

# NORMAL AND ABNORMAL TORSIONAL DEVELOPMENT OF THE LOWER EXTREMITIES

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A frequent complaint of parents and often a reason to consult the orthopedic surgeon is out-toeing and intoeing children. The reason is almost never to be found in the foot, except for a residual or resistant metatarsus adductus. Our attention will therefore be focused on rotational development of the lower limbs, on tibia and femur.

## NORMAL AND ABNORMAL TORSION OF THE TIBIA

The most classic clinical picture is that of the toddler who in-toes, owing to increased internal torsion of the tibia. Three children in ten in-toe in the 4-year-old group. Tibial torsion can be measured by evaluating the angle between the transcondylar axis and the transmalleolar axis of the tibia. This is however neither very accurate nor easy. A good clinical method for evaluating tibial torsion is measuring the thigh-foot angle, with the child lying prone on the table with the knee in 90° of flexion (fig. 1).

The data collected by Staheli (6), on the thigh-foot angle, show a wide normal range, going from -30° (internal torsion) to +20° (external torsion) at age one, with a mean of -2° to 3°. At age 15 the mean is +15°, with a range of -5° to +30° (fig. 1).

For these figures, two observations are important: one, the in- or out-toeing child almost always fits in the normal range; two, the thigh-foot angle and consequently the tibial torsion show a tendency toward external rotation with growth, especially between one and 5 years of age. After the age of 5 or 6, tibial torsion does not change very much, as was shown by a recent study

by Posciak *et al.*, who measured tibial torsion by ultrasound (5).

In-toeing due to internal tibial torsion is therefore mainly a physiological phenomenon, not requiring any treatment and correcting spontaneously in most of the cases. The figures of Staheli show, however, that although there is a tendency to outward rotation, slight internal tibial torsion can persist at an older age.

The deformity is however very rarely severe enough to warrant a derotation osteotomy.

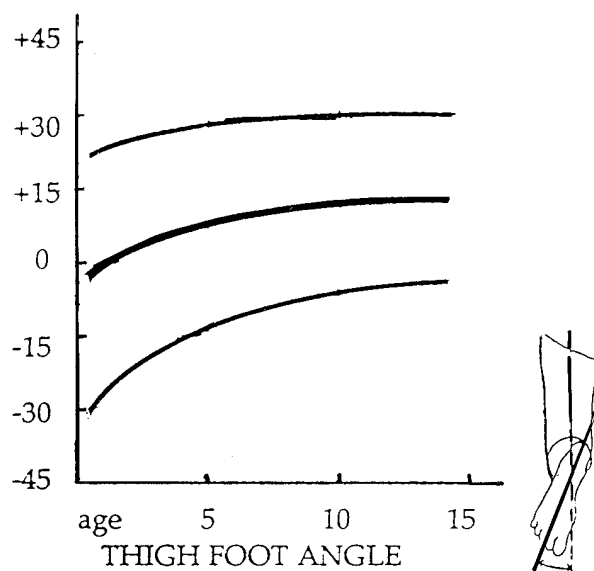


Fig. 1. — Tibial rotation measured by the thigh-foot angle according to Staheli (6).

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Is any conservative treatment ever indicated? Many doctors use derotation splints and are convinced that it helps. Never, however, has an objective study shown a derotation effect of a splint, e.g. Dennis Brown splint.

In severe cases, we have the impression, that toeing-in improves after a few months in Dennis Brown splints. We have probably just altered the behavior of the child, not the rotation. We surely do not recommend splints routinely and warn the parents that if sleepless nights are the price paid for wearing splints, they should be discarded at once.

Out-toeing is much less frequent. Typical is the very young child around 10 months of age who tries to stand with an extreme external position of the feet and the whole lower extremity. This picture is very often seen in the child who sleeps prone with the legs externally rotated. A spontaneous correction occurs almost always, once the child is able to walk normally. The older child who toes-out usually presents a different clinical picture. The tibia is externally rotated and does not show a clear tendency to correct. Internal rotation of the tibia does not occur with growth; the tendency is always toward external rotation. Although very rare, in our experience, children with severe external rotation of the tibia usually have needed a derotation osteotomy.

### NORMAL AND ABNORMAL TORSION OF THE FEMUR

Torsion of the femur, usually referred to as anteversion, shows a normal tendency toward decrease from an average of  $32^\circ$  at age 1 to  $16^\circ$  at age 16 (3) (fig. 2). A substantial number of

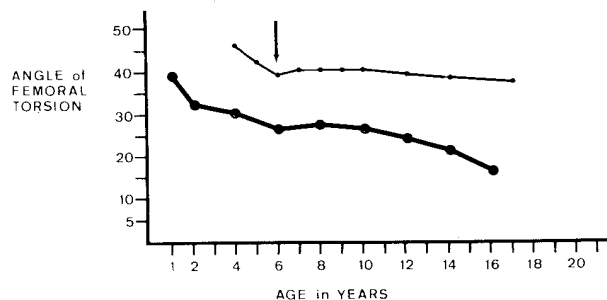


Fig. 2. — Normal anteversion and increased anteversion in intoeing children.

children, however, show a toeing-in gait due to increased femoral torsion or anteversion.

