnoses. DDH is commonly seen up to age 3 years whereas LCP disease, juvenile idiopathic arthritis (JIA), and leukemia should be considered among children ages 4 to 10 years. Joint sprains, overuse syndromes, SCFE, and tumors should be considered in the adolescent age group.

Fever is an important historic factor, as it may suggest an infectious (eg, osteomyelitis, septic arthritis or Lyme arthritis) or an inflammatory (eg, transient synovitis, discitis) cause for limping. Rheumatologic and oncologic processes, such as JIA and leukemia, are less commonly associated with fever but should be considered in the differential diagnosis in the presence of systemic symptoms such as weight loss, night sweats, loss of appetite, bone pain, or fatigue. In the setting of a recent febrile viral illness or streptococcal infection, postinfectious causes of limping are more likely and include transient synovitis, myositis, or serum sickness.

Back pain or lateral thigh pain may indicate lumbar spinal disorders such as discitis, herniated disc, or vertebral fracture. Additionally, symptoms such as incontinence or leg weakness also suggest spinal cord lesions or pelvic mass.

The duration of the limp can help to differentiate between acute versus chronic etiologies. Typically, acute-onset limp presents in the setting of trauma or an infectious cause, such as a septic arthritis or osteomyelitis. A longer duration or insidious onset of symptoms may be more indicative of LCP disease, SCFE, or a rheumatologic etiology.

A thorough physical examination with the child completely undressed should be performed on all children presenting with a limp. The height and weight of the child should be noted and, if possible, compared to that from prior visits, as poor growth may be an indicator of an underlying chronic disease. A complete neurologic examination assessing for tone (hypotonia or spasticity), hypo- or hyperreflexia, presence of clonus, or loss of sensation should be performed to rule out central or peripheral nervous system pathologies. Examination of the back/ spine for curvature and point tenderness is also an important aspect of the physical examination.

The gait of the patient should be assessed while they are wearing a short gown and walking in bare feet. Each leg should be assessed individually through the swing and stance phase. Look for erythema, swelling, or signs of trauma such as abrasions, lacerations, or puncture wounds. The feet, legs, hips, and back should be palpated in small segments at a time to elicit tenderness or note any “step offs” or masses. Passive and active range of motion of joints should be assessed and compared to the opposite side.

Specific clinical tests may have to be performed to confirm or rule out specific cause for a limp. For the Trendelenburg test, the child stands on the affected leg and the observer looks for the drop of the pelvis toward the un-affected side. A positive test indicates disorders of the hip such as DDH, LCP disease, or SCFE. In the Galeazzi sign test, the child lies in the supine position with both hips and knees flexed. The practitioner observes heights of the knees and if one side is lower than the other, the test is positive, revealing a limb-length discrepancy with the lower side shorter than the other. The Flexion, Abduction and External Rotation test is performed by having the child lay supine while the examiner flexes, abducts, and externally rotates the hip joint. If this results in hip pain or limitation of flexion, it implies a disorder of the sacroiliac joint.

One should also examine the inguinal region to rule out hernias and scrotal/testicular lesions.

Laboratory Evaluation

The differential diagnosis considered in a patient dictates the laboratory evaluation to be performed. When an infectious or inflammatory cause for the limp is suspected on clinical evaluation, laboratory tests to be considered include a complete blood count (CBC), blood culture, and acute phase reactants such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR). A clinical guideline developed by Kocher et al. proposed that a history of fever, nonweight-bearing on the affected side, ESR >40 mm/h, and serum white blood cell count of >12,000 cells/mm3 is indicative of septic arthritis as opposed to transient synovitis. They found that if only 1 of the 4 was present, the predicted probability for septic arthritis was about...
3%, but it increased to 99% when all four criteria were present. If the patient lives in an area where Lyme disease is endemic, it may be pertinent to obtain a two-step serologic test including an enzyme-linked immunosorbent assay followed by a confirmatory Western blot for Lyme disease. The synovial fluid can be tested for Lyme polymerase chain reaction as well. If there is a high suspicion for a septic joint, synovial fluid (obtained at bedside or in the operating room) needs to be sent for Gram stain, cultures, white blood cell count, glucose, and protein analysis. If there is clinical suspicion for rheumatologic diseases, antinuclear antibody titers and rheumatoid factor may need to be checked.

**Imaging Studies**

Radiography and ultrasonogram (US) of the hip are the commonly used imaging modalities to evaluate a child with a limp. X-ray of the hip is particularly useful in the diagnosis of LCP disease and SCFE, whereas US of the hip is useful when DDH or septic arthritis are suspected. Plain radiographs are not particularly sensitive in diagnosing acute osteomyelitis, so in those cases nuclear medicine scans can be used; however, they have low specificity in diagnosing acute osteomyelitis. Recently, magnetic resonance imaging (MRI) has been used with high frequency to evaluate children with suspected acute or chronic osteomyelitis. MRI is also very useful in diagnosing discitis. A computed tomography (CT) scan is helpful in diagnosing chronic osteomyelitis as it clearly delineates cortical destruction as compared with MRI.⁹

**COMMON CAUSES OF LIMP**

**Inflammatory Conditions**

The most common cause of nontraumatic limp in children age 10 years or younger is transient synovitis.¹⁰ The exact etiology of this is unclear, although the most commonly accepted explanation is an inflammatory reaction following a viral illness. Typical presentation is a limp that is noted in a child after a viral upper respiratory infection. On clinical examination, the child is well appearing, has full range of motion of the joints, and is usually able to bear weight after taking nonsteroidal anti-inflammatory drugs (NSAIDs). Laboratory evaluation, including CBC and serum inflammatory markers such as CRP and ESR, are usually within normal limits. Symptoms usually resolve in 1 to 2 weeks. Rest and NSAIDs are the treatment of choice.

