

## CHAPTER 6

# The Limping Child

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Limping is common in children, and it may represent a diagnostic challenge for the orthopaedist. A painful or painless limp may be caused by myriad conditions, with the differential diagnosis ranging from the benign (e.g., an unrecognized splinter in the foot) to the serious (e.g., a septic hip or a malignant neoplasm).<sup>\*</sup> It is important that the clinician approach each patient in a systematic and orderly manner so as not to miss or delay making the correct diagnosis.

A thorough history and physical examination is the first step toward achieving this goal<sup>28,53,54</sup> and may lead to early identification of the underlying problem causing the limp. The joints are inspected for swelling, effusion, erythema, and warmth; the presence of muscle atrophy is noted and measured; and active and passive range of motion are assessed. Particular attention is paid to the child's gait. Because various pathologic conditions often produce a characteristic limp, carefully observing the child's gait can be extremely helpful in diagnosing the cause.

The need for ancillary diagnostic tests is based on the history and clinical examination findings.<sup>†</sup> These tests may include laboratory studies, radiography, and, in some cases, ultrasonography, bone scintigraphy, computed tomography (CT), or magnetic resonance imaging (MRI). In general, for the younger child who presents with a limp but is otherwise normal on physical examination and appears to be well, the gait disturbance is likely to be self-limited and radiographs are unlikely to assist in making a diagnosis. Persistent symptoms, however, warrant further investigation.

This chapter describes the different abnormal gait patterns associated with childhood limps (normal gait is described in detail in Chapter 5, Gait Analysis) and presents a general overview of many of the possible conditions that may be responsible for a limp. A more thorough explanation of these disorders is provided in their respective chapters. Limps due to an obvious injury will not be addressed. Disorders most commonly responsible for an abnormal gait generally vary based on the age of the patient. Thus, to enable the clinician to more effectively address the diagnostic challenge of a limp, the special considerations of three different

age groups—toddlers (1 to 3 years), children (4 to 10 years), and adolescents (11 to 15 years)—also are presented (Table 6-1).<sup>53,55</sup>

## Abnormal Gait Patterns in Children

A child's gait pattern can be affected by numerous factors, including pain, weakened muscles, abnormal muscle activity, joint abnormalities, and limb length discrepancy.<sup>28,53-55,81</sup> Each of these pathologic conditions produces a characteristic limp, which can be recognized by observing the movements of the pelvis and trunk and the position of the joints of the lower extremities as the child walks and runs. Being familiar with these abnormal patterns helps significantly in correctly diagnosing the underlying cause of a limp. Additional gait disturbance patterns exist; however, the following abnormal patterns reflect the majority of conditions that may cause limping in a child.

### ANTALGIC GAIT

An antalgic gait, which is caused by pain in a lower extremity or occasionally in the back, is generally the most common type of gait disturbance in the limping child. In an attempt to avoid the pain the child will take quick, soft steps on the affected leg ("short stepping"), which reduces the amount of time the extremity is in the stance phase of gait. If the source of pain is in the hip, the patient also leans toward the affected side during stance phase to decrease the abductor force across the joint. Because the unaffected limb is brought forward more quickly than normal in swing phase, it remains longer in stance phase. An antalgic gait can be caused by any condition that causes pain during weightbearing in a lower extremity, and the pain can originate from any part of the extremity, from the foot to the hip. Another form of antalgic gait may be observed in children whose pain is due to spinal disorders such as diskitis or vertebral osteomyelitis. In such cases the child will walk very slowly or refrain from walking altogether to avoid jarring the back and aggravating the pain.

<sup>\*</sup>See references 3, 14, 18, 23, 28, 43, 46, 52-55, 62, 67.

<sup>†</sup>See references 4, 5, 7, 8, 11, 13, 45, 58, 59, 73.

TABLE 6-1 Differential Diagnosis of Limping in Various Age Groups

Toddler (1-3 yr)	Child (4-10 yr)	Adolescent (11-15 yr)
Transient synovitis	Transient synovitis	Slipped capital femoral epiphysis
Septic arthritis	Septic arthritis	Hip dysplasia
Diskitis	Legg-Calvé-Perthes disease	Chondrolysis
Toddler's fracture	Discoïd meniscus	Overuse syndromes
Cerebral palsy	Limb length discrepancy	Osteochondritis dissecans
Muscular dystrophy		
Developmental dysplasia of the hip		
Coxa vara		
Pauciarticular juvenile arthritis		
<i>Rarities</i>		
Leukemia		
Osteoid osteoma		

### TRENDELENBURG GAIT

A Trendelenburg gait is observed in patients with functionally weakened hip abductor muscles, a condition that makes it difficult to support the body's weight on the affected side. This gait disturbance is commonly observed in children with developmental dysplasia of the hip (DDH), congenital coxa vara, or coxa vara secondary to other pathology (i.e., Legg-Calvé-Perthes disease or slipped capital femoral epiphysis).<sup>28</sup> In all of these conditions the abductor muscles themselves are normal but are at a mechanical disadvantage. As a result, during the stance phase of gait, the hip abductors function ineffectively and the pelvis tilts away from the affected side. In an attempt to lessen this effect, the child will compensate by leaning over the affected hip. This brings the center of gravity over the hip and reduces the degree of pelvic drop (Fig. 6-1). The characteristic pattern of the Trendelenburg

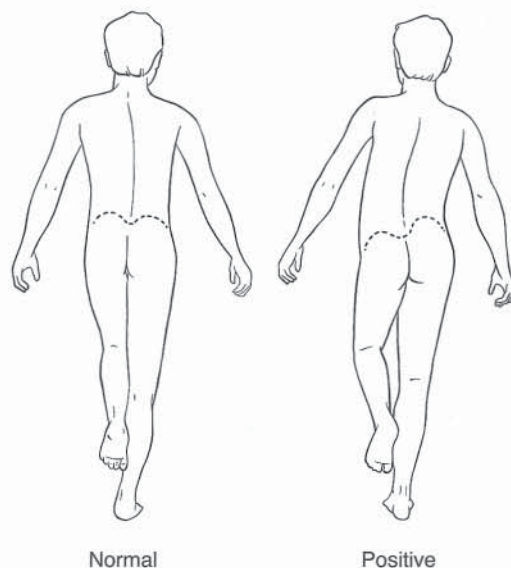


FIGURE 6-1 Trendelenburg gait. In this example, the hip abductor muscles on the involved right side cannot effectively support the weight of the body. The pelvis tilts down and away from the right hip. In an effort to compensate, the patient leans toward the affected side.

gait usually is obvious after the child has repeated the gait cycle a couple of times. Because there is no pain, the amount of time spent in stance phase on the affected side may be normal (which is distinctly different from an antalgic gait).

### PROXIMAL MUSCLE WEAKNESS GAIT

Weakness of the proximal musculature, as seen in children with muscular dystrophy, may cause limping in the older toddler or young child. The lack of hip extensor strength forces the child to walk with increased lordosis of the lumbar spine in order to remain upright. Gowers' sign is often present as the child arises from a sitting position. The child must "climb up" himself by pushing off with the hands against the shins, knees, thighs, and finally the hips (Fig. 6-2). As the proximal musculature, in particular the gluteus medius and maximus, weakens further, the child "lurches" back and forth over the hips to maintain balance.

