Study of Angle of Femoral Torsion in Western Region of India

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Abstracts: Background: The femur is thighbone. The angle of femoral torsion is the angle obtaining between the transverse axes of the neck and head that of the lower end of the bone. In the adult, the angle measures about 12 to 15 degrees, but it is considerably greater in the fetus and at birth averages 40 degrees. In postnatal development a reduction of the FNA angle usually occurs during growth. Aim: to evaluate femoral torsion value on dried femora and to find the difference between Japanese, Caucasian and Indian femoral torsion. Method: The present study was carried out on 200 dry normal adult human femora. The bones studied were free of any pathological condition. The male bones were 117 and 83 were female femora out of 200 dried femora. Out of 111 were left and 89 were right femora. The gender of each specimen was determined by the recognized established practice. The angle of anteversion as measured by placing the femur on the osteometric board, the horizontal surface represents the retrocondylar axis and the plane of reference against which the anteversion is measured with the help of the axis of head and neck of the femur. Results: The average anteversion is 16.1 and 15.65 on the right and left sides respectively in male, 18.17 and 17.95 on the right and left sides respectively in female. Statistical analysis using 'z' test revealed significant ($p<0.05$), greater average anteversion in female bones and right-left variations, being greater on the right side. Conclusion: The objective measurement of this angle is of paramount importance in orthopedic surgery for total replacement to attain a normal activity of the replaced joint. [Varlkar P NJIRM 2011; 2(4) : 60-64]

Key Words: Angle of femoral torsion, femoral neck anteversion (FNA), medial femoral torsion.

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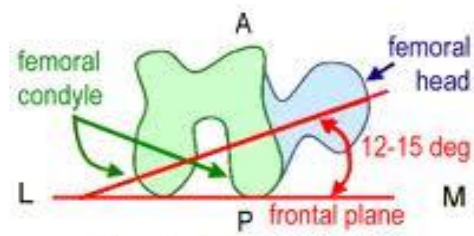
Introduction: In adults without pathology, the femur is twisted so the head and neck of the femur are angled forward between 15 and 20 degrees from the frontal plane of the body[1, 2]. Angle of femoral torsion or Femoral neck anteversion (FNA) describes the normal torsion or twist present in the femur. It is defined as the angle between an imaginary transverse line that runs medially to laterally through the knee joint and an imaginary transverse line passing through the center of the head and neck[1,2]. Femoral neck anteversion sometimes is called "medial femoral torsion"[2, 3]. It is thought to result from medial (internal) rotation of the limb bud in early intrauterine life. In postnatal development, a reduction of the FNA angle usually occurs during growth [2, 3]. This angle is little less in men (less then 15 degrees) and little more in women (18 degrees) [2, 4].

The Gray's Anatomy states that the transverse axis of the head of the femur makes an angle of approximately 15 degrees with the transverse condylar axis and orthopedics books quote it to range form 10-30 degrees. Value of this angle is varying between individuals and between populations[5].



Angle of Anteversion
Right Hip, Bottom View

There are several methods for measurement of femoral torsion; here we used retrocondylar line as transverse axis of lower end of femur by placing it horizontally on osteometric board, the transepicondylar line is tedious and difficult.

Material and Methods: The present study was carried out on 200 dry normal adult human femora obtained from the collection of bones in the Department of Anatomy Medical Collage, Vadodara, Gujarat. The bones studied were free of any pathological condition. The femora were cleaned dried and observed in good daylight. The gender of each specimen was determined by the recognized established practice [6]. The gender of the obtained femora is determined by following criteria.

V1 –Maximum length-greatest distance between lower end of medial condyle and upper end of femur using osteometric board.
V2 –Trochantaric length – Distance between the highest point of the greater trochanter and the lowest point of the lateral condyle using osteometric board.
V3 -Antero-posterior diaphyseal curvature – The femur was placed horizontally on osteometric board and measurement was taken at the highest point of curvature using scale.
V4 –Weight using electronic weighing machine.

Muscular marking presences on femur are prominent on the male gender, while in female gender marking are comparatively smooth. These all are the important measurements that will differentiate the sex of the femora. Weight was one of the best subjective measures between the male and the female femora. The angle of anteversion as measured by placing the femur on osteometric board so that the condyles of the inferior end touch on vertical part of osteometric board where Protractor was placed right angle to Horizontal plane. The specimen was considered to be anteverted when the head lay anterior to the horizontal plane determined by the greater trochanter and the two condyles of the lower end. The horizontal surface represents the retrocondylar axis and the plane of the reference against which the anteversion is measured with the help of the axis of the head and neck of the femur. Transverse axis of upper end of femur was measured by placing a scale joining the centre of head with centre of greater of trochanter. A Glass rod was placed parallel to shaft of femur in a manner that one end of it should intersect scale showing transverse axis of femur and other end should rest on protractor attached on limb of osteometric board. The point of intersection on protractor indicated the angle of anteversion. The vertical limb was held parallel along the axis of the head and neck of the femur, the horizontal surface represents the retrocondylar axis and the plane of reference against which the anteversion is measured with the help of the axis of head and neck of the femur. The angle subtended was recorded (Fig.)

Result: The male bones were 117 and 83 were female femora out of 200 dried femora. Out of 111 were left and 89 were right femora. In the present study there was no incidence of retroversion in any of the femora. All specimens showed anteversion. The present study showed no correlation between anteversion and the length of the femora. The average anteversion is 16.1 and 15.65 on the right and left sides respectively in male dried bones. It is 18.17 and 17.95 on the right and left sides respectively in female dried bones. Statistical analysis using 'z' test revealed significant ($p<0.05$) greater average anteversion in female bones and right-left variations, being greater on the right side.

