Limping in childhood

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Limp is an abnormal gait which can be caused by pain, muscular dysfunction or deformity. Limp is never normal and the cause should be established. There is a long list of possible diagnoses. A complete history and thorough physical examination are the most helpful tools in sorting out the various causes of limping.
Laboratory tests and imaging studies should be based on findings in the history and physical examination. Certain causes of limping must be diagnosed at the first visit. Sometimes the cause of limping cannot be determined, and after exclusion of any serious disease, the child should be observed. Many of them will have spontaneous resolution without treatment.

INTRODUCTION

Limping or even refusal to walk in children are common reasons for consulting. The ability to tell normal from abnormal gait is of fundamental importance to the orthopaedic surgeon. The term limp implies an abnormal gait pattern and should be differentiated from physiologic torsional deformities, such as intoeing and outtoeing, and from physiologic frontal deformities.

Normal gait is dependent not only on normal and painless joints and muscles, but also on an intact neurological system. Limp normally results from pain, weakness or deformity. However, there is a long list of potential diagnoses that may produce a limp in childhood. Limping may be caused by something as simple as a poorly fitted shoe or a stone in the shoe, but it may also be the first manifestation of a malignant neoplasm.

EVALUATION OF GAIT

To assess a limp, a thorough understanding of the normal gait pattern is necessary. Children's gait pattern differs from that of an adult, and the aspect of gait changes during childhood. Normal age-related gait must be differentiated from gait impairment. Toddlers have their own specific gait pattern. They walk with a wide base and at a faster cadence than an adult. At about three years of age, the child is able to stand on one foot for longer than one second. The adult gait pattern develops between the ages of three and five years. Normal gait is a rhythmic, smooth performance. Walking can be divided into two phases : the stance phase and the swing phase. During stance phase, one limb bears all the body weight. The stance phase starts with heel strike and ends with toe off. During swing phase, the foot is not touching the ground. The swing phase starts with toe off and ends with heel strike. The trunk normally maintains a neutral position while the pelvis normally rotates a small amount. During walking each joint of the lower limbs moves through a certain range. The hip flexes slightly at heel strike. The knee flexes about 70 degrees during swing phase and is extended at toe off. The

ankle moves from about 10 degrees of dorsiflexion to about 30 degrees of plantar flexion (9).

TYPES OF LIMP

The most common types of limping are :

Antalgic limp : This common type of limp is caused by pain. The stance phase is shortened on the affected side. The child shortens the stance phase to prevent pain. In addition he places his foot on the painful side more cautiously onto the ground, and to reduce the duration of weight-bearing, the normal leg comes forwards more quickly.

Gluteus medius limp : This type of limp results from an altered hip mechanism. During the stance phase, the gluteus medius muscle contracts on the same side and normally maintains the pelvis level. If the gluteus medius is insufficient the pelvis drops on the opposite side. To preserve balance, the patient leans the trunk toward the affected side. This produces a typical lurch during the stance phase, and this results in a gait that swings from side to side. This pathologic gait pattern is referred to as a Trendelenburg gait or an abductor lurch. A Trendelenburg gait may result from changes in fulcrum (the hip joint) such as can be seen in congenital hip dislocation or changes in the lever arm (the femoral neck) such as in congenital short neck, coxa vara or from muscle weakness such as is seen in some neuromuscular diseases.

Bilateral involvement of the gluteus medius muscles leads to a waddling gait.

Gluteus maximus limp : The child walks with the trunk in hyperextension to maintain the center of gravity behind the hip joints. This is a characteristic gait that can be seen in Duchenne muscular dystrophy.

Quadriceps femoris limp : The child locks the knee during stance phase by placing the hand on the thigh and brings his center of gravity forward. This is a characteristic gait in conditions such as poliomyelitis.

Circumduction gait : This gait pattern is characterized by excessive hip abduction during swing phase. Circumduction functionally shortens the limb and allows walking with a stiff knee. Circumduction can also be seen in a patient with a painful ankle, as circumduction requires less ankle movement.

Equinus gait : Equinus gait is usually caused by heel cord contraction, which leads to the typical toe-walking. Equinus is often associated with a recurvatum of the knee during stance phase. This is characteristic of conditions such as cerebral palsy.

