A STUDY ON TIBIAL TORSION IN ADULT DRY TIBIA OF EAST AND SOUTH INDIAN POPULATION

Jami Sagar Prusti[1], Sushma Korukonda[2], Purna Chandra Maharana[3]

[1]Professor and HOD, Department of Anatomy, SLN Medical College, Koraput, Odisha.
[2]Assistant Professor, Department of Anatomy, Gayatri Vidya Parishad Institute of Healthcare and Medical Technology, Visakhapatnam, Andhra Pradesh.
[3]Professor and HOD, Department of Anatomy, Gayatri Vidya Parishad Institute of Healthcare and Medical Technology, Visakhapatnam, Andhra Pradesh.

ABSTRACT

BACKGROUND

Rotational deformities of the lower limbs are very common. There is increasing evidence that abnormal torsion in the tibia is associated with severe knee and ankle arthritis. Primary knee osteoarthritis is a leading cause of disability in older persons. Varus or valgus alignment increases the risk of osteoarthritis. Coexistence of tibial torsional deformity may increase the risk further. Variability in the tibial torsion has been reported and is due to the torsional forces applied on tibia during development.

The aim of the study is to estimate the angle of tibial torsion on both sides and both sexes. The present study was an attempt to provide baseline data of tibial torsion in the East and South Indian population.

MATERIALS AND METHODS

The study was conducted mechanically on 100 dry adult unpaired human tibia, i.e. 50 male and 50 female bones. The measurements were recorded and statistically analysed using Student's unpaired t-test using GraphPad Prism 5.0 (free trial version).

RESULTS

Out of the 100 tibia undertaken, mean value of tibial torsion angle obtained is 25.8°. In males, it is 23.68° and in females it is about 27.86°. Statistical analysis revealed significant greater average angle of tibial torsion in female bones. The angle of the right-sided bones was more and this was statistically significant.

CONCLUSION

The gender variation for the angle could be the result of the difference in lifestyle in day-to-day activities. The knowledge of the angle in a population could be helpful in understanding the incidence of pathogenesis related to gait and knee osteoarthritis and in view of reconstructive surgeries in orthopaedic practice.

KEYWORDS

Angle, Transitional Axis, Tibial Torsional Deformity.

HOW TO CITE THIS ARTICLE: Prusti JS, Korukonda S, Maharana PC. A study on tibial torsion in adult dry tibia of east and south Indian population. J. Evid. Based Med. Healthc. 2017; 4(43), 2604-2607. DOI: 10.18410/jebmh/2017/515

BACKGROUND

Bone torsional deformity is excessive, anatomical or axial twist of proximal portion with respect to distal. Tibial torsion is the twisting of the tibia about its longitudinal axis resulting in a change in alignment of the planes of motion of the proximal and distal articulations.[1] Torsion is measured on the dry bone and is the twisting in the axis of a single unit.[2] High angles in adults have also been observed in population that spend a large proportion of time in a squatting posture (Charles, Aitken, 1905). The torsion begins to develop in utero and progresses throughout the childhood and adolescence till skeletal maturity is attained. Tibial torsion is approximately 30° in Caucasian and Asian population, but is significantly greater in people of African origin (Eckhoff et al, 1994).[3] Some of the femoral neck anteversion seen in the newborn may persist in adult females. This causes the femoral shaft and knee to be internally rotated and the tibia may develop a compensatory external torsion to counteract the tendency of the feet to turn inwards (Gray's anatomy, 40th Ed.). Knowledge of the normal range of the angle of tibial torsion at various ages and its accurate clinical measurement is important in the assessment of the extent of a torsional deformity before corrective surgery is undertaken. Tibial torsional deformity has been studied both in vivo and in dry bone using a variety of techniques by various researchers.

With this background, the study was carried out to estimate the angle of tibial torsion on both sides and either

Financial or Other, Competing Interest: None.
Submission 17-05-2017, Peer Review 20-05-2017,
Acceptance 23-05-2017, Published 26-05-2017.
Corresponding Author:
Dr. Jami Sagar Prusti,
Professor and HOD, Department of Anatomy,
SLN Medical College, Koraput, Odisha-760004.
E-mail: sagarprusti72@gmail.com
DOI: 10.18410/jebmh/2017/515

gender and to provide baseline data of tibial torsion in the East and South Indian population.

MATERIALS AND METHODS

This cross-sectional study was carried out on 100 dry unpaired adult tibia devoid of any gross pathology to measure the tibial torsion angle. The material for the study was collected from the bone bank of Department of Anatomy, MKCG Medical College, Berhampur, Odisha, and from the personal bone sets available with undergraduate medical students, which are used for their routine study of anatomy.

