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STUDY ON ANGLE OF TORSION IN DRY HUMAN FEMORA IN SOUTH INDIAN POPULATION

Anatomy

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ABSTRACT

The torsion of the femur is the inclination of the axis of the femoral neck with reference to the trans condylar plane of the distal end of the femur. If the axis of the neck inclines forward (anterior to the transcondylar plane), the angle of torsion is called anteversion, ante rotation, or anterior twist; similarly, if it points backward (posterior to the trans condylar plane), it is called retroversion, retro torsion, or posterior twist.Femoral neck anteversion (FNA) is one of the most important parameter of femur anatomy having important clinical implications(3, 4). Its consideration and correction is considered a crucial step in total hip arthroplasty and hemiarthroplasty. From literature reviews, it was obvious that a difference exists in the angle of torsion of femur between the right and left sided femur in both genders. More study need to be conducted in this field, as knowledge about these differences may prove great use in the management of orthopedic hip conditions and defines the prognosis in hip replacement as well as correction procedures.Attempt to discourage the tendency to view the limbs as mirror images of one another was the driving motive behind this study.

KEYWORDS

Femur,Angle of torsion,Anteversion.

INTRODUCTION:

Femur is the longest and strongest bone of human body. The head of the femur articulates with the acetabulum of hip bone forming the hip joint, while the distal part of the femur articulates with the tibia and patella forming the knee joint.(1)

The anatomy of the proximal end of the femur has in recent years received much attention because of the emphasis on early treatment of congenital dislocation. One of the more difficult studies has been evaluation of the degree of anteversion in normal and abnormal children. Although there was early recognition that this is best determined by a true axial projection of the femur, most of the reports state that the technical problem involved makes this direct method impractical. Considerable effort has been put forth by many authors, each devising an indirect method of varying complexity.

The anteversion angle (declination) of the femur can be defined as the angle formed by the femoral condyles plane (bicondylarplane) and a plane passing through the center of the neck and femoral head (6,7). If this transverse plane (bi-condylar) passes behind the center of femoral head, neck anteversion is present; if the plane described above passes in front of the femoral head, retroversion is present(7,8).Femoral neck anteversion usually diminishes with age(8).This angle is first identifiable at 7 weeks as -10 degrees. It increases to 0 degrees by 3rd month, 12 degrees by 5th month. When the baby is born it reaches an average of 24 degrees. Then it gradually decreases and reaches adult value of 7-16 degrees.

AIMS AND OBJECTIVES:

- To measure angle of femoral torsion in 200 dry femora from south indian region.
- To compare the measurements between right sided bones and left sided bones.
- To compare the measurements of bones belonging to male and female genders.
- To find out wheather a significant relationship exists between the angle of torsion with gender and laterality.
- To statisticaly analyse the results and draw conclusions.

Awareness of anatomical differences between genders and laterality in the angle of femoral torsion helps in designing implants and positioning it and also in prevention of dislocations in total hip arthroplasty.

REVIEW OF LITERATURE

According to LeVeau BFand Bernhardt DB (33),the femur twists from torsional forces applied perpendicular to the epiphyseal growth plate. Wolff's Law explains the remodeling in adult bone. It states that every change in the form and the function of a bone is followed by changes in the bone's internal and external architecture in accordance with mathematical laws. Femoral Neck Anteversion also may develop because of changes in thestress placed on the adult femur diaphysis by torsional forces.Muscle, by either its passive elastic connective tissue or itscontractile force, contributes the greatest stress on bones and adds the torsional force on the femur. At birth, anteversion is about 32 degrees. It progressively decreases with the child's growth and in the adult it is an average of 8 degrees (2).