Other inflammatory causes of a nontraumatic limp in children include serum sickness, Henoch-Schonlein purpura (HSP), and rheumatologic disorders. Serum sickness is a type III hypersensitivity reaction to recent illness or medication. Most commonly involved medications include the penicillins, cephalosporins, and NSAIDs. The child typically presents with fever, rash, and joint pain or swelling. Rash typically resembles a target lesion. Symptoms are noted 7 to 21 days after antigen exposure. Treatment is largely supportive care. If the child is taking antibiotics and if the medication is suspected to be the cause of serum sickness, then it should be discontinued immediately.

HSP is a vasculitis that affects young children. Purpuric rash is noted in the dependent areas after a viral illness or vaccination. Clinical presentation includes low-grade fever, rash, and arthritis that usually involves the lower extremity joints. Joint involvement is inflammatory in origin, is nonerosive, and does not lead to permanent damage. Symptoms respond well to NSAIDs. Gastrointestinal manifestations include nausea, vomiting, and abdominal pain. Children with HSP are at higher risk for intussusception and nephritis. Laboratory evaluation may show elevated serum inflammatory markers. Treatment is largely supportive. All symptoms resolve in most patients within 4 weeks.

Acute rheumatic fever (ARF) is an inflammatory disorder with multiorgan involvement and is caused by an immune response to group A streptococcal infection. The Jones criteria are used for the diagnosis of rheumatic fever. Major criteria include carditis, chorea, erythema marginatum, and subcutaneous nodules. Minor criteria include fever, arthralgia, prolonged PR interval, and elevated acute phase reactants. The presence of two major criteria, or one major and two minor criteria, along with laboratory evidence of a preceding streptococcal infection indicates a high likelihood of ARF.¹¹

Rheumatologic disorders such as JIA present with erythematous swollen joints with pain that typically improves with activity. This diagnosis should be considered in a child younger than age 16 years who complains of early morning joint pain. It can affect single or multiple joints. Eye involvement in the form of uveitis is also commonly noted.³,⁵,¹⁰

**Infectious Conditions**

Osteomyelitis and septic arthritis of the hip can present as limp, and
their clinical presentation may mimic that of a transient synovitis. Early diagnosis and timely treatment are required to prevent serious consequences such as joint damage and related complications. Infection may reach the area via blood stream, direct contamination, or from infection of nearby skin (such as cellulitis). The most common causative organism in children is *Staphylococcus aureus*. Other organisms that can cause septic arthritis include *Escherichia coli*, group B streptococci in neonates, and *Neisseria gonorrhoeae* in a sexually active teenager.

Septic arthritis is more common in children in the age group of 2 to 3 years. Fever may be more profound and the child may appear sicker compared to those with transient synovitis. Crying when the child is picked up or with every diaper change should be a clue to consider septic arthritis, as should if the child refuses to move and bear weight on the affected extremity. Poor feeding and irritability may be seen in younger children and infants.3,9,10

Evaluation for these patients includes CBC, blood culture, ESR, and CRP. An elevated CBC and inflammatory markers are noted in patients with osteomyelitis and septic arthritis. A clinician can use the Kocher criteria,7,8 which combine clinical and laboratory criteria, to consider septic arthritis.

US of the affected joint should be obtained. US is a useful test to identify effusion, although it cannot distinguish between clear and purulent fluid.12,13 If the index of suspicion for septic arthritis is high, joint aspiration should be performed and the synovial fluid should be obtained for evaluation. Plain radiography has limited utility in children younger than age 9 years presenting with nontraumatic limp.14,15 Plain radiography findings in osteomyelitis include periosteal bone thickening, lytic lesions, and new bone apposition (Figure 1). These findings may not be apparent until 10 to 14 days of illness.16 The sensitivity of US for diagnosis of osteomyelitis ranges from 32% to 72% based on the stage of the illness. The sensitivity can be further improved with use of high-resolution and power Doppler sonography.16,17

Deep soft tissue swelling, subperiosteal abscess, fluid adjacent to the bone, cortical erosion, and increased flow within periosteum are some of the findings noted on US that are suggestive of osteomyelitis. Findings can be detected by US much earlier than by plain radiography. CT scan is the preferred test for diagnosis of cortical destruction in chronic osteomyelitis. Otherwise, MRI is the diagnostic study of choice in children with suspected acute or chronic osteomyelitis9 (Figure 2).

Nuclear medicine scans are not used as often because of their low specificity in diagnosing osteomyelitis.

