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Research Article

MORPHOMETRIC STUDY OF ANGLE OF FEMORAL NECK ANTEVERSION IN WESTERN UTTAR PRADESH POPULATION OF INDIA

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A B S T R A C T

Introduction: Awareness of femoral neck ante-version with respect to sex, race, sides and different geographical area is useful to surgeon to treat the patients in different cases and also to design prosthesis. Femoral neck ante-version is the angle formed by the femoral condylar plane (bicondylar plane) and a plane passing through the center of the neck and the femoral head (Kim *et al* 2000, Napoli 1995). If the axis of the neck inclines forwards to transcondylar plane the angle or torsion is called ante-version.

Aims & Objective: The present study is proposed to remove the lacuna of information about angle of anteversion in Indian population which can be used for designing suitable implants for various corrective orthopaedic surgeries in order to avoid post-op problems and revision surgeries.

Materials and Methods: Present study was conducted in the department of anatomy, L.LR.M. Medical College Meerut on 100 dry femora of unknown age and sex of Cadaveric origin. The adult cadaveric femoral morphology was determined to measure angle of ante-version of femur by the Kingsley- Olmsted method using standardized technique with the help of digital vernier caliper and goniometer.

Result: On comparison of angle of ante-version on left and right side we found that mean ± S.D. on left side was $20.14^0 \pm 4.65$, on right side $22.90^0 \pm 5.98$ respectively, with highly significant p value of 0.012. The maximum angle of ante-version on left and right side was 35^0 and 36^0 respectively while minimum angle of anteversion on both sides was 14^0.

Conclusion*:* The knowledge of Femoral neck anteversion nowadays is becoming more significant with the increase in demand for total hip replacement, and anthropological studies. The present study adds to the preexisting data and may be used in the fields of orthopedic surgery to various hip pathologies and anthropology to determine the racial differences and may be supportive for the interventional procedures undertaken in this population.

INTRODUCTION

Anthropometric skeletal measurements are used to show up regional diversity between different populations or within the same population. (Partnen *et al* 2001). There are metric differences in skeletal component among populations and the variations are related to genetic factors, environmental factors, like geography, diet, and life-style. The racial characteristics of population are determined by human skeletal measurements (Faulkner *et al* 1993).Variation of the upper femoral morphology between racial groups may be significant enough to require modification in hip prosthesis design.

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Current data regarding the correct sizing of a prosthesis and technical guides to insertion are largely based on Osteometric measurement in Caucasians (Alonso *et al* 2000). It is not known whether such measurements are directly applicable to the hips of non-Caucasians and whether there are any morphometric differences between Indians and the Caucasian hips. The knowledge of normal femoral neck anteversion is of extreme importance in selection of patients for prosthesis and preoperative planning for total hip replacement surgery and anthropological studies. It has to be taken into consideration when reduction and fixation is selected as a method of treatment (Keating *et al* 2010).

The neck of the femur in humans is an important functional modification after humans attained erect bipedal posture. Awareness of femoral neck ante-version with respect to sex, sides, race and different geographical area is useful to surgeon

to treat the patients in different cases and also to design prosthesis. The femoral neck ante-version can be defined as the angle formed by the femoral condylar plane (bicondylar plane) and a plane passing through the center of the neck and the femoral head (Kim *et al* 2000, Napoli 1995).

If the axis of the neck inclines forwards to transcondylar plane the angle or torsion is called ante-version, if it points posterior to transcondylar plane, it is called retroversion and if the axis of neck is in the same line of transcondylar plane it is known as neutral version.

The FNA is first, identifiable at 7 weeks of gestation (Crelin *et al* 1981) when it is reported to be -10^0. This gradually increases with gestational age and is reported to be 0^0at 3^{rd} month of age and $+24.4^0$atbirth (Eltman 1945). It changes throughout by detorsion in childhood and adolescence until the adult average angle of +12 degree is reached (Staheli 1985).

