

## Clinical practice

### Static, axial, and rotational deformities of the lower extremities in children

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**Abstract** Static, axial, and rotational deformities of the lower extremities are very frequent in children and often a reason for clinic visits. It is important to make a difference between physiological, usually spontaneously healing conditions, and real pathology. Flatfeet and less frequently cavus feet are the main foot problems. Special attention should be paid to the cavovarus foot that often has an underlying neurological disorder. Localized foot pain has usually a very specific cause and needs further investigation. *Genua valga* and *genua vara* are typical for a given age group and correct usually spontaneously. Toeing in and toeing out are mainly cosmetic problems and can be caused by tibial or femoral rotation, very rarely by a foot deformity. Leg length discrepancy is also frequent and in most patients limited to less than 2 cm, causing no further problems. Follow-up is, however, needed because of possible increasing discrepancy during growth.

**Keywords** Cavus foot · *Genua valga* · *Genua vara* · Flatfoot · Toeing-in · Toeing-out · Leg length discrepancy

#### Introduction

Static, axial, and rotational deformities of the lower extremities (LE) are very frequent in children.

Most of these conditions are physiological and do not need any treatment. They present, however, very often a major concern for the parents and should be taken seriously. The task of the physician is first to make a correct diagnosis and to determine the nature of the deformity, whether it is physiological or needs follow-up and treatment. Second, the parents should be very clearly informed to avoid over- and undertreatment. If a physiological deformity is merely dismissed as “no problem”, the parents will tentatively seek other opinions, with great danger of commercially inspired overtreatment.

Ninety percent of clinic visits for foot problems concern flatfeet. The deformity is mainly physiological, but more severe cases and especially the ones associated with pain should be treated. A cavus foot or high arched foot is less frequent but requires special attention because of possible underlying neurological disorders. Localized pain in the foot is not so frequent in children but needs a radiographic exam in search of typical acquired diseases, such as avascular necrosis of the navicular bone or of the head of the second metatarsal.

Axial and rotational deformities of the LE are mainly physiological, as there are *genua valga* and *vara* and toeing in and toeing out. Leg length discrepancy is frequent in children but mainly limited to less than 2 cm. Follow-up is, however, necessary in the growing child for a timely diagnosis of an increasing discrepancy.

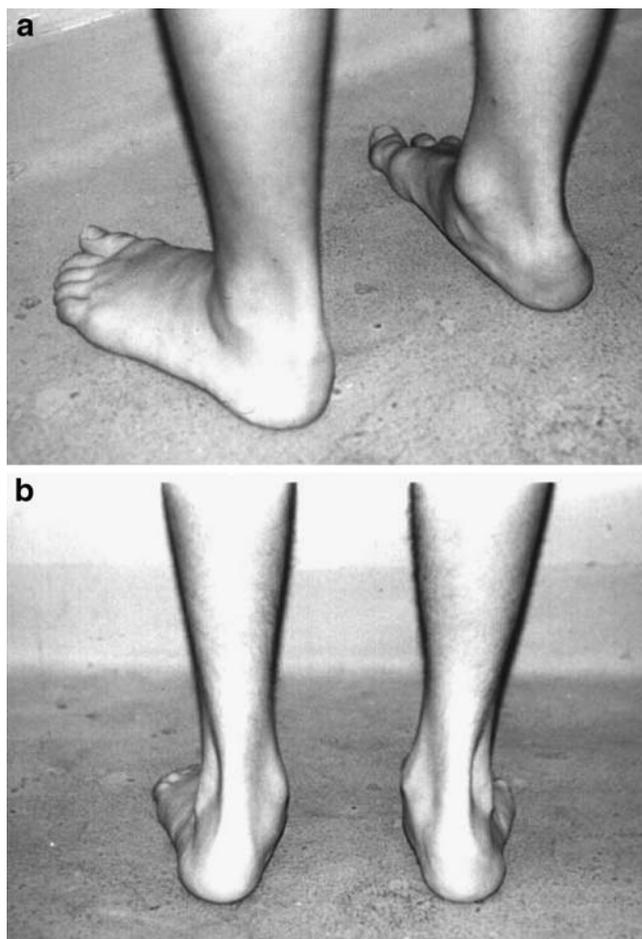
#### Pes planovalgus or flatfoot

Clinically, a flatfoot has two components: sagging of the medial arch and a valgus of the heel (Fig. 1a, b). Most typical is the flexible flatfoot, which corrects when the child is asked to stand tiptoe (Fig. 2). Usually there are no