There are so many factors affecting the development of angle of femoral torsion which includes-Intra-uterine position of fetus, Mechanical forces, Fetal development,Heredity,Habitual sitting and sleeping postures(10,11). The effect of an anteverted and retroverted torsion angle could be noted by external and internal rotation of the femur, causing out-toeing and in-toeing (pigeon toe) respectively (Norkin C., 1992). The femoral neck anteversion angle is an important factor for hip stability and normal walking. It is multifactorial result of evolution, heredity, fetal development, intrauterine position, and mechanical forces. Abnormal FNA sometimes can be associated with many clinical problems ranging from harmless in toeing gait in the early childhood, to disabling osteoarthritis of the hip and the knee in the adults. In most cases is associated with minor functional problems in children during growth, but cause a concern in parents for children future. (12)The femoral anteversion (AV) angle is important in were without previous or present hip disease or conditions such as congenital hip dysplasia, in toeing etc. It increases in Perthes disease, Cerebral palsy, anterior poliomyelitis, Postural defects, Flatfoot, In toeing etc. Femoral torsion also has been implicated in the pathogenesis of patellar luxation and cranial cruciate ligament disease (CCLD).

Significance of Anteversion Many orthopedists feel that an abnormal degree of anteversion may preclude healing in congenital hip dislocation (9, 11), due to the inherent instability produced by the relationship of the femoral head to the acetabulum. It has also been suggested that this may be a factor in the etiology of the dislocation, but whether abnormal anteversion is a cause or a result is not yet known. In either event, there seems to be general agreement that congenital hip dislocations refractory to ordinary treatment should have rotation osteotomy if an abnormal degree of anteversion exists. The lack of agreement as to what degree of anteversion should be considered an indication for osteotomy is no doubt the result, at least in part, of previous difficulties in accurate measurement.

When rotation osteotomy is performed for tibial torsion, for fractures healed in poor position, or for other deformities, measurement of anteversion would seem to be the best control available. It is not commonly known that increased anteversion is associated with slipped femoral epiphysis.Persistent Femoral Anteversion (PFA) is excessive anterior twist within the upper femur. . Normally in adults the upper femur is anteriorly rotated in relation to the lower femur (femoral condyles) by 15°. In young children this angle is about 30°, but this steadily reduces to adult angles by the onset of adolescent growth spurt On examination of the hips in children with PFA, the most striking feature is excessive range of internal rotation, but limited external

rotation. In most cases this is an entirely benign condition and requires no treatment. It decreases in Rickets, Chondrodystrophy and toeing out. A diminished angle in adolescents is often associated with slipped capital femoral epiphysis of the hip. Studies also have shown that an increased or decreased angle is associated with degenerative hip joint disease. Selection of patients for prosthesis and preoperative planning for total hip replacement surgery. It is also important in Anthropological studies.

Studies to find the average anteversion in normal population are available mainly by direct observations on dry bones. The angle of anteversion of the neck of the femur varies through a wide range,thus making it extremely difficult to determine normal range for a society. The pioneering studies by western authors found it to range from -25° to +50° with the mean angle varying from 8 to 28°.(13-15) Accordingto Gray's anatomy, the average value is 10 to15°and orthopedics books quote it to range from 10° to 30°(.1).

Many methods of measuring femoral anteversion have been described since the early work by Drehmann(1909) who determined anteversion by fluoroscopy. The majority of the methods have been indirect : femoral anteversion was deduced from radiographs, usually biplanar, taken with the patient in a set position. The angles measured on these radiographs were used with tables and graphs to provide an angle of anteversion (Ryder and Crane 1953).

Paul.K.C and Olmsted K.L.(1948) studied 630 dry femora and angle of torsion was measured. In 305 left femora the mean angle was 7.472 degrees and in 325 right femora the mean angle was 8.536 degrees. In male type, the average angle was 7.938 degree and in entire group of female type it was 8.107 degree. Thus right femur was found to have a slightly greater degree of torsion than left and in female type, the angle is found to be greater than in male type.(16)

In a study conducted by Wali Ullah Khan etal at Peshawar, Pakistan in 211 dry adult femora, right and left side distribution was 103 (48.8%) and 108 (51.2%) respectively.The mean femoral neck anteversion angle in degrees for right femur was 8.4° ± 8.9° (-19 to 27) with a range of 46.0, and for left femur it was 7.8° ± 10.5° (-27 to35) with a range of 62.0, eventhough the difference between the two femora was non-significant statistically (p=0.642).(23)

In an ultra-sound study conducted by Martinus BrAten etal at Trondheim, Norway,in 100 subjects, the mean AV angle was 18" in the women and 14"in the men. The mean Ieft-right difference was significant, but not very high (r = 0.49 and-0.49, respectively(24)

