*Original Article*

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# Femoral Neck Torsion: A Study of Adult Dry Femoral Bones

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**Abstract**

*Background:* Femoral torsion is defined as the angle formed between long axis of head and neck of femur proximally and the transverse axis of the femoralcondyles distally. When this axis passes forwards it is termed as anteversion and when it passes backwards it is termed as retroversion. It is important to know the angle of torsion, as it is varies widely from person to person. *Materials and Methods:* Unpaired 113 dry femurs, 58 right sided and 55 left sidedwithout any gross morphological deformities were used to measure the femoral torsion by goniometer. Maximum femoral length was measured by using osteometric board and the data were statistically analyzed. *Results:* Out of total 113 femur studied, 102 femur were found to be anteverted whereas 11 were found to be retroverted. Mean angle of anteversion was 10.39° irrespective of side. In case of right femurs mean value was 10.05° and for left it was 10.82°. Though mean values were higher in left sided bone, no statistically significant difference was found ($p < 0.05$). Mean value of retroversion was found to be 4.60° which is much lower than the mean value of anteversion. *Conclusion:* Any change in the angle of femoral torsion is associated with various clinical conditions. Study data will be useful for various orthopaedic procedures and diagnosis, in the fields of General Human Osteology and Forensic anthropology.

**Keywords:** Femoral Torsion; Anteversion; Retroversion; Length.

## Introduction

Morphological study of femur includes recognition of the femoral neck torsion. The head of the femur passes forwards and medially with respect to the transverse axis of the lower end (angle of femoral torsion). Normal value of femoral anteversion ranges between 10°–15°. Angle may vary amongst individuals, races and different populations [1].

Lower average value of torsion of 7°- 8° degrees was seen in Caucasian skeletal studies [2,3] while greater average values of torsion of 19° was found in African population [4,5]. It is an important factor for longevity of the joints especially after total joint replacement surgery.

Femoral torsion in human is not only developmental but also a result of torsional stresses produced on the femoral neck during daily activities. This angle facilitates bipedal postures during locomotion by reducing the horizontal bending forces experienced at hip and thereby reducing bony tensile stress.

The knowledge of torsion angle is very important in hip replacement surgeries as properly placed implants not only reduce bony strain but also helps to prevent implant loosening and increase the stability of the joint as well [6,7].

The angle of femoral torsion is measured as the angle between the longitudinal axis of the head and neck of the femur proximally and the transverse axis of the femoral condyles distally (Figure 1).

The present study tries to evaluate the normal femoral torsion range in adult dry femora of Indian population. We also try to determine if there is any right and left sided difference as well as any correlation between maximum length of femur with femoral torsion.