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**Fig. 1** **a** Sagging of the medial arch in a flatfoot. **b** Valgus of the heel

complaints and no underlying disorders. In some patients with general hyperlaxity, the flatfoot can be severe and deforms the shoe [3].

Flatfeet can occasionally be painful, with more specific complaints after sport exercises or long walks. The pain is diffuse in the feet and lower legs. A differential diagnosis has to be made with the rigid flatfoot, which is usually painful and caused by either congenital tarsal synostoses, congenital vertical talus, or inflammatory disorders. Further investigation and treatment are necessary.

Course and prognosis of the flexible flatfoot are benign. When the child begins to stand, (s)he will show very often a flat foot, which disappears normally around 4 years of age. This evolution is, however, in many cases slower, with a correction of the flatfoot around 8 to 10 years of age. In approximately 15% of cases, the deformity does not disappear and remains into adulthood, when stiffness can cause pain.

Treatment is mainly directed toward symptoms of pain and severity of the deformity. The deformity is



**Fig. 2** Flexible flatfoot corrects when standing tiptoe

quoted as severe when the medial foot arch is completely flat and an obvious valgus of the heel is present (Fig. 2, left foot). The treatment of choice is a well-molded custom-made insole. This device does, however, not correct the flatfoot but alleviates pain and prevents shoe deformation. The flatfoot will either correct spontaneously or remain into adulthood in a minority of cases. It is recommended to treat a flatfoot with insoles after 10 years of age to prevent stiffness in later years.

The regular flexible flatfoot in most children, however, does not need a special treatment.

## FLATFOOT

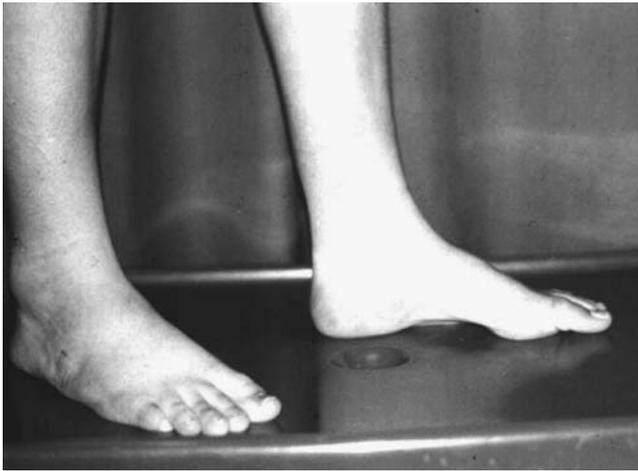
**Flexible flatfoot is mostly physiological**

**Differentiate flexible from rigid flatfoot.**

**Insoles when pain or severe deformity.**

## Pes cavus or high-arched foot

Clinically, the cavus foot shows a high medial arch with consequently an elevated instep, causing sometimes problems with the shoes, rubbing against the skin at the dorsum of the foot. In the typical idiopathic cavus foot, the heel is in neutral position (Fig. 3). The presence of varus of the heel (cavovarus foot) and especially associated with claw toes indicates an underlying neurological condition, such as Charcot–Marie–Tooth disease or spinal dysraphism. The deformity usually increases, and further investigation and adequate treatment are necessary (Fig. 4).



**Fig. 3** High-arched or cavus foot

The prognosis of the mild idiopathic cavus foot is good. The deformity remains unaltered throughout life.

Treatment is symptomatic, with sometimes the need of molded insoles, when metatarsal or heel pain is present [4].