In a study conducted by Dr. Ankur Zalawadia and Dr. Srushti Ruparelia in India, Ankur.Z and Ruparelia.S. (2010) studied 92 unpaired dry femurs, 50 of female (27 right and 22 left) and 42 of male (22 right and 20 left) devoid of any gross pathology waUnpaired 92 dry femurs, 50 of female (27 right and 23 left) and 42 of male (22 right and 20 left) devoid of any gross pathology were used to measure the femoral neck angle (FNA) from Department of Anatomy, Govt. Medical College, Bhavnagar in year 2005. They were evaluated by the Kingsley Olmsted method, and the data were statistically analyzed. In female femoral neck anteversion range form –8.3° to +30.4ºwith a mean of 16.4º on left and 10.5º on right sides. In male femoral neck anteversion range from –13.7° to +25.6º with a mean of14.3º on right and 7.2º on left sides.

The female femora showed about 2.7° more anteversion than the male femora. The average left-sided femora showed about 6.4° more anteversion than the right-sided femora. The angle of torsion showed a mean of 14.3 degrees on right and 7.2 degrees on left sides. The female femora showed about 2.7 degrees more torsion than male femora. The average left sided femora showed 6.4 degrees more torsion than right sided femora(17).

Verlekar et al studied on 200 dry normal adult human femur. 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 and there was a higher mean (15.8° and 18.1° for males and females respectively) for FNA with a statistically significant differences between FNA means of right and left femora (16.1° and 15.7° respectively)value being higher for right side femora as compared to left side.(18)

Ramos in India did a very important study and his study revealed more FNA mean for left side femora against the right femora with narrower range for right femora in contrast to left bones (-9 to -29 for right and -20 to -36 for left bones).(5)

Yoshioka and colleagues (1987) studied paired femora and found no statistical difference between right and left sided femora, although there were differences in the angle between the right and left sides of the same individual(19)

Nagar M etal. Studied the 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. 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.(20)

Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater in the females as compared to males. Previous studies by kingsley and olmstead recorded a slight difference between the male and female anteversion in Caucasians but this was not statistically analyzed(16).

Parsons et al. had also documented anteversion to be greater in females.(21) The average adult femoral anteversion has been documented to range between 7°-16° in multiple skeletal surveys whereas LeDamany (1903) quoted it to range from –25 to+37 degrees.(22)

In a study conducted by Srimathi T and Muthukumar T. ,the angle was measured using goniometer in 164 dry bones and the mean value was 9.8 deg. The mean value was 9.49 deg on the right side and 10.13 deg for the left side femora with a standard deviation of 1.66 and 1.50 respectively showing a higher angle in the left side femora. A statistically significant difference of 0.64 was found for the angle of anteversion between the right and left side bones with a 'p' value of <.001. The mean value of male type bones was 9.78 deg and 9.79 deg of female type bones with a standard devation of 1.70 and 1.54 respectively. Though the value was higher in the female type bones, no statistically significant difference was found for the angle of anteversion between the male-and female-type bones in the present study. 7.9% bones were in the range of 0-8°, 54.2% bones were in the range of 8-10°, 21.9% were in the range of 10-12°, 15.8% bones had angle more than 12° showing most bones with a value of anteversion in the range of 8-10°.a statistically significant difference of 0.64 was found for the angle of anteversion between the right and left side bones and the value was higher in the female type bones.(14)

Schachar et al have done a polyethnic study by measuring FNA angle on dry bones of three different races, namely European, African and two Asian groups using same method and same setting. This study shows gross differences between the mean FNA values of different races. Their result showed 15.7° mean FNA value for African, 11.1° for European, 23.0° for Asian and 33.4° for the Inuit group which was a subpopulation of Asian group.31

From the above literature reviews, it is obvious that a difference exists in the angle of torsion of femur between the right and left sided femur in both genders.

More study need to be conducted in this field, as knowledge about these differences may prove great use in the management of orthopedic hip conditions and defines the prognosis in hip replacement as well as correction procedures. This study is also an attempt to discourage the tendency to view the limbs as mirror images of one another.

MATERIALS AND METHODS:

SOURCE OF DATA:

In this study, 200 dry human adult femora of both sexes and both sides from Department of Anatomy in Medical colleges in Kerala, Tamilnadu and Karnataka are used.

