



ORIGINAL RESEARCH ARTICLE

MEASUREMENT OF TIBIOFEMORAL ANGLE IN NEPALESE CHILDREN: A CLINICAL STUDY IN NORMAL SUBJECTS BETWEEN AGES OF 1-8 YEARS

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ABSTRACT

In evaluation of genu valgum/varum Tibiofemoral angle (TF), Inter-condylar Distance (IC) and Inter-malleolar Distance (IM) are commonly measured. In this study normal limits and mean values of TF angle IC/IM distances was determined in 413 normal Nepalese children aged between 1-8 years using clinical methods. A significantly higher degree of valgus angle was noted compared to other studies performed in different races. The maximal mean valgus angle was 10.5 at 4-5 years for boys and 10.6 at 6-7 years for girls. **Conclusion:** A measurable varus or valgus angle higher than 11 degrees during this period should be considered abnormal.

Key words: Intercondylar distance, Intermalleolar distance, Tibiofemoral angle

INTRODUCTION

Mild to moderate bowing of the lower limbs involving both the tibia and femur is a common and normal finding in the new born and young infant. It probably represents the persistence of the in utero position of the lower limbs. With the development of upright stance and locomotion, the medial deviation of the legs, are spontaneously corrected.

With advancements of age and development of mature gait, the "pendulum" swings towards genu valgum between two and three years of age, and finally the knocked knees are also spontaneously corrected between four to ten years of age.¹

In evaluation of genu varum/valgum, TF angle, IC and IM distance are commonly measured. Knowledge of the normal limit of Tibiofemoral angle is important as both orthopedic surgeons and pediatricians are often faced with these clinical entities in day to day practice.

Several studies in various ethnic groups have been reported during certain stage of development.²⁻⁷ The normal limits of TF angle in these studies have been

different. This strongly suggests the presence of racial variation in normal development of TF angle.

There are no reports carried out on studies in Nepalese population. Thus, this study aimed to determine the mean values and normal limits, for TF angle, IC distance and IM distance in normal Nepalese children aged from 1-8 years using clinical methods.

METHODS

The present study is a cross sectional study conducted in 413 Nepalese children. There were 244 boys and 169 girls. The subjects were selected from 5 schools and a day care center. The subjects were grouped according to age (table 1). Children with history with trauma of lower limb (femur and tibia), musculoskeletal disorders and positive family history with persistent and excessive genu varum/valgum were excluded from the study.

Table 1

Age (years)	Male	Female
1-2	21	21
2-3	21	22
3-4	42	22
4-5	30	26
5-6	22	25
6-7	65	36
7-8	43	17

The clinical TF angle, IC and IM distance was measured using methods adopted by Cheng et al⁵, Arazi et al⁸ and Morley.⁷

Tibiofemoral Angle (TF)

For each child, Anterior superior Iliac Spine was identified and marked (point A). Similarly, the center of patella was identified by a point, which was formed by a mid point in a transverse line joining the superior and inferior pole of the patella with a horizontal line drawn in right angles to the previous line connecting the mid points of the widest diameter in between medial and lateral margins of the patella (point B). The midpoint of the ankle joint was taken in between the two malleolus (point C). The TF angle will thus be represented by the line joining point A-B, with the line joining point B-C.

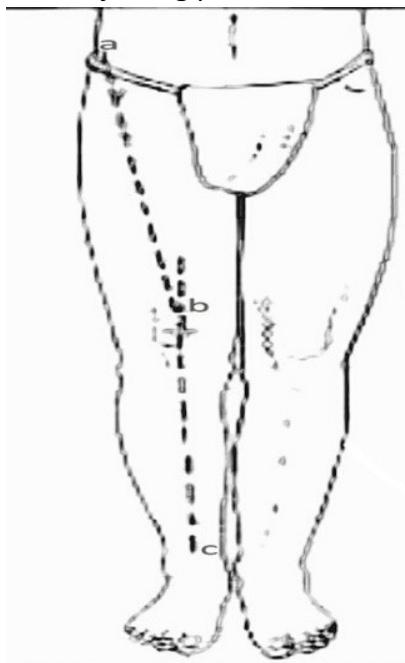


Figure 1

Intermalleolar Distance (IM)

The degree of knock knees was measured by the distance between the medial malleoli (with patella facing forward, the medial surface of the knees just touching and the ankle dorsiflexed to the neutral position).

Intercondylar Distance (IC)

The degree of bow legs was measured by the distance between the medial condyles of the distal femur with the malleolus just touching each other.

Body weight and height was also measured for each child to investigate relationship of TF angle to them.

To assess the intraexaminer variability, 20 randomly selected children (40 measurements) were measured after a period of 2 weeks, from the original population. Likewise, to assess the intraexaminer variability, another orthopedic surgeon measured 20 randomly selected children from same population.

Statistical Analysis

Variables for differences between different age groups of boys and girls were also assessed. Student T- test was utilized for this purpose. Pearson's correlation test was performed to assess the correlation between TF angle and weight and height. To assess intraexaminer and interexaminer variability Paired t- test was used. In all statistical tests, the null hypothesis was rejected at $p < 0.05$.

RESULTS:

TF Angle

The mean TF angle in boys and girls in different age groups are shown in table 2 and 3. The maximal mean valgus angle of 10.5 degrees in boys at 4-5 years and 10.6 degrees for girls at 6-7 years was noted. There was a steady rise in TF angle from age group 1-2 years till it reached its maximum value during 4-6 years, after which there was steady decline. There was a strong correlation between TF angle and age, p -value = 0.024.

