The Limping Child: A Systematic Approach to Diagnosis

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Deviations from a normal age-appropriate gait pattern can be caused by a wide variety of conditions. In most children, limping is caused by a mild, self-limiting event, such as a contusion, strain, or sprain. In some cases, however, a limp can be a sign of a serious or even life-threatening condition. Delays in diagnosis and treatment can result in significant morbidity and mortality. Examination of a limping child should begin with a thorough history, focusing on the presence of pain, any history of trauma, and any associated systemic symptoms. The presence of fever, night sweats, weight loss, and anorexia suggests the possibility of infection, inflammation, or malignancy. Physical examination should focus on identifying the type of limp and localizing the site of pathology by direct palpation and by examining the range of motion of individual joints. Localized tenderness may indicate contusions, fractures, osteomyelitis, or malignancy. A palpable mass raises the concern of malignancy. The child should be carefully examined because nonmusculoskeletal conditions can cause limping. Based on the most probable diagnoses suggested by the history and physical examination, the appropriate use of laboratory tests and imaging studies can help confirm the diagnosis. *(Am Fam Physician*. 2009;79(3):215-224.

A normal mature gait cycle consists of the stance phase, during which the foot is in contact with the ground, and the swing phase, during which the foot is in the air. The stance phase is further divided into three major periods: the initial double-limb support, followed by the single-limb stance, then another period of double-limb support.[1]

The gait undergoes orderly stages of development. Walking velocity, step length, and the duration of the single-limb stance increase with age, whereas the number of steps taken per minute decreases. A mature gait pattern is well established by three years of age, and the gait of a seven-year-old child closely approximates that of an adult.[2]

Abnormal Gait

Abnormal gait can be antalgic or nonantalgic. An antalgic gait, which is characterized by a shortening of the stance phase, is a compensatory mechanism adopted to prevent pain in the affected leg. Because there is decreased contact between the affected leg and the ground, a child with such a gait may not report pain. There are several different types of nonantalgic gait *(Figure 1);* most of these do not require urgent evaluation and treatment.

The incidence of limping in children is unknown. One study of children presenting to an emergency department for an acute atraumatic limp reported a rate of 1.8 per 1,000 children younger than 14 years, a male-to-female ratio of 1.7:1, and a median age of 4.4 years.[3] The limb involved (right or left) was nearly equal, and 80 percent of the children reported pain. Transient synovitis was the most common diagnosis.

Diagnosis

Limping in a child can have a variety of etiologies *(Table 1)*. A detailed history and physical examination, in addition to appropriate laboratory tests and imaging, are essential for making a correct diagnosis *(Figure 1* and *Figure 2*[4-6]*)*.

HISTORY

A thorough history should be obtained from the child and parents. In some cases, such as when child abuse is suspected, the child and parents should be interviewed separately. The initial history should be structured to determine the presence and nature of pain, history of trauma, and associated systemic signs *(Table 2)*. Isolated musculoskeletal pain in the absence of other signs or symptoms

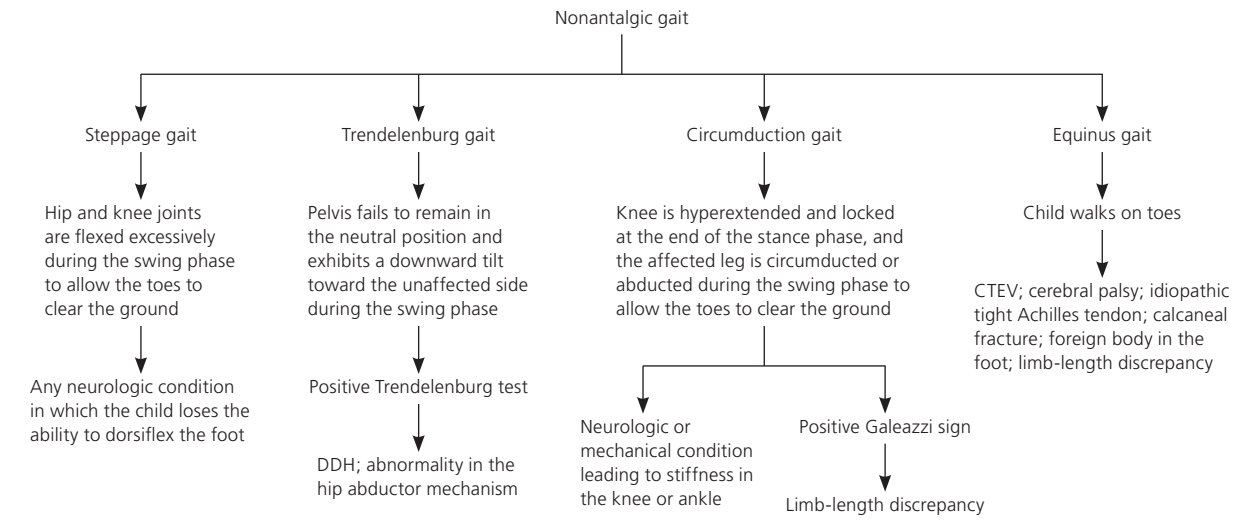

Figure 1. Diagnostic approach to a child with a nonantalgic gait. (CTEV = congenital talipes equinovarus; DDH = developmental dysplasia of the hip.)