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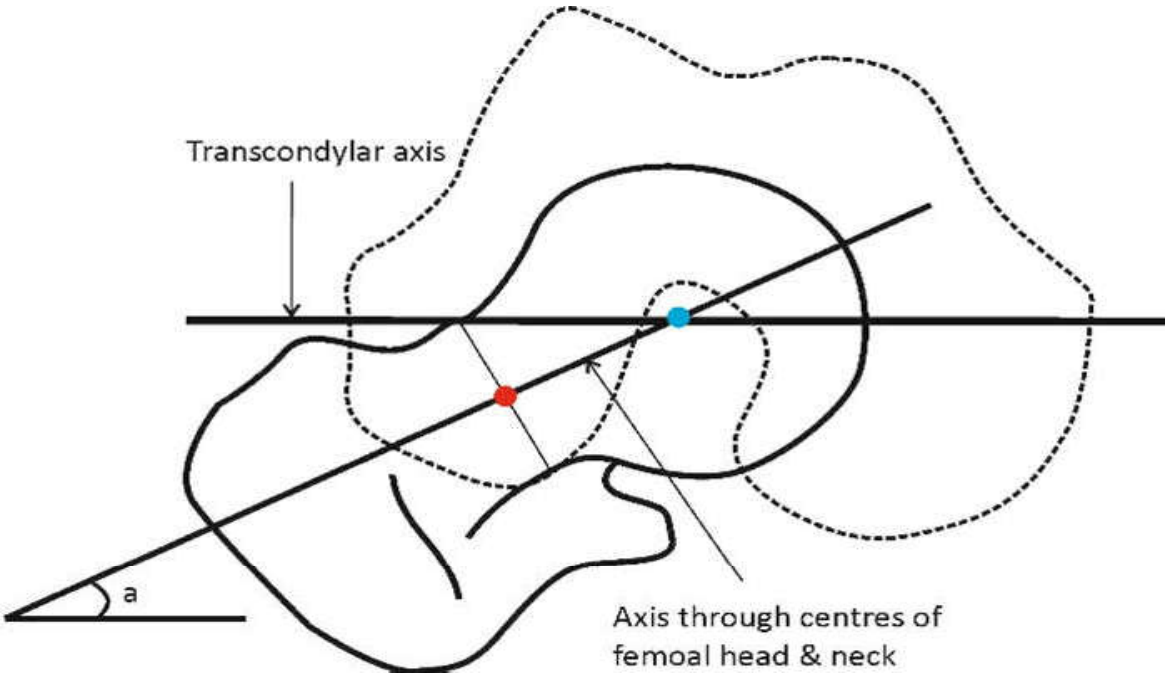


**Fig. 1:** Shows angle of femoral neck anteversion

## Materials and Method

Unpaired 113 dry femurs, 58 right sided and 55 left sided without any gross morphological deformities were used to measure the angle of femoral torsion. The angle of femoral torsion was measured by Kingsley Olmsted method [8]. After placing the specimen at the edge of a glass 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 experimental table. 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 torsion is measured with the help of the axis of head and neck of the femur.

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

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

Maximum femoral length was measured by using osteometric board from the most superior point on the femoral head to the most inferior aspect of the medial condyle.

## Result

The results obtained after measurement of the femoral torsion angles in dry adult bones were tabulated and analyzed.

The mean value of femoral torsion on right side was 10.05° with standard deviation of 6.746 and that for left side it was 10.82° with standard deviation of 6.162. The mean angle on left side was higher than the right side but the difference was not statistically significant.

**Table 1:** Angle of torsion for right and left side

| Angle of torsion | Range | Mean | Standard deviation | Standard error | T and P value |
|---|---|---|---|---|---|
| Ungrouped (n=102) | 0° - 28° | 10.39° | 6.475 | .641 | - |
| Right (n=57) | 0° - 28° | 10.05° | 6.746 | .894 | t = 0.608 |
| Left (n=45) | 0° - 28° | 10.82° | 6.162 | .919 | p = 0.5444 |

**Table 2:** Percentage wise distribution of femoral anteversion angle in right and left femur

| Angle of torsion | Right side | | Left side | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| 0-5 degree | 18 | 31.58 | 9 | 20 |
| 5-10 degree | 11 | 19.30 | 13 | 28.89 |
| 10-15 degree | 16 | 28.07 | 15 | 33.33 |
| > 15 degree | 12 | 21.05 | 8 | 17.78 |
| Total | 57 | 100 | 45 | 100 |

**Table 3:** Pearson's correlation coefficient (r) of right and left anteversion angle with maximum femoral length

| Correlations Anteversion angle & length | N | r-value | p-value |
|---|---|---|---|
| Ungrouped | 102 | -0.261 | 0.008 |
| Right | 57 | 0.065 | 0.065 |
| Left | 45 | 0.059 | 0.059 |

