International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(2.3):6636-40. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2019.192

Original Research Article

ANALYSIS OF FEMORAL NECK ANTEVERSION IN DRY ADULT BONES: A MORPHOMETRIC STUDY

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ABSTRACT

Introduction: The femoral neck anteversion can be defined as the angle between femoral bicondylar plane and a plane passing through the centre of the neck and head of femur. Adult femoral anteversion has been documented at the range between 7-16 degrees.This angle is widely recognized as an important factor for hip stability. The present study aimed to evaluate the normal anteversion range in adult Indian femur which would be of great help in explorative orthopedic procedures and in designing of hip prosthesis.

Materials and Methods: Study conducted in 202 femurs of 94 male (48 right and 46 left) and 108female bones (52 right and 56 left). And the angle was measured using Kingsley Olmsted Method.

Observation and Results: The mean value of anteversion angle of femurwas 7.61 degrees for male and 12.71 degrees for females.Mean anteversion angle for both male and female femur was 10.37 degrees. Retroversion was observed in 10 femurs(5%) and neutral version was observed in12 femurs (5.9%).

Conclusion: Determining the anteversion angle is crucial for the diagnostic and therapeutic planning of patients with various pathologies such as hip development dysplasias, cerebral palsy, varum thigh, flat thigh, epiphysiolysis, congenital club foot, congenital dislocation of the hipand other development abnormalities. Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater among females than males.

KEY WORDS: Neck of Femur, Anteversion, Retroversion, Neutral version, Total hip replacement, congenital dislocation of hip.

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Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2019.192	Article Information
	Received: 29 Mar 2019 Accepted: 06 May 2019 Peer Review: 29 Mar 2019 Published (O): 05 Jun 2019 Revised: None Published (P): 05 Jun 2019

INTRODUCTION

The Femoral Neck Anteversion (FNA) can be defined as the angle formed between the femoral condyles plane (Bicondylar plane) and a plane passing through the centre of the neck and head of femur [1, 2]. The angle of torsion is called anteversion If the axis of the head and neck isrotated forward to transcondylar plane. While the axis of the head and neckis rotated posterior to the transcondylar plane it is called retroversion and if the axis of head and neck is in the same plane as that of transcondylar plane it is known as neutral version [3].The femoral anteversion ranges from 30 to 40 degrees at birth

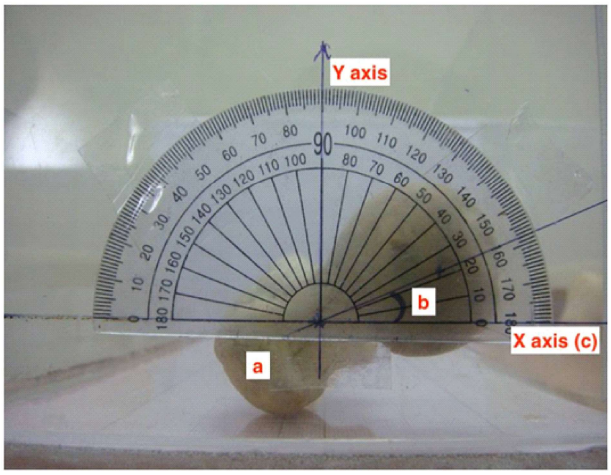
and decreases progressively throughout growth [4]due to hereditary factors and local muscle forces, [5]. The average adult femoral anteversion has been documented at the range between 7-16 degrees in multiple skeletal surveys [6]. .Anatomists and Orthopaedicians have long been interested in the femoral neck anteversion angle, since it is widely recognized as an important factor for hip stability [7]. There are several methods existing for the measurement of femoral anteversion such as dry bone study,roentgenographic techniques includes fluoroscopy, biplanar imaging, axial roentgenography, axial tomography, ultrasound and CT scanning.

The present study wasaimed to evaluate the normal anteversion range in adult Indian femur and to compare it with other studies which would be of great help in explorative orthopedic procedures and in designing hip prosthesis.

