

Evaluation of the Limping Child

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Abstract: Prompt evaluation of a younger child (age <5) with gait disturbance or refusal to walk is necessary to distinguish orthopedic urgency (trauma or infection) from relatively benign processes and chronic problems such as arthritis. Physical examination should include evaluation of gait, supine and simulated prone hip examination (on the parent's lap to keep the child comfortable), and the crawl test. There are six radiographic views of the lower extremities that can assist in the diagnosis. In conjunction with the detailed history, a thorough physical exam, and radiographs from the orthopedic provider can determine the need for laboratory tests and other imaging.

Key Concepts:

- Evaluation of the limping child begins with a thorough history.
- Physical examination of the limping child can be optimized by utilizing the parent to hold the child while the examiner moves the extremities and checks the back.
- Six screening radiographs can be obtained to assist in making the correct diagnosis.
- Laboratory analysis and magnetic resonance imaging can be obtained if the diagnosis remains elusive.

Introduction

Evaluation of gait disturbance in the younger child is an important skill for the pediatric orthopedic surgeon. Although the true incidence is unknown, it is estimated that there are 1.8 per thousand children that will present to the pediatric emergency department with complaint of gait disturbance. With a Male:Female ratio of 1.7:1, the average age is 4.3 years.¹ Alterations in gait have a differential diagnosis ranging from common etiologies of trauma and infection to less common causes such as neuromuscular disorders, arthritis, malignancy, and malnutrition. When a younger-aged child (<5 years) presents with onset of a limp or inability to walk, a careful history, physical examination, and selected imaging can often lead to the correct diagnosis. History should focus on identifying the duration, any inciting event, the trajectory of symptoms, or associated

symptoms. Utilizing the parent in the physical examination can help elicit a more detailed examination of the child. Focused radiographs can then be utilized to support a suspected diagnosis. From there, the need for laboratory analysis and further advanced imaging can be determined.

History

A careful history can help distinguish between different conditions and should include a detailed birth and developmental history, past medical history, immunization status, exposure to other persons with active infections, and family history of metabolic, rheumatologic, neuromuscular, or immunocompromised conditions. The onset of symptoms, perceived location, quality of the pain, severity of the symptoms, the time of

day, associated symptoms, and duration of the pain must be ascertained.

Onset: Acute trauma is more likely if there was a fall and the child cried and failed to walk immediately thereafter. If there was a delay in the onset of the limp or pain; or history of trauma is unclear, infection or synovitis is more likely. Additionally, the duration of the symptoms should be appreciated in the context of the trajectory of those symptoms. Worsening of symptoms would add support for an infectious/inflammatory process rather than trauma. To help determine trauma from inflammatory causes, the examiner should ask the following questions:

- Was the injury witnessed?
- Did the child cry immediately after the fall?
- When did the child start to limp—immediately?
- If the child won't walk, will he or she crawl?
- Are there any puncture wounds?

Position: The caretaker should be asked regarding the side involved, and if the child is limping or unable to bear weight completely. If the child is not walking, the examiner should inquire regarding the ability of the child to crawl. A normally ambulatory child who can crawl has the ability to bear weight through the femur and hip and knee, and the inability to walk is likely due to pathology in the tibia or foot.

Quality/severity: Characterization of the pain in terms of being constant or intermittent can be beneficial. Constant pain is more indicative of an interosseous process such as infection or developing tumor. When there is a clear fracture and no history of trauma given, pathological fracture or child abuse should be considered.^{1,8}

Timing: The time of day that the pain occurs should be obtained. Pain that wakes the child from sleep at night suggests a more aggressive process rather than pain after intense activity. Morning pain associated with stiffness



Figure 1. The child is more comfortable while being held by the parent.

of the joints suggests an inflammatory process, including rheumatologic conditions.^{8,9}

Gait

Understanding normal age appropriate gait and identifying deviation is critical for evaluation. The mature gait cycle consists of stance phase and swing phase, with 62% of the cycle in stance phase.²⁻⁵ According to Sutherland et al.³ there are five determinants of mature gait: duration of single-limb stance, walking velocity, cadence, step length, and the ratio of pelvis span to ankle spread.

