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Original Article

Anatomy Section

A Study on Femoral Neck Anteversion and Its Clinical Correlation

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ABSTRACT

Aim: To measure the angle of anteversion of femoral neck in both gender types and on both sides and to correlate it clinically.

Materials and Methods: This study was carried out to determine the average femoral neck anteversion in Indian population. The angle was measured mechanically on 164 dry femora 88 right and 76 left intact, dried adult human femora (unpaired) with 81 male type bones and 83 female type bones were studied by conventional methods. The results obtained were statiscally analysed.

Results: The angle between centre head neck line to transcondylar line 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°.

Conclusion: Any increase or decrease in the angle of femoral anteversion is associated with various clinical conditions. It increases in 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. The data established in this study will be useful for various orthopaedic procedures and diagnosis, in the fields of General Human Osteology and Forensic anthropology.

Key Words: Angle of anteversion, Femur, Torsion angle

INTRODUCTION

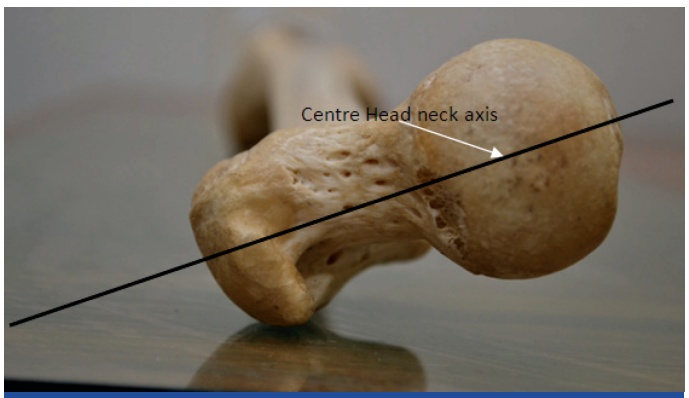
Femoral nek anteversion describes the angle subtended by the femoral neck with reference to the transcondylar plane of the distal end of the femur and is usually 15° to 45°. This along with the neck shaft angle, hip axis length, femoral neck width influence the risk of femoral neck fracture. Femoral neck anteversion angle has to be taken into consideration when reduction and fixation is selected as a method of treatment [1]. If the axis of the neck inclines anterior to the transcondylar plane, the angle of torsion is called anteversion, anterotation; simlarly, if it points posterior to the transcondylarplane, it is called retroversion, retrotorsion. If the axis is in the same plane of transcondylar axis then it is called neutral version.

In the past few decades, researchers worldwide have used various methods to measure the angle. They have measured the angle mechanically on cadaveric bones as well as in patients by using roentgenography , ultrasound, computerised tomography and MRI. Earlier studies [2] revealed that the angle varies in populations.and also according to the method adopted. Thus the data from western countries may not be applicable to Indian population. Hence the anteversion for Indian population was calculated using dry bones.

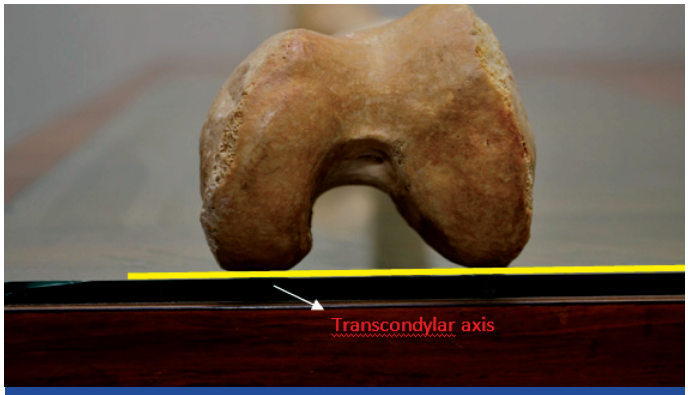
MATERIAL AND METHODS

164 dried adult human femora (unpaired) – 88 right and 76 left, with 81 male type bones and 83 female type bones were studied. Any femur that showed a significant bony or arthritic deformity was excluded from the study. Each femur was placed with the posterior surface of its condyles and greater trochanter touching a smooth horizontal surface. The centre head neck line and retrocondylar line were determined. The Kingsley Olmsted method was followed to determine the angle of femoral torsion in our study.