Steppage gait : Walking with a foot drop is the result of weakness of the ankle dorsiflexors usually associated with peroneal neuropathy. This can be seen in conditions such as Charcot-Marie-Tooth disease.

Calcaneus gait : The child walks on the heel. This may result from a neuromuscular disease. The child with a puncture wound on the ball of the foot may also walk on the heel.

Ataxic gait : The child walks with an unsteady broad-based gait. This can be seen in conditions such as Friedreich's ataxia.

Cautious gait : The child walks slowly and cautiously to avoid jarring his back. This is typical for painful diseases of the spine such as discitis.

Hysterical gait : If no obvious physical disease can be found after thorough evaluation, conversion hysteria must be considered. There are two possible varieties of hysterical gait. The grotesque limp pattern : the gait is bizarre, unlike any other abnormal gait, and associated with atypical complaints often out of proportion. The features are inconsistent with any organic pathology. The grotesque limp is usually easier to diagnose than the other variety. The imitative limp : the child reproduces the limp of a relative or a friend. The limp looks the same as the limp due to a physical disease. Evaluation may be confusing, and the diagnosis is made by exclusion.

HISTORY

By careful history taking the long list of potential causes can be narrowed to a few. The age of the child is an important factor that will make certain diagnoses more suspect (table I). The past medical history and the achievement of developmental motor milestones should be reviewed. The onset

Table I. — Common and occasional causes of limping
in childhood

1-3 years
Septic arthritis
Osteomyelitis
Trauma - Toddler fracture
Foreign body in the foot
DDH[1]
JCA[2]
Coxa vara
Discoid meniscus
Discitis
Neurologic disorder
Malignant neoplasm

4-9 years
Trauma
Transient synovitis
Legg-Calvé-Perthes
Septic arthritis
Osteomyelitis
Calcaneal apophysitis
Köhler's disease
Accessory navicular
Ingrown toenail
Neurological disorder
Duchenne muscular dystrophy
JCA
Lyme arthritis
Benign bone lesion
Malignant neoplasm

10-15 years
Trauma-stress fracture
Overuse syndrome
SCFE[3]
Freiberg's infarction
Osteochondritis dissecans
Tarsal coalition
Malignant neoplasm

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[1] DDH : developmental dysplasia of the hip
[2] JCA : juvenile chronic arthritis
[3] SCFE : slipped capital femoral epiphysis

(when and how the limp started) and the duration of the limp should be explained. An acute onset of antalgic limp in a previously normal child suggests an infection, an inflammatory disease or a traumatic event. However it should be emphasised that a history of trauma given by the child may be misleading, especially if the injury occurred during some forbidden activity. A gradual onset of limping with mild discomfort suggests a previously undiagnosed neurological or neuromuscular disease. If limp is associated with pain, the site of origin must be localised. The toddler age group is especially challenging because these children cannot verbalise their complaints. Toddlers often refuse to bear weight and pain is poorly localised (2, 8). In children, the pattern of referred pain seems more obvious than in adults. Hip pain is often referred to the inner aspect of the thigh or the knee. The history should further focus on the characteristics of the pain. Severe acute pain suggests an acute infection or a fracture. Constant pain may result from a chronic low-grade infection or a tumoral process. Lower extremity pain and limping may be the first manifestation of leukaemia (10, 12, 14).

Pain worse in the morning may be a sign of juvenile chronic arthritis.

Intermittent pain and especially pain related to physical activities suggests an overuse syndrome. Pain in multiple joints is a manifestation of an inflammatory arthritis.

PHYSICAL EXAMINATION

The physical examination should start with an overall assessment. The temperature should be recorded, and if the child appears systematically ill, an infection or even leukaemia should be considered. Many things can be learned by simply observing the child stand and walk. Concern about lower limb position is one of the most frequent reasons that parents seek orthopedic advice. Most of these conditions represent normal physiologic development. They correct spontaneously and should be differentiated from a pathologic gait pattern. Knowledge of their natural history avoids unnecessary investigations and overtreatment. Evaluation of a limping child often requires patience. Uncooperative children are difficult to evaluate (2). The child should be observed walking with and without shoes wearing little clothing below the waist to allow inspection of the lower limbs. The duration of the stance phase should be noted. An antalgic gait or any other type of abnormal gait can be determined by careful observation. In case of an antalgic limp, the exact site of pain should be