Selection of samples:

Inclusion criteria:-Adult human femora with normal anatomy.

Exclusion criteria:

1. Bones with visible deformities
2. Bones with prosthesis
3. Damaged bones

4. Pediatric bones
5. Diseased bones.

MATERIALS USED:
Osteometric board, Sliding vernier caliper, Goniometer, marker pen.

METHOD USED:
In the past few decades, researchers worldwide have used various methods to measure this angle. They have measured the angle mechanically on cadaveric bones as well as in patients by using X-ray , ultrasound, CT and MRI.Estimation of the angle of anteversion on dry bone is considered to be the most accurate method [3].

Different investigators have used diffirent methods to determine FNA on dry bones. It is important to determine the angle of anteversion in a particular population by a method that is accurate and easily reproducible The Kingsley Olmsted method has been used in large number of bones by various authors and is considered to be the most accurate one [3,27]. Hence, this method was followed to determine the angle of femoral torsion in this study.

The angle was measured mechanically on 200 dry femora right and left intact, with male type bones and female type bones using Kingsley-Olmstead method.

The gender and laterality of the bones were determined using conventional methods listed below:

Determination of gender:
1 Maximum length-greatest distance between lower end of medial condyle and upper end of femur using osteometric board.
2 Trochantaric length – Distance between the highest point of the greater trochanter and the lowest point of the lateral condyle using osteometric board.
3 Weight using electronic weighing machine
4 Prominence of muscular markings.

Determination of laterality:
1. Upper end bears a rounded head that is directed medially.
2. Lower end is expanded to form two large condyles.
3. Cylindrical shaft is convex forwards

The angle of femoral torsion is determined using Kingsley-Olmstead method.This method is based on two important lines which were defined below.

Centre head-neck line: Centre of head was the centre of maximum anteroposterior thickness of head of femur. The centre of neck was the centre of maximum anteroposterior thickness at the base of the neck. Both these points were determined with the help of sliding caliper and were marked on the surface of head and neck respectively. The line passing through these points was the centre head-neck line.

Retrocondylar line: It passes through posterior most points of both condyles of femur.

The angle of anteversion was measured by Kingsley Olmsted method after placing the specimen at the edgeof a horizontal surface so that the condyles of the inferior end rest on the surface.The horizontal limb of a goniometer was fixed at the edge of the osteometric board. The vertical limb was held parallel along the axis of the head and neck of femur which was pre-determined and marked on the bone by calculating the center point of maximum anteroposterior dimension of the head and neck of femur with the help of a sliding caliper.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.

All measurements were repeated twice by two independent observers to identify any intra and inter-observer variability of these techniques.Data collected was tabulated according to gender and sides and statistically analyzed.

OBSERVATIONS :
Of the 200 bones measured,95 belonged to left side,constituting47.5% and 105 belonged to right side constituting 52.5%(table.1)and 101 belonged to female gender and 99 to male gender constituting 50.5% and 49.5% distribution.(Table.2)

Table.1: Frequency and percentage of distribution of sample size in terms of laterality:

	Frequency	Percent
Left	95	47.5
Right	105	52.5
Total	200	100.0

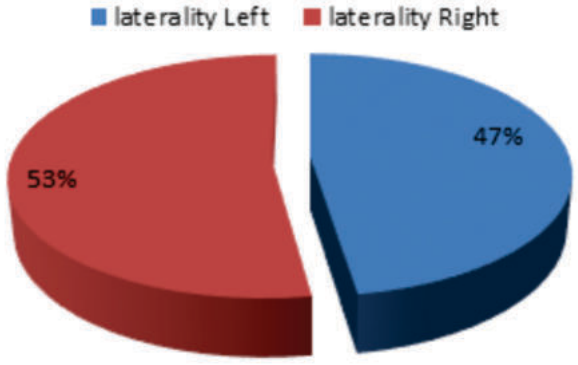

Fig.1-Pie diagram showing percentage of distribution of laterality:

Table.2: Frequency and percentage of distribution of sample size in terms of gender:

	Frequency	Percent
Female	101	50.5
Male	99	49.5
Total	200	100.0

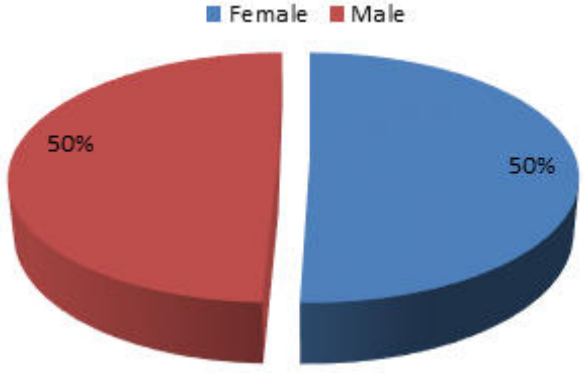

Figure.2:Pie diagram showing percentage of distribution among gender:

Also an attempt was made to compare gender difference within laterality and vice-versa, ie; wheather a difference exist between male and female gender in right side and also in left side is sought for.Likewise,wheather a difference exists between right and left sides in males and also in females were studied. In left sided bones,48 belonged to female sex(50.5%) and 47 belonged to male sex(49.5%).In right sided bones,53 belonged to females(50.5%) and 52 belonged female sex(49.5%).(table-3)

Table-3: Frequency and percentage of distribution of sample size among gender and laterality:

		sex		
		Female	Male	Total
laterality	Left	48	47	95
		50.5%	49.5%	100.0%
	Right	53	52	105
		50.5%	49.5%	100.0%
Total		101	99	200
		50.5%	49.5%	100.0%

The mean angle of torsion in left side was calculated to be 12.53% of which in male gender contributes to 12.43% and female gender,12.The mean angle of torsion in right side was calculated to be 14.43 of which male gender contributes 14.45 and female gender 14.4.(TABLE-4)

Two way ANOVA test was done and p-value calculated which shows a highly significant diffirence in the angle of torsion between right and left sided femur.The gender difference and its interaction with

laterality turned out to be insignificant statisticaly.(Table-4)

Table-4:Mean and Standard Deviation with 95% confidence interval calculated in terms of gender and laterality

Angle of torsion

laterality		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Left	Female	48	12.63	4.205	11.40	13.85	5	22
	Male	47	12.43	3.693	11.34	13.51	4	22
	Total	95	12.53	3.941	11.72	13.33	4	22
Right	Female	53	14.45	2.886	13.66	15.25	8	20
	Male	52	14.40	3.108	13.54	15.27	9	21
	Total	105	14.43	2.983	13.85	15.01	8	21

Table-4:Two –way ANOVA test results showing significance of results

Two way ANOVA results

: Angle of torsion

	ANOVA F	p	
Comparison between laterality	14.847	.000	HS
Comparison between sex	.063	.802	NS
Interaction effect of laterality * sex	.023	.879	NS

Pairwise comparisons are done by Bonferroni test and the comparison of laterality among females turned out to be significant and among males,highly significant.(Table-5)

Table-5:Pair-wise comparison of results by Bonferroni test showing significance .

Pairwise Comparisons by Bonferroni test

Dependent Variable: Angle of torsion

sex		Mean Difference	Std. Error	p	
Female	Comparison between left and right	-1.828	.712	.012	sig
Male	Comparison between left and right	-1.978	.684	.005	HS

The results were represented using Error chart and Bar diagram as follows:(fig.3 and fig.4)

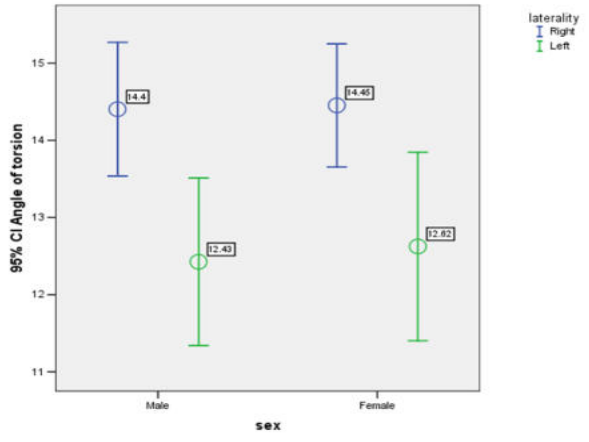

Figure 3: Error chart showing the results of the study:

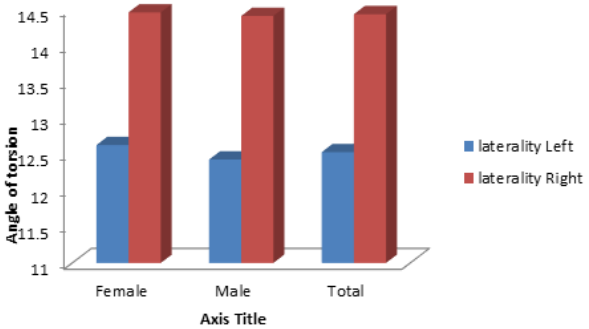

Figure 4:Bar diagram showing the results of the study

The present study shows that there is a highly significant diffirence in the angle of torsion between right side and left as whole and also this diffirence is highly significant among females and significant among males.There is no statisticaly significant diffirence in angle of femoral torsion between males and females.

DISCUSSION

The knowledge of normal femoral anteversion is important in selection of patients for prosthesis and preoperative planning for total hip replacement surgery and also in the field of anthropological studies. Although newer methods using computed tomography(CT) have been shown to be ±1° accurate, there is no universal femoral neck axis and the femoral condylar axis 25. The angle of anteversion varies through a wide range,thus making it extremely difficult to determine normal range for a society. Estimation of anteversion on drybone is still considered the most reliable method.There areonly few studies done in India on this parameter. Western studies results are less applicable in Indian population as femoral anteversion differs in both populations 26. Indians are more adapted to participate in floor level activities, in contrast toWestern persons, our hips have to be evolutionally different from theirs. Thus, the same procedure produces a different outcome in Indian population. Hence a population-specific protocol and assessment criteria must be devised. A femoral component of a total hip replacement should be done with an anteversion angle that closely represents that of the Indian population to achieve the best surgical outcome. In India with the increasing demand for total hip replacement, this anteversion angle becomes more important.17. Abnormal femoral neck anteversion sometimes can be associated with many clinical problems ranging from harmless intoeing gait in the early childhood, to disabling osteoarthritis of the hip and the knee in the adults.

Accurate measurement of femoral neck anteversion is important for orthopaedic diagnosis and for selection of patients and planning before derotation osteotomy of femur [27]. Any increase or decrease in the angle of femoral anteversion is associated with various clinical conditions. The increased angle of anteversion is associated with failure of treatment of CDH, Perthes disease, cerebral palsy, anterior poliomyelitis, postural defects, apparent genu valgum, external tibial torsion, flat foot, and intoing. The decreased femoral torsion has been shown to be associated with toing out, rickets, chondrodystrophy. 28,29. Indian average anteversion is probably higher than Caucasian and Oriental values but shows lower values in Africans.. 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 anteversion angle. It was also noted that children with an in-toeing or out-toeing gait were having an increased or decreased FNA angle. This may lead to 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 hip30. Studies also have shown that an increased or decreased FNA angle is mostly associated with degenerative hip joint diseases.

The angle is wider in squatters because squatting counteracts de-torsion after birth, and also wider in females, an adaptation for child bearing function18. During first two years after birth there is a gradual de-torsion until the adult angle of 12 degrees is reached which is associated with medial rotation that may result from an alteration in fetal posture or due to activity of the Ilio-psoas muscle. Torsion occurring after birth may be associated with postural mechanisms that are concerned with growth and weight transmission. Knowing right vs. left anteversion mean value and difference in our population will help in planning and correcting different deformities about hip and understanding normal from abnormal in different clinical conditions of the hip.

