Reduced tibial torsion in congenital clubfoot

CT measurements in 24 patients

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Submitted 00-07-08. Accepted 00-10-10

ABSTRACT – We determined leg torsion with CT scans through the femoral condyles and the ankle joints in 24 children (17 boys) with congenital clubfoot. In 16 cases, there was a bilateral clubfoot, in 5 cases it was left-sided and in 3 cases, it was on the right side. These children were compared to 17 healthy boys and 7 girls. The ages of all children ranged between 3 and 12 years.

The average external torsion of the leg in the patients with clubfoot was 20 (15) versus 31 (7) degrees in the healthy children (p = 0.002). This study shows that there are great variations in leg torsion in children with congenital clubfoot and, on average, the external torsion is significantly lower than in healthy subjects.

Adduction of the tarsal and metatarsal bones is a well-recognized feature of congenital clubfoot (Wynne-Davis 1964a, Irani and Sherman 1972). Less is known about the anatomy of the ankle and tibia. Reduced external torsion of the leg has been described as a factor for persistent intoeing (Staheli 1990). However, there is disagreement as to whether there is abnormal leg torsion in congenital clubfoot, and tibial osteotomy in the treatment of these children is a controversial procedure (Napiontek and Nazar 1994). We investigated whether congenital clubfoot is associated with rotational abnormalities of the leg.

Patients and methods

The patient group consisted of 17 boys and 7 girls aged 3–12 years admitted to our hospital due to congenital clubfoot. In 16 cases, the clubfoot was bilateral, resulting in a total of 40. These children were compared to 24 age- and sex-matched healthy subjects selected from a Kindergarten. The parents and the children were given written information about the purpose of the study and scanning procedures, and all parents gave their consent for the examinations. The radiation exposure of one scanogram and tomograms through the knee and ankle joints was accepted by the National Department for Radiation and the Regional Committee for Ethics in Science. The average effective dosage was estimated at < 0.05 mSv.

Toshiba X-peed CT equipment was used. The patients were placed supine with hips and knees fully extended and the thighs and legs horizontal and parallel. After a scanogram, a 5-mm-thick tomogram was obtained through the femoral condyles (Figure 1). This gave a proximal reference line as the tangent to the dorsal aspects of the femoral condyles. A tomogram, just below the articular cartilage of the ankle joint, was selected as the distal reference line, drawn from the center of the lateral malleolus to the center of the medial malleolus. Torsion of the leg was measured as the inclination between the dorsal tangent to the femoral condyles and the distal reference line.

All lines were drawn and measured on the tomograms by the same radiologist. The values on the right and left sides were calculated for each child and averaged in patients with bilateral clubfoot and in the healthy children. This pooling of the data identified the patient (but not the leg) as the unit for analysis. In cases with unilateral clubfoot, only the value of the affected side was used.

Data are expressed as the mean and the dispersion as one standard deviation (SD) of the mean.

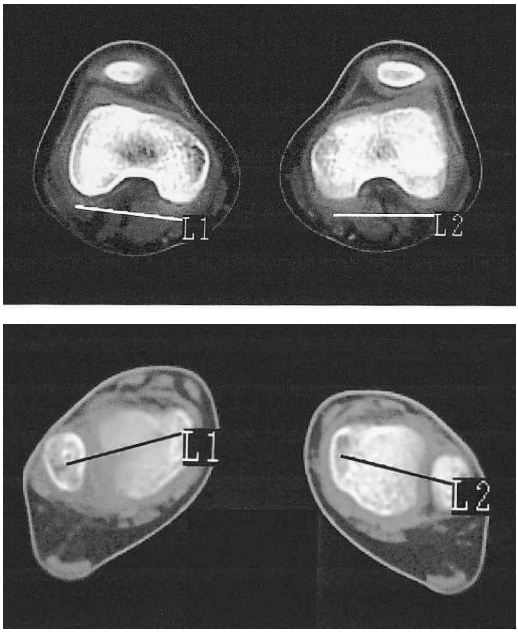

Figure 1. Computed tomography for measuring tibial torsion. The proximal reference line is determined as the dorsal tangent to the femoral condyles. The distal reference line is measured from the center of the medial malleolus to the center of the lateral malleolus. Tibial torsion is measured as the angle between the two lines.