In children Cyvin *et al* (1977) found that ante-version angle was an average 3^0 larger in girls than in boys. They also reported that an asymmetry of ante-version angle of over 10^0 was found in 25% of normal children.

The average adult femoral anteversion has been documented to range from 7 to 16^0 in multiple studies as done by Eltman *et al* (1945), Yagi *et al* (1986), and Yashioka *et al* (1987).

Le Damany (1903) quoted it to range from -25^0 to $+37^0$, Dunlop *et al* (1953) designated ante-version angleas ‘‘plus angle” and retroversion as ‘‘minus angle”.

Many published reports had suggested that habitual sleeping and sitting postures, in which the hip is held at near the end of medial or lateral rotation may produce changes in femoral neck ante version. These extreme postures often will produce an increase in hip rotation in one direction with the corresponding decrease in hip rotation in opposite direction (Cibulka *et al* 2004).

Angle of ante-version is multifactorial result of evolution, heredity, fetal development, Intra Uterine 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 hip & knee in adults.

Data for Indian population is meager. Since built, physique, habitat and genetic makeup vary markedly in different ethnic groups; it is possible that anthropometric dimensions described as normal for proximal end of femur for westerners might be quite different from those encountered amongst Indians. Presently in developing countries like India, injured/broken femur replacements are carried out using standard sized Austin-moor femur implant selected from a range provided by manufacturers. Femur implant is available in standard sizes of angle of anteversion. The present study is proposed to remove the lacuna of information about angle of anteversion in Indian population which can be used for designing suitable implants for various corrective orthopaedic surgeries in order to avoid post-op problems and revision surgeries. The purpose of carrying out this study is to produce a sound anatomical analysis technique and enable the manufactures to create most advanced prosthesis & to provide the data needed in calculation of parameter in repositioning of femur after traumatic dislocation.

Aims and Objectives

Several attempts have been made to evaluate the morphometry of proximal end of femur, because surgeries on the proximal femur are one of the commonest in orthopaedic surgical practice.

The present study aims to measure angle of anteversion of femur which will establish the parameters in Indian population of Western U.P. This will be further helpful for implant designing that will be more specific for ethnicity and gender of this geographical zone and thereby reducing post surgical complications and revision surgeries. Numerous published studies have underlined the importance of a close fit between the femur and the implanted stem. (Mishra *et al* 2009).

This study aims to measure femoral angle of anteversion which has important implications in arthroplasties, evaluation of pathological conditions of hip and various corrective osteotomies (Jain *et al*. 2005).

MATERIALS AND METHODS

Present study was conducted in the department of anatomy, L.LR.M. Medical College Meerut on 100 dry femora of unknown age and sex of Cadaveric origin. Specimens that showed osseous pathology or previous fracture were excluded from the study.

The adult cadaveric femoral morphology was determined to measureangle of ante-version of femur by using standardized technique with the help of slidingvernier caliper and goniometer. For measuring the femoral neck ante-version 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 in our study.

Centre-head-neck line-centre of head was the centre of maximum antero-posterior thickness of head of femur. The centre of neck of femur was the centre of maximum antero-posterior thickness at the base of neck. Both these points were determined with the help of sliding vernier caliper. Now these points 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 horizontal limb of goniometer was fixed at the edge of experimental table, the vertical limb was held parallel along the axis of the centre of head and neck of femur. The horizontal surface represented the retrocondylar axis and the plane of reference against which the anteversion is measured with the help of axis of head and neck of the femur. The angle subtended was recorded to the accuracy of 1^0.All measurements were repeated twice by two independent observers to identify any intra and inter-observer variability of the technique. Data collected were tabulated and mean and standard deviation (S.D.) were determined. The above parameters were then be correlated with other established indices.

