Walking problems in young children

S Tennant, F Monsell

This article attempts to define normal development throughout childhood and provide straightforward advice in the physical assessment of the child in this situation. It also attempts to outline the groups of conditions that lead to walking abnormalities and highlight the salient physical features and special investigations that are required to make these diagnoses with confidence.

Ms S Tennant is Specialist Registrar, Royal National Orthopaedic Hospital, Stanmore and **Mr F Monsell** is Consultant Orthopaedic Surgeon, Great Ormond Street Hospital for Children, Great Ormond Street, London and Royal National Orthopaedic Hospital, Stanmore, Middlesex HA7 4LP

Correspondence to: Mr F Monsell

The development of normal walking is variable and it is not until the age of 8 years that the adult pattern is achieved (Sutherland et al, 1980). Many children who present with a walking problem may simply be at the end of a range of normal variation. Assessment requires an understanding of normal development and its variations, and includes a thorough history, examination directed to the specific problem, and appropriate further investigations.

For simplicity, this article will classify walking problems in the young child into those concerning normal variants, those where a deformity is apparent, neuromuscular disorders, and other disorders that produce a limp.

NORMAL VARIANTS

Intoeing and outtoeing

Children with intoeing, or less commonly outtoeing, often present to GPs, paediatric and orthopaedic clinics. In general they represent an extreme of normal and there is no underlying pathology.

Internal rotation of the tibia is common at birth and may produce intoeing in the toddler, which decreases soon after resolution of the bowing which often accompanies it. External tibial torsion producing out-toeing is less common (Kling and Hensinger, 1983; Staheli et al, 1985).

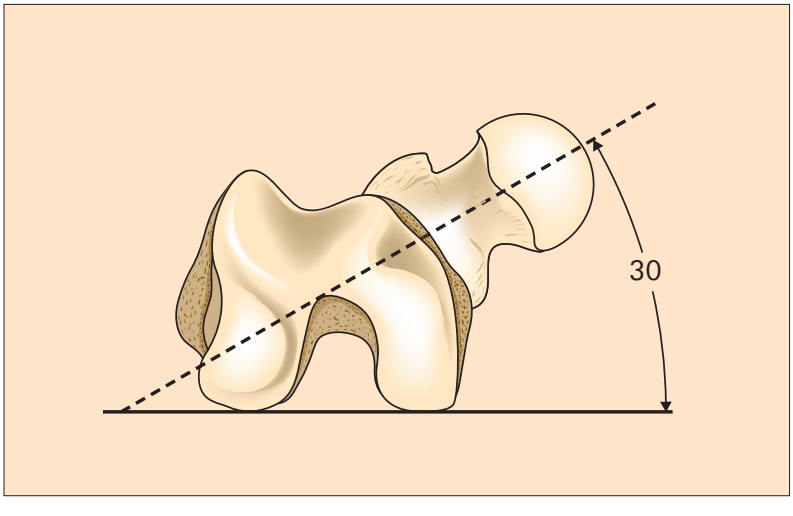
Intoeing in this age group may also be caused by metatarsus adductus where the forefoot turns in as a result of intrauterine moulding. The majority correct spontaneously, requiring only parental reassurance; however, there is an association with developmental dysplasia of the hip and all children should therefore have an ultrasound examination of the hips.

In children between 3 and 10 years, femoral anteversion is usually the cause of intoeing. Version describes the angle subtended by the femoral neck with the femoral shaft, with anteversion describing an anterior tilt of the neck and head (*Figure 1*). In the young child anteversion may be as much as 40°, requiring the rest of the leg to point inwards to allow the femoral head to articulate within the acetabulum. Femoral anteversion decreases to approximately 20° by the age of 10 years, and this is associated with a gradual loss of intoeing (Engel and Staheli, 1974; Kling and Hensinger, 1983).

The arc of rotation of the hip is assessed with the child prone and knees flexed (*Figure 2*). An intoeing gait is associated with greater medial rotation of the hip than lateral, but is considered to be within the normal range as long as there is 20° of lateral rotation. Similarly, an outtoeing child has a normal range if there is at least 20° of internal rotation (Kling and Hensinger, 1983; Fabry et al, 1994; Staheli, 1994).

The alignment of the sole of the foot to the thigh is known as the thigh–foot angle and com-

Figure 1. Anteversion of the hip. The dashed line is bisecting the head and neck of the femur. The solid line is paralleling the transcondylar axis of the distal femur.



bines the effect of any foot deformity as well as tibial torsion. Palpation of the positions of the malleoli demonstrates the presence of tibial torsion (*Figure 3*).