Fig. 1. — Fracture of the right calcaneus in a three-year-old girl. The initial radiograph, at first presentation, was normal. This film (a) taken two weeks later shows an undisplaced fracture of the calcaneus (arrows). Left calcaneus (b) to compare (note sclerosis of the tarsal navicular).

sought. The shoes and the feet should be examined, as limping may be caused by poorly fitted shoes. The foot should be examined for a puncture wound or an ingrown toenail, and the limbs and joints should be examined for painful areas, limited motion, swelling and rashes. A neurological disease may be the origin of limping, and therefore a careful neurological examination including evaluation of muscle strength should be performed. Ask the child to hop and to walk on his heels and toes. These tests permit detection of less obvious muscle weakness and coordination problems. Limited but painless range of motion of joints of the lower limbs may suggest a neurological disorder. The spine should be inspected for a midline dimple or an abnormal hairy patch. If the orthopaedic and neurological examination is normal, the abdomen and genitals should be inspected to rule out appendicitis or torsion of the testis as a cause of limping.

TESTS

The exact diagnosis of limping cannot always be made by history and physical examination alone. A variety of tests is at our disposal. Specific tests may help to clarify our initial impression about the limp. In other cases the diagnosis is completely obscure. One should then start with noninvasive tests, progressing to more invasive examinations if indicated.

Standard radiography is the most common initial examination. Normal examination however does not exclude pathology. Certain conditions cannot be diagnosed on routine films. Conditions such as a toddler's fracture or a stress fracture may require repeated radiographs before the lesion is visible (11) (fig 1 a, b). Acute osteomyelitis is not apparent on radiography for the first weeks (2, 6). Pyarthrosis of the hip joint may present as a benign

transient synovitis, and routine radiography does not help to differentiate between the two pathologies.

Ultrasonography, a valuable diagnostic test, can detect an effusion in the joint early but is aspecific. The limitation of ultrasonography is that it cannot differentiate among joint effusion, pus or haematoma.

Bone scan (technetium 99m diphosphonate bone scintigraphy) is useful for the evaluation of the obscure limping child (1, 3, 6, 7). The bone scan can best be used initially in the screening rather than late. Bone scan shows abnormal uptake much earlier than radiography. Bone scan is helpful in detecting osteomyelitis (fig 2), stress fracture or a toddler's fracture (2, 3, 6) (fig 3, a,b). Furthermore, the bone scan may be the first test to detect infiltrative bone diseases and can suggest the diagnosis in leukaemia or neuroblastoma when the initial presentation relates to skeletal symptoms including limping (3, 14).

CT scan (computer axial tomography) can be helpful to diagnose anomalies such as tarsal coalition (9) (fig 4, a,b).

MRI (magnetic resonance imaging) is useful to detect an infection at an unusual location such as pyomyositis (4, 13) (fig 5). MRI is also useful to evaluate the spinal canal and for screening of bone and soft tissue tumors or to diagnose intra-articular derangements (fig 6, a,b).