AUTHOR	YEAR	MEAN ANGLE
Shrikant Rokade, Arati K Mane	2009	18.68° and 16.34 °
Jain AK, Maheshwari AV	2005	8.9°
Maini PS, Chadha G	2005	16.31°
Nagar M, Bhardwaj R,et al	2002	11.32 ± 0.37 and 21.23 ± 0.39 on the left & right sides in male dried bones and 11.02 ± 0.34 and 20.87 ± 0.35 on the left and right sides in female dried bones.
Ankur Zalawadia, Srushti Ruparelia	2010	10.9° in males,13.6 in females
RC Siwach, S Dahiya	2003	13.68°
Srimathi T., Muthukumar T	2011	9.8°, 9.78° in male type bones and 9.79° in female type bones 9.49° in right side and 10.13° in left side bones

Padma varlekar, B.B. Gosai.	2011	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.
Wali Ullah Khan, Malik Javed Iqbal	2013	Right and left side distribution was 103 (48.8%) and 108 (51.2%) respectively. The mean femoral neck anteversion angle in degrees for right femur was 8.4° ± 8.9° (-19 to 27) with a range 46.0 and for left femur it was 7.8° ± 10.5° (-27 to 35) with a range of 62.
Present study	2014	The mean angle of torsion in left side was calculated to be 12.53% of which in male gender contributes to 12.43% and female gender,12.The mean angle of torsion in right side was calculated to be 14.43 of which male gender contributes 14.45 and female gender 14.4

SUMMARY:

Angle of torsion in 200 dry human femora were studied using Kingsley-Olmstead method.

Of these 200 femora, 95 belonged to right side and 105 belonged to left side. 99 bones were of male gender and 101 wereof female gender.

Our aim was to determine wheather a significant diffirence exsists in the angle of torsion between the genders and laterality .

Statistical analysis of the results showed that-

1. There is a highly significant diffirence in the angle of torsion between right side and left side.
2. This diffirence is highly significant among females
3. This difference is also significant among males
4. There is no statisticaly significant diffirence in angle of femoral torsion between males and females.

CONCLUSION

This study is an attempt to discourage the tendency to view the limbs as mirror images of one another.

From the study results, it is obvious that a difference exists in the angle of torsion of femur between the right and left sided femur in both genders. More studies are to be conducted in this field, as knowledge about these differences may prove great use in the management of orthopedic hip conditions and defines the prognosis in hip replacement as well as correction procedures. The results of this study will be definitely helpful in the selection of patients for prosthesis and preoperative planning for total hip replacement surgery and to diagnose various hip pathologies and in planning de rotation osteotomy of femur. This study also provides valuable information in the fields of forensic anthropology to determine the racial variations of the femoral anteversion and also to the anatomists in the fields of general osteology and anthropology.

