Physiological alignment of the lower limbs changes during childhood. A clinical Study in South-West Greece

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Abstract - It is well known that the physiological alignment of the lower limbs changes during the first years of life. Mild to moderate bowlegs in newborns and knock-knees in early childhood are well-defined and quite common orthopaedic problems. The established reference values of paediatric lower limb alignment are based on clinical or/and radiographic measurements of the tibiofemoral (TF) angle and the Intermalleolar (IM) and Intercondylar (IC) distance. In our study, we determine the mean values and normal limits for the TF angle and the IC/IM distance of 316 normal children in South-West Greece. In total, 160 boys and 156 girls aged from 3 to 9 years were examined using clinical methods. The average value of the tibiofemoral angle starts around 7° at the age of 3 years and gradually decreases to under 4° at the age of 7 to 8 years. The average value of the IM distance ranges from greater than 3.5 cm at the age of 3 years and progressively falls to under 2 cm at the age of 7 to 8 years. We noted significantly different results than other similar reports. These differences may reflect racial differences between Greek children and those of other races.

Key words: knock knees, children, normal limits, SW Greece

1. Introduction
Pediatricians or paediatric orthopaedic surgeons often face bowlegs or knock-knee deformities of the lower limbs, which usually concern the parents of the children. The valgus-varus alignment of a growing human knee depends on growth of its articular cartilages and development at the growth plates in the adjacent femur and tibia. As the plates typically grow more than 5 times faster than the articular cartilages, the plates exert most of the control of the knee’s valgus-varus alignment. Varus develops if the medial sides of those plates that grow slower than the lateral sides. Alternatively, valgus may develop if the medial sides grow faster.

2. Determination of the normal limits of valgus knees
Knowledge of normal limits of the tibiofemoral (TF) angle is very important not only for the differential diagnosis of a pathological condition but also for an explanation of some informative details about normal development of children to parents. The purpose of our study is to determine the mean values and normal limits for the TF angle and IC/IM distance in normal Greek children aged 3 - 9 years using clinical methods.

3. Evaluation of the physiological Knock Knees range

3.1 Material and Methods
The lower limbs of 316 normal Greek children aged from 3 to 9 years were included in our study. These were 160 boys and 156 girls, examined at the Outpatient Department of our Organization from January 2008 to January 2009. Children with a history of musculoskeletal system disorders were excluded from the study.

3.1.1 Tibiofemoral Angle (TF)
The Tibiofemoral angle was measured following a clinical method using an upright protractor, following
exactly the methodology introduced by Cheng et al [1]. Specifically, the superior iliac spines, the region and the center of the knee and the midpoint of the ankle joint were TF angle was measured thoroughly in both designed with a dermographic pen. Then, the legs. The valgus angle was measured with a positive sign.

3.1.2 Intermalleolar distance (IM)

The measurement of the distance between the malleoli was measured in an upright position using a tape measure and was expressed with a positive sign.

The assessment of the severity of the valgus knee was based primarily on the measurement and was classified as mild when the IMD was from 2-5 cm, moderate when the IMD was 5-9 cm and severe when the IMD was greater than 9 cm, based on previous reports.

3.2. Statistical Analysis

The data were initially entered in a Microsoft Excel 2007 spreadsheet and then analyzed statistically using SPSS version 17.0. In all statistical tests, the null hypothesis was rejected at p<0.05.

3.3 Results

In total, we examined 316 children of which 160 were boys and 156 girls, i.e. the proportion of Males: Females was 50.5: 49.5. The children’s ages ranged from 3 to 9 years, with a mean age of 5.77 (Min 3.00, Max 9.00 and SD 1.77), while their average height, weight and Body Mass Index (BMI) were 116.89 (Min 92.00, Max 141.00 with SD 11.78), 22.60 (Min 12.00, Max 51.00 with SD 6.71) and 16.20 (Min 10.59, Max 26.98 with SD 2.36) respectively.

The average tibiofemoral (TF) angle starts around 7° at the age of 3 years and gradually decreases to around 5.5° at the age of 4, to 4.5° at the age of 6 and stabilizes under 4° at the age of 7 to 8 years. The average value of the IM distance ranges from more than 3.5 cm at the age of 3 years and progressively falls to 2.5 cm at the age of 6 and stabilizes under 2 cm at the age of 7 to 8 years.

3.4 Discussion

Angular deformities of the lower extremities in children are commonly encountered in clinical practice. Lower limb malalignment can be either physiological or secondary to a variety of congenital and acquired aetiologies. For the measurement of the TF angle, several methods, like roentgenographic or clinical techniques, have been used by different studies. Recently, clinical examinations have become very popular as they are easily applicable and avoid radiation exposure. This is why we applied this in our study too.

Different maximal mean valgus angle values and ranges were reported in different studies. Engel and Straheli [2] found maximal valgus of 6 to 7 degrees at age 2-3 years but Salenius and Vankka [3] reported maximal mean valgus of 12 degrees at 3 years and 5-6 degrees in children between ages 7 and 12 years. Cheng et al [1] reported maximal mean valgus of 8 degrees at 3.5 years while, after the age of 4 the TF angle inclined toward 0 degrees. Furthermore, Heath and Straheli [4] observed at least 2.5 degrees of valgus in white children at the age of 11 years. Similar results were reported by Cahuzac et al [5] in European children. They observed a valgus angle of 5.5 degrees until the age of 13 years. On the contrary, the study of Arazi et al [6] reported significantly higher degrees of mean valgus angle. In detail, the observed maximal mean valgus angle was 9.6 degrees at 7 years for boys and 9.8 degrees at 6 years for girls. In a Nigerian population of about 6 years, the mean angle was 5o and remains between 5o and 6o until the 12th year [7].

Moreover, significant differences in the measurement of IC and IM distances have been reported in studies from different countries. Cheng et al reported mean IC and IM distances of 0 cm at age of 8 years in Chinese children. Heath and Straheli noted a mean IM distance > 2 cm at age of 7 years in white American children. The study of Arazi et al in a Turkish population showed significantly lower IM distance values.

Concerning the maximal mean valgus angle values and ranges according to age, our results are similar to those of Heath and Straheli. Differences in measurement methodology, the technique used by the examiner and racial features may explain the noted discrepancies.

4. Conclusion

The present study is a research on the normal values and ranges of TF angle in a Greek population. Our results suggests that Greek children aged between 3-9 years exhibit < 80 physiologic valgus. A measurable angle higher than that should be considered abnormal and further evaluation should be deemed necessary.
References