When a child begins to walk, usually prior to 18 months of age, the gait is immature.³⁻⁵ It is important to understand the normal toddler gait to differentiate pathologic alterations. In stance, the feet are widened to support the body. The joint motion is similar, but the knees are more flexed, and ankles are more dorsiflexed in stance. Single leg stance cannot be maintained for a significant amount of time as seen in mature gait mentioned above. The knee flexion wave during the swing phase is diminished. During the gait cycle, the stride is shorter than a mature gait, but the cadence is faster with an overall slower velocity. As the gait matures the cadence decreases, but the overall velocity and stride length increase making a more energy efficient and stable gait.^{2,4,5}

A limp is any deviation of the normal gait cycle that can appear irregular, asymmetric, laborious, or erratic. The etiology of an abnormal gait can result from pain, weakness, mechanical alterations, or neurologic abnormalities. An antalgic gait is characterized by decreased duration of stance on the affected side, decreasing the time spent bearing weight can reduce pain. This also reduces the stride length of the opposite limb.⁶ Antalgia can present with a guarded gait that can appear like a slow, shuffling gait, as the presentation can occur with spine related pathology.⁷

Physical Exam (see video)

Gait observation should be done where there is plenty of space and the ability for the child to move without changing the gait due to obstacles. The gait can be observed prior to the formal history and physical, if the examiner is able to see the child mobilize down the clinic hallway or in the emergency department.^{8,10}

The physical examination of the child should utilize the parent in promoting gait and providing comfort while moving through palpation and passive range of motion of the back and lower extremities. This portion of the exam should be done gently and quietly on the parent's lap (Figure 1). In order to gain trust, the examination should start with areas that are clearly not the source of pathology. Palpate the back, pelvis, and trochanters, then move distally and palpate the distal femurs, tibias and feet. Look for knee and ankle swelling. Once the child is comfortable in the parent's lap, the examiner should finally attempt to localize the area of pain. Always save the portion of the exam that might be painful for last and avoid any noxious tests such as blood draw for the end.

Two helpful tests are:

1. Simulated prone internal rotation of the hip

(Figure 2): For the younger child, this is best done with the child held by the parent chest to chest, with hips fully extended. The extended position increases joint pressure by decreasing the volume of the joint capsule.



Figure 2. Simulated prone hip range of motion keeps the hip extended and a decrease in internal rotation can suggest hip pathology. Hip extension, abduction, and external rotation can also be documented.



Figure 3. Crawl Test: If the child can crawl, it is unlikely that the hip or femur is involved.

Furthermore, this position provides a more accurate measure of the hip's internal rotation compared to the normal side by stabilizing the child's pelvis. This is the most sensitive indicator of hip joint involvement for subacute disorders ranging from synovitis, arthritis, and Perthes disease. Even hip flexion, extension, and abduction can be done from this position.

2. Crawl Test (Figure 3): This will be most useful for lateralization and localization of the pathology. If the child will not stand, try to entice the child to crawl. If by