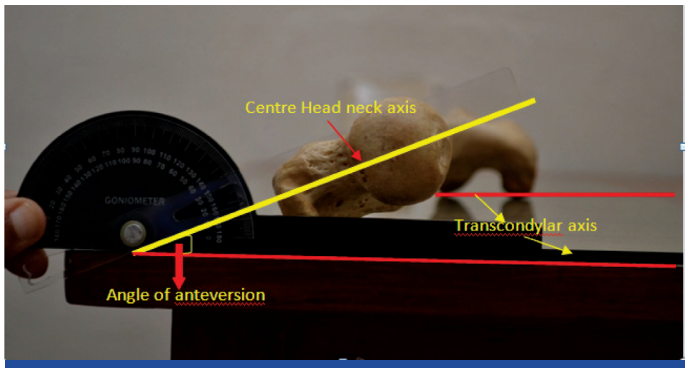
Centre head-neck line: Centre of head was the centre of maximum anteroposterior thickness of head of femur. The centre of neck was the centre of maximum anteroposterior thickness at the base of the neck. Both these points were determined with the help of sliding caliper and were marked on the surface of head and neck respectively. The line passing through these points was the centre head-neck line [Table/Fig-1].



[Table/Fig-1]: Line shows centre head neck axis of the femur



[Table/Fig-2]: Line Shows Transcondylar Axis



[Table/Fig-3]: Measurement of angle of anteversion of femur between transcondylar and centre head neck axis

Retrocondylar line: It passes through posterior most points of both condyles of femur [Table/ Fig-2]. The horizontal limb of a goniometer was fixed at the edge of the experimental table. The vertical limb was held parallel along the axis of the centre of 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 to the accuracy of 1° [Table/Fig-3]. The angle was measured in all 164 femora.

RESULTS

The results obtained after measurement of the femoral neck anteversion angles in dry bones was tabulated and analysed. [Tables/Fig-4,5,6,7]

DISCUSSION

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 [3] and adds the torsional force on the femur.

At birth, anteversion is about 40 degrees. During first year of life, it decreases by about 8 degrees, thereafter 1 degree per year until in the adult it is an average of 10-15 degrees [4]. It is multi-factoral as a result of evolution, heredity, fetal development, intrauterine position, and mechanical forces.

The anteversion angle was measured mechanically on 144 adult dry femora by method 1 – between centre head neck line and retrocondylar line and method 2- anterior head trochanter line and retrocondylar line. These two methods gave significantly different mean angles, method-1 8.68° (+/-6.37) and method-2 16.34 ° (+/-7.7) [5]. In the present study the angle between centre head neck line to transcondylar line was measured using goniometer in 164 dry bones and the mean value irrespective of the side and gender type was 9.8° [Table/Fig-4].

Femoral neck anteversion was measured using 300 dry bones and compared with CT, X-ray, and Clinical methods. [6] The mean value by dry bones on the right side (147 bones) was 7.3°, and on the left side (153 bones) mean value was 8.9° with a statistically significant difference (p=0.04). The mean angle of the left side was higher than the right side. Analysis of 30 bilateral hips showed the mean anteversion angle of the femoral neck to be 16.31°. On the right side the mean anteversion angle of the femoral neck was 16.01° and that on the left was 16.61° [7].

In the present study also,the mean value was 9.49° for the 88 right side femora with a standard deviation of 1.66 and for the 76 left side femora mean value was 10.13° with a standard deviation of 1.50, showing a higher angle in the left side femora [Table/Fig-4]. A statistically significant difference of 0.64 was found for the angle

Femur side and gender type	N	Minimum	Maximum	Mean	Std. Deviation	Range
Rt Femur	88	6.8	13.4	9.492	1.6665	6.6
Lt Femur	76	7.8	13.4	10.132	1.5069	5.6
Male Type	81	7.2	13.4	9.783	1.7040	6.2
Female Type	83	6.8	12.4	9.794	1.5472	5.6

[Table/Fig-4]: Descriptive Statistics for Femur Side and Gender Type

Angle of anteversion		Right side		Left side	
		Frequency	Valid Percent	Frequency	Valid percent
Valid	0-8 deg	12	13.6	1	1.3
	8-10 deg	49	55.7	40	52.6
	10 -12 deg	15	17.0	21	27.6
	>12 deg	12	13.6	14	18.4
	Total	88	100.0	76	100.0