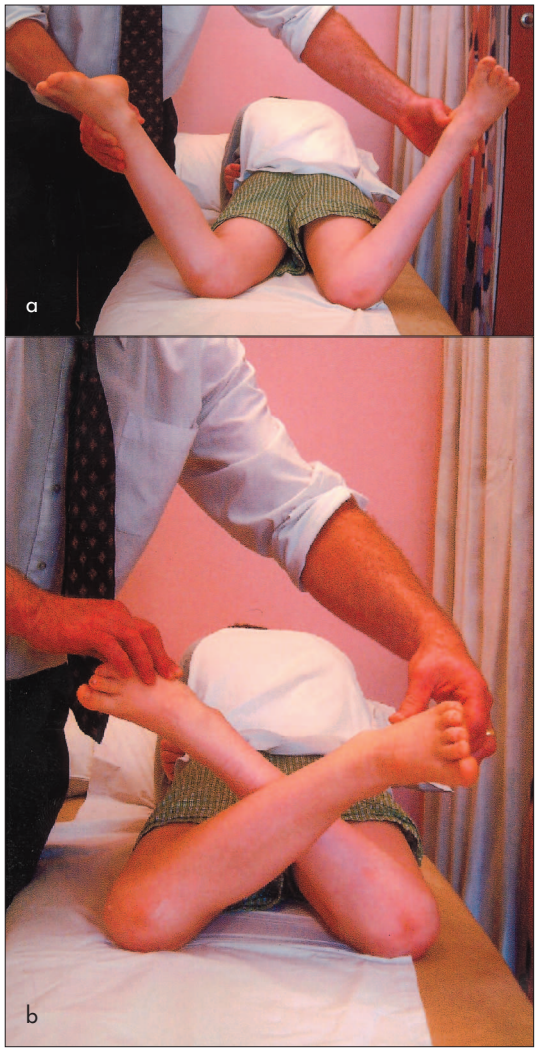
Rotational profiles in the normal child are variable and charts documenting normal values are available. A rotational profile which lies outside two standard deviations of the mean is considered abnormal and a pathological cause should be considered (Staheli et al, 1985).

Physiological rotational abnormalities have not been shown to have any long-term consequences and parental reassurance is the cornerstone of treatment. Shoe modifications and orthotics are unnecessary (Kling and Hensinger, 1983; Staheli, 1994).

Genu varum and valgum

The changes in coronal plane alignment of the lower limbs during growth and development have been described by Salenius and Vankka (1975) (*Figure 4*). A varus alignment describes the distal part of the extremity, which is the tibia in the case of the knee, deviating towards the midline. A valgus deformity describes the tibia deviating away from the midline (*Figure 5*). Knee alignment at birth is 10–15° of varus, correcting to neutral by the age of 14 months. In the infant and early walker genu varum (bow legs) is common. Longitudinal growth results in genu valgum (knock knees) that peaks at about the age of 4 years, settling to the accepted 'normal' adult value of 7° of tibiofemoral valgus by about the age of 7 years.

Figure 2. Examination of hip. a. Internal rotation. b. External rotation.