### SPASTIC GAIT

A spastic gait, as is seen in children with cerebral palsy, is caused by hypertonicity and imbalanced activity between muscle groups.<sup>9,17,32,34,49,63,71,80</sup> Spastic hamstring muscles restrict extension of the knee, which may cause the child to crouch at the knee and walk with a shortened stride length. Spastic quadriceps muscles may result in a stiff, extended-knee gait. Children with cerebral palsy often exhibit a scissoring gait owing to excessive hip adduction throughout the gait cycle, resulting in difficulty moving the swing leg forward. Sustained activity of the gastrocnemius may cause ankle equinus and toe-walking. With hemiplegia, the patient may appear to be dragging the affected extremity.

Usually the spastic gait is a combination of several of these findings. The lower extremity spasticity becomes even more apparent when the child runs, and subtle upper extremity posturing may be noted (i.e., elbow flexion, forearm pronation, wrist flexion, and clenched fist). In some cases, though, these gait patterns and the clinical presentation may be very subtle, making the diagnosis difficult. For example, in patients with very mild hemiplegia, where increased tone in the gastrocnemius leads to slight ankle equinus, the only gait abnormality may be excessive hyperextension of the knee during the stance phase (needed to place the foot flat on the ground).

### SHORT-LIMB GAIT

Gait asymmetry is usually seen in children when limb length discrepancies are in excess of 3.7 to 5.5 percent.<sup>35,64</sup> In an effort to keep the pelvis level throughout the gait cycle, the child will walk on the toes of the foot of the shorter limb. The child may be forced to maintain flexion of the hip and knee of the longer extremity when it is in stance phase. Children with discrepancies of less than 3.7 to 5.5 percent usually are able to use a combination of compensatory strategies to normalize the mechanical work performed by the lower extremities.

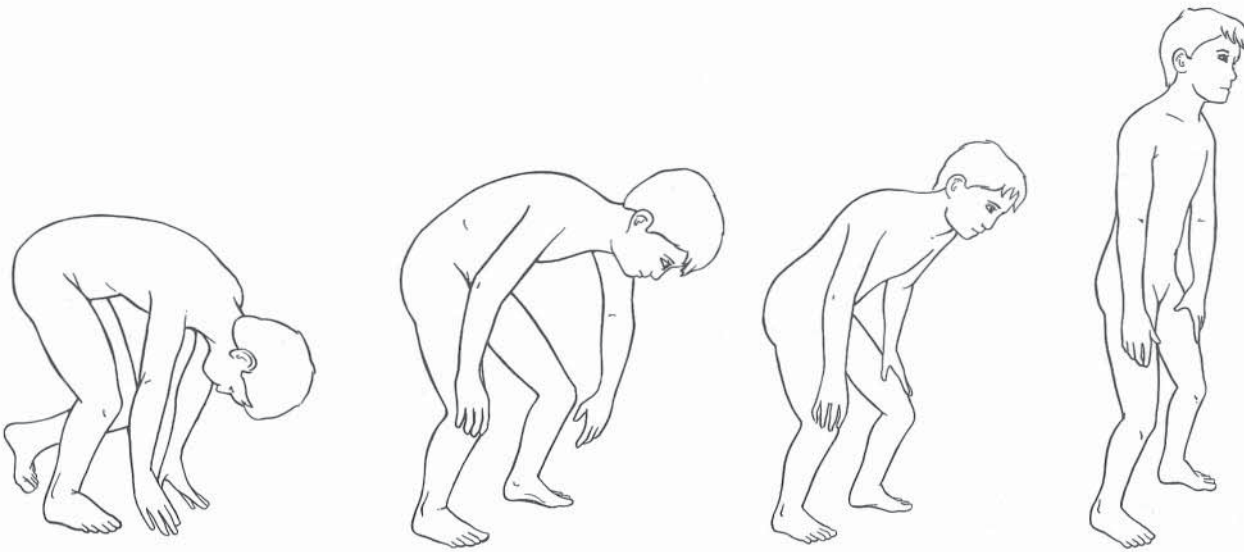


FIGURE 6-2 Gowers' sign. Weakness of the proximal hip muscles can severely limit the child's ability to rise from a sitting position. In order to stand, the patient uses his or her hands and arms to "climb up" the body by pushing off from the shins, knees, thighs, and finally the hips.

## Special Considerations Based on Age Group

### TODDLER (AGES 1 to 3 YEARS)

Determining the cause of a limp is most difficult in toddlers. It often is difficult to attain a reliable history directly from them because they are unable or unwilling to talk, or because they cannot accurately describe the problem. In addition, their parents may not recall minor incidents that can result in a limp, such as a splinter in the foot or a toddler's fracture of the tibia.

Because toddlers often are apprehensive or frightened at the physician's office, the least intimidating part of the examination should be conducted first. The examiner should observe their gait while they are walking uninhibitedly with their parents' and look for limited range of motion of the joints of the lower extremity to help localize an abnormality responsible for the limp. Other important findings include localized tenderness on palpation and evidence of inflammation, specifically erythema, heat, swelling, and pain.

Because the neuromuscular development in toddlers is immature, their normal gait pattern is distinctly different from that of older children and adults.<sup>53</sup> To achieve better balance, toddlers walk with a wide-based gait, increased flexion of the hips and knees, and arms held out to the sides with the elbows extended. To maintain their balance during the gait cycle, they spend more time in double-limb stance. Because toddlers cannot increase their speed by extending their step length, they compensate by increasing their cadence, which may make their gait appear uncoordinated and quick. Increasing maturity is accompanied by smoother movements, reciprocal arm swing, and an increase in step length and walking velocity.

Although the most common reason why children limp is to lessen pain from an extremity, toddlers in particular often limp for other reasons. Painless disorders that can

cause limping in toddlers include DDH, limb length discrepancies, and mild static encephalopathies, to name just a few.

Painless toe-walking in toddlers is a common pediatric orthopaedic referral (Fig. 6-3). The differential diagnosis of toe-walking in these young children primarily includes idiopathic, mild spastic diplegia and hereditary spastic paraparesis.<sup>19,22,31,48</sup> A thorough evaluation of the perinatal and family histories and close examination of the gait for underlying spasticity will generally identify a neurologic or inherited cause. On occasion, further helpful information can be gained from a gait analysis study.<sup>38</sup> Other less obvious causes for toe-walking should always be considered, particularly if the toe-walking is asymmetric.<sup>39</sup> If the toe-walking is idiopathic, conservative management with casting or bracing is used on occasion but has not proved effective.<sup>70</sup> Surgical intervention is rarely needed.

### CHILD (AGES 4 to 10 YEARS)

Evaluating a limp in this age group is easier than in toddlers because older children communicate better and are more cooperative. In addition, their gait is more mature. Normally, by 5 years of age the child has developed a stable velocity pattern, and an adult gait pattern is usually attained by 7 years of age. Because children in this age group usually are more interested in play than in ancillary gains, limping and complaints of pain should always be taken seriously. Parents may report that the child complains of leg discomfort, typically in the evening before bedtime, that is alleviated only after massage and, on occasion, medication. Before dismissing such discomfort as "growing pains," the clinician should perform a thorough evaluation to rule out an underlying disorder.

### ADOLESCENT (AGES 11 to 15 YEARS)

The limping adolescent usually can provide the clinician with an accurate history. However, symptoms may be under-



FIGURE 6-3 A 4-year-old idiopathic toe-walker. Despite frequent heel cord stretching exercises and encouragement to stand with his heels down, he constantly walks on his toes. Other diagnoses, such as mild spastic diplegia or hereditary spastic paraparesis, must be ruled out.

stated if the individual wishes to return quickly to enjoyable activities, or they may be exaggerated if the individual hopes to avoid unpleasant physical activity requirements. During a thorough evaluation the examiner usually can determine the true nature and extent of the condition.