Laboratory testing

Most routine laboratory tests are neither specific nor sensitive but when combined with information obtained from history, physical examination and imaging studies, they can assist in establishing the diagnosis. Laboratory tests are indicated when infection, inflammatory arthritis or neoplasm are suspected. Appropriate tests include a complete blood cell count, ESR (erythrocyte sedimentation rate), CRP (C-reactive protein), and if indicated antinuclear antibody, rheumatoid factor and Lyme titers should be requested. Blood and joint fluid cultures should be obtained when infection is considered.
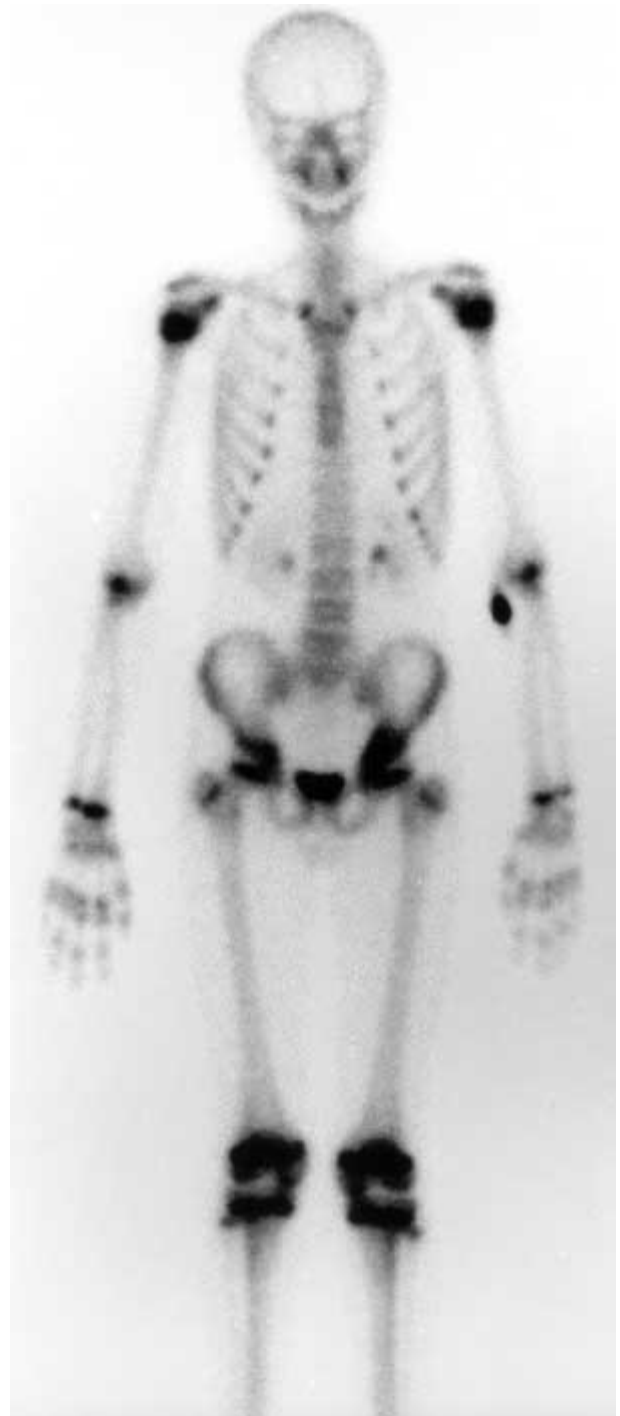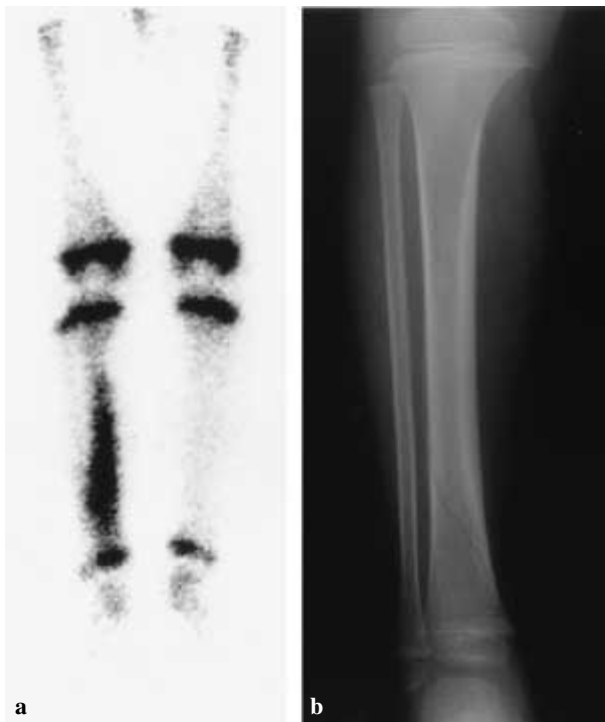

Fig. 2. — Bone scan can detect osteomyelitis at an unusual site. This 2 1/2 -year-old girl was suspected of having an infection of the hip joint. Bone scan shows an increased uptake at the pelvic bone which indicated the correct diagnosis of acetabular osteomyelitis.