Table 1. Differential Diagnosis of Limping in Children

Bone conditions
Benign neoplasm
- Osteoblastoma
- Osteoid osteoma

Congenital condition
- Clubfoot
- Congenitally short femur
- Developmental dysplasia of the hip

Developmental condition
- Legg disease
- Slipped capital femoral epiphysis

Infection
- Osteomyelitis

Limb length discrepancy
Malignant neoplasm
- Ewing sarcoma
- Leukemia
- Osteosarcoma

Osteonecrosis
- Sickle cell disease

Overuse injury
- Osteochondritis dissecans
- Stress fracture

Trauma
- Child abuse
- Fracture (toddler's fracture)

Intra-abdominal conditions
Appendicitis
Neuroblastoma
Psoas abscess

Intra-articular conditions
Congenital condition
- Discoid lateral meniscus

Hemarthrosis
- Hemophilia
- Trauma

Infection
- Gonorrhea
- Lyme disease
- Septic arthritis

Inflammation
- Acute rheumatic fever
- Juvenile rheumatoid arthritis
- Reactive arthritis
- Systemic lupus erythematosus
- Transient synovitis

Trauma
- Intra-articular injury

Neuromuscular conditions
Cerebral palsy
Meningitis
Muscular dystrophy
Myelomeningocele

Soft tissue conditions
Congenital condition
- Idiopathic tight Achilles tendon

Infection
- Cellulitis
- Pyomyositis or viral myositis
- Soft tissue abscess

Overuse injury
- Chondromalacia patellae
- Jumper's knee
- Osgood-Schlatter disease
- Sever disease

Trauma
- Child abuse
- Foreign body
- Sprains and strains

Spinal conditions
Diskitis
Spinal cord tumors
Vertebral osteomyelitis

is almost never a presenting symptom in children with chronic arthritis.[7] Malignant bone tumors can present with intermittent pain at rest, which often misleads physicians into believing the condition is temporary and benign.[8] The presence of systemic symptoms such as fever, weight loss, night sweats, and anorexia is highly suspicious for infection, inflammation, or malignancy.

PHYSICAL EXAMINATION

The main goals of the physical examination are to identify the type of limp and, if possible, to localize the site of pain *(Table 3)*.

Limp Type. Gait is best examined by having the child walk and run while he or she is distracted. Each limb segment should be observed systematically through