## Differential Diagnosis of Limping in Children

### INFLAMMATORY AND INFECTIOUS DISORDERS

**Transient Synovitis.** Transient (toxic) synovitis of the joint is probably the most common cause of lower extremity pain and most likely responsible for the majority of cases of limping due to an irritable joint.<sup>26,54,72,73,76,78</sup> The condition is seen most often in children between 3 and 8 years old and manifests with the rapid onset of hip pain, limited joint range of motion, and limping (or an inability to walk, if the condition is severe). Often, there is a history of an antecedent viral illness.

Although the clinical presentation may mimic that of septic arthritis, patients rarely have a temperature above

38°C or indications of systemic illness. The white blood cell (WBC) count, C-reactive protein level, and erythrocyte sedimentation rate (ESR) usually are within normal limits. Radiographs are normally unremarkable. Ultrasound examination of the affected hip will show the effusion associated with transient synovitis (Fig. 6-4).<sup>3,47,73</sup> Aspiration of the joint may be necessary to rule out the diagnosis of septic arthritis. Analysis of the joint aspirate usually reveals a WBC count between 5,000 and 15,000 cells/mL, with more than 25 percent polymorphonuclear leukocytes.

The primary aim of treatment is to expedite spontaneous resolution of the underlying inflammatory synovitis. This objective is best met with a brief period of bedrest and nonweightbearing, and the use of oral nonsteroidal anti-inflammatory drugs (NSAIDs). Light traction during bedrest may be beneficial. Routine aspiration of the joint has not been shown to be of therapeutic benefit. When the pain has subsided, the patient should be instructed to use crutches until the limp is no longer present. Clinical symptoms usually resolve gradually and completely over a period of several days to weeks (the average duration is 10 days), and the long-term outcome is generally favorable.

**Septic Arthritis.** Septic arthritis requires urgent medical management because of the potential for significant joint destruction (Fig. 6-5).<sup>26,43,62,78</sup> It must be differentiated from transient synovitis, as both conditions produce a limp because of joint pain.<sup>26</sup> During the acute phase, it is crucial that the clinician accurately distinguish between the two. As a result, hospitalization of the child for clinical evaluation, laboratory investigations, and medical management is common.

Like patients with transient synovitis, patients with septic arthritis usually present with the acute onset of joint pain. The child may walk with a limp or refuse to walk because of pain. There may be a history of antecedent mild trauma to the extremity or concurrent infection or illness. Unlike transient synovitis, septic arthritis usually progresses to a febrile systemic illness, and the child will have fever, chills, and malaise.

On clinical examination, the child will hold the affected extremity immobile. There may be swelling of the joint, erythema, warmth, and tenderness on palpation. Passively moving the affected joint through its range of motion will cause the child obvious pain, as will weightbearing on the affected extremity. Some patients present with less dramatic findings, especially those who have been partially treated.

Unless the patient is immunocompromised, laboratory values (WBC count, C-reactive protein, and ESR) usually are elevated. Blood cultures are positive in nearly 50 percent of patients with septic arthritis.

Except for signs of tissue swelling, radiographs may be normal when obtained at the onset of symptoms. Radiographic changes secondary to bone infection typically do not become apparent until 7 to 10 days after the infection has started. Radiographic changes indicate a protracted active infectious process. In more advanced infection, erosion and joint space narrowing may be noted as the articular cartilage is destroyed. Bone scans are not required if it is possible to localize the lesion to a joint or periarticular region, or if the diagnosis of septic arthritis can be made based on findings from the history, physical examination, laboratory studies,

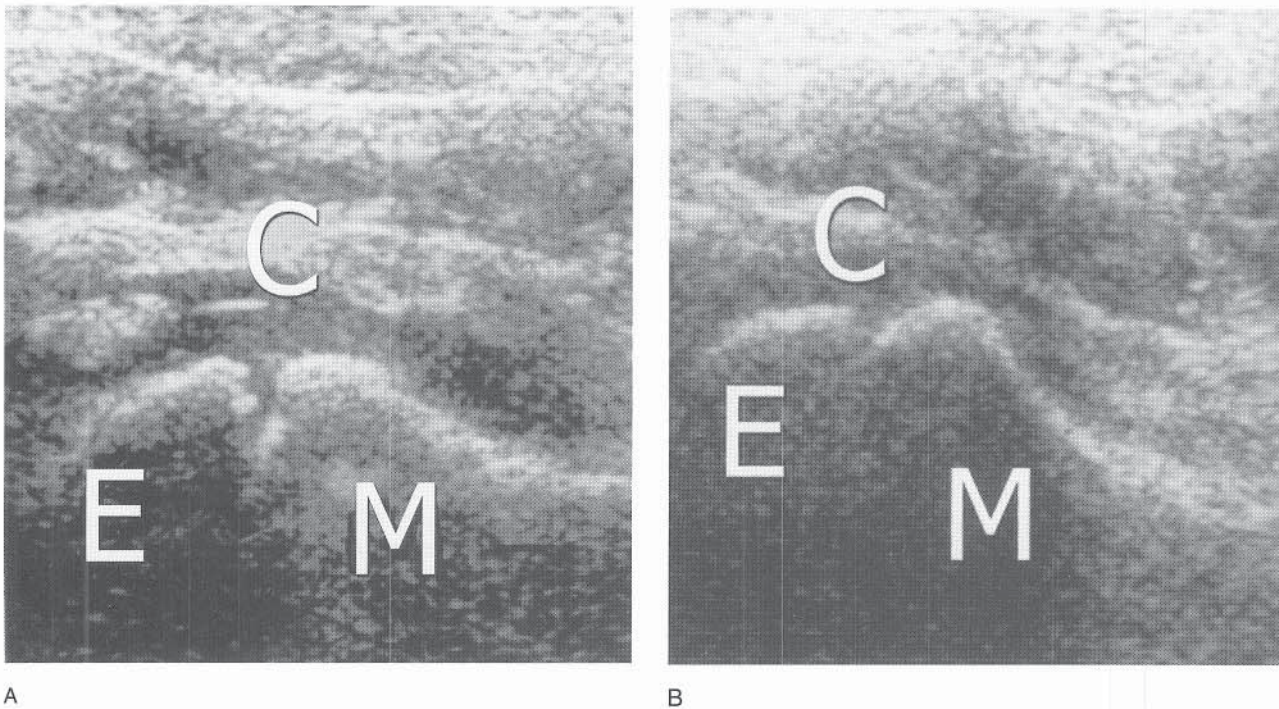


FIGURE 6-4 Ultrasound examination in a 4-year-old boy with a painful left hip associated with limited range of motion demonstrated (A) an effusion in the left hip joint and (B) a normal right hip (E = epiphysis, M = metaphysis, C = capsule).

and radiographs. If not, acute triphase scintigraphy is very accurate in localizing the abnormality.

Joint aspiration is important to corroborate the diagnosis and identify the causative bacterial organism. The aspirate WBC count is generally between 80,000 and 200,000 cells/mL, with greater than 75 percent polymorphonuclear leukocytes. Gram stains are helpful in selecting the appropriate initial antimicrobial agent. Newer bacterial DNA tests can be performed on synovial fluid to confirm the presence of infection.<sup>44</sup> These tests require a minimum of time and may have greater sensitivity than standard diagnostic tests, such as Gram stain. Commonly, the synovial fluid is culture positive unless the patient has recently taken antibiotics. *Staphylococcus aureus* is the most common organism associated with septic arthritis; however, it is important to rule out group B streptococcus in the toddler. *Hemophilus influenzae*, previously found to be a significant cause of septic arthritis in toddlers, is rarely seen today because of the *H. influenzae* immunization.