PITFALLS IN DIAGNOSIS

The child who limps presents a diagnostic challenge. For some conditions that cause the child to limp a delay in diagnosis will not endanger the patient. Other conditions however require urgent diagnosis and treatment. Errors in diagnosis often arise from incomplete and inaccurate evaluation. The diagnosis must be consistent with the history, clinical examination and results of the additional tests.

Child abuse. Children under two years of age presenting with a fracture should be evaluated cautiously for evidence of child abuse. Child abuse

Fig. 3. — Bone scan of a three-year-old boy. The child was seen because of limping. There was no clear history of trauma. The bone scan (a) shows an increased uptake in the right tibia. Radiography (b) of the right tibia demonstrates a subperiosteal (Toddler's) fracture.
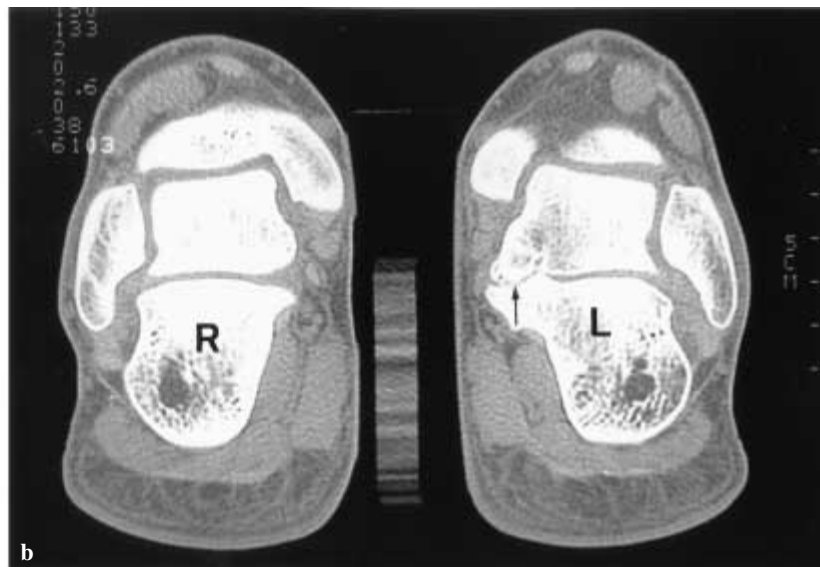

Fig. 4. — A calcaneonavicular coalition can be demonstrated by standard radiography (a). A talocalcaneal coalition is best visible on a CT-scan of the hindfoot (b).
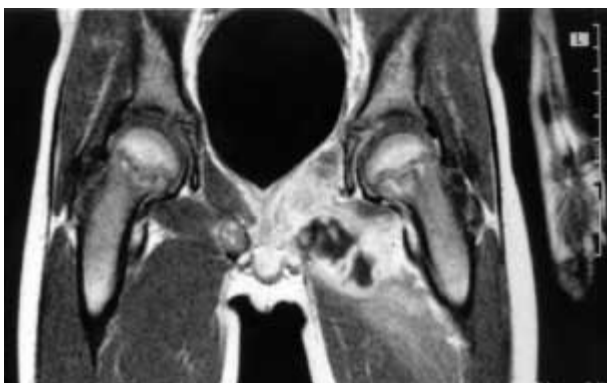
Fig. 5. — MRI demonstrating an abscess in the adductor muscles (pyomyositis).

should also be considered when the history is incompatible with the injury.

DDH (Developmental dislocation of the hip). Delayed diagnosis. If the diagnosis is not picked up in the newborn period it produces a painless limp in the young child. If not considered, the diagnosis may be missed in the walking child, especially the bilateral case.

Transient synovitis. Transient synovitis must be differentiated from septic arthritis of the hip. An important diagnostic error is to make the "easy" diagnosis of a transient synovitis of the hip while overlooking a septic arthritis. The diagnosis of transient synovitis should not be made in a child younger than two years. Aspiration is indicated if any doubt exists.

SCFE *(slipped capital femoral epiphysis).* Delayed diagnosis is common. The pain is often referred to the knee. A common error is to neglect obtaining hip radiographs in a patient with knee pain. A minimal slip may be missed on radiography. The only radiographic sign may be the appearance of a wider growth plate (fig 7).

Growing pains. The diagnosis of growing pains is all too often readily accepted and too frequently diagnosed while other serious conditions may be overlooked.