Diagnosis of Children with an Antalgic Gait

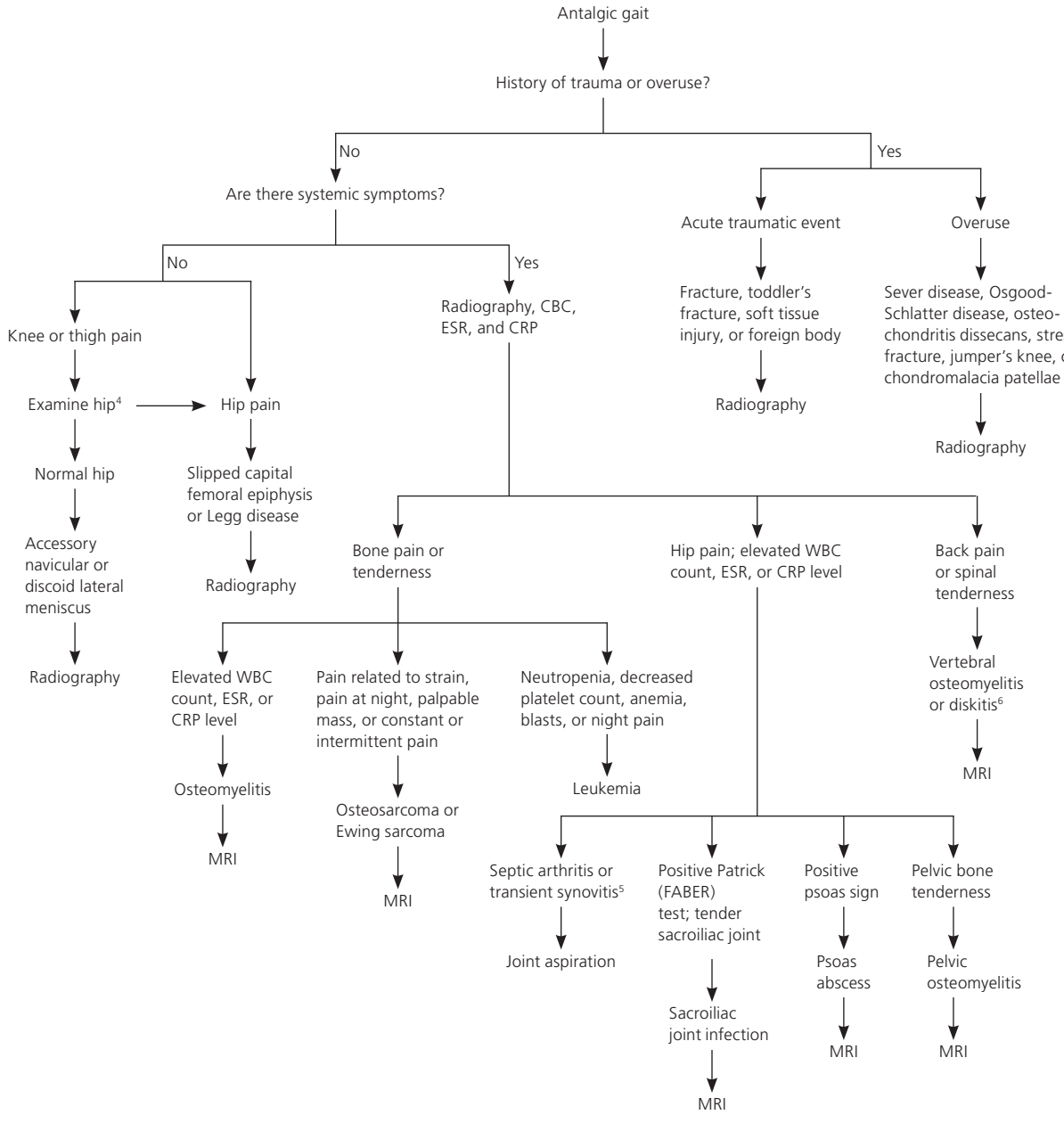

Figure 2. Diagnostic approach to a child with an antalgic gait. (CBC = complete blood count; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; MRI = magnetic resonance imaging; WBC = white blood cells.)

Information from references 4 through 6.

several gait cycles. The stance and swing phases should be compared in both legs, and the range of motion of each joint should be evaluated. Upper body posturing and frontal plane abnormalities (e.g., scoliosis, varus and valgus deformities) should be noted. Differentiating between antalgic and nonantalgic gait and identifying the specific type of nonantalgic gait *(Figure 1)* help narrow the differential diagnosis.

Site of Pathology. The child should be unclothed during the examination. The resting limb position should be noted, and both sides should be compared for symmetry; areas of erythema, swelling, and deformity should be noted. The legs should then be palpated to localize the point of maximal tenderness and to detect any masses. Range of motion should be assessed in each joint, especially the hip *(Figure 3* and *Figure 4[9])*. Joints adjacent to

Table 2. Findings from Patient History That Suggest Possible Causes of Limping in Children

Sign or symptom	*Possible cause*
Acute onset of pain	Fracture
Associated abdominal pain	Acute abdomen
	Neuroblastoma
	Psoas abscess
Associated back pain	Diskitis
	Spinal cord tumors
	Vertebral osteomyelitis
Associated fever, anorexia, weight loss, night sweats	Malignancy
	Osteomyelitis
	Rheumatologic disorder
	Septic arthritis
Associated neck pain, photophobia, or fever	Meningitis
Burning pain	Nerve involvement
Constant pain	Infection
	Malignancy
Focal pain	Fracture
	Infection
	Malignancy
Gradually worsening pain	Malignancy
	Osteomyelitis
	Rheumatologic disorder
	Stress fracture
History of bleeding disorder	Hemarthrosis
History of insect bite	Lyme disease
History of preceding diarrhea	Reactive arthritis
History of preceding pharyngitis	Acute rheumatic fever
History of trauma	Fracture
	Intra-articular injury
	Soft tissue injury
Intermittent pain at rest	Malignancy
Migratory polyarthralgia	Acute rheumatic fever
	Gonococcal arthritis
Morning stiffness	Rheumatologic disorder
	Stress fracture
Pain improves with activity	Rheumatologic disorder
Pain worsens with activity	Overuse injury
	Stress fracture
Pain in morning or after inactivity	Rheumatologic disorder
Pain at night	Malignancy
Radiating pain	Nerve or spinal cord involvement
Sexually active child	Gonococcal arthritis
	Reactive arthritis