**Osteomyelitis.** In the child presenting with a limp, if infection has settled into bone, it is usually the result of hematogenous spread.<sup>3,54</sup> *Staphylococcus aureus* continues to be the most common offending organism, but other respiratory pathogens such as *Diplococcus pneumoniae* and group B streptococcus may be responsible. The clinical picture varies with the age of the patient. In toddlers and children, osteomyelitis may manifest with localized swelling, pain, or pseudoparalysis, and may be associated with the sudden onset of fever and a toxic state. In older adolescents the course may be more indolent, resulting in a delay in the diagnosis of hematogenous osteomyelitis.

Evidence of deep localized soft tissue swelling is often

the earliest radiographic sign of osteomyelitis in toddlers. Destruction of bone, commonly in the metaphyseal region, usually is not appreciated until several days have passed.

**Diskitis.** Infection of the intervertebral disk may interfere with normal walking as a result of the associated back pain.<sup>16,54,56,74</sup> In fact, the child may have stopped walking altogether. During the clinical examination, if asked to perform a task that requires bending downward (e.g., picking up an object from the floor), the child either will refuse to do so or will hold the lower back straight and bend only at the hips in an effort to prevent spinal motion.

Although the patient may not appear ill, the ESR is elevated in approximately 80 percent of cases of diskitis. Blood cultures may be positive and, if they are, usually show *S. aureus* to be the causative organism. This can be verified by needle or open biopsy, but because *S. aureus* is so commonly found, biopsy normally is not necessary and currently is not recommended as a routine diagnostic procedure.

Early in the course of the infection, radiographs may be unremarkable. However, as the disease progresses over several days to weeks, radiographs may demonstrate narrowing of the disk space and irregularities in the vertebral end-plate (Fig. 6-6). Scintigraphy can help corroborate the initial diagnosis and facilitate localizing the infection.

The patient should be treated with systemic antibiotic therapy, which results in quicker resolution of the symptoms than oral antibiotics alone or no antimicrobial therapy at all. The need for immobilization varies. Bedrest alone may suffice for some; a brace or a cast may be needed for others.

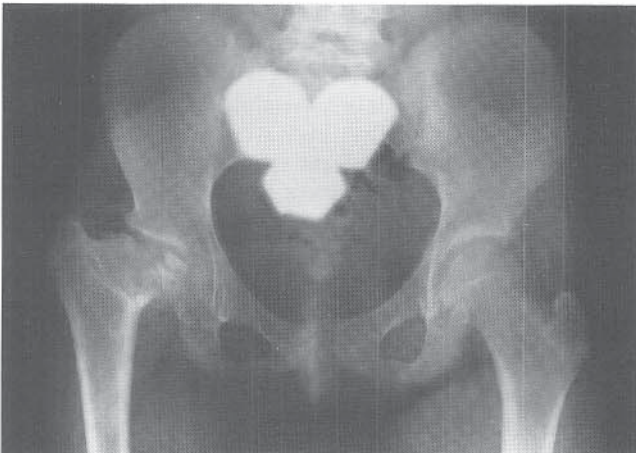
Diskitis and vertebral osteomyelitis were at one time thought to be distinct entities, but MRI studies have subsequently shown that they probably represent different stages



A



B



C

FIGURE 6-5 A, An 18-month-old girl presented with a 14-day history of fevers and pain in the right hip. Incision and drainage confirmed the diagnosis of septic hip. B, Five months later, the ossific nucleus had resorbed. C, At age 11 years 7 months, the right hip exhibits the residual changes associated with the septic process. The right lower extremity is 3.5 cm shorter than the left side.

of a similar infectious process. The term *infectious spondylitis* encompasses the entire spectrum of infection involving the disk space and vertebrae.<sup>56</sup>

**Pauciarticular Juvenile Arthritis.** Pauciarticular juvenile arthritis,<sup>54,61</sup> the most common type of juvenile arthritis, usually leads to a mild limp in children around 2 years of age. The disease affects girls four times more often than boys. The most commonly involved joints of the lower extremity are the subtalar, ankle, and knee joints. Discomfort is accompanied by limited joint range of motion, mild swelling, and warmth. Laboratory values (WBC count, ESR, and rheumatoid factors) may be normal, and in 50 percent of cases the antinuclear antibody (ANA) test may also be negative. As the condition progresses, though, these values may change. If joint swelling persists and the laboratory values reflect the likelihood of the disorder, the child should be referred to a pediatric rheumatologist. Most children with pauciarticular arthritis do not need orthopaedic intervention and are able to return to normal function with appropriate medical treatment.

## NEUROLOGIC DISORDERS

An underlying neurologic disorder should be considered if the child has always had an abnormal gait or if the child did not begin ambulating within the normal time frame. Most toddlers start walking at around 12 months of age, but the normal range extends to 18 months of age. Beyond this age would be regarded as an abnormal delay in walking. A cause for the limp may be found in the prenatal, perinatal, or postnatal history. It is important to note whether there were any difficulties associated with the pregnancy or delivery; a history of prematurity, low birth weight, failure to thrive, or perinatal infections; or a need for ventilatory assistance after birth.

**Cerebral Palsy.** Gait disturbance in patients with cerebral palsy is usually caused by muscle spasticity or poor balance, with the severity of the limp depending on the degree of neurologic involvement.<sup>9,17,32,34,49,63,71,80</sup> In severe cases, the diagnosis of cerebral palsy has usually been made before the orthopaedist is asked to evaluate the patient's abnormal gait. The diagnostic challenge is posed by the child with mild cerebral palsy who has not been previously diagnosed with the neurologic disorder and whose muscle imbalance and limp are minor. In these cases, a thorough history (with emphasis on the concerns noted above) and examination are often necessary. The patient will have limited range of motion of the ankle and knee joints, hyperreflexia, clonus, and some degree of spastic gait. Radiographs are unremarkable in most cases, and other diagnostic studies usually are not necessary. Although the orthopaedist may be the first to make the diagnosis of cerebral palsy, the patient and parents should be referred to a pediatric neurologist if further explanation or treatment of the underlying neurologic condition is needed.