#### **PES CAVUS**

**Pes cavus or high-arched foot : usually idiopathic with good prognosis.**

**Cavo-varus foot points to a neurological condition.**

#### **Pain in the foot**

As mentioned above, flat and cavus feet can cause pain, which is usually diffuse and also localized in the lower legs. Also, obesity and sport activities can be responsible for pain. More defined complaints are usually secondary to localized problems.

*Avascular necrosis* of the head of the second metatarsal causes local pain and needs sometimes an operation. More benign is the avascular necrosis of the navicular bone, which always heal spontaneously and is treated symptomatically.

Heel pain is rather frequent and caused by strain in sport or other activities. Treatment is conservative with rest and insoles relieving the painful area. The Haglund deformity is an exostosis at the distal insertion of the Achilles tendon, causing pain by interfering with the border of the shoe. The exostosis has often to be removed surgically.

#### **Genua valga (knock-knees) and genua vara (bow-legs)**

Axial deformities of the LE are frequent in childhood and mostly physiological. Up to around 3 years of age, children



**Fig. 4** Cavovarus foot with varus of the heel

often present with *genua vara*, which are mainly apparent secondary to internal rotation of the tibia (see further). True *genua vara* is very seldom and seen in rickets, skeletal dysplasias, or unilateral closure of the proximal medial tibial growth plate (Blount's disease). Apparent *genua vara* always correct spontaneously (Fig. 5).

After 3 to 4 years of age, children develop frequently *genua valga*, which are also physiological and correct practically always by the age of 7 years. If the deformity increases under the age of 7 years or persists thereafter, an underlying disorder should be sought for, as rickets or skeletal dysplasias.

Sometimes idiopathic *genua valga* start after the age of eight and do not correct spontaneously. They are called "adolescent *genua valga*" and if severe enough have to be corrected surgically.

#### **GENUA VALGA and GENUA VARA**

**Physiological forms do not need treatment.**

**When the deformity increases or does not correct, look for underlying conditions.**

#### **Toeing in and toeing out**

Rotational problems of the LE are a frequent reason for clinic visits. Important to note is that toeing in or out is practically never caused by foot problems. Nevertheless, many children are treated with special shoes or other more elaborated devices [1].

#### **Toeing in**

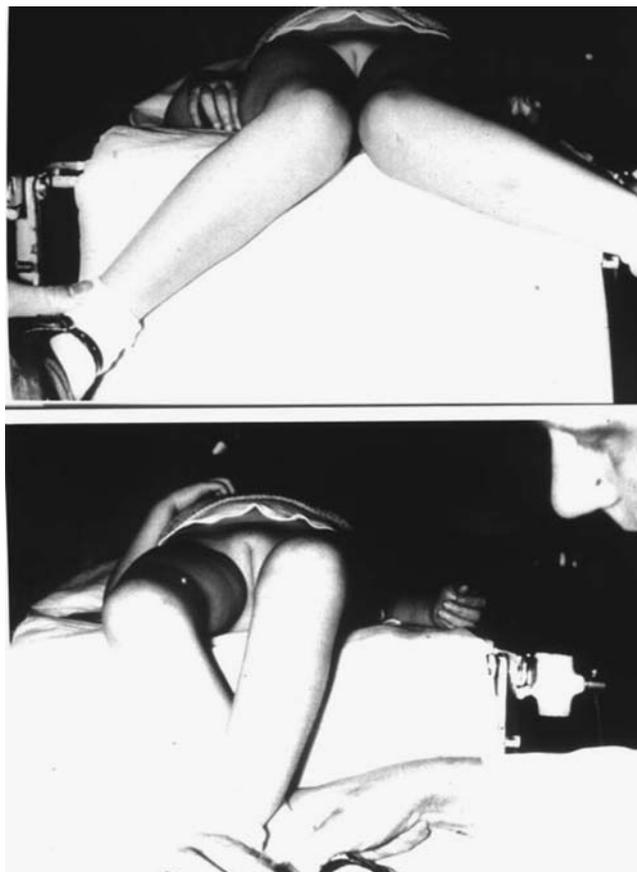
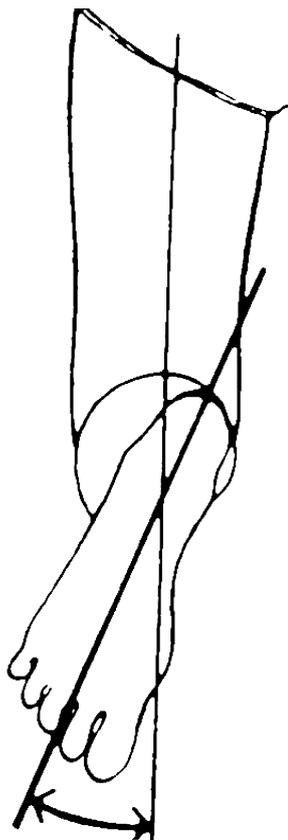
Between the ages of 2 and 5 years, the cause of toeing in is mainly due to internal rotation of the tibia, with also often