Table 3. Findings from Physical Examination That Suggest Possible Causes of Limping in Children

Finding	*Possible cause*
Abdominal mass	Neuroblastoma
	Psoas abscess
Abdominal tenderness	Acute abdomen
Asymmetrical gluteal and thigh skin folds	Developmental dysplasia of the hip
Calf hypertrophy	Muscular dystrophy
Conjunctivitis, enthesitis, oligoarthritis, urethritis	Reactive arthritis
Erythema chronicum migrans	Lyme disease
Erythema marginatum	Rheumatic fever
External hip rotation with hip flexion	Slipped capital femoral epiphysis
Galeazzi sign	Limb-length discrepancy
Hepatomegaly, lymph-adenopathy, splenomegaly	Malignancy
	Rheumatologic disorder
Hip joint flexed, abducted, externally rotated	Hip joint effusion (position maximizes joint volume and relieves pain)
Joint swelling	Hemophilia
	Inflammatory arthritis
	Reactive arthritis
	Septic arthritis
Localized bony tenderness	Contusion
	Fracture
	Malignancy
	Osteomyelitis
Loss of hip abduction	Developmental dysplasia of the hip
Loss of hip internal rotation	Legg disease
	Slipped capital femoral epiphysis
Malar rash	Systemic lupus erythematosus
Muscular arthropathy	Disuse muscular atrophy
	Neurologic disorder
Neck pain and stiffness, Brudzinski and Kernig signs	Meningitis
Non-weight bearing, painful limitation of range of motion	Septic arthritis
Obesity	Slipped capital femoral epiphysis
Overlying warmth or redness	Inflammatory arthritis
	Osteomyelitis
	Septic arthritis
Painless, nonpruritic maculo-papular or vesicular skin rash, polyarthritis, tenosynovitis	Gonococcal arthritis
Palpable bony mass	Malignancy
Positive Patrick (FABER) test	Sacroiliac joint pathology
Positive pelvic compression test	Sacroiliac joint pathology
Positive Trendelenburg test	Developmental dysplasia of the hip
	Weak hip abductors
Psoas sign	Appendicitis
	Psoas abscess

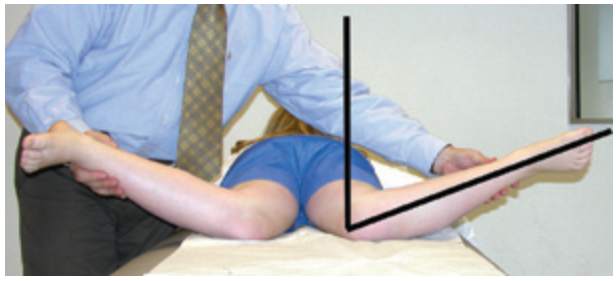

Figure 3. Internal rotation of the hip is measured by placing the child in the prone position with knees flexed 90 degrees and rotating the feet outward. Loss of internal rotation is a sensitive indicator of intra-articular hip pathology and is common in children with Legg disease and slipped capital femoral epiphysis.

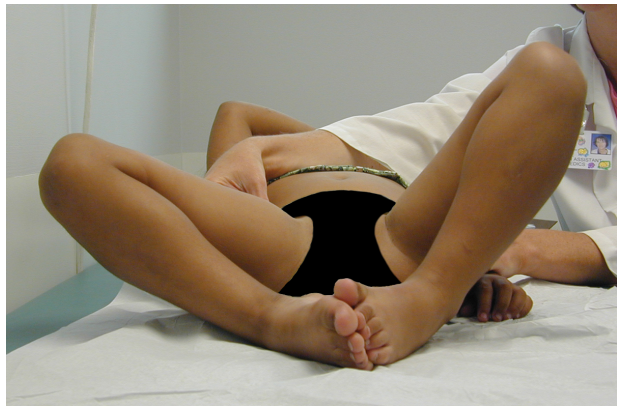

Figure 4. Hip abduction is measured by placing the child in the supine position with hips and knees flexed and the toes placed together. To measure abduction, both knees are allowed to fall outward. Limited hip abduction, as in this child's left hip, occurs in children with developmental dysplasia of the hip.