MATERIALS AND METHODS

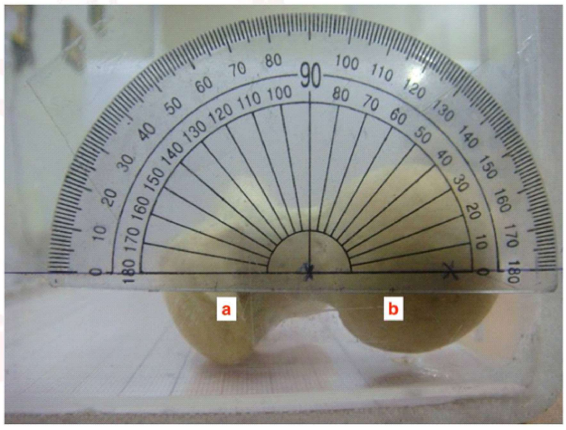
The study was conducted in the Department of Anatomy, Sri Ramachandra Medical College and Research Institute, Sri Ramachandra University, Chennai and SreeGokulam Medical College and Research Institute, Trivandrum, Kerala. A total of 202 adult Indian dried femurs, without any signs of erosion or any gross pathology were studied. The distribution by gender was 94 male (48 right and 46 left) and 108 female bones (52 right and 56 left). The angle of anteversion was measured by Kingsley Olmsted Method [8]. The femur was placed on a smoothlevel"L" shaped glass board, in such a way that the head is towards the vertical surface and the bone rests on three points namely the posterior aspects of the two femoral condyles and the posterior aspect of the greater trochanter on the horizontal surface. The horizontal surface represents the retro condylar plane. The centre of the head and neck of the femur was determined by using a Vernier caliper. A line was drawn connecting the centre of the head and neck of the femur on the vertical limb of the glass board, the line was extended till it meets the transcondylar plane. All the observations were made at the eye level and two observer method was used to eliminate the parallax error.Theangle subtended between the two planes was then calculated using a protractor. The angle obtained by this method was then tabulated and statistically analyzed (fig 1 and fig 2).

Fig. 1: Anteversion angle of femur



a- center of neck of femur b- center of head of femur
c- Transcondylar line

Fig 2: Neutral version of femur



a- center of neck of femur b- center of head of femur

RESULTS

In this study the angle of anteversion was measured in 202 femurs (94 male: 48 right and 46 left; 108female: 52 right and 56 left).

The mean anteversion angle among males was 7.6 ± 5.7 degrees and 12.71± 7.1 degrees for females respectively.

In this study predominant number of male femurs showed retroversion and neutral version (3.5% each) when compared to the female femurs. Most of the male femurs were in the range of 6- 10 degrees (18.8%) while most of the female femurs were in the range of 11-15 degrees (19.3%). Out of the total bones measured, 30.7% of the bones range between 6-10 degrees (Table 1).

Table 1: Angle sub classification, Gender Cross distribution.

	Angle range	Frequency (no of bones)	Gender		Total
			Male	Female	
Angle sub classification	< -1	10	3.50%	1.50%	5.00%
	-1 to +1	12	3.50%	2.50%	5.90%
	2 to 5	18	6.90%	2.00%	8.90%
	6 to 10	12	18.80%	11.90%	30.70%
	11 to 15	60	10.40%	19.30%	29.70%
	16-20	24	3.00%	8.90%	11.90%
	> 20	16	0.50%	7.40%	7.90%
Total		202	46.50%	53.50%	100.00%

Table 2: The mean anteversion angle among various groups.

Angle	N	Mean	SD	SE	Minimum value	Maximum value
Male Right	48	6.69	5.98	0.86	-6	18
Male Left	46	8.56	5.46	0.8	-4	21
Female Right	52	11.63	6.23	0.86	-10	24
Female Left	56	13.71	7.76	1.04	-7	29
Total	202	10.37	6.99	0.49	-10	29

Table 3: Multiple Comparisons using Scheffe.

(I) Femur	(J) Femur	(I-J)Mean Difference	Standard error(SE)	P Value	95% Confidence Interval	
					Lower Bound	Upper Bound
Male Right	Male Left	-1.87772	1.33759	0.58	-5.6493	1.8939
	Female Right	-4.94712*	1.29758	0.003	-8.6059	-1.2883
	Female Left	-7.02679*	1.27515	0	-10.6223	-3.4313
Male Left	Male Right	1.87772	1.33759	0.58	-1.8939	5.6493
	Female Right	-3.0694	1.31217	0.144	-6.7693	0.6305
	Female Left	-5.14907*	1.28999	0.002	-8.7864	-1.5117
Female Right	Male Right	4.94712*	1.29758	0.003	1.2883	8.6059
	Male Left	3.0694	1.31217	0.144	-0.6305	6.7693
	Female Left	-2.07967	1.24846	0.43	-5.5999	1.4406
Female Left	Male Right	7.02679*	1.27515	0	3.4313	10.6223
	Male Left	5.14907*	1.28999	0.002	1.5117	8.7864
	Female Right	2.07967	1.24846	0.43	-1.4406	5.5999

* The mean difference is significant at ≤0.05 level.

In this study the angle of anteversion was measured in 202 femurs (94 male: 48 right and 46 left; 108female: 52 right and 56 left).