Statistical evaluations were done with the paired and unpaired two-tailed t-tests. $P < 0.05$ was considered significant. Linear regression analysis was used to assess development with time.

Results

The external torsion of the right and left clubfoot legs was 20 (17) and 20 (14) degrees, respectively (Table). In the control children, the external torsion of the right and left legs was 33 (9) and 30 (7) degrees, respectively. Pooling of the data by averaging the angles on the right and left sides in bilateral cases and in the controls gave an average external torsion of the leg of 20 (15) versus 31 (7) degrees in patients with clubfoot and healthy persons, respectively ($p = 0.002$). In the unilateral cases, there were no significant differences between the clubfoot leg (20 (17) degrees) and the healthy one (22 (11) degrees). Linear regression analysis showed an increase in external torsion with age in both groups (Figure 2).

Discussion

We found that congenital clubfoot is associated with a diminution of the normal external torsion of the leg. Interestingly, in the 8 children with a unilateral clubfoot, the tibial torsion of the healthy leg did not differ from the affected leg. This could mean that children with unilateral clubfoot, on average, also have a rotational deformity of their leg with a seemingly normal foot, but this malrotation is not noticed because of the more conspicuous deformity on the affected side or the lack of phenotypical expression or clinical penetrance of a clubfoot on the unaffected side.

There has been disagreement whether abnormal torsion of the leg occurs more frequently in association with clubfoot than in healthy children. Some authors have reported a relative internal torsion of the tibia (Hutchins et al. 1986, Krishna et al. 1991), but others found that children with clubfoot have normal tibial torsion (Swann et al. 1969, Lloyd-Roberts et al. 1974, Herold and Marcovich 1976, Cuevas De Alba et al. 1998). On the other hand, Wynne-Davis (1964b) reported that clubfeet tended to have a higher than average external torsion. These seemingly inconsistent observations may be interpreted in the light of our results. We

CT measurements of external tibial torsion (degrees) in 16 children with bilateral and 8 with unilateral clubfoot versus 24 age- and sex-matched healthy children

	Gender (female/male)	Age (years) mean (range)	Right leg (degrees) number	mean	*SD*	(range)	Left leg (degrees) number	mean	*SD*	(range)
Clubfoot	7/17	6.2 (3–12)	19	20	*17*	(-10–55)	21	20	*14*	(-3–42)
Healthy	7/17	6.3 (3–11)	24	33	*8.5*	(17–46)	24	30	*6.9*	(18–41)