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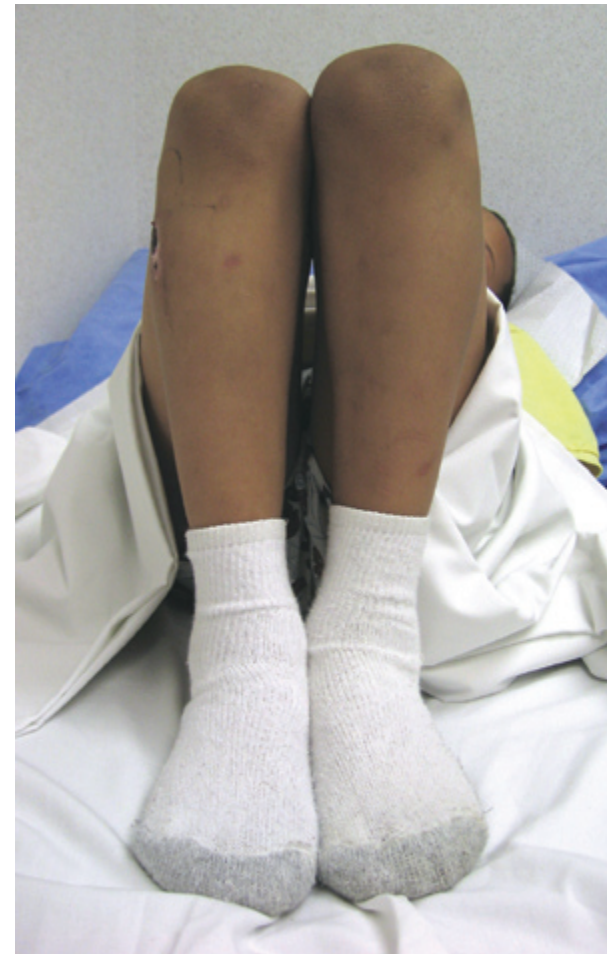

Figure 5. Positive Galeazzi sign. The child is placed in the supine position with the hips and knees flexed. In a positive test, the knee on the affected side is lower than the normal side. This can occur in patients with any condition that causes a leg-length discrepancy, such as developmental dysplasia of the hip, Legg disease, or femoral shortening.

the painful one should be examined to rule out referred pain. This is especially important for hip conditions, which can present as knee or lateral thigh pain,[4] leading to delayed diagnosis.[10]

Tests. The Trendelenburg test can be used to identify conditions that cause weakness in the hip abductors. The child stands on the affected limb and lifts the unaffected limb from the floor. In a positive test, the pelvis fails to stay level and drops down toward the unaffected side.

The Galeazzi sign can signal conditions that cause a leg-length discrepancy. The child should lie in the supine position with the hips and knees flexed. The test is positive if the knee on the affected side is lower than that on the normal side *(Figure 5)*.

The Patrick test (also called the FABER test; *Figure 6*) can indicate pathology of the sacroiliac joint. With the child in the supine position, the examiner flexes, abducts, and externally rotates the hip joint. In a positive test, pain occurs in the sacroiliac joint.

The pelvic compression test also can indicate the presence of sacroiliac joint pathology. With the child in the supine position, the examiner compresses the iliac wings toward each other. Pain with this maneuver indicates sacroiliac joint pathology.

The psoas sign can signal a psoas abscess or appendicitis. With the child lying on his or her side, the hip is passively extended. Pain with hip extension indicates a positive test.

Special attention should be paid to performing a thorough spinal, pelvic, neurologic, abdominal, and genitourinary examination. Conditions affecting these systems are associated with limping *(Table 1)*.

LABORATORY TESTS

A complete blood count with differential and measurement of the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels should be obtained when infection, inflammatory arthritis, or malignancy is

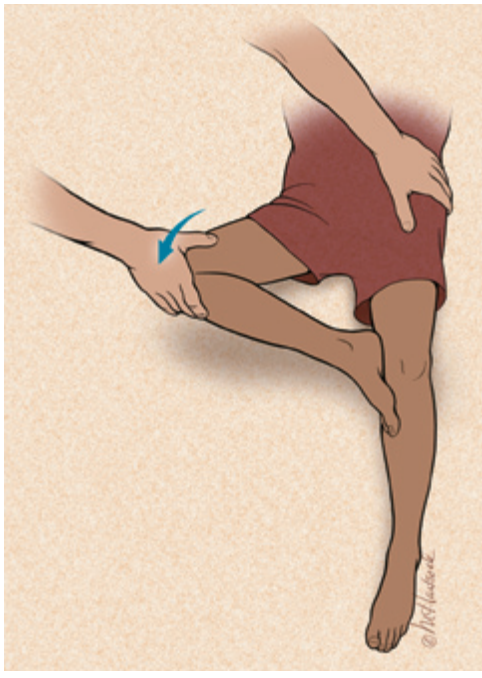

ILLUSTRATION BY MARCIA HARTSOCK

Figure 6. The Patrick (FABER) test. Note how the examiner has flexed, abducted, and externally rotated the child's right hip.