**Muscular Dystrophy.** Gait abnormalities caused by this uncommon condition are usually first noted in boys between 2 and 5 years of age. The child may have a history of delayed ambulation and current problems such as stumbling, falling, and difficulty climbing stairs. Clinical examination may demonstrate proximal muscle weakness, Gowers' sign, and

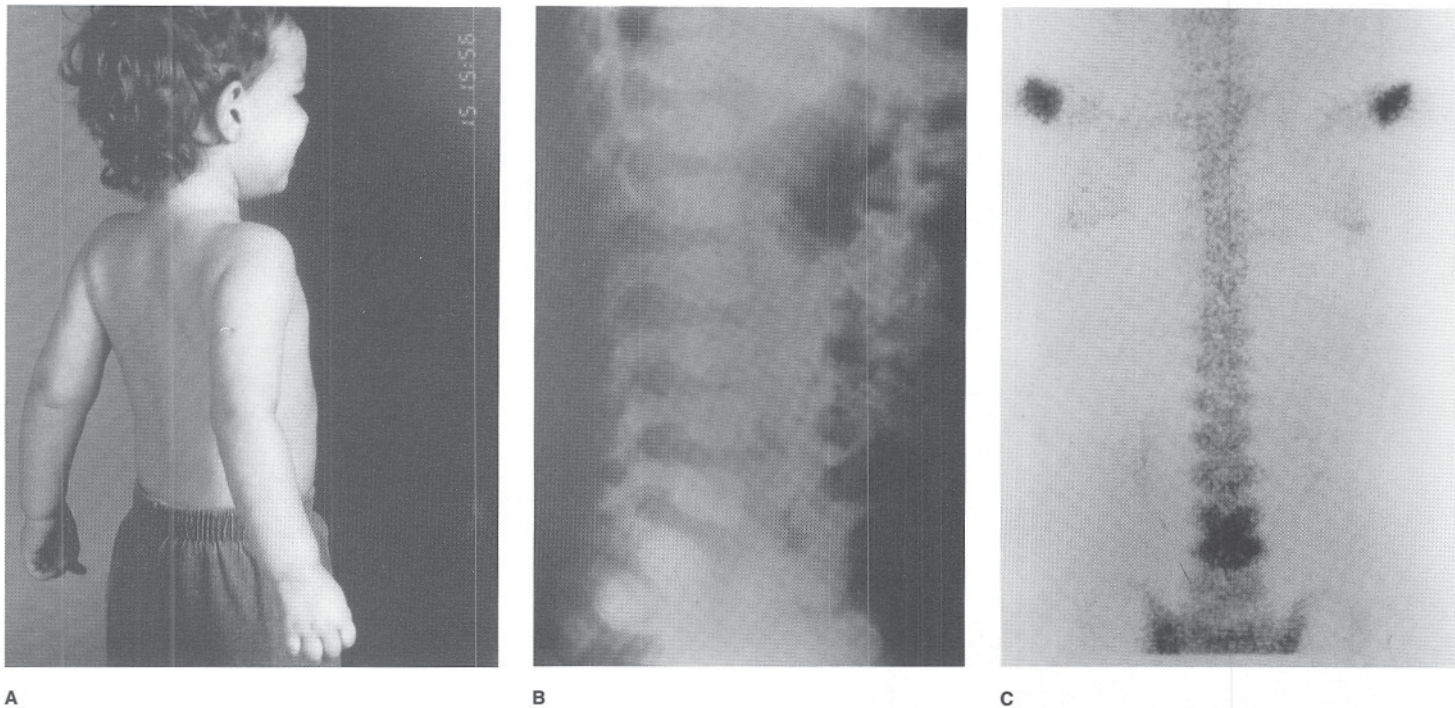


FIGURE 6-6 A, A 2-year-old boy with a 3-week history of low back pain. He would not allow flexion of his lumbar spine. B, Lateral radiograph of lumbar spine demonstrating narrowing of the L3-4 disk space. C, Bone scan showing reaction in the L3-4 region.

toe-walking. The child may also have pseudohypertrophy of the calf. Measuring the patient's serum creatinine phosphokinase (CPK) level helps to confirm the diagnosis.

## ANATOMIC DISORDERS

**Developmental Dysplasia of the Hip.** This disorder causes a painless limp in the toddler.<sup>3,53-55</sup> With DDH, the femoral head is partially or completely displaced from the acetabulum. The parents will often report that the child did not start walking until age 14 to 15 months (a slight delay from the expected 12 months of age, but still within the normal time frame).

The child may have a shortened lower extremity and may exhibit one-sided toe-walking, along with a limp, during ambulation. If the condition is bilateral, the child may have a swayback appearance and walk with a waddle (Fig. 6-7). An abductor lurch to the affected side (Trendelenburg gait) is readily evident. When the child stands on the affected extremity, the pelvis sags to the contralateral side and the patient tries to compensate by leaning over the affected hip (Trendelenburg sign). When the child is examined in the supine position, restricted abduction of the affected hip (as compared with the normal contralateral hip) may be noted and mild flexion contracture may be present.

A radiograph of the pelvis of children 6 months old or older readily verifies the diagnosis of DDH. CT, MRI, and ultrasound evaluations are not necessary since they do not provide any additional worthwhile information in the ambulatory toddler.

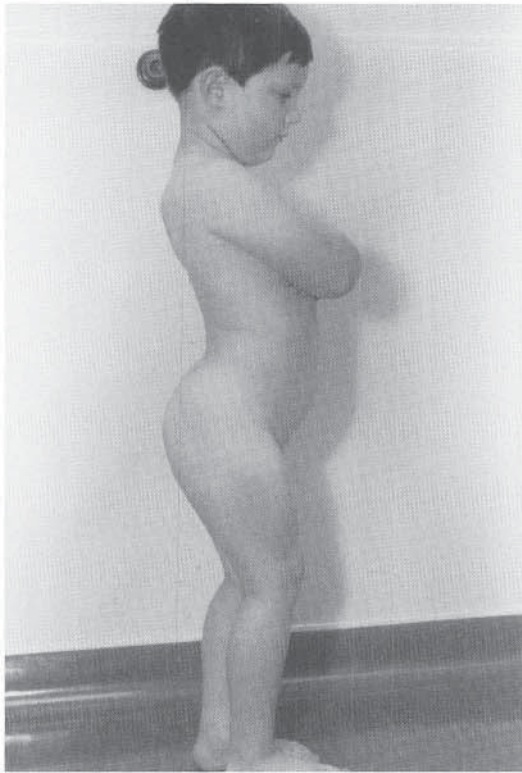
In some individuals, hip pain and limp secondary to hip dysplasia may not become clinically apparent until adolescence. Before this, the patient or parents may have been

unaware of the presence of any hip disorder. The common presenting complaint is an aching discomfort in the hip, groin, or thigh region after extended physical activity. The clinical examination may be normal or may reveal mild loss of hip range of motion. The diagnosis is confirmed with standing radiographs of the pelvis.

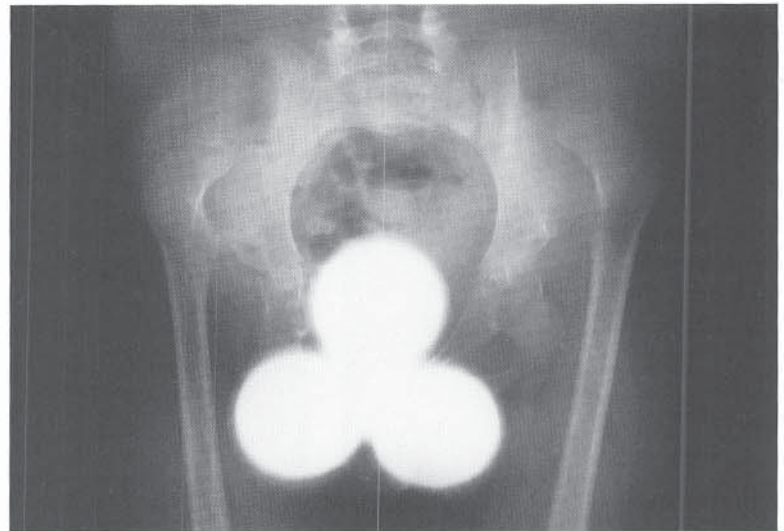
**Coxa Vara.** Congenital or developmental coxa vara is a painless disorder that is similar in clinical presentation to DDH.<sup>3,55</sup> If the condition is unilateral, the patient may have an abductor lurch owing to functional weakness of the abductor muscles (Trendelenburg gait). If the disorder is bilateral, the patient may have a waddling gait. When the patient is examined in the supine position, both hip abduction and hip rotation are restricted (in contrast to DDH, in which only hip abduction may be limited). The diagnosis is readily confirmed with radiographs of the hip, which will show a decrease in the angle between the femoral neck and shaft and a vertical orientation of the physis (Fig. 6-8).