Early antibiotic therapy and orthopedic consultation are required for the management of these patients. Parenteral clindamycin or vancomycin is the drug of choice in communities where meticillin-resistant *S. aureus* (MRSA) is prevalent. If the community prevalence of MRSA is <10%,
Intravenous nafcillin or oxacillin or a first-generation cephalosporin can be started as empiric therapy. *Kingella kingii* is a gram-negative cocccobacillus and has been a common cause of osteoarticular infections in children younger than age 3 years. In this age group, empiric coverage with cefazolin or ceftriaxone is recommended in addition to the coverage for MRSA. Duration of therapy ranges from 4 to 6 weeks. *Salmonella* osteomyelitis should be a consideration in children with sickle cell disease.

Discitis is an inflammation of the disc space and adjacent vertebral end plates that typically affects the lumbar spine. Neonates and young children are more susceptible to discitis because of characteristic anatomy of blood vessels in this age group: the small blood vessels terminate adjacent to the intervertebral disc, which renders the disc space more susceptible to infection. Also, children have a large network of interosseous collateral arteries as compared with adults. The possible role of infection in discitis is somewhat controversial, but the most commonly considered organisms are coagulase negative staphylococci and *S. aureus*. Presentation of discitis can be very nonspecific, and a high index of suspicion is required for diagnosis. Clinical presentation ranges from refusal to walk or bear weight, and irritability on spine immobility. Point tenderness over the spine can aid in the diagnosis. Inflammatory markers may or may not be elevated early in the course of the illness. Plain radiographs show narrowing of the disc space and end plate irregularities. These findings are noted only after 2 to 4 weeks of illness. MRI is the most sensitive and specific test for diagnosis. Treatment includes consideration of parenteral antibiotics and immobilization of the spine. Operative treatment is rarely necessary.

Although rare, intracranial abscess should be considered in a patient with fever and limp. It is more prevalent in patients with congenital heart disease. It results from extension of local infection or due to septic emboli. The most common organisms cultured are from the *Streptococcus milleri* group. CT scan of the head with contrast is the diagnostic test of choice. Therapy includes abscess drainage and intravenous antibiotics. Initial therapy should be with vancomycin and ceftriaxone. Subsequent therapy is tailored according to the culture results.

**Vascular Conditions**

LCP disease and sickle cell disease are the common vascular causes of limp in children. These disorders are associated with an interruption of blood supply to the femoral head. LCP disease is typically seen in children ages 4 to 10 years and is more common in boys than in girls. Classic presentation is a painless limp. Hip radiographs aid in the diagnosis (Figure 3). Findings vary according to the stage of the disease. These include asymmetric femoral head size, and widening of the joint space and linear area of subchondral lucency (crescent sign). These patients should be referred to orthopedic surgery for definitive care.

In patients with sickle cell disease, intravascular sickling of red blood cells causes sludging, thrombosis, and ischemia leading to avascular necrosis of the head of femur (Figure 4). The general approach is nonsurgical management in younger children and surgical intervention in older children and adolescents.

**Neoplastic Conditions**

Leukemia and bone tumors can present as a limp. Approximately 20% to 30% of cases present with clinical manifestations involving bones or joints. These conditions are usually associated with bone pain secondary to malignant proliferation of cells. Imaging studies including a CT scan and MRI do not aid in the diagnosis. CBC

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Figure 3. An X-ray of the pelvis and hips showing right-sided Legg-Calve-Perthes disease.

Figure 4. An X-ray of the hips showing avascular necrosis of the left femoral head in a patient with sickle cell disease.
may help establish the diagnosis, but a single negative result does not rule out leukemia. If limp persists, one should consider repeating the blood work and also consider bone marrow studies.

Other
SCFE is a disorder of the immature hip, the exact etiology of which is unknown. There is anatomic disruption through the proximal femoral physis causing it to displace posteriorly and inferiorly. Childhood obesity is a major risk factor for SCFE. It affects the adolescent age group. Long-term outcomes depend on the associated complications, mainly avascular necrosis of the femoral head. The patient usually presents with hip or knee pain and occasional limp. High index of suspicion is required for the diagnosis. Patients with suspected SCFE should be nonweight bearing until the diagnosis is ruled out. Hip X-rays help in diagnosis. If the X-ray is suggestive of SCFE, an immediate orthopedic consult should be sought (Figure 5).

RESOLUTION OF THE CASES
Case 1
The child had a high white blood count of 50,000 cells/mm$^3$ and peripheral smear showed blasts. He was admitted to the oncology service for management of leukemia.

Case 2
Presentation was consistent with serum sickness. WBC count and inflammatory markers were mildly elevated. The child was discharged home on ibuprofen to be taken as needed. Symptomatic acute polyarthritis and discitis: differences between septic arthritis and oligoarticular infections in a pediatric population. J Bone Joint Surg Am. 2012;64(9):1109-1118.

Case 3
The presentation was consistent with transient synovitis. WBC count and inflammatory markers were mildly elevated. Pain and weight bearing improved with ibuprofen. US of the hip showed small effusion. The child was discharged home on ibuprofen. Symptoms resolved after 1 week.

REFERENCES