Table 2: TFA in boys

Age group	Maximum	Minimum	Mean	SD
1-2	11	4	7.6	0.8
2-3	13	4	8.9	2.7
3-4	15	6	10	2.19
4-5	17	6	10.5	3.1
5-6	15	3	9.5	3.2
6-7	15	4	9.3	3.4
7-8	16	4	9.6	2.5

Table 3: TFA in girls

Age group	Maximum	Minimum	Mean	SD
1-2	11	4	7.33	2.19
2-3	15	5	10	3.1
3-4	16	4	10.15	3.2
4-5	16	7	10.22	1.9
5-6	16	3	10.6	3.7
6-7	16	5	10.4	2.6
7-8	16	3	9.05	3.3

IC and IM Distance

The mean IC and IM distance in boys and girls in different age groups are shown in table 4 and 5.

The maximum IM distance was seen in 7-8 years age group for boys. The mean being 4.00 and standard deviation was 2.01. For the girls, the mean IM distance was 4.316 and standard deviation was 2.35

in the 5-6 years age group.

Only 5 children had measurable IC distance. In the age group of 6-7 years, two boys had IC distance of 1 cm and two girls had IC distance of 1 and 0.5 cm. Similarly, one child in age group of 7-8 years had measurable IC distance of 1 cm.

Table 4: IM distance in boys

Age group	Maximum	Minimum	Mean	SD
1-2	3.6	0.8	2.40	0.8
2-3	4.8	0.6	2.8	1.6
3-4	6.3	1.5	3.44	1.25
4-5	6.8	1.6	3.7	1.7
5-6	8.3	0.5	3.2	1.9
6-7	8.8	0.5	3.4	2.05
7-8	9.6	0	4	2

Table 5: IM distance in girls

Age group	Maximum	Minimum	Mean	SD
1-2	3.6	0.8	2.40	0.8
2-3	4.8	0.6	2.8	1.6
3-4	6.3	1.5	3.44	1.25
4-5	6.8	1.6	3.7	1.7
5-6	8.3	0.5	3.2	1.9
6-7	8.8	0.5	3.4	2.05
7-8	9.6	0	4	2

TF Angle versus IC/IM distance

The correlation between TF angle and IM distance was found to be significant (p-value < 0.001). Two variables were strongly positively correlated $r = 0.835$. As there were only five positive readings for IC distance, correlation between IC distance and TF angle could not be computed.

TF Angle versus Weight and Height

The correlation between TF angle and weight has been found to be significant (p-value = 0.001). However the magnitude of the relationship is not that strong, $r = 0.160$. The correlation between TF angle and height was also significant (p-value < 0.001), however the magnitude of the relationship was not that strong, $r = 0.112$.

Intra-observer and Inter-observer variability

Paired t-test was done to access the interexaminer and intraexaminer variability. At 99% confidence level or 1% level of significance, there was no sufficient evidence to suggest that the reading of the investigator and another examiner are different. Therefore, there is no interexaminer or intraexaminer variability for both TF angle and IM/IC distance.

CONCLUSION:

The present study is a cross-sectional in nature, conducted in normal Nepalese children between the ages of 1 to 8 years, to determine the normal development of tibiofemoral angle. The study was based on clinical measurements.

Various authors have reported the normal development of tibiofemoral angle in different population using clinical methods. Cheng et al.⁵

reported the normal angular and rotational profile of the lower limb in 2630 Chinese children from birth to age 12 years by using clinical methods. After this study, Health and Staheli⁶ reported the normal limits of TF angle determined by clinical and photographic techniques in Caucasian children from 6 months to 11 years old. Another similar clinical study was reported by Cahuzac et al.⁹ in 427 normal European children aged from 10-16 years. Recently, Arazi et al.⁸ conducted and reported the normal development of TF angle in 590 normal Turkish children, utilizing clinical methods.

Our results showed significantly higher degrees of mean valgus angle than did previous reports. We observed maximal mean valgus angle of 10.5 degrees in boys at 4-5 year of age group and 10.6 degrees for girls at 6-7 years age group. These differences can result from racial as well as environmental factors. External factors such as early use of walking chairs, late independent walkers, and longer dependent walker all seem to have high correlation with development of tibiofemoral angle.¹ There was a steady rise in TF angle from age group of 1-2 years till it reached its maximum value during 4-6 years. After which there was steady decline which illustrated in the graph below. Our study also showed strong correlation between TF angle and angle, p-value= 0.024 (table: 11).

We found fair degree of correlation between weight/ height and TF angle. The largest IM distance was found in overweight children. Cahuzac et al.⁹ observed this and noted that this finding could result from soft tissue thickness over the knees. This was also observed by Bonnet et al.¹¹, they consistently found higher values for IM distance in overweight children.

CONCLUSION:

The present study is a normative study about the normal values and ranges of TF angles in Nepalese children. This study does not give information with which to decide about surgery or other treatment modalities for extreme varus or valgus. Sharrad et al.³ revealed detailed and clear information about pathologic conditions for TF angle in different ages of children. According to Sharrad, the conditions needed a further evaluation when an IM distance was > 10 cm at ages 3 and 4 years, and when IM distance was >10cm with knock knees at ages 10 or 11 years, and unilateral knock knee and a varus angle with IC distance >5cm in a child of any age. A severe TF deformity not included in these conditions will correct itself.

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