suspected. If septic arthritis is suspected, joint fluid should be aspirated urgently for Gram stain, culture, and cell count. Blood cultures should be obtained when infection is suspected, and bone cultures should be obtained in patients with suspected osteomyelitis. The role of specific laboratory testing is summarized in *Table 4*.[11-28]

IMAGING

Imaging should begin with standard orthogonal radiographs of the area of concern.[29] When imaging the hip, frog-leg lateral radiographs should always be obtained *(Figure 7)*. The exception is in patients with suspected acute slipped capital femoral epiphysis, in whom a true lateral view of the hip should be obtained because a frog-leg view can cause exacerbation of the slip.[30] In children with a nonfocal clinical examination, and in those who are too young to localize pain or give a reliable history, the entire lower legs should be imaged.[29] Initial radiographs may be normal in children with stress fractures, toddler's fracture,[31] Legg disease, osteomyelitis, or septic arthritis.

Ultrasonography is highly sensitive for detecting effusion in the hip joint, but it cannot differentiate between sterile, purulent, or hemorrhagic fluid accumulations.[32] If an effusion is seen in the hip joint and the

Table 4. Laboratory Tests for Diagnosis in a Limping Child

Test	*Condition*	*Expected finding*
ANA	SLE	Positive
ASO	Acute rheumatic fever	Increased ASO titers
Blood culture	Infection	Positive
Bone culture	Osteomyelitis	Positive
CBC	Infection	Increased WBCs and platelets
	Inflammation	Increased WBCs and platelets
	Malignancy	Cytopenia[22]
Coagulation profile	Known hemophilia or hemorrhagic effusion	Increased activated partial thromboplastin time
CRP	Infection	Increased CRP levels
	Inflammation	Increased CRP levels
	Malignancy	Increased CRP levels
ESR	Infection	Increased ESR
	Inflammation	Increased ESR
	Malignancy	Increased ESR
Lyme titer	Lyme disease	Positive
Synovial fluid analysis	Septic arthritis	Turbid synovial fluid; WBC count > 50,000 to 100,000 per mm^3; PMNs > 75 percent[27]
	Transient synovitis	Clear yellow synovial fluid; WBC count 5,000 to 15,000 per mm^3; PMNs < 25 percent[27]
Synovial fluid culture	Septic arthritis	Positive
	Transient synovitis	Negative
Throat culture	Acute rheumatic fever	Group A hemolytic streptococci
Urethral, cervical, pharyngeal, and rectal cultures	Gonococcal arthritis	*Neisseria gonorrhoeae*
Urethral and stool cultures	Reactive arthritis	*Chlamydia* in urethral cultures[28]; *Salmonella, Shigella, Yersinia,* and *Campylobacter* in stool cultures[28]

ANA = antinuclear antibodies; ASO = antistreptolysin O titer; CBC = complete blood count; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; PMN = polymorphonuclear neutrophils; SLE = systemic lupus erythematosus; WBC = white blood cell.

Information from references 11 through 28.

Comments
Present in 94 percent of children with SLE[11]; a negative ANA test virtually rules out SLE.[12] The test's predictive value is low in most nonspecialty settings; most positive results do not indicate SLE.[13] Ten to 40 percent of healthy children can have a positive test.[12,14] Test can be positive in patients with other medical conditions (e.g., infection, malignancy, other autoimmune conditions).[13,15] A titer between 1:160 and 1:320 offers the best combination of high sensitivity and high specificity.[12] A positive test by itself is not diagnostic for SLE; three additional criteria must be present.[16] Test is of no diagnostic utility in ruling in or ruling out juvenile rheumatoid arthritis.[17]
Indicates true infection rather than carriage. Elevated ASO titers are found in up to 80 percent of patients with acute rheumatic fever.[18] Sensitivity can be further increased by testing for additional antibodies.[18]
Test is positive in 30 to 60 percent of patients with osteomyelitis[19] and in 40 to 50 percent of patients with septic arthritis.[20]
Test is positive in 48 to 85 percent of patients with osteomyelitis.[19] *Staphylococcus aureus* is the most common pathogen isolated.[19]
WBC count is neither sensitive nor specific for infection, inflammation, or malignancy. Blast cells, lymphocytosis, and neutropenia may be seen in patients with leukemia.[21] Cytopenia may occur in patients with SLE.[11]
—
Test is neither sensitive nor specific for infection, inflammation, or malignancy. The negative probability of septic arthritis is 87 percent when CRP level is > 1 mg per dL (10 mg per L).[23] In patients with osteomyelitis and septic arthritis, CRP levels should rapidly normalize after initiation of therapy. A persistently elevated CRP level after the initiation of antibiotics indicates a poor response to therapy.[24,25]
Test is neither sensitive nor specific for infection, inflammation, or malignancy. The negative probability of septic arthritis is 85 percent when ESR is > 25 mm per hour.[23] A low or normal platelet count in the presence of an elevated ESR suggests malignancy.[22]
All children who live in or have recently traveled to an area endemic for Lyme disease should be tested.[26]
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Test is positive in 50 to 80 percent of patients with septic arthritis.[20] *S. aureus* is the most common pathogen isolated in patients with septic arthritis.[27]
Positive in only 10 to 33 percent of patients with acute rheumatic fever.[18]
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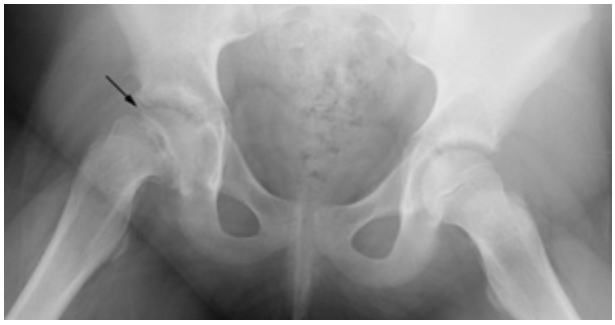