**Fig. 5** Physiological *genua vara* (with internal tibial torsion) and *genua valga*

apparent bow-legs, as mentioned above. Rotation of the tibia can clinically be measured by examining the child supine with the knee flexed at 90° and evaluating the angle between thigh and foot (Fig. 6). Normally this angle is 10–

**Fig. 6** Measurement of the thigh-foot angle



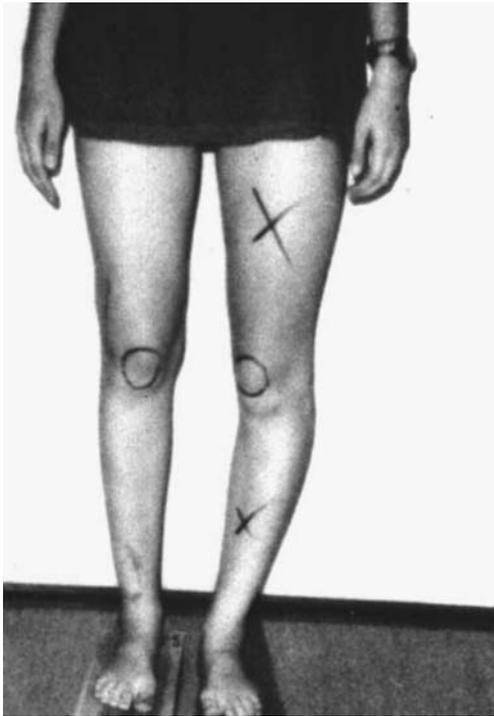
**Fig. 7** Increased internal versus external rotation of the hip in increased femoral torsion

15° in exorotation; 0° or a negative angle means that the tibia is internally rotated. This deformity practically always corrects spontaneously.

In the older child, the internal rotation is usually present in the femur. The femur is internally rotated over its whole length. Clinically, the femoral torsion can be measured by evaluating hip rotation. An increased internal versus external rotation of the hip is an indication of increased femoral torsion or rotation (Fig. 7). The evolution of femoral torsion is variable. It can disappear spontaneously, remain stationary, or increase. This last situation is rather seldom and can even more seldom lead to an operative correction. A special deformity, called “malalignment of the LE” is caused by an increased internal femoral torsion combined with tibial external rotation (Fig. 8). This causes an external pull on the patella with sometimes knee pain in the adolescent child. It is seldom that rotational osteotomies are indicated.

Altogether, however, the main complaint of toeing in is cosmetic, and an operative correction should only be considered in severe cases.

Finally, one foot deformity causing toeing in should be mentioned. Once in a while an uncorrected *metatarsus adductus* is encountered. This is a congenital deformity where the forefoot is in adduction and which corrects



**Fig. 8** Malalignment of the left lower limb, with increased femoral torsion and external rotation of the tibia (the right limb underwent already a derotation)

spontaneously or is treated with corrective casts around the age of 3 to 4 months.

#### Toeing out

Walking with the feet outward is much less frequent than inward. The cause is an external rotation of the tibia in the younger and external torsion of the femur in the older child. Both of these deformities do not correct spontaneously since the normal evolution of rotation in the LE is toward external rotation. External rotation of the femur causes sometimes pain in the hip. A surgical derotation is only indicated in severe cases.