**Table 4:** Comparison of present study with previous studies

| Author | Population | Year | Mean Anteversion Angle |
|---|---|---|---|
| Jain et al. [12] | India (Delhi) | 2003 | 8.1 [right –7.3, left – 8.9] |
| Badjatiya et al. [13] | India (Udaipur) | 2014 | 8.67° |
| Srimathi et al. [14] | India (Chennai) | 2012 | 9.8°[right– 9.49°, left– 10.13°] |
| Sugano et al. [15] | Japan | 1998 | 19.8° |
| Reikeras O et al. [2] | Norway | 1983 | 13° |
| Eckhoff et al. [5] | Africa | 1994 | 17° [right – 21°, left – 17°] |
| Maheshwari et al. [16] | India (Delhi) | 2010 | 8° |
| Present study | India (Gujarat) | 2017 | 10.39° [right – 10.05°, left – 10.82°] |

In the present study, we also found 11 femur having retroversion. Out of these, 10 were of the left side and only 1 was of right side. The mean retroversion angle found in left side was 4.66° with maximum value of 10° and minimum value of 1° whereas angle of retroversion on right side femur was 9°.

## Discussion

The knowledge of normal femoral torsion is very helpful in selection of patients for prosthesis and preoperative planning for total hip replacement surgery and anthropological studies. Results of western studies cannot be applied to Indian population because femoral torsion differs in different populations [9].

Changes in the stress placed on the femur diaphysis may affect the development of femoral neck torsion. In populations which are more habitual to do moderate to heavy ground level physical activities require an internally rotated posture. This is required to keep the femoral head in the acetabulum and hence result in femoral neck torsion to the anterior side. Ground level activities such as squatting, mopping, laundry, cooking, farming and preference of floor sitting are common in Indian population.

Our study does not show any significant difference ($p > 0.05$) between both side torsion as right side shows lower value. Highest cases (18) femur on right side had anteversion angle of 0-5 degrees followed by 16 cases where the angle was in range of 10-15 degrees. In left side, highest cases (15) femur had anteversion angle of 10-15 degrees followed by 13 cases where angle was in range of 5-10 degrees. So present study opposes the hypothesis that both limbs are symmetrical in development. We also found retroversion in 11 cases in which 10 were of left side and 1 was of right side. This further confirms the asymmetry in development and torsion between right and left sides.

Hamill et al. stated that any increase in bone lengths is accompanied by lower extremity adjustments as a result of excessive torsion [10]. Valmassy said that torsion of femur usually demonstrates angle of gait or posture changes which are caused due to overall growth spurts and increase in height [11]. Populations differ from each other in size and proportions and these differences can affect the metric assessment of femoral torsion [Table 4]. Table 4 also shows that angle of anteversion not also varies greatly in different populations of India as well. In our study no statistically significant correlation was found between femoral torsion and femoral length on the right side and left side ($p > 0.05$). This is in contrast to the study done by

Debnath et al. in Bengali population where a strong relation was found between angle of anteversion and length of the femur.

Measurement of femoral neck torsion is very important for various orthopaedic diagnosis and procedures, because measurement of femoral torsion in living subjects is complicated with several limitations [10,11,12].

Any increase or decrease from normal range of femoral torsion is related with different disease conditions. These problems vary from minor postural defects in children to immobilizing hip osteoarthritis in adults. Diseases with increased femoral torsion are perthes disease, cerebral palsy, poliomyelitis, apparent genu valgum, external tibial torsion, flat foot. Diseases with decrease femoral torsion are toing out, rickets, chondrodystrophy etc. Accurate measurement of femoral torsion is important for diagnosis and corrective procedures related to femur and hip joint [7,8,12,14,17].

## Conclusion

The average angle of anteversion obtained by Kingsley and Olmsted method was 10.39 (SD 6.475°). The angles of anteversion in 26%, 24%, 30% and 20% were in the range of 1°-5°, 5°-10°, 10°-15° and >15° respectively. Altogether, 9.73% of femur showed retroversion. No statistically significant difference was found between the angle of anteversion in right and left side. Great amount of variation in angle of anteversion was found not only in populations of different countries but also in populations of different regions of India.

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