Figure 7. Frog-leg lateral radiograph of a patient with slipped capital femoral epiphysis. Note the slip in the patient's right hip *(arrow)* compared with the normal left hip.

clinical suspicion for septic arthritis is high, urgent ultrasound-guided aspiration should be performed, and the joint fluid should be sent for Gram stain, cell count, and culture. In such circumstances, aspiration must not be delayed.[33] If ultrasonography is not available, aspiration of the hip can be performed under fluoroscopic guidance. If neither of these imaging modalities is available, blind needle aspiration of the hip joint can be performed, but it carries a risk of injury to the femoral and obturator neurovascular structures, and the proper location of the needle cannot be confirmed. Blind needle aspiration should be performed only by experienced physicians when neither sonographic nor fluoroscopic guidance is available.

Bone scintigraphy is an excellent test for evaluating a limping child when the history, physical examination, and radiographic and ultrasound findings fail to localize the pathology.[33-36] Bone scanning allows the entire skeleton to be imaged simultaneously and is useful for detecting occult fractures, stress fractures, osteomyelitis, tumors, and metastatic lesions. Although it has a high sensitivity, this imaging modality lacks specificity.

Computed tomography (CT) is indicated when cortical bone must be visualized.[33] Magnetic resonance imaging (MRI) gives excellent visualization of joints, soft tissues, cartilage, and medullary bone.[33] Unlike bone scanning, MRI has both high sensitivity and specificity. It is especially useful for confirming osteomyelitis[37,38] *(Figure 8),* delineating the extent of malignancies, identifying stress fractures,[39,40] and diagnosing early Legg disease.[41-43] Fifteen to 63 percent of patients with slipped capital femoral epiphysis have involvement of the contralateral hip,[44] and MRI is useful for diagnosing "pre-slips" in these patients.[45]

Common Diagnostic Dilemmas

SEPTIC ARTHRITIS VS. TRANSIENT SYNOVITIS OF THE HIP

Children with transient synovitis often are afebrile, appear nontoxic, and have less acute pain and range-of-motion restriction in the hip than those with septic arthritis, who typically appear toxic and have pain with movement of the joint in any direction. However,

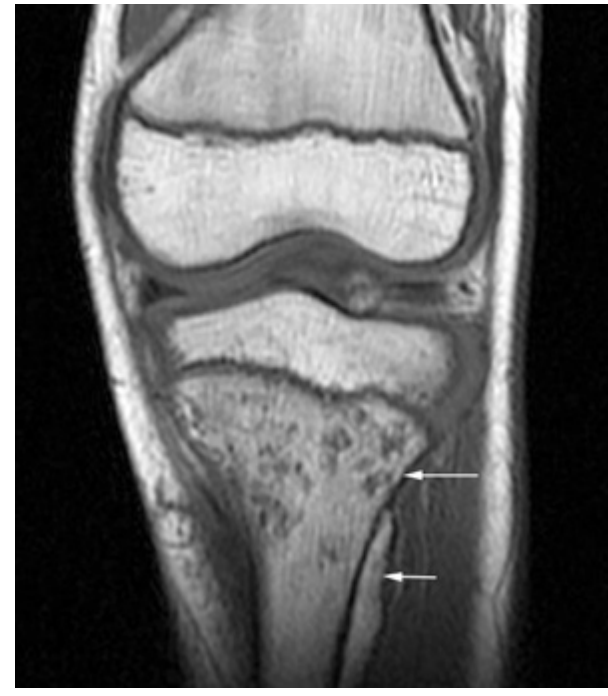

Figure 8. Magnetic resonance image of a patient with osteomyelitis. Note the signal change within the bone marrow consistent with osteomyelitis *(long arrow)* and a subperiosteal abscess *(small arrow).* This patient had normal plain radiographs.