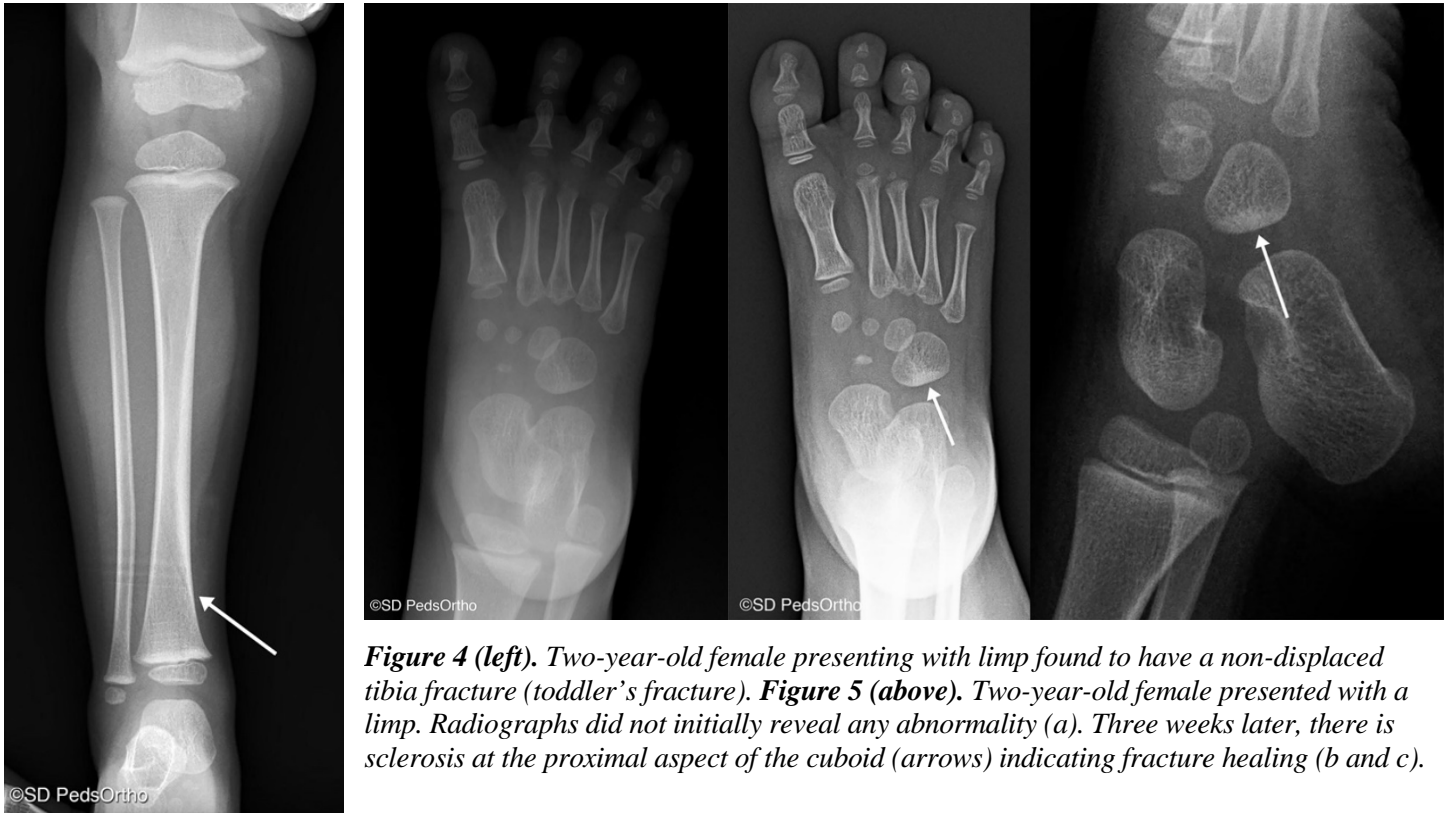


Figure 4 (left). Two-year-old female presenting with limp found to have a non-displaced tibia fracture (toddler's fracture). **Figure 5 (above).** Two-year-old female presented with a limp. Radiographs did not initially reveal any abnormality (a). Three weeks later, there is sclerosis at the proximal aspect of the cuboid (arrows) indicating fracture healing (b and c).

history or by exam a reciprocal crawl is possible, the pathology is distal to the knee. Pelvis osteomyelitis and hip and knee sepsis are extremely unlikely in the child who can crawl, and physical examination and imaging studies can now be limited to the leg and feet. Examples of pathology that limits crawling include tibia fracture, osteomyelitis of the distal tibia, foot fracture, osteochondritis of the foot (Kohler disease, etc.), or foreign body in the foot.

The tabletop evaluation of the child is used to observe the patient for erythema, ecchymosis, wounds, deformity, etc. Look at the plantar aspect of the foot and between the toes for injection sites for foreign bodies. Limb length difference or asymmetry can be assessed with the child in supine position. The position of the resting limb should be evaluated, as the hip with an effusion is at its most relaxed position in flexion, external rotation, and abduction. The entire limb should be palpated, noting withdrawal to pain or grimacing.^{1,8,10-14}

Radiographs

Imaging should start with plain radiographs of the area that is suspect based upon the history and physical examination. Without specific localization of a limping child or a child who will not bear weight, these authors recommend these radiographic views:

1. AP and frog pelvis (omit these films if normal hip motion and symmetrical crawling is possible)
2. AP both tibias together
3. Lateral of each tibia to include the knee and entire foot
4. AP of both feet together

Plain radiographs are both sensitive and specific for localization and diagnosis for most causes of a limp such as fracture or foreign body.^{8,15-17} In cases where radiographs are negative, ultrasonography can be utilized to identify fracture of a predominantly cartilaginous

joint, locate a radiolucent foreign body, detect a joint effusion, or identify soft tissue swelling/abscess. Ultrasound is also an effective adjunct for aspiration of a joint effusion or soft tissue fluid collection.¹⁶

MRI is useful for characterizing the bone, cartilage, muscles, and soft tissues and is useful for disorders such as discitis which is suspected in toddlers based upon symptoms such as failure to walk, abdominal pain, and limited spinal mobility on physical examination. Plain radiographs may show disc space narrowing. MRI is useful for diagnosis of infection or tumor and can direct the next phases of care for the orthopedic surgeon. For instance, initial radiographs are usually normal for children presenting with acute hematogenous osteomyelitis. Computed tomography (CT scan) is occasionally used to evaluate the abdomen for a limping toddler who may have neuroblastoma. CT carries risk of radiation exposure and therefore is not used to search for a cause but to evaluate a specific finding (hepatosplenomegaly) or in the limping toddler to further differentiate the quality of bone. As such, CT is in general less useful for evaluating the etiology of a limp.^{15,17}



Figure 6. A two-year-old female with a right proximal tibia fracture after jumping on a trampoline.