Fig 1 showing measurement of femoral neck anteversion

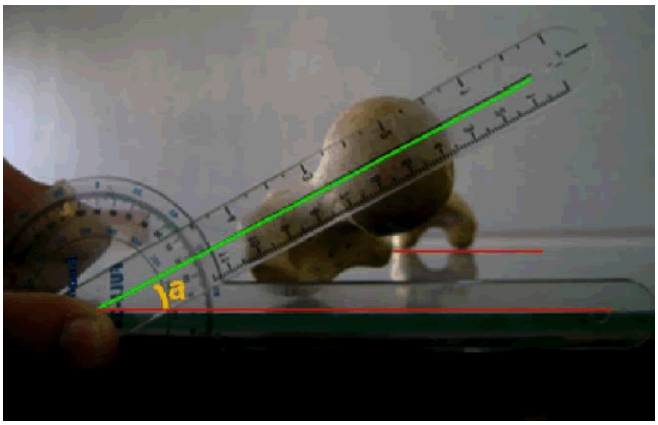

Fig 2 showing measurement of femoral neck anteversion

OBSERVATIONS AND RESULT

To our knowledge literature about femoral angle of ante-version in Indian literature are scarce, therefore this study was carried out on 100 dry femora of cadaveric origin in the department of anatomy L.LR.M.Medical College Meerut, and following results were obtained.The measurements of all the femora on the leftand right were obtained & subjected to statistical analysis. Results shown in the table-1 given below.

Resultobtained ondescriptive Statistical Analysis of Angle of Ante-Version of Femur on Left and Right Sides **Table-1**

Side	N	Mean^0	S.D.	SEM	P value	Minimum^0	Maximum^0
Left	50	20.14^0	4.65	0.65	0.012	14^0	35^0
Right	50	22.90^0	5.98	0.84		14^0	36^0

On comparison of angle of ante-version on left and right side we found that mean ± S.D. on left side was 20.14^0 ± 4.65, on right side 22.90^0 ± 5.98 respectively,with highly significant p value of 0.012. The maximum angle of ante-version on left and right side was 35^0 and 36^0 respectively while minimum angle of anteversion on both sides was 14^0. From above descriptive statistical analysis it was quite clear that values of femoral angle of ante-version was higher on right side in comparison to left side.

DISCUSSION

The knowledge of normal femoral neck anteversion is of extreme importance in selection of patients for prosthesis and preoperative planning for total hip replacement surgery and anthropological studies. It has to be taken into consideration when reduction and fixation is selected as a method of treatment (Keating *et al* 2010).

Although newer methods using CT scan have shown to be $\pm1^0$ accurate, there is no universal consensus for locating the femoral neck axis and the femoral condylar axis. Hence estimation on dry bone is still considered the most accurate method for measuring angle of anteversion(Keating J. 2010).

In present study the angle of anteversion on right side was found as 22.90^0 ± 4.65 (14^0 - 36^0) and left side as 20.14^0± 5.98 (14^0- 35^0) with highly significant p value (p = 0.012). So it clear that in present study the angle of anteversion on right side was found to be greater than left side.Herzberg *et al* (1991) studied that angle of ante-version varied over a wide range 10.5^0 ± 9.22^0.Measurments on right and left side demonstrated an asymmetry as right as 8.2^0±9.14^0, left as 12.6^0±8.99^0.

Nagar *et al* (2002) studied 182 adult Indian dried femora (104 of male and 78 female). The average anteversion was 11.32 ± 0.37 and 21.23 ± 0.39 on the left and right sides respectively in males and 11.02 ± 0.34 and 20.87± 0.35 on the left and right sides respectively in with significant p value (0.0001).The values were higher on right sides in both male and female femora in comparison to left side as in present study. Tonnis *et al* (1992)had shown the relationship between reduced femoral neck ante-version angle and degenerative disease of hip and told that normal femoral ante-version angle lies between 15^0 - 20^0. Maini *et al* (2005) analyzed 30 bilateral hip and showed mean angle of ante-version to be 16.31^0 , on the left and right side as 16.010, 16.61^0 respectively i.e. right angle of anteversion greater than left. This study has also matched with our study. Comparison of present study with other authors shown in the table-2 given below.