REFERENCES

1. Williams A, Newell RLM, Davis M, Collins P. Pelvic girdle, gluteal region and hip joint. In: Standring S,Ellis H, Healy JC, Johnson D, Williams A, editors.Gray's Anatomy. 39th ed. Philadelphia: ElsevierChurchil Livingston; 2005. p.1431.
2. DUNLAPK, NOX;SHANDSA, . R., JR;HOLLISTERL,. C., JR.;GAUL,J. S., JR.; and STREIT,H. A.: A New Method of Determination ofTorsion of the Femur. J. Bone and Joint Surg., 35-A: 289-31 1,April 1953.
3. Jain AK, Maheshwari AV, Singh MP, Nath S, Bhargava SK. Femoral Neck Anteversion: A comprehensiveIndian Study. Indian J Orthop 2005;39:137-44.
4. Cibulka MT. Determination and significance offemoral neck anteversion. Phys Ther 2004; 84:550–8.
5. Ramos A. Analysis of the Anteversion and Neck Shaft Angle in Dry Femora of South Indian Origin[Dissertation]. Bangalore: Rajiv Gandhi University of Health Sciences; 2012.
6. Kim JS, Park TS, Park SB, Kim JS, Kim IY, Kim SI. Measurement of femoral neck anteversion in 3D. Part 1: 3D imaging method. Med Biol Eng Comput 2000; 38:603-9.
7. Napoli MMM, Apostólico Netto A, Suguimoto C, Takedo LT. Anteversão doscolos femorais: estudo radiológico. Rev Imagem 1985; 7:111-6.
8. Tonnis D, Skamel HJ. Computerized tomography in evaluation of decreased acetabular and femoral anteversion. Radiologe 2003; 43:735-9.
9. Fabeck L, Tolley M, Rooze M, Burny F. Theoretical study of the decrease inthe femoral neck anteversion during growth. Cells Tissues Organs, 2002; 171:269-75.
10 Dunlap K, Shands AR Jr, Hollister LC Jr, Gaul JS Jr, Streit HA. A new method of determination of torsion of the femur. J Bone Joint Surg Am 1953; 35:289-311.
11. Ryder CT, Crane L. Measuring femoral anteversion: the problem and a method.J Bone Joint Surg Am 1953; 35:321-8.
12. G. Gulan1, D. Matovinovi}1, Femoral Neck Anteversion: Values,Development, Measurement,Common Problems, \Coll. Antropol. 24 (2000) 2: 521–527
13. Siwach RC, Dahiya S. Anthropometric Study ofProximal Femur Geometry and its Clinical Application.Indian J Orthop 2003; 37:247–51.
14. Srimathi T, Mathukumar T, Anandarani VS, Sembian U, Subramanian R. A Study on Femoral NeckAnteversion and Its Clinical Correlation. J ClinDiag Res 2012; 6:155-8.
15. Desai SG, Trivedi BD. Anteversion of Adult Femorain Gujrat Population. Indian J App Basic Med Sci2013; 15:93-100.
16. . Kinsley P.C, Olmsted K.L, A Study to determine the angle of anteversion of the neck of femur .The Journal of bone and joint surgery 1948;30:745-751
17. . Zalawadia.A, Ruparelia.S, Shah.S, Study of femoral neck anteversion of adult dry femora in Gujarat region NJIRM 2010;1(3):7-11.
18. Varlekar.P, Gossai.B.B, Study of angle of femoral torsion in western region of India. NJIRM 2011; 2:60-64
19. Yoshioka Y, Cooke TD. Femoral anteversion: assessment based on function axes. J Orthop Res1987; 5:89-91
20. Nagar M, Bhardwaj R., Prakash R. Department of anatomy University College of medical science Shahdara, Delhi, Journal of the Anatomical Society of India Vol. 49, No. 1 (2000-01 - 2000-06)
21. Parsons FG. The characters of the English thigh bone. J Anat Physiol 1914;48:238-67.
22. Le Damany. Les torsions osseuses leur roledans la transformation des members.Journal of Anatomical Physiology 1903,39:246-450.
23. Khan WU, Iqbal MJ, Marwat M, Ilahi M. Femoral neck anteversion: is the side wise difference significant? Gomal J Med Sci 2013; 11:199-203.
24. Martinus BrAten etal, Femoral anteversion in normal adults, Acta Orfhop Scand 1992; 63 (1): 29-32
25. Murphy SB, Simon SR, Kijewski PK, et al.Femoral anteversion. J Bone Joint Surg Am 1987;69:1169-76.
26. Eckhoff DG, Kramer RC, Watkings JJ, Alongi CA, van Greven DP. Variation in femoral Anteversion. Clinical Anatomy 1994;7:71-75
27. Ruwe PA, Gage JR, Ozonoff MB, DeLuca PA. Clinical determination of femoral anteversion: a comparison with established techniques.J Bone Joint Surg Am. 1992; 74: 820–30.
28. L Ruby, MA Mital, J O'Connor and U Patel. Anteversion of the femoral neck. J Bone Joint Surg Am. 1979; 61:46-51.
29. Crane L. Femoral torsion and its relation to toeing-in and toeing-out.J Bone Joint Surg Am. 1959; 41: 421–28.
30. Gelberman RH, Cohen MS, Desai SS, et al. Femoral anteversion: a clinical assessment of idiopathic intoeing gait in children. J Bone Joint Surg Br.1987; 69:75-79.
31. Schachar JS, Charubhumi D, Marquez S. Femoral neck anteversion: an orthopaedic evaluation between Multi-regional Populations FASEB J 2009; 23:822-6.
32. Standring S. Gray's Anatomy, The Anatomical Basis of Clinical Practice. 39th Edition. Elsevier Churchill Livingstone, New York, 2005. Page
33. LeVeau BF, Bernhardt DB. Developmental biomechanics: effect of forces on the growth, development, and maintenance of the human body. Phys Ther.1984; 64(12): 1874–82.
34. Romanes GJ. Cunningham's Manual of Practical Anatomy. Vol: 1 Upper and Lower limbs.15th edition. Oxford University New York, 1998. Page