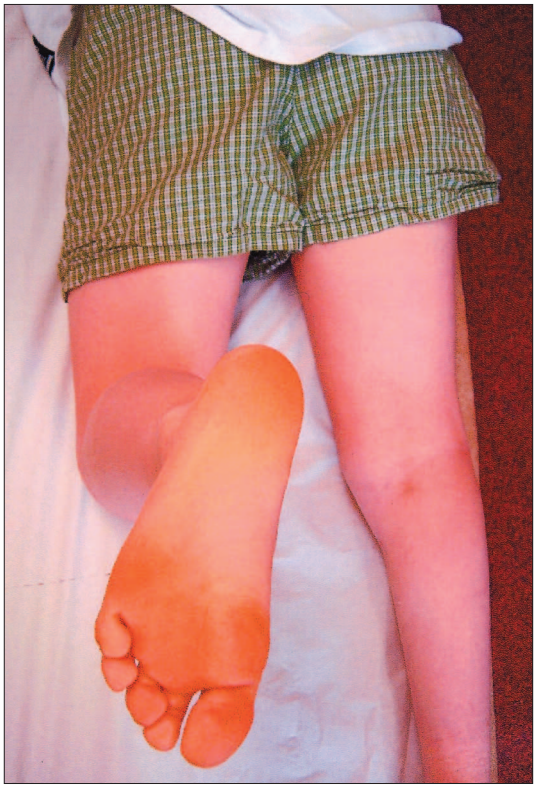
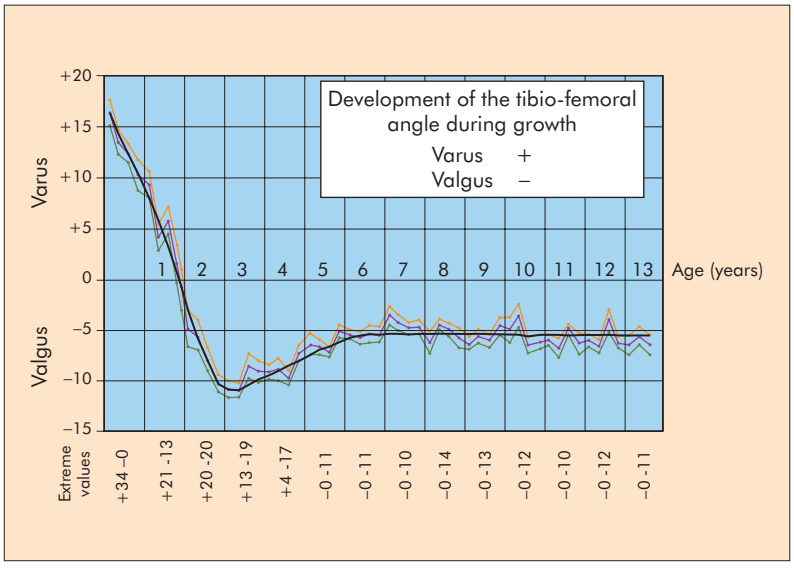


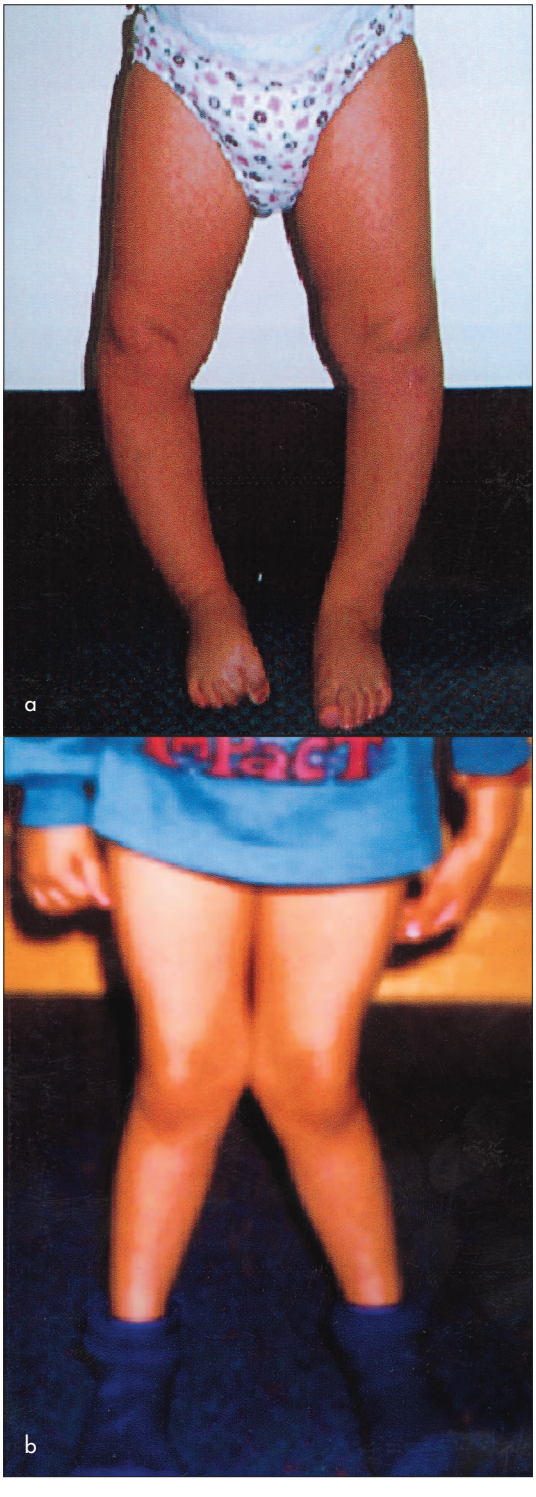
Figure 3. The thigh–foot angle.