A self-designed osteometric board, an Edward Vernier sliding calipers, a rounded protractor, a 'L' shaped transparent fibre plate with midline marking were used for measuring the angle of tibial torsion.

Inclusion Criteria

Adult dry unpaired tibias devoid of any gross pathology were included in the study.

Exclusion Criteria

Tibia with evidence of disease, skeletally deformed tibia having osteophytes and those with damaged ends and with any signs of previous fractures were excluded.

The tibia were numbered and grouped into two basing on their side; 50 (right) and 50 (left). The length of each tibia was measured from the osteometric board. The bones in each group were further differentiated into male and female tibia[4] (right - male (25), female (25); left - male (25), female (25)). Transverse axis of both upper and lower ends was taken with the help of sliding calipers.

The angle of tibial torsion was defined by Eckhoff et al[3] as the angle between the posterior axis of the proximal plateau and the transtibial axis of the ankle. The transtibial axis of the distal tibia was defined by drawing a line on distal articular surface of tibia connecting the tip of the medial malleolus to the midpoint of lateral border. In this method, the tibia was placed on an osteometric table and its length was measured. The transverse axis of upper and lower ends were determined with the help of sliding calipers and marked. The tibia was placed on the horizontal plates on the board. The transverse axis of upper end is made parallel to the wooden plate beneath it by using moulding clay. The two wooden plates are adjusted to lie at the level of zero degree on the protractor attached to one end of the osteometric board. Thus, the horizontal plates at the zero degree level represent the transtibial axis. A transparent fibre plate having short and long arms with markings on it was used to measure the angle. The marking on the long arm is aligned along the line marked across the transverse axis of the lower end of tibia and the angle subtended by the short arm on the protractor represents the angle of tibial torsion. All measurements were repeated twice by two independent observers to identify any intra- or interobserver variability of this technique. Data collected was tabulated according to sides and was statistically analysed (Figure 1-4).

Statistical Analysis

The data was analysed using GraphPad Prism 5.0 (free trial version). For comparing the continuous variables, i.e. the mean angle of tibial torsion between both sides and sexes, the Student's unpaired t-test was used. A p value <0.05 was taken to be statistically significant.

RESULTS

The mean tibial torsion angle obtained in the study was 25.8° ± 6.98°. It was found that the angle of tibial torsion in the females was more than that of males. The mean of left-sided tibia was more than that of right-sided tibia. The mean tibial torsion angle in male tibia was 23.68° and in female 27.86° with a mean difference of 4.18°. A statistically significant difference was found for the angle between male and female bones with a $p < 0.05$ (Table 1). The mean of left tibia was 23.90° and that of right tibia was 27.64° with a mean difference of 3.64 with the $p < 0.05$ (Table 2). The angle of tibial torsion of right side in males was 25.72°, and in females, it was 29.56°. With a mean difference of 3.84 and the $p < 0.05$, which is statistically significant. The angle of tibial torsion of left side in males was 21.64°, and in females, it was 26.16° with a mean difference of 4.52 and the $p < 0.05$, which is statistically significant (Table 3).

	Male (n=50)	Female (n=50)	Mean Difference	P value
Mean angle of tibial torsion (in degrees)	23.68	27.86	4.18	0.0024*
* = statistically significant				

Table 1. Mean Tibial Torsion Angle in Male and Female

	Right (n=50)	Left (n=50)	Mean Difference	P value
Mean angle of tibial torsion (in degrees)	27.64	23.90	3.74	0.0068
* = statistically significant				

Table 2. Mean Tibial Torsion Angle in Right and Left Tibia

Angle of Tibial Torsion				
	Male	Female	Mean Difference	P value
Right	25.72	29.56	3.84	0.0206
Left	21.64	26.16	4.52	0.0316
* = statistically significant				

Table 3. Comparison of Angle of Tibial Torsion (Present Study)

Authors (year)	Mean	Right	Left	Male	Female
Staheli and Engel (1972)	17	NA	NA	NA	NA
Ritter et al (1976)	21	NA	NA	NA	NA
Malekafzali and Wood (1979)	24	NA	NA	NA	NA
Staheli et al (1985)	21	NA	NA	NA	NA
Butler-Manuel et al (1992)	35	NA	NA	NA	NA
Eckhoff et al (1994)	NA	38	33	NA	NA
Swathi Gandhi et al (2014)	NA	29.38	28.06	28.92	28.52
Present study	25.8	27.64	23.90	23.68	27.86

Table 4. Comparison of Angle of Tibial Torsion Obtained by Various Authors in their Studies

Figure 1. Specimens, Self-Designed Osteometric Board and Equipment

Figure 2. Transverse Axis of Both Upper and Lower Ends were taken with the Help of Sliding Calipers