Angle of anteversion as observed by other Indian &Westners authors **Table-2**

Author	Year	Number	Method	Angle of anteversion^0
Ogat & Goldsand *et al*	1979	138hips (69R,69L)	Simple biplanner	MeanFNA=11.5^0±5.4, R=10.6±5.3,L=12.3^0±5.4
Reikeras *et al*	1982	48pairs (24M,20F) femora	Radiograph (X ray)	MeanFNA =10.4^0±6.7^0
Siwach *et al*.	2003	75pairs (150 bones)	Morphologically, Radiologically	Mean FNA= 13.68^0
Maini *et al*	2005	30 B/L Hip	Radiologically	MeanFNA=16.31^0,L=16.61^0, R=16.01^0
Jain *et al*	2005	300dry bones	Kingley-Olmsted method,CT, X-ray	MeanFNA=8.1^0±6.6, R=7.3^0±6.7,L=8.9^0±6.5^0
Saikia *et al*	2008	104 hips	radiologically	Mean FNA=20.2^0 (16^0-45^0)
Rokade *et al*	2009	144	Morphologically, By two method	Method1meanFNA=18.68^0±6.37 Method2meanFNA=16.34^0±7.7
Ankur *et al*	2010	92 dry femora, 50M, 42F	Kingley-Olmsted method	Mean FNA, in-male-L=14.3^0 ±0.38,R= 21.23^0 ±0.39^0,in Female-L=11.02^0±0.34, R=20.87^0±0.37
Maheshwari *et al*	2010		CT scan	MeanFNA =20.4^0 (8^0 – 40^0)
Caciaro *et al*	2012	18 dried bones	CT scan	MeanFNA =20 ± 7^0.
Srimathi *et al*	2012	164dry femora	Kingley-Olmsted method	MeanFNA,R=9.49^0±1.66, L=10.13^0±1.50
Present study	2012	100 dry femora	Kingley-Olmsted method	Mean FNA, R=22.90±5.98, L=20.14±4.65

The present study clearly shows that the mean angle of anteversion was higher on right side in comparison to left with significant p value, this result of present study was almost similar to Nagar *et al* (2002) Saikia *et al*(2008) Rokade *et al*(2009), Ankur *et al* (2010), Maheshwari *et al*(2010), Caciaro *et al* (2012) but different from Ogat & Goldsand *et al* (1979), Maini *et al* (2005) Jain *et al* (2005), Srimathi *et al*(2012).

Variations in the dimensions of femoral angle of anteversion reported in the present study and by earlier workers may be due to geographical and racial variation, morphometric methodology adopted and absence of sex and age matched femora.

The Indian subcontinent comprises a vast collection with different morphological, genetic, cultural and linguistic characteristics, while much of this variability is indigenous; a considerable fraction of it has been introduced through large scale immigration into India in historical times.

The western UP part of north India is inhabited by numerous edogenous castes that have their own distinct social, linguistic and biological identity. Ethnically speaking most of the groups predominantly belongs to Jaats but also show a mosaic of features of other communities like Punjabis. These caste groups are usually have taller individuals groups with heavy built incomparison to other parts of India as south and north-eastern part of India where individuals are of short stature.

In present study which was conducted in the L.L.R.M. Medical College Meerut in the western UP population, the result obtained were different in comparison to results obtained in other parts of India by other authors.The angle of anteversion also more pronounced in individuals belonging to Western UP in comparison to people belonging to other parts of India as South India (Srimathi *et al* (2012), and northeast of India

CONCLUSION

Use of orthopaedic implants designed according to Western standards yields poor results in other population. So identifying and comparing the femoral angle of anteversion of various populations is essential in proximal femoralgeometry in addition to the other femoral head & neck diametersfor designing the implants. Therefore the present study adds to the preexisting data and maybe used in the fields of orthopedic surgery to various hip pathologies andanthropology to determine the racial differences.

Conflict of Interest: None

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