Differential Diagnosis

The differential diagnosis for the etiology of a limp can be narrowed based on the age of the child.^{8,12-14,18,19} For the younger child (<5 years), the causes include trauma, infection, and less likely, arthritis, tumor, leukemia, neuromuscular abnormalities, and avascular necrosis (Table 1).

Trauma: Relatively common fractures that can result in presentation of a limping child include a toddler’s fracture (Figure 4) or a foot fracture. These patients

Table 1: Differential Diagnosis for a Limping Child Less than 5 years of Age

Traumatic	Infectious	Inflammatory	Other
Fracture Tibia fracture Cuboid fracture Physeal injury	Septic hip	Transient synovitis	Foot anomaly Osteochondritis – Navicular (Kohler’s Disease)
Foreign body	Osteomyelitis	Systemic juvenile idiopathic arthritis	Perthes disease
Sprain/strain	Diskitis	Lyme disease	Nutritional deficiency Rickets Scurvy
Non-accidental trauma	Pyomyositis		Congenital/developmental Developmental dysplasia of the hip Discoid lateral meniscus Neuromuscular/genetic disease
			Malignancy Tumor Leukemia



Figure 7 (left). A two-year-old male who sustained a distal tibia fracture after being dropped. **Figure 8 (middle).** A 13-month-old female presenting with antalgic gait where she would only walk on her heel. Radiographs of the foot showed a sewing needle present at the plantar aspect of the forefoot. **Figure 9 (right).** A two-year-old female presenting with a limp and fever for three days who localized to the tibia. An MRI was obtained showing hyperintensity to the distal tibia metaphysis consistent with acute hematogenous osteomyelitis.

often have an acute presentation with a previously normal gait that changed suddenly. A traumatic event may or may not be reported, especially in the case of a foot fracture. The radiographs of cuboid fracture, also known as the nutcracker fracture, can be negative in the acute setting.²⁰⁻²² In this case, radiographs taken at a later date show sclerosis from fracture healing (Figure 5). Tibia fractures may present acutely with gait disturbance, particularly after higher energy injuries such as seen from trampolines or a fall (Figure 6 and 7).

With the acute onset of a limp, another possibility is a foreign body lodged in the foot. The child may choose to bear weight on a different part of the foot to avoid weight bearing through the foreign body (toe walking in the case of a thorn in the heel). A puncture site may or may not be present. If so, there may be surrounding erythema, ecchymosis, or an open wound.²³ If the object is radio-opaque [metal (except aluminum), animal bones, and glass], they can be identified with radiographs. Radiolucent materials (plastic, wood, and many fish bones) can be visualized with ultrasound, but sometimes MRI is needed^{23,24} (Figure 8).

Infection: Infectious etiologies usually have a more insidious onset and may be associated with other symptoms, including lethargy, fever, weight loss, night sweats, or anorexia. If the history and physical exam point to an irritable hip, further studies such as radiographs or ultrasound may distinguish a relatively benign process from an orthopedic surgical urgency. Septic arthritis can be difficult to distinguish from non-septic joint inflammation (transient synovitis or juvenile rheumatoid arthritis). However, a good examination of the hips in the parent's lap can help predict septic arthritis from synovitis where slow gentle movement can be tolerated. With hip sepsis, picking the child up or any motion will be very painful unless anti-inflammatory drugs are on board.

Kocher et al. initially proposed²⁵ and validated²⁶ four criteria that can help distinguish between a septic and non-septic hip joint, with increasing probability of sepsis when more criteria were positive. Positive criteria include a white blood cell count (WBC) greater than 12,000/mm³, erythrocyte sedimentation rate (ESR) greater than 40 mm/hr, fever over 38.5° Celsius, and

inability to bear weight. These criteria were further validated and enhanced by Caird et al.²⁷ with the addition of C-reactive protein (CRP) greater than 2.0 mg/dL. If there is enough concern for septic hip (greater than 3 Kocher Criteria), an ultrasound can be obtained of the hip to look for an effusion and possibly aspirate the joint for synovial fluid analysis. Osteomyelitis can have a similar presentation in isolation or with an associated septic joint. After the history, physical, and initial radiographic imaging, laboratory analysis and advanced imaging can be used to determine the need for surgical intervention and the trajectory of the disease course (Figure 9).²⁸

Summary

The evaluation of a limping child should start with a thorough history to help determine the cause for limp and delineate between trauma, infection, tumor, or developmental problems. A physical examination utilizing the parent to keep the patient comfortable can further localize the region causing the child pain. Simulated prone hip examination and the crawl test are sensitive tools that aid in this task. Six radiographic views of the lower extremities can assist in localizing the involved area. If this fails to provide the diagnosis, then laboratory analysis and further imaging can be considered to help with the diagnosis.

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