[Table/Fig-5]: Percentagewise Distribution of FNA in Right and Left Femur

Angle of anteversion		Male type femur		Female type femur	
		Frequency	Valid Percent	Frequency	Valid Percent
Valid	0-8 deg	9	11.1	4	4.8
	8-10 deg	37	45.7	52	62.7
	10 -12 deg	23	28.3	13	15.7
	>12 deg	12	14.8	14	16.9
	Total	81	100.0	83	100.0

[Table/Fig-6]: Percentagewise distribution of FNA in male and female type femur

Side and Gender Type		Mean difference	Std. Deviation difference	P value
Side of femur	Rt Femur – Lt Femur	0.64	0.16	0.000
Gender type	Male Type – Female Type	0/01	0.16	0.368

[Table/Fig-7]: Samples differences – side and gender type

of anteversion between the right and left side bones in the present study also with a 'p'-value of <.001 [Table/Fig-7].

One hundred and eighty two adult Indian dried femora, hundred and four male and seventy eight female were studied. The average anteversion was 11.32 ± 0.37 and 21.23 ± 0.39 on the left & right sides respectively in male dried bones and 11.02 ± 0.34 and 20.87 ± 0.35 on the left and right sides respectively in female dried bones. Statistical analysis using paired 't' test revealed significant ($p<0.0001$) greater average anteversion in male bones & right-left variations, being greater on the right side. It was statistically significantly ($p<0.0001$) higher on the right side and showed sexual dimorphism, being greater in males in comparison with female subjects [8].

Unpaired 92 dry femurs, 50 of female and 42 of male devoid of any gross pathology were used to measure the femoral neck angle (FNA) by Kingsley Olmsted method.The mean anteversion in male bones was 10.9°. In females, it was 13.6° [9]. Statistical analysis revealed greater angle in the females as compared to males. In a study of 30 bilateral hips. The mean anteversion angle for males was 17.43° and that for females was 14.84° showing a statistically significant difference for the angle of anteversion between the male- and female-type bones [7]. In the present study the mean value for 81 male type bones was 9.78° with a standard devation of 1.70 and the mean value for 83 female type bones was 9.79° with a standard devation of 1.54 [Table/Fig-4] Though the value was higher in the female type bones, the difference was not statistically significant [Table/Fig-7]

Femoral neck anteversion was measured using 300 dry bones. Retroversion was observed in 9.33% bones. Neutral or almost neutral version (-1 to +1°) was found in 7.33% bones. 15.3% of the bones were in the range of 0-5°, 42.3% range of 5.1 -10°, 21.3% of the bones were in the range of 10-15°,11.6% of bones had angle >15°. [6] In the present study also, 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°.Range with Percentagewise distribution according to the side is represented in [Table/Fig-5] and gender type is represented in [Table/Fig-6].

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 [10,8]. 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 [11,12].

Proximal femoral geometry was studied morphologically and radiologically in 75 pairs of dried femora. The impact of these findings on future implant design was evaluated. The anteversion angle was found to be 13.68° [13]. In the present study the angle was measured in 164 dry bones and the mean value irrespective of the side and gender type was 9.8°.

It is important to determine a standard value of the angle of anteversion in a particular population by a method that is accurate and easily reproducible. Estimation of anteversion on dry bone is considered to be the most accurate method [6]. Different investigators have used various methods to determine FNA on dry bones. The Kingsley Olmsted method has been used in large number of bones by various authors and is considered the most accurate one [10,6]. Hence this method was followed to determine the angle of femoral torsion in our study.

Comparison of the present study with previous studies

Author	Year	Mean FNA in dry bones
Shrikant Rokade, Arati K Mane	2009	18.68° (+/-6.37) and 16.34 °(+/- 7.7)
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°
Present study	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

SUMMARY AND CONCLUSION

In the present study the mean femoral neck anteversion was 9.8°. The value was higher on the left side than the right a statistically significant difference. There was no significant difference between the male and female type bones. Most i.e 54.2% bones had the range of 8° to 10° of femoral neck anteversion. Therefore this study will be of use in the fields of orthopaedic surgery to diagnose various hip pathologies and in planning derotation osteotomy of femur, forensic anthropology to determine the racial variations of the femoral anteversion and also to the anatomists.

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