Figure 4. The development of the tibiofemoral angle during growth.



Physiological bowing has been defined as more than 10° of bilateral varus after 18 months (Levine and Drennan, 1982). A family history is common and intoeing is typically associated. Parental reassurance is all that is required, with spontaneous correction expected within 2–4 years. Physiological genu valgum is less common and usually presents between 3 and 5 years of age (Kling and Hensinger, 1983; Heath and Staheli, 1993).

Figure 5. a. Varus alignment. b. Valgus alignment.



Pathological causes of bilateral genu varum and genu valgum include metabolic bone disorders such as rickets, and skeletal dysplasias such as achondroplasia. There will usually be other features of disease such as short stature. In rickets, the deformity tends to accentuate physiological alignment so that bow legs are the commonest deformity in young children and knock knees in the older age group. Plain radiographs are usually diagnostic, showing widened physes and flared metaphyses, with diffuse bowing throughout the length of the bone.

Unilateral cases of genu varum or valgum are pathological until proven otherwise, and disorders such as congenital anomalies, trauma, tumour and infection need to be considered. A thorough history and examination is usually sufficient to exclude pathology, and radiographs in both genu varum and valgum are only considered necessary in children with excessive tibiofemoral angles, those outside the expected age ranges, those with asymmetric deformity or short stature. A useful aid to differentiating pathological from physiological deformity is summarized in *Table 1*.

The flat foot

Mobile pes planus or flat foot is a common finding in the infant, and may resolve with growth. If there is a family history it may persist into adolescence, but is usually only a cosmetic problem. It must, however, be differentiated from a rigid or symptomatic flat foot as this is usually a result of underlying disease.

DEFORMITY

Foot deformities

Foot deformities may be related to neurological abnormality so that every child presenting with a foot deformity should have a thorough neurological assessment and examination of the spine.

Talipes equinovarus is a congenital abnormality which can be treated at birth with serial plas-

TABLE 1.
Indicators of a pathological cause of deformity

Asymmetry
Symptoms
Stiffness
Syndromes
Systemic illness

ter casts. In more severe cases, soft tissue surgery may be needed and this is usually performed at the age of 8–12 months. In untreated and recurrent disease, the sole of the foot does not contact the ground and the child walks on the lateral border of the foot with varus of the heel and adduction of the forefoot, callosities form and there are problems with shoe fitting. The foot and the calf are never completely normal, and a leg length discrepancy may be apparent later in childhood.

Pes cavus describes a high-arched foot which usually has a neuromuscular cause, such as muscular dystrophy, spinal dysraphism, polio or cerebral palsy. It is often associated with varus of the hindfoot and thus a tendency to weight-bear on the lateral border of the foot, producing discomfort, ankle instability and callosities, and an abnormal walking pattern.

Toe-walking

Walking on tiptoe may occur in otherwise normal 2–3-year-olds, but persistence beyond this age is abnormal and subtle forms of spastic diplegia and muscular dystrophy must be excluded. Measurement of creatine phosphokinase is mandatory in boys who walk late or develop tiptoeing to exclude a diagnosis of Duchenne muscular dystrophy. Unilateral tiptoeing may be caused by a leg length discrepancy, but the idiopathic case is bilateral and may be associated with a tight heel cord. Treatment involves heel-cord stretching and occasionally serial stretching casts, with surgical heel-cord lengthening reserved for the unresponsive case and performed at 6–8 years of age.

NEUROMUSCULAR PROBLEMS

Spastic hemiplegia and diplegia are common causes of gait abnormality in the young child and mild cases of cerebral palsy may only be noticed when the child starts to walk. As well as disordered posture and balance, gait is impaired as a result of spasticity and weakness of affected muscles, with muscular imbalance producing secondary deformity.

Mildly affected hemiplegic children may have weakness of tibialis anterior only. If the tendo-achilles is spastic, an equinus deformity occurs and the child may appear to walk on tiptoe. More proximal involvement produces knee flexion, and adduction and flexion contractures of the hip.

The child with spastic diplegia displays similar but bilateral deformities. Complex neuromuscular imbalance in these children may produce a crouch gait, as hips and knees flex to centralize the centre of gravity. The energy required to maintain gait with muscular imbalance is significant, and with maturation, it may not be possible for the child to continue walking.