**Legg-Calvé-Perthes Disease.** Legg-Calvé-Perthes disease is most prevalent in children between 4 and 12 years old, but it can be seen in younger children as well as in adolescents who have not yet reached skeletal maturity.<sup>29,52</sup> The disorder affects boys four times more often than girls. Affected children most often present with a limp that is exacerbated by vigorous physical activities and alleviated by rest. The pain usually is worse late in the day, and, occasionally, children have night pain. If pain is present, it may be localized to the groin or hip or referred to the thigh or knee.

In the earlier phases of the disorder, the child will have an antalgic limp during ambulation because of the discomfort. Findings on clinical examination will depend on the severity of the disorder. Patients with mild disease may have only a



A



B

FIGURE 6-7 A, Five-year-old boy with bilateral developmental dislocation of the hips. The patient has excessive lumbar lordosis (swayback). B, Radiograph showing bilateral hip dislocations of the boy in A.

slight loss of hip motion. Those with more severe disease will have greater loss of range of motion (particularly abduction and internal rotation), and the patient will experience discomfort during passive range of motion.

The primary initial radiographic signs of this disorder are a slight lateralization of the femoral head in the acetabu-

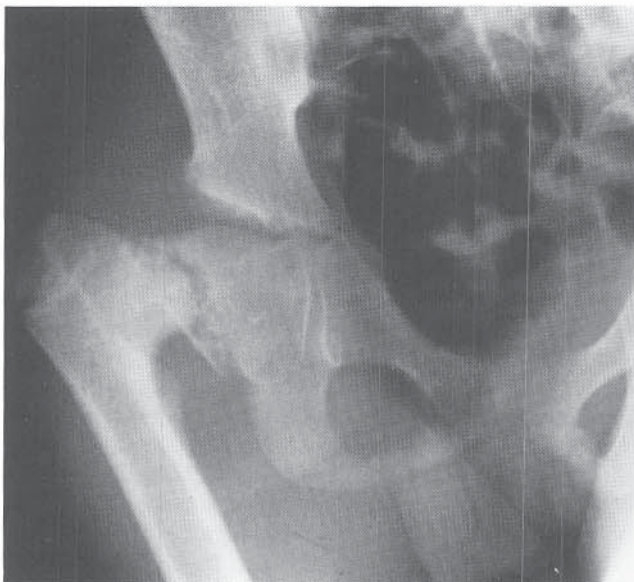


FIGURE 6-8 Coxa vara involving the right hip of a 7-year-old girl. The femoral neck-shaft angle is diminished and the inclination of the physis is nearly vertical.

lum and a slightly smaller ossific nucleus (Fig. 6-9). In about one-third of cases, a subchondral lucency in the femoral head is seen on the frog-leg lateral view. Later, as the disease progresses, collapse and fragmentation of the femoral epiphysis occurs. Radiographic changes may not be apparent early in the course of Legg-Calvé-Perthes disease. In these cases, MRI and scintigraphy are effective in diagnosing the disorder.<sup>41,75</sup>

**Slipped Capital Femoral Epiphysis.** Slipped capital femoral epiphysis (SCFE), one of the more common adolescent hip disorders, occurs when the capital femoral epiphysis displaces posteriorly and medially on the femoral neck.<sup>6,12,20</sup> Slippage can occur acutely or gradually and is usually seen in boys between 12 and 15 years of age or in girls between 10 and 13 years of age. Boys are affected more often than girls.

On presentation, the typically overweight patient complains of constant, mild pain in the hip, groin, thigh, or knee and walks with an antalgic gait. If the slippage is chronic and stable, the symptoms may have been present for several months. On clinical examination, pain is elicited on passive motion of the joint, and there is loss of range of motion in internal rotation and abduction. When the hip is flexed, the lower extremity often rotates externally owing to the orientation of the capital epiphysis on the femoral neck.

Less often, patients present with the sudden onset of severe pain and inability to walk owing to acute slippage of the epiphysis. This unstable condition is similar to an acute fracture and is associated with an increased incidence of avascular necrosis.<sup>42</sup>

In patients with SCFE, radiographs of the hips confirm the diagnosis (Fig. 6-10). A lateral view is mandatory be-



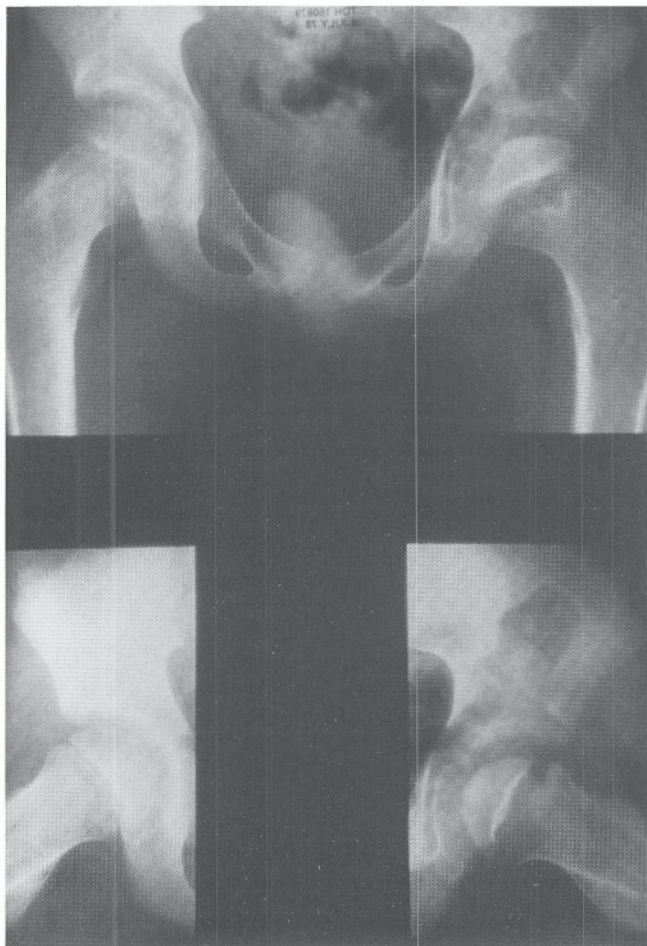


FIGURE 6-9 Early Legg-Calvé-Perthes disease. There is slight lateralization of the left femoral head in the acetabulum and relatively increased density of the ossific nucleus.

cause an AP radiograph may not clearly demonstrate the subtle changes of mild slippage. Both hips should be examined, as a significant percentage of patients are affected bilaterally. Other imaging studies (e.g., CT, MRI, bone scan) are not necessary for diagnosing SCFE.

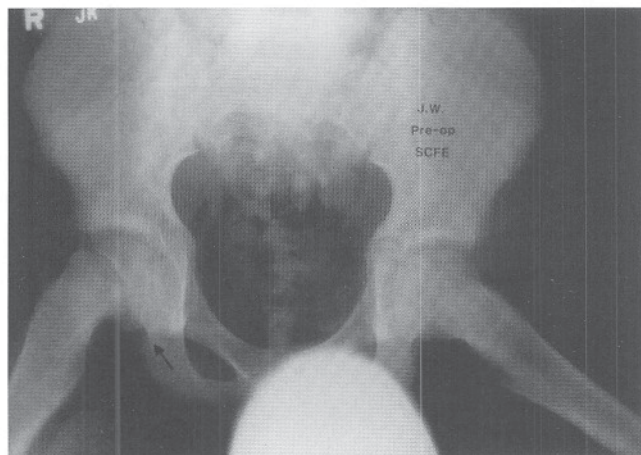


FIGURE 6-10 Lateral radiograph of the hips in a 12-year-old boy showing a mild slipped capital femoral epiphysis on the right.