Fig. 6. — Discoid meniscus, demonstrated by MRI in a four-year-old girl who was seen because of limping. AP (a) and lateral (b) view.

Fig. 7. — A minimal slip of the hip. Widening of the growth plate (arrows) is a radiological sign of SCFE.

Fig. 8. — Köhler's disease. Flattening and sclerosis of the tarsal navicular are diagnostic.

Growing pains are characterised by pain late in the evening or that wakes the child from sleep, but the child is completely asymptomatic in the morning.

"Growing pains are not associated with limping".

Limping and knee pain. Knee pain is a common presenting complaint, but knee pain may be referred pain. Knee pain in an adolescent may be an overuse syndrome ; however the knee may be the site of more serious conditions. Osteomyelitis and osteogenic sarcoma develop more often about the knee than at any other site.

Leg length discrepancy. Limping is too often attributed to leg length difference. Differences up to two cm do not alter the walking pattern and should not be considered as the cause of limping.

Leukaemia. Acute leukaemia is the most common neoplasm in children. Musculoskeletal complaints are the presenting feature in 20% of patients (10). Generalised symptoms should be recognised (14).

JCA. (Juvenile chronic arthritis). One of the earliest signs may be limping. There are many medical conditions that present with symptoms resembling JCA (table II). Some of these are rare. Children with long-standing arthritis are at an increased risk of septic arthritis. The diagnosis should not be missed.

Limping and foot pain. Young children's feet grow very quickly and shoes that are too tight can hamper the child's walking.

Köhler's disease (tarsal navicular osteochondritis). Boys are afflicted more often than girls, and the age of onset is usually between three and five years of age. Familiarity with this condition and its typical radiological appearance avoids unnecessary investigations (fig 1b, fig 8).

Table II. — Differential diagnosis of childhood arthritis

JCA
Acute rheumatic fever
Reactive arthritis
Henoch-Schönlein purpura
Reiter syndrome
Sickle cell disease
Villonodular synovitis
Reflex sympathetic dystrophy

Fig. 9. — Freiberg's infarction. There is flattening and fragmentation at the head of the third metatarsal.

Freiberg's infraction (metatarsal head osteochondritis). This condition is analogous to Köhler's disease and represents segmented avascular necrosis of the head of a metatarsal, usually the second. It most often affects girls, usually during adolescence. The standard radiographic picture is typical (fig 9).

Neurological and neuromuscular diseases. The diagnosis may be overlooked at first presentation. Some of these disorders have a slow, progressive evolution. Duchenne muscular dystrophy is a typical example of a progressive disease that may be missed at first presentation. Spinal cord tumours whose first manifestation is an alteration of the walking pattern are often diagnosed late. A mild, asymptomatic limp in a toddler may be the only manifestation of a mild form of cerebral palsy.

Trauma. Trauma is one of the most common conditions that cause a child to limp, but it can be difficult to detect. Nearly all limping children have a history of a fall, and the limp may be too easily attributed to the injury. A malignant tumour may pass as "shin splints". Older children and adolescents do not always tell the truth about trauma or do not mention it at all.

Occult fractures in the toddler. The toddler's fracture is sometimes difficult to diagnose acutely. The initial radiographs may be interpreted as normal. The diagnosis is often made late. Bone scan may be helpful to clarify the diagnosis (1).

Conversion hysteria. Before attributing the limping to an underlying psychological problem, the orthopaedist needs to be sure that there is no physical ailment.

Abdominal and genitourinary pathology. Although uncommon they may manifest solely as a limp.

CONCLUSION

Limping may occur at any age, and the differential diagnoses of a limp in childhood are broad. In most cases the diagnosis can be made by history, physical examination and the use of selected imaging and laboratory tests. However in some children a definite diagnosis cannot be made. If the child is not ill nor in great distress, careful observation is recommended. Many limps will disappear, and a number of children will never have a definite diagnosis. (5) Although many children with a limp will have spontaneous resolution, certain conditions worsen with a delay in diagnosis. Serious errors are often caused by an incomplete and inaccurate evaluation followed by a quick and easy diagnosis.

Clinical, imaging and laboratory findings must be consistent with the final diagnosis.

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