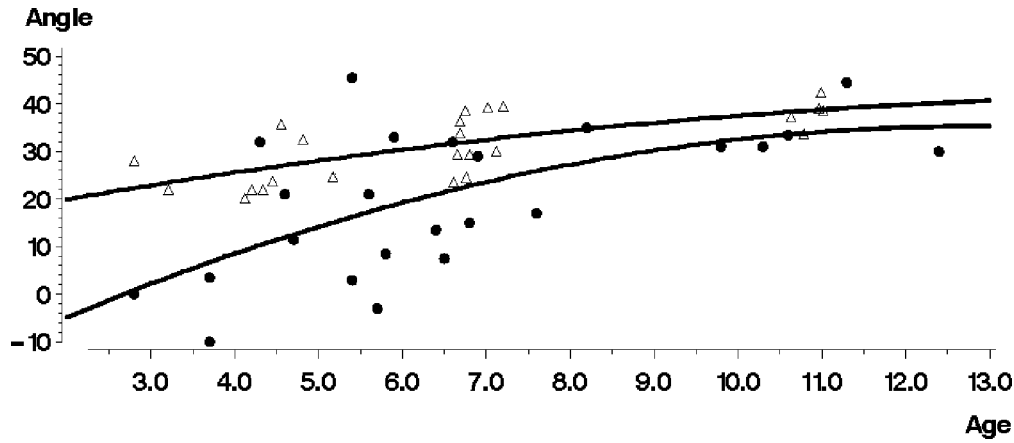

Figure 2. Diagram showing regression lines of external tibial torsion angle (degrees) measured by CT, in relation to age (years) in children with clubfoot (dots) and in healthy children (triangles). In bilateral cases and in the controls, the average angles on the right and left sides are shown.

found that there is a wider range of tibial torsion in clubfoot than in the normal population.

The question as to whether the leg has an abnormal torsion in clubfoot can be answered only by measuring the relative alignment of the proximal and distal surfaces, as compared to healthy children. Tibiofibular torsion has been defined as the angle formed by the articular axes of the knee and ankle joints. In the literature, however, there are variations concerning reference axes, lines and anatomical landmarks, and there is no standard for measuring methods. Anthropometric techniques cannot be used clinically, pseudoaxial radiographic methods are generally accepted as imprecise, and it is agreed that clinical methods for measuring tibiofibular torsion have a wide range of interobserver errors. Measurement with CT is based on reference lines proximally and distally on the tibia (Jakob et al. 1980, Jend et al. 1981). Measurements with these methods, however, are not entirely reliable, and it has been concluded that it is difficult to determine precise reference lines on the tibia because of its rounded form (Laasonen et al. 1984). In our study, we used the dorsal tangent of the cartilage surface of the femoral condyles as the proximal reference line. This line is easy to determine, and it is well accepted as the reference line for determination of femoral anteversion. Furthermore, we used a scan through the ankle joint with both malleoli for the distal reference line. In a previous study, the accuracy of the method was evaluated, and the inter- and intraobserver variations in the values measured were 0.4 (2.1) and 0.7 (1.9) degrees, respectively (Reikerås and Høiseth 1989). It may be argued that the dorsal aspect of the femoral condyles as a reference line for tibial torsion may give indirect determinations. However, the extended knee does not allow rotation, except in patients with knee joint instability. Such patients, then, cannot be examined with this method.

Tibial osteotomy for the treatment of congenital clubfoot is seldom done, and the scarcity of publications on the subject indicates that it is a controversial procedure. It has been claimed that derotational osteotomy may mask the adduction of the forefoot or subtalar complex. According to Swann et al. (1969) and Lloyd-Roberts et al. (1974), the hindfoot in patients with clubfoot is laterally rotated on a tibia which itself has no rotational deformity. Osteotomy will then not contribute to repair the clubfoot and has no place in the primary treatment. However, it may be suitable in older children with malalignment syndrome. It is well known that during the first years of life, the tibia twists externally (Staheli 1990). In our study too, we saw a gradual increase in external tibial torsion with age in both groups. Since the tibia normally rotates with time, internal tibial torsion may improve, while lateral external torsion may worsen.

It has been assumed that rotational malalignment of the lower limb may correct spontaneously before the age of 7 years (Staheli 1990). After this age, persistent symptoms may justify operative

correction. However, the evaluation of tibial osteotomy is influenced by the position of the foot, and by rotation of the femur. If the patient has an increase in femoral anteversion, a diminution in tibial torsion exaggerates intoeing. The correct treatment, then, relies on determinations of the direction of the bones. In our study, the proximal reference line could be used to determine the degree of rotation of the femur, and the distal reference line to determine the position of the tibia and fibula in relation to the talus. The level of rotational abnormalities could then be determined accurately.

In conclusion, we found great variations in leg torsion in children with congenital clubfoot and, on average, the external torsion was significantly lower than in healthy children. This should be considered when evaluating secondary corrective procedures.

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