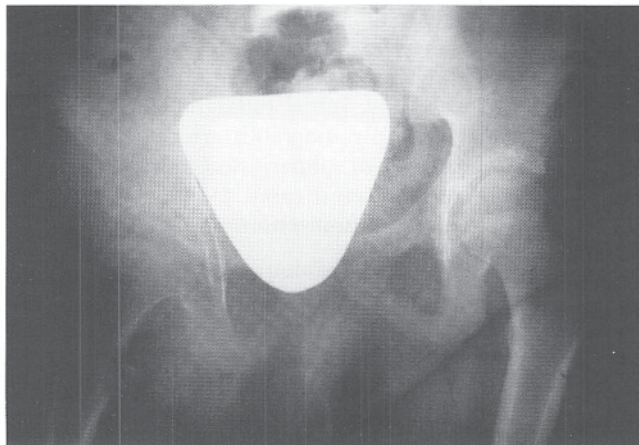


FIGURE 6-11 AP pelvic radiograph of an 11-year-old girl showing chondrolysis involving the right hip. The classic findings include osteopenia secondary to joint disuse, narrowing of the joint space, and subchondral lucencies.

**Chondrolysis.** Chondrolysis is an uncommon hip disorder that is seen most often in African Americans, in girls, and in adolescents 12 to 14 years old.<sup>21</sup> It is frequently associated with SCFE (with a reported incidence of up to 8 percent), but the exact cause is not known.<sup>77</sup> The most common patient complaint is insidious hip or groin pain, similar to that of SCFE or hip dysplasia. The patient has an antalgic limp, and clinical examination generally reveals limitation of joint motion in all directions. Laboratory tests usually are normal. Radiographs demonstrate osteopenia secondary to joint disuse, narrowing of the joint space compared with the contralateral side (more than 2 mm difference), and subchondral lucencies (Fig. 6-11). Scintigraphy shows increased uptake on both sides of the joint, but the significance of this finding is unclear. To lessen the joint synovitis that accompanies chondrolysis, treatment consists of extended rest (nonweightbearing) of the affected extremity and exercises to improve and maintain joint range of motion.

**Osteochondritis Dissecans.** This disorder is most frequently seen in adolescents.<sup>3</sup> Although the knee is most commonly affected, the hip and ankle joints can also be involved. A tunnel projection of the knee provides the best radiographic view of the defect and demonstrates its classic position on the lateral aspect of the medial femoral condyle.

**Discoid Meniscus.** This disorder of the lateral meniscus is usually seen in children between 8 and 12 years of age, but it may also affect younger children between 3 and 8 years of age.<sup>1,15,60,66</sup> In most cases there is no history of antecedent trauma. Accompanying the child's limp may be intermittent swelling of the knee, inability to fully extend the joint, and a clicking sensation. Tenderness may be elicited on the lateral joint line. Radiographs are usually unremarkable, but in some cases they may show widening of the lateral joint space with flattening of the lateral femoral condyle. MRI establishes the diagnosis.<sup>15,60,66</sup>

**Toddler's Fracture.** A spiral fracture of the tibia, without concomitant fibular fracture, may occur when there is a

torsion type of injury to the lower extremity (Fig. 6–12).<sup>3,33,51</sup> However, parents may not recall a history of trauma. The child presents with a limp or may resist any weightbearing on the affected extremity. Initial radiographs may appear normal. When follow-up radiographs are obtained 1 to 2 weeks later, some degree of subperiosteal new bone formation is normally seen. In most cases, the patient is treated only with short-term immobilization.

**Tarsal Coalitions.** As cartilaginous tarsal coalitions in the hindfoot begin to ossify, clinical symptoms appear.<sup>40,68,79</sup> Contracture of the peroneal muscles is common, resulting in a stiff, everted flatfoot. Oblique radiographs of the feet show the calcaneonavicular coalitions (Fig. 6–13). A radiograph of the subtalar joint (Harris view) may be helpful in showing a talocalcaneal coalition. In most cases, though, CT of the hindfoot is required to diagnose subtalar coalitions (Fig. 6–14).<sup>30,69</sup>

**Overuse Syndromes.** As children become more involved in organized sports, overuse injuries appear with greater frequency.<sup>10,27,50,54</sup> The most commonly affected joint is the knee, in which patellar tendinitis or apophysitis of the tibial tubercle (Osgood-Schlatter disease) arise. On clinical examination, point tenderness on palpation helps confirm the presence of these disorders. In cases of apophysitis, radiographs may reveal fragmentation of the tibial tubercle. Physical activities that result in repetitive loading of the lower extremities can lead to stress fractures of the tibia or fibula. Radiographs may be normal, may show a subtle sclerotic line, or may demonstrate periosteal reaction. If a stress fracture is suspected, scintigraphy is very helpful in confirming

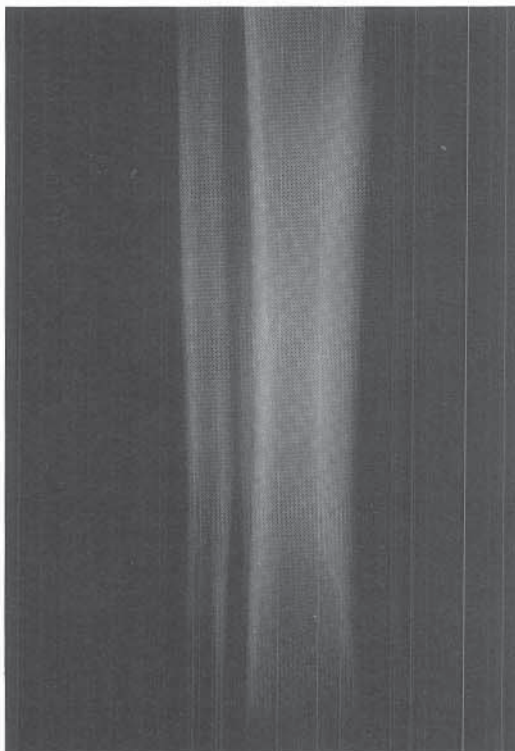


FIGURE 6–12 Radiograph obtained 12 days after onset of a limp in a toddler shows a tibial fracture. Periosteal new bone formation is evident in the vicinity of the linear fracture.