#### **TOEING-IN and TOEING-OUT**

##### *Toeing-in*

**physiological in the young child.**

**in the older child , variable evolution , correction may be needed.**

**deformity is almost never in the feet**

##### *Toeing-out*

**does not correct with time, needing sometimes surgical correction**

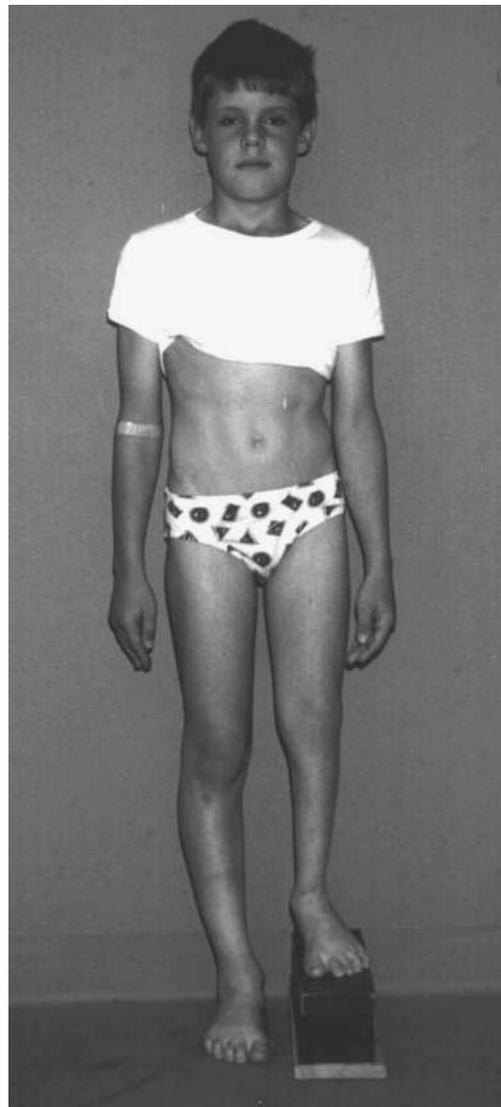
#### **Leg-length discrepancy**

A difference in length in the LE is frequently seen in the growing child. In most cases, the difference does not exceed the acceptable limit of 1.5–2 cm. Up to 2 cm, no negative consequences are to be expected in later life.

Clinically, a shortening is best measured in the standing child with blocs of known thickness under the foot of the shorter leg to level the pelvis (Fig. 9). In the prewalking age, a shortening is sometimes difficult to measure and should be done with the hips and knees flexed at 90°. Especially in babies, full extension of hips and knees is not possible.

Prediction of the evolution of the difference is, however, not always easy, and therefore, a six monthly check during growth is recommended.

When no underlying disorder or congenital anomaly is present, leg length discrepancy can disappear spontaneously



**Fig. 9** Measuring leg shortening with wooden blocs

or remain stable. Sometimes, however, an increase is seen in idiopathic shortening. Treatment depends on the amount of shortening. Between 1 and 2 cm, a shoe lift is usually all that is needed.

Discrepancies of more than 2 cm are treated surgically by arresting (epiphysiodesis) the growth plate of the distal femur or proximal tibia or both of the longer leg, thus allowing the shorter leg to catch up. The timing of this epiphysiodesis is calculated according to the amount of shortening and the bone age of the child [2]. Severe discrepancies of 5 cm or more are treated by length lengthening procedures.

#### **LEG LENGTH DISCREPANCY**

**2 cm is acceptable limit.**

**Only regular follow-up determines evolution .**

#### **References**

1. Fabry G, Liu XC, Molenaers G (1994) Normal and abnormal torsional development in children. *Clin Orthop* 302:22–26
2. Hensinger RN (1986) Standards in pediatric orthopedics. Tables, charts and graphs illustrating growth. Raven, New York
3. Rao UB, Joseph B (1992) The influence of footwear on the prevalence of flatfoot. A survey of 2300 children. *J Bone Joint Surg* 74-B:525–527
4. Samilson RL, Dillin W (1983) Cavus, cavovarus and calcaneocavus. *Clin Orthop* 177:125–132

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