differentiating the two conditions can be difficult. A recent study used an oral temperature of greater than 101.3°F (38.5°C), refusal to bear weight on the affected leg, ESR greater than 40 mm per hour, peripheral white blood cell count of more than 12,000 cells per mm^3 (12.0×10^9 cells per L), and a CRP level greater than 2.0 mg per dL (20.0 mg per L) as predictors to distinguish between the two conditions.[5] The probability of having septic arthritis was 37 percent with one predictor present, 63 percent with two, 83 percent with three, 93 percent with four, and 98 percent with all five predictors. Hip aspiration is the gold standard for diagnosing septic arthritis and should be performed whenever septic arthritis is suspected, because the sequelae of a missed or late diagnosis can be severe.[46]

DISKITIS VS. VERTEBRAL OSTEOMYELITIS

Children with diskitis or vertebral osteomyelitis can present with a fever, back pain, or a limp, or they may refuse to walk. Although fever is present in both conditions, it is much more common, usually higher, and of longer duration in children with vertebral osteomyelitis.[6] Children with diskitis usually do not appear ill, whereas those with vertebral osteomyelitis have a toxic appearance. In addition, diskitis involves the lumbar region almost exclusively, whereas vertebral osteomyelitis can involve any part of the spine. Radiographs of children with diskitis may show disk space narrowing and variable degrees of destruction of adjacent vertebral

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	*Evidence rating*	*References*
The following clinical features are more predictive of septic arthritis than of transient synovitis: • Oral temperature > 101.3°F (38.5°C) • Refusal to bear weight on affected leg • ESR > 40 mm per hour • Peripheral white blood cell count > 12,000 cells per mm^3 (12.0×10^9 cells per L) • CRP level > 2.0 mg per dL (20.0 mg per L)	C	5
The initial imaging modality for a limping child who has focal findings on physical examination is anteroposterior and lateral radiography of the involved site.	C	29
The initial imaging modality for a limping child who has no focal findings on physical examination is radiography of both lower extremities.	C	29
Ultrasonography is recommended over plain-film radiography for detecting hip effusion.	C	32
A bone scan is recommended for detecting underlying pathology when other imaging modalities have failed.	C	33-36
When infection, inflammatory arthritis, or malignancy is suspected, a complete blood count with differential and measurement of ESR and CRP level should be obtained.	C	23-25, 33, 46

CRP = C-reactive protein; ESR = erythrocyte sedimentation rate.

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to http://www.aafp.org/afpsort.xml.

end plates; in children with vertebral osteomyelitis, localized rarefaction of one vertebral body and bony destruction may be seen. MRI is the diagnostic study of choice in children with suspected vertebral osteomyelitis.

MALIGNANCIES VS. RHEUMATOLOGIC DISEASES

Children with malignancies or rheumatologic conditions can have overlapping clinical features, such as musculoskeletal pain, fever, fatigue, weight loss, hepatomegaly, and arthritis.[22] Nonarticular bone pain, back pain, bone tenderness, severe constitutional symptoms, night sweats, ecchymoses, bruising, abnormal neurologic signs, and abnormal masses are suggestive of malignancy.[22] An elevated ESR in the presence of a normal or low platelet count also is worrisome for malignancy.[22] One study found that in children presenting with unexplained musculoskeletal symptoms, a history of nighttime pain and the presence of a low white blood cell count and a low to normal platelet count has a sensitivity of 100 percent and a specificity of 85 percent for the diagnosis of acute lymphocytic leukemia.[47]

PSOAS ABSCESS VS. SEPTIC ARTHRITIS

Children with a psoas abscess commonly present with a limp and pain around the hip. Differentiating a psoas abscess from septic arthritis of the hip can be challenging. Patients with a psoas abscess may have a palpable abdominal mass and a positive psoas sign. Because of the proximity of the psoas abscess to the spine and the peripheral nerves, scoliosis, sciatica, and femoral nerve neuropathy may be present.[48] Unlike children with septic arthritis, in whom range of motion is painfully limited in all directions, flexing the hip of a child with a psoas abscess relieves the pain and allows painless internal and external rotation of the hip. Plain-film radiography in children with psoas abscess may show obscuration of the sacroiliac joint; CT or MRI can be used to confirm the diagnosis.

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