Figure 3. Alignment of the Tibia on Osteometric Board

Figure 4. Measuring the Angle of Tibial Torsion

DISCUSSION

Bone torsional deformity is excessive anatomical or axial twist of proximal portion with respect to distal. Tibial torsion is measured as twist of the tibial plateau axis with respect to distal tibia malleolus. Torsional deformity has been studied both in vivo and in dry bone using a variety of techniques by various researchers. This leads to wide range of reported femoral and tibial torsion values. Review of literature reveals wide range of normal tibial torsion. 0-20° (M. S. Turner, I. S. Smillie[5] 1981), 24-40° (Laason et al and Piekeras) -10 to 40° (Dave Harson, March 28, 2003). In our study, no cases of internal tibial torsion were obtained. Svenninensen et al reported 4% in adults. The mean tibial torsion angle in the present study was found to be 25.8° irrespective of sex. There is no correlation between the length and the angle. The difference in normal tibial torsion values obtained by various studies is expected to be caused by the different lifestyles and postures of the different populations such as cross-legged sitting positions. In our study, we have used the dry bone method for assessing the angle of tibial torsion in the Indian population. Tibial torsion can also be measured in vivo using MRI, CT scan, x-rays, clinically by goniometer, Broca's instruments, etc. Though many studies have used indirect methods to assess the angle of tibial torsion, this seems to vary significantly from the results obtained by the direct dry bone study. This maybe because the indirect methods require a certain amount of subjective judgment as to precise positioning of the apparatus used. Indirect methods are less reliable for accurate measurement of the angle in a population because the sample size would be too small and maybe these studies would be better for assessment of an individual case for a surgical correction.

The dry bone method remains to be the better choice for estimation of angle of tibial torsion as it can give an idea of the average angle in the population studied. But, this may require a very large sample size to come to a conclusion of the accurate angle. A comparison of the angle of tibial torsion obtained in various studies is tabulated (Table 4). Majority of studies address the difference in tibial torsion with right and left limbs[6] only few studies have identified variation in tibial torsion based on gender.[7] In the study done by Swati Gandhi et al,[8] the value of angle of tibial torsion was more on the right side in both the sexes.

From the results obtained in our study, the difference in the angle between male and female maybe due to the involvement for more hours in floor sitting activities of the Indian women compared to that of the Indian men. The cross-legged posture, the childhood playing activities maybe a contributing factor in addition to heredity, mechanical forces, sleeping and sitting positions that result in wide variation in the angle of tibial torsion in different populations. The reason for the values to vary in studies done by various authors could also be due to the lack of a perfectly designed apparatus to record the accurate measurement of angle. Torsional deformities of tibia have been reported to be associated with club-foot, patellofemoral instability, osteoarthritis of knee joint and Schlatter disease. Following posttraumatic malunion, corrective osteotomies may require the knowledge of the angle of tibial torsion. There is increasing evidence that abnormal torsion in the tibia is associated with several knee and ankle arthroses including arthritis. Though varus, valgus and other axial deformities were well known in causing osteoarthritis, coexistence of torsional deformity is a recent addition to our knowledge.

CONCLUSION

In the present study, the mean tibial torsion measured is 25.8° ± 6.98°. There was a gender variation for the value of angle of tibial torsion in the population studied with females showing higher value than that of males with a statistically significant difference. The reason for the difference obtained could be the more involvement of females in floor level activities compared to that of male. The value was higher in the right compared to that of left and this was statistically significant. These values maybe significant in view of the alignment guides in knee reconstructive surgeries and also in understanding the pathogenesis of knee osteoarthritis and in understanding pathogenesis of developmental or posttraumatic gait abnormalities and planning treatment strategies.

REFERENCES

[1] Hutter CG, Scott W. Tibial torsion. Journal of Bone and Joint Surgery 1949;31A:511-518.
[2] Rosen H, Sandick H. The measurement of tibiofibular torsion. Journal of Bone and Joint Surgery 1955;37A:847-855.
[3] Eckhoff DG, Kramer RC, Watkins JJ, et al. Variation in tibial torsion. Clin Anat 1994;7(2):76-79.
[4] Iscan MY. Determination of sex from the tibia. Am J Phys Anthropol 1984;64(1):53-57.
[5] Smillie IS, Turner MS. The effect of tibial torsion of the pathology of the knee. J Bone and Joint Surg Br 1981;63-B(3):396-398.
[6] Ledamany. La torsion due tibia, normale pathologique experimentale. J Anat Physiol 1909;45:598-615.
[7] Yashioka Y, Siu DW, Scudamore RA, et al. Tibial anatomy and functional axes. J Orthop Res 1989;7(1):132-137.
[8] Gandhi S. Human tibial torsion–morphometric assessment and clinical relevance. Biomed J 2014;37(1):10-13.