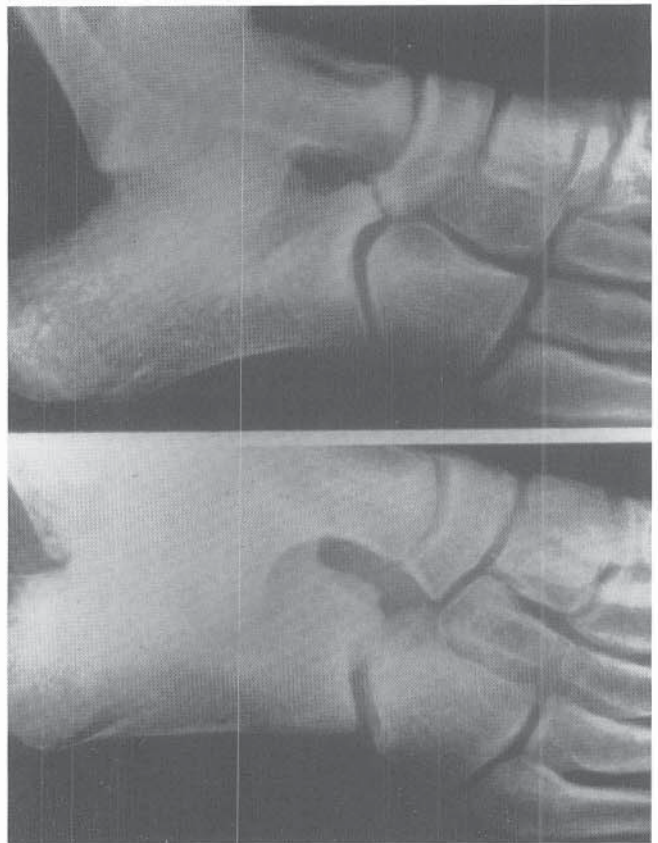


FIGURE 6–13 Top: Oblique radiograph of the foot demonstrating a calcaneonavicular coalition. Bottom: Postoperative oblique radiograph demonstrating a resected coalition in which a fat graft was interposed.

the diagnosis. During the acute phase of overuse injuries, treatment consists of rest, ice, and anti-inflammatory medications. For long-term alleviation, the patient may need to change activities, equipment, or training programs.

**Limb Length Discrepancy.** Gradually progressive limb length discrepancies (LLD) may become apparent in children between 4 and 10 years of age. To maintain a level pelvis and smooth gait pattern, the child may toe-walk on

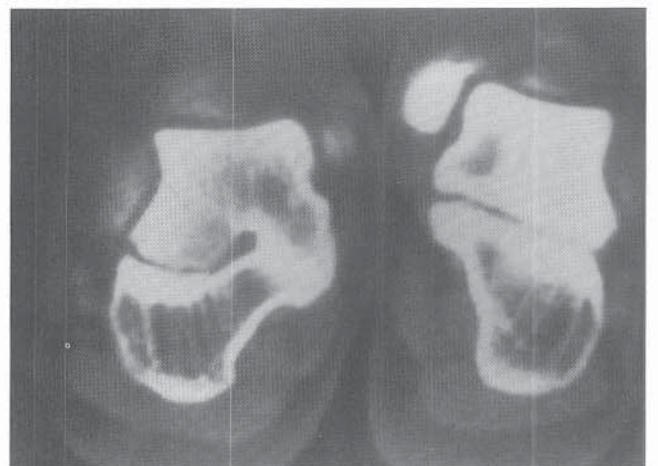


FIGURE 6–14 CT scan of the hindfoot of both lower extremities demonstrating a subtalar coalition on the left.

the shorter leg.<sup>35,64</sup> The best clinical method to accurately measure the discrepancy is to have the child stand with the shorter extremity on blocks until the pelvis is level. To determine radiographically which part of the leg is responsible for the LLD requires a standing film (long cassette) of the entire lower extremity. Careful scrutiny of this radiograph may reveal findings such as a mild congenitally short femur, a physal abnormality following a remote infection, or a mild fibular hemimelia.

### NEOPLASMS TO CONSIDER IN THE LIMPING CHILD

Most primary bone tumors are detected before the age of 20 years.<sup>3,24,53,54,65</sup> They are often diagnosed on plain radiographs, but some, such as leukemia or Ewing's sarcoma, may be difficult to recognize. In children under 5 years of age, metastatic lesions, such as neuroblastoma or leukemia, should be included when neoplasm is considered possible. In older children, benign tumors such as osteoid osteoma, simple bone cysts, and osteochondromas are most often diagnosed; however, malignancies such as lymphomas and Hodgkin's disease can also occur. Tumors involving the central nervous system (CNS) can also cause a child to limp. Deterioration of gait or loss of previously achieved motor milestones is suggestive of a CNS tumor or neuromuscular disease.

**Leukemia.** Acute leukemia is the most common cancer in children under 16 years of age, with the incidence peaking between 2 and 5 years of age.<sup>45,57,65</sup> Generalized symptoms include lethargy, pallor, fever, bruising, and bleeding. In approximately 20 percent of cases, the child presents with musculoskeletal complaints. Lymphoblastic leukemia is the form that most frequently causes bony changes. The patient may have a painful limp, and the pain originating from bone involvement may be described as discomfort in an adjacent joint.

The clinical presentation—with the exception of bruising, bleeding, and hepatosplenomegaly—may be similar to that of arthritis, cellulitis, septic arthritis, or osteomyelitis. The presence of joint symptoms and bone pain, along with skin bruising, bleeding, and hepatosplenomegaly, should lead the clinician to include leukemia in the differential diagnosis.

Laboratory tests may reveal anemia, an elevated or depressed peripheral leukocyte count, and an elevated ESR. Initial radiographs may be unremarkable, or transverse zones of lucent metaphyseal bands adjacent to the growth plate may be seen. Scintigraphy is often normal. If a thorough evaluation is nondiagnostic but the clinician still suspects leukemia, the patient should be referred to a pediatric hematologist for bone marrow studies.

**Osteoid Osteoma.** This benign bone-forming lesion primarily affects individuals under 30 years of age.<sup>2,25,36,37</sup> However, it is rare in children under 5 years of age and is particularly difficult to diagnose in toddlers who are just beginning to walk.<sup>34</sup> The most common clinical manifestations of osteoid osteomas are localized pain and a limp.<sup>25</sup> Radiographs may reveal a small (less than 1 cm) lucent lesion (nidus) surrounded by marked reactive sclerosis (Fig. 6–15). If the

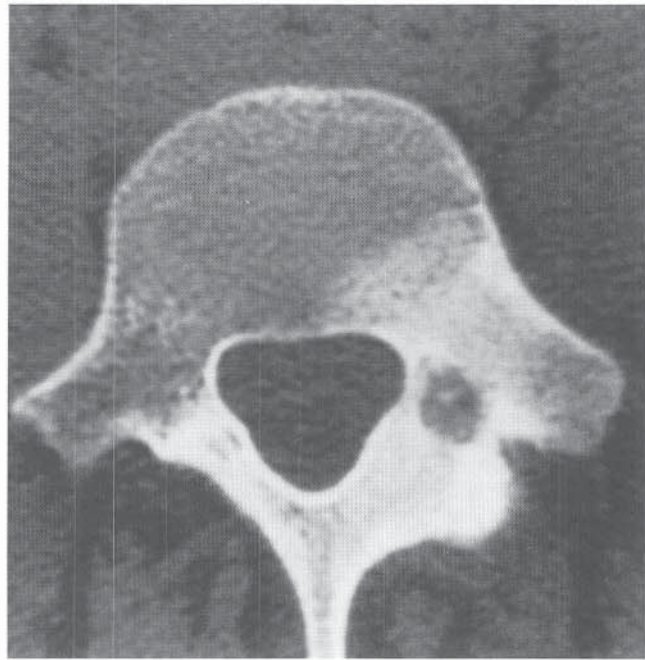


FIGURE 6–15 CT scan of the fourth lumbar vertebra demonstrating an osteoid osteoma of the right side posterior element. The patient had low back discomfort and walked with a limp on the right lower extremity.

initial radiographs are normal, scintigraphy can be extremely helpful in identifying the lesion.

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