The toeing-in can be explained by the higher range of internal rotation of the hip in increased anteversion. Toeing-in due to increased anteversion usually appears clinically after the age of 5. Before that age, the normal external rotation of the hip exceeds the internal rotation by  $15^\circ$  (to  $30^\circ$  in the very young) (6), which probably compensates for a possible ill effect on rotation, owing to increased anteversion (6).

In the older child, external and internal rotation are usually almost equal, and increased anteversion correlates very well with increased internal rotation and decreased external rotation of the hip. In our experience, decreased external rotation of the hip especially is indicative of increased anteversion.

A study performed 25 years ago on a group of children with toeing-in showed a significant average increase in anteversion ( $42.68^\circ$  versus  $24.14^\circ$  in the normal), without any tendency to decrease, especially after the age of 8 years (3). After 5 years 6 months follow-up, the anteversion had not changed significantly.

In 50% of the cases, however, toeing-in had corrected because of increased external rotation of the tibia, called “compensatory” at that time. The clinical picture changed, but the anteversion did not decrease.

More recently a new study was undertaken, showing the same evolution of the normal and abnormal anteversion, in a group of children between 3 and 14 years old (2).

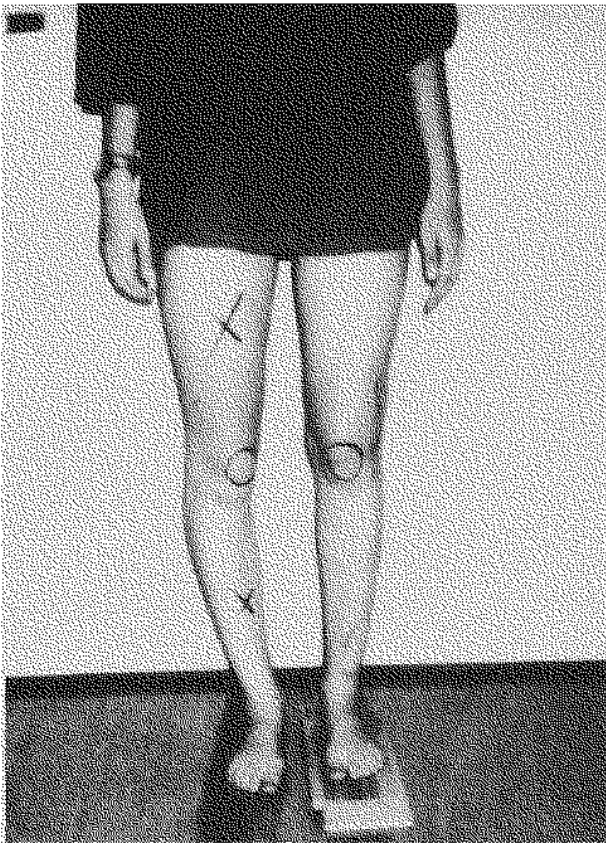
More attention was paid, however, to the tibial rotation in the group with increased anteversion: 40.3% showed an external tibial torsion of  $21.6^\circ$  on average, making the children walk with internally rotated knees and straight forward or outward pointing feet.

The other children presented with an average tibial rotation of  $5.3^\circ$ , making them walk with internally rotated knees and feet. It is noteworthy that there is no difference in age between the group with external rotation of the tibia and the group with internal rotation, and more importantly that external rotation occurs at all ages. We can therefore no longer speak of compensatory external rotation, which would imply a change in rotation

over time. The tibial rotation is probably unrelated to the femoral torsion and presents the normal wide distribution as shown before. The study of Posciak *et al.* comes to the same conclusion (5).

#### How is our clinical picture influenced by all this?

Children with increased anteversion show a wide variety of gait patterns, ranging from severe intoeing to outtoeing but with malalignment of the lower extremities (fig.3). The anteversion does not seem to change very much, but the tibial rotation influences mainly the gait pattern.



**Fig. 3.** ... Severe malalignment of the right lower limb. The left limb has undergone a double osteotomy.

There is until now no study showing an ill effect on the hip due to increased anteversion. More attention has been paid to possible patello-femoral problems in adolescents with malalignment of the lower extremities (1, 8). The increased anteversion

together with the external rotation of the tibia produces an increased Q-angle, with maltracking of the patella.

#### Is any treatment necessary?

It has been shown that conservative treatment does not influence the anteversion (3). No splints or corrective shoes should be prescribed. We advocate a derotation osteotomy when anteversion exceeds 50° or when malalignment is important, especially with painful knees. Therapeutic restraint should however be observed, especially when treatment is required for cosmetic reasons.

If a derotation osteotomy is indicated, the Ilizarov frame has proven to be a reliable method (4).

To complete the picture of rotational deformities, retroversion of the femur should be mentioned. It is much less frequent than anteversion, but seems to play a greater role in the possible development of osteoarthritis (7). A derotation is therefore more frequently indicated.

### CONCLUSION

Internal tibial torsion is almost never a problem and should be considered as a physiological phenomenon. A correction is very rarely indicated in the older child. Increased external tibial torsion is very rare, but does not show any tendency to correct and is sometimes an indication for treatment. Increased anteversion does not correct, but shows a wide variety of clinical pictures. Only the extremes form an indication for correction, frequently depending on the rotation of the tibia, which is however not compensatory. Retroversion is rare, but is usually an indication for correction. In none of the rotational deformities in children, does conservative treatment change anything in the problem, and it should therefore not be prescribed.

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