Treatment involves physiotherapy including stretching spastic muscles to prevent contractures and to improve balance and coordination. Botulinum toxin is increasingly used in the dynamic stage of deformity to maintain muscle relaxation and is also useful for predicting the effect of surgery. The surgical treatment of cerebral palsy is notoriously difficult, and is increasingly being preceded by gait laboratory analysis.

LIMPING

The painful limp

A painful limp is characterized by a decrease in the time spent in the stance phase on the affected side. There are many causes, and only the most important and commonest causes will be considered here. In the acute case, fractures or infection of bone or joints must be excluded. In particular a fracture of the tibia in toddlers is a common and often missed diagnosis. In more chronic cases, tumour and inflammatory joint disease need to be considered.

Hip disorders often result in a painful limp, but knee pain may be the only symptom. Therefore any child with knee pain should have a thorough clinical evaluation of the ipsilateral hip, with radiographs if suspicion exists.

The ‘irritable hip’ syndrome is a common problem in young children, presumed to be a reactive synovitis to a recent viral illness, but the diagnosis should only be made once more important disorders, particularly Perthes’ disease and septic arthritis of the hip, have been excluded by inflammatory markers and radiographs. Perthes’ disease is a form of avascular necrosis of the femoral head and presents classically between the ages of 4 and 7 years, more commonly in boys. It is believed to be caused by vascular insufficiency resulting in progressive fragmentation of the femoral head, followed by healing, often with some deformity. The disease runs its own course over a period of approximately 2–3 years; for most children, treatment is symptomatic, although in severe cases surgery may be required.

Slipped capital femoral epiphysis is a condition usually seen around the time of the adolescent growth spurt, but can occur in younger age groups. The epiphysis of the femoral head slips off the neck of the femur through the growth plate and presents in acute or chronic form with a painful limp. The consequences of a missed or delayed diagnosis can be extreme

as there may be irrecoverable damage to the hip joint. Early referral to an orthopaedic surgeon via the casualty department is strongly encouraged in any child with a painful limp to exclude this condition.

The Trendelenburg gait

The Trendelenburg gait describes a dipping of the pelvis on the unsupported side as a result of weakening of the hip abductor muscles on the weightbearing side (Hardcastle, 1985). This is usually accompanied by a shift of the trunk and upper extremity to maintain balance. Neuromuscular disease, pain or a short femoral neck may weaken the abductor muscles, for example in the case of a dislocated hip. Despite a clinical and ultrasound-based screening programme in the UK, children still present late, after the age of 1 year, with developmental dysplasia of the hip. Walking is not delayed or painful, but they walk with a Trendelenburg gait, a short leg and show decreased abduction of the hip.

The short leg gait

The child with a leg length discrepancy usually equalizes his/her leg lengths during gait by walking on the toes of the short leg, a compensation which is not seen in adults.

Many factors may alter leg length either by changing the length of the bone directly or by altering its growth. For example, fractures may produce direct shortening of bone as a result of over-riding of the bone ends or lengthening during the healing process, while infection and epiphyseal fractures may destroy the physis resulting in loss of growth potential.

The degree of discrepancy depends on the cause, the age of the child and their future growth potential. Assessment includes an estimate of the degree of discrepancy at the cessation of growth to allow planning of the appropriate corrective procedures and their timing. In general, discrepancies of more than 2 cm may benefit from surgery, either to lengthen the short leg or shorten the long leg.

CONCLUSION

A large number of children with 'walking problems' are normal and, given time, will develop normally. These children tend to be at the extremes of normal variability and it is only with knowledge of this variation that a diagnosis of normality can be made with confidence.

Pathological causes of a walking abnormality include anatomical deformities, neuromuscular diseases and conditions that lead to pain. Management is by exclusion of a pathological process with appropriate reassurance to the family or identification of a specific disease with appropriate diagnosis and treatment. HM

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Conflict of interest: none.

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KEY POINTS

- The adult pattern of walking develops at approximately 8 years and 'abnormalities' in early childhood may represent a variation of normal.
- Indicators of a pathological cause include asymmetrical, symptomatic deformity in a stiff joint. A pathological cause should also be considered if there are systemic features or other signs of a generalized or syndromic condition.
- Late walkers or acquired tiptoeing in boys should alert a clinican to a potential diagnosis of Duchenne muscular dystrophy which should be excluded with relevant investigation (creatinine phosphokinase).
- Hip pain or knee pain at the time of the adolescent growth spurt should alert a clinician to a potential diagnosis of a slipped upper femoral ephiphysis.