The mean anteversion angle among males was 7.6 ± 5.7 degrees and 12.71± 7.1 degrees for females respectively.

In this study predominant number of male femurs showed retroversion and neutral version (3.5% each) when compared to the female femurs. Most of the male femurs were in the range of 6- 10 degrees (18.8%) while most of the female femurs were in the range of 11-15 degrees (19.3%). Out of the total bones measured, 30.7% of the bones range between 6-10 degrees (Table 1).

The mean anteversion angle of 202femurs was 10.37 ± 6.99 degrees.Mean anteversion angle for male right bones was 6.69 ± 5.98degrees andfor male left bones was 8.56± 5.46 degrees. The female right bones showed a mean anteversion angle of 11.63 ± 6.23degrees and the female left bones showed a mean anteversion angle of 13.71 ± 7.76degrees.The lowest angle measured was -10 degrees and the

highest angle measured was 29 degrees (Table 2).Thereforeleft sided bones had a higher anteversion angle than right side bones in both male and female group.

Multiple comparison of individual groups had the statistically significant difference between female right and male right (P: 0.003), female left and male right (P: 0.00), female left and male left anteversion angles (P: 0.002) (Table 3). Independent t-test between male and female bones had significant difference between male and female anteversion angles(P <0.05).

DISCUSSION

Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater in the females compared to males. A statistically significant difference was found for the angle of anteversion between the male and female femurs. Female femursshowed about 5 degreeshigheranteversion anglecompared to male femurs. Present study findings are in accordance with the findings of Parsons FG [9], who documented anteversion to be greater in females. Similarly, Kingsley PCet al [8] observed a negligible difference of 0.08 degrees, and Yoshioka et al [6] found a difference of 1°. Nagar Met al [10] conducted study on Indian femur and found greater average angle of anteversion among male femurs compared to the female femursin contrast to the present study and studies conducted by other researchers. Study conducted by AnkurZalawadiaet al [3]showed a similar value (around 1° difference) as that of the present study for the right male and female femurs, the left male femurs had about 5.7 degrees more and the left female bones had about 7.3 degree lesser angle than that of the present study (Table-4).

Many non-operative methods have been proposed (shoe wedges, twister cables, night splints) to treat abnormal anteversion or retroversion of femur. Appearance of increased femoral anteversion less than 8 years of age has to be observed and in 99% has spontaneous regression. This is confirmed by findings of SvenningsenS et al [4] who found that frequencies of in-toeing gait decreased from 30% in 4 years old children to 4% in adults.

Table 4: Femoralanteversion as observed by other researchers.

	Researcher	Sample size	Mean angle of anteversion in degree		
			Right	Left	Average
Western studies	Yoshioka Y et al (1987)	32			M-7 F-8
	Kingsley PC et al (1948)	630	M-8.54 F-7.47	M-7.94 F-8.11	8.02
	Parsons FG et al (1914)	266	M-13.0 F-18.0	M-13.0 F-16.0	15.3
Indian Studies	Kate BR et al (1976)	108	9	8.6	8.8
	Nagar et al (2005)	182	M-21.2 F-20.9	M-11.3 F-11.0	M-16.3 F-10.9
	Ankurzalawadia et al (2010)	92	M-7.2 F-10.5	M-14.3 F-6.4	12.4
	Present study (2012)	202	M-6.7 F-11.6	M-8.6 F-13.7	M-7.6 F-12.7

CONCLUSION

Our study concludes that the mean anteversion angle among females (12.71± 7.1) was higher than males (7.6 ± 5.7) among Indian population. The anteversion angle value is crucial for the diagnostic and therapeutic planning of patients with various pathologies such as hip development dysplasias, varum thigh, flat thigh, epiphysiolysis and so on. The knowledge of normal femoral anteversionholds great importance in selection of patients for prosthesis, pre- operative planning for total hip replacement (THR) surgery. Although newer methods using computed tomography (CT) have been shown to be ±1° accurate, there is no universal consensus for locating the femoral neck axis and the femoral condylar axis. Hence estimation of anteversion on dry bone is still considered the most accurate method.

ACKNOWLEDGEMENTS

We would like to thank the Management of Sri Ramachandra Medial College, Dr.Ramesh kumar, HOD of AnatomyAnd Dr.Chandrakumari.

Conflicts of Interests: **None**

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How to cite this article:

Manikanta Reddy V, Rajesh S. ANALYSIS OF FEMORAL NECK ANTEVERSION IN DRY ADULT BONES: A MORPHOMETRIC STUDY. Int J Anat Res 2019;7(2.3):6636-6640. **DOI:** 10.16965/ijar.2019.192