The mean anteversion in male bones was 16.1 degrees and 15.65 degrees on the right and left sides respectively averaging to about 15.76 degrees. In females, it was 18.17 and 17.95 degrees on the right and left side respectively combined average angle on both sides is being 18.05 degrees in females.

Table 1: Statistical comparison of Anteversion Angle (Degrees) in Male and Female

Variable		Male	Female
Total Bone	**No**	**117**	**83**
	Mean	**15.76**	**18.05**
	SD	**4.74**	**5.26**
Right Bone	**No**	**54**	**35**
	Mean	**16.1**	**18.17**
	SD	**4.81**	**5.7**
Left Bone	**No**	**63**	**48**
	Mean	**15.5**	**17.95**
	SD	**4.69**	**5.03**

Table 2: Statistical Comparison of Anteversion Measured in Dried Bones

Variable	Z test	P value	Significance
Male & Female	**3.14**	**< 0.05**	**Significant**
Right & Left Male	**2.75**	**< 0.05**	**Significant**
Right & Left Female	**5.45**	**< 0.05**	**Significant**

Discussion: Structural architectural studies of femur lead to the recognition of the anterior torsion of the femoral neck. Definition of anteversion is the angle between the coronal plane through the femoral condyles and the oblique plane passing through the femoral head [7]. This angle becomes identifiable at seven weeks of gestation[8] and changes throughout childhood and early adolescence[9] but individual variations persist into adulthood[2]. The average adult femoral anteversion has been documented to range between 7-16 degrees in multiple skeletal surveys [10,11,12,13], also quoted 25 to + 37 degrees[14]. Thus, literature reveals variable values of femoral anteversion without any mention about the impact of origin of the population on these values. Angle of anteversion in adult Indian dried femora in normal subjects in reference to gender and side the study carried out and result showed average anteversion is 11.32 and 21.23 on the left & right sides respectively in male dried bones[6]. It is 11.02 and 20.87 on the left and right sides respectively in female dried bones.

Their study showed greater average anteversion in male bones & right-left variations, being greater on the right side. Present study was carried out on 200 dry normal adult human femora in subject of western Indian population showed a higher value of torsion and also showed higher value in female femora than male femora unlike the study done previously[6]. Earlier found lower average anteversion of 7 and 8 degrees respectively in Caucasian skeletal survey[13].

These lower average values of anteversion can be accounted for by the different techniques employed. They have used a transepicondylar axis rather than the retrocondylar axis as the distal axis. As a routine, it is the retrocondylar axis, which is used by the orthopaedicians in clinical practice. Subsequently they used the retrocondylar axis in the same skeletal population and found the average anteversion to be 13 degrees[13]. Evidently the angle of anteversion is dependent on the axis used for its measurement. Greater average anteversion of 19 degrees is documented in an African population using retrocondylar axis. Despite using the same axis, lower anteversion values presently found in the Indian i.e. 15.76 in males and 18.05 degrees in females can be attributed to racial variations, as it is well known that certain morphologic characteristics of human lower limb demonstrate documented population variations like femora are longer and narrower in blacks as compared to the whites[15].

Probably racial variations exist in femoral anteversion, which may have an important implication in assessment and correction of anteversion in orthopedic surgery in the different racial groups. Indian average anteversion is probably higher than Caucasian and Oriental values but lower than African figures. An increased or decreased FNA angle has been associated with a variety of lower-extremity problems in newborns, children, and adults. The interest in determining the precise FNA angle began in the early 20th century with the observation that newborns with congenital hip dislocation often had an increased FNA angle. Soon after, children with an in-toeing or out-toeing gait were noted to have an increased or decreased FNA angle. Excessive in-toeing or out-toeing has been shown to be related to many different compensatory problems of the lower extremities, including tibial torsion, genu valgum, genu valgus, pes planus, pes equinus, and metatarsus varus. Many other studies have shown the relationship between an increased or decreased FNA angle and other orthopedic problems of the lower extremity.

A diminished FNA angle in adolescents is often associated with slipped capital femoral epiphysis of the hip[16]. Studies also have shown that an increased or decreased FNA angle is associated with degenerative hip joint disease. In the present study, the average anteversion angle of the right femur is 16.88 degrees greater than that of 16.59 degrees in left. Variables affecting anteversion also include gender and side. Anteversion was found to be statistically significantly greater on the right side. Greater right side anteversion has been documented[14, 17, 13] in Caucasians, Oriental & African population. This significant bilateral limb asymmetry should discourage the tendency to view the lower limbs as mirror images of one another. Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater in the females as compared to males. Previously[17] recorded a slight difference between the male and female anteversion in Caucasians but this was not statistically analyzed.

The angle is wider in squatters because squatting counteracts detorsion after birth, and also wider in females, an adaptation for child bearing function[18]. Developmentally, the angle is minus 10 degrees at 17 mm stage, zero degree at 3rd month of intrauterine life, and plus 24.4 degrees at birth. During first two years after birth there is a gradual detorsion till the adult angle of 12 degrees is reached. It has been suggested that it is associated with the medial rotation, which the fetal lower limb undergoes, that it may result from an alteration in fetal posture, or it may be due to activity of the Iliopsoas muscle. Torsion occurring after birth may be associated with postural mechanisms and alteration, concerned with growth and weight transmission.

Conclusion: The present study is an attempt to evaluate the normal anteversion range in adult Indian femora, the average anteversion angle of the right femur is greater than that of left and in female angle is more than that of male, which support the previous studies. The knowledge of normal femoral anteversion is of extreme importance in selection of patients for prosthesis and preoperative planning for total hip replacement surgery and anthropological studies.

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