# Determining the angle of femoral torsion and association with shaft length and mid circumference

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## ABSTRACT

**Background:** Angle of femoral torsion has an anatomical variation based on sex, geography, ethnicity and occupation and concludes various impact factor on determining the angulation as well as the length of the bone. **Aims and Objective:** Thus, present study is aimed to determine the angle of femoral torsion in Nepalese population. **Materials and Methods:** This is a cross-sectional study carried out at the Department of Anatomy, Nobel Medical College and Teaching Hospital, Biratnagar, Nepal. Of the total 60, unpaired and unknown gender, dry femora were collected during one year period and separated as right sided (n = 30) and left sided (n = 30) according to the standard anatomical landmarks. Measurement of angle was done by Kingsley Olmsted method and the length, mid-circumference by measuring tape. **Results:** The angle of torsion in dry femora (n = 60) for right (16.73 ± 3.095) and left (16.67 ± 2.963) side were recorded. The mean shaft length, mid circumference for right sided femora were recorded as 39.367 ± 0.9185 and 7.933 ± 0.6661cm respectively. The mean shaft length and mid circumference were 38.917 ± 0.8914 and 7.933 ± 0.5833cm respectively for left sided femora. Differences (ATF, p = 0.932, LF, P = 0.059, MCF, P = 1) of variables between right and left femora were analyzed and correlation of angle of femoral torsion with shaft length and midshaft circumference (ATF vs MCF, p = 0.571 and LF, p = 0.153) was done. **Conclusion:** Documenting the femoral angle of torsion with shaft length, midshaft circumference in normal dry femora of cadaver is of great importance for Orthopedic surgeons since it provides a knowledge for planning the hip surgeries.

**Key words:** Femoral angle; Bicondylar plane; Midshaft circumference; Kingsley Olmsted; Cadaver

## INTRODUCTION

The angle of femoral torsion (AFT) can be defined as angle formed by femoral condyle's plane (bicondylar plane) and a plane passing through the center of the neck and femoral head. If the axis of the neck inclines forward to transcondylar plane the AFT is called femoral neck anteversion (FNA), if it points posterior to transcondylar plane it is called femoral neck retroversion. If it is in the same line as of transcondylar plane it is known as neutral version.[1] The angulation and torsion of the proximal femur in normal populations become a concern for the

orthopedic surgeon for surgical background and thus has been subject to research for decades.[2]

Understanding and treatment of pathologic conditions in the hip joint must be supported by exact knowledge of the normal values of these parameters, especially in growing children, but also in skeletally mature patients.[3] A study has determined the value of AFT at birth to be 40 degrees and with advancing age it decreases gradually to 20 degrees at ten to around 8 to 15 degrees in adulthood.[4-6] A comparative study between median torsion angle in Caucasians and Asians was recorded not more than 15° (5.5–21.4°).[7] Again

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the another study documented the anteversion angle ranged from 12.10° to 17.59° to the right and from 14.77° to 19.73° to the left, making an average of 14.84° ± 7.60° in right and 17.25° ± 6.89° in left.[8] Koerner et al. found markedly higher (8%) proportions of retroverted hips in their study population, ranging from 23.5% in African American females to 7.2% in Hispanic males. This difference is probably methodological: In Koerner's study, a 2D-CT model was used.[9] There are variations among studies. Excessive femoral torsion may be associated with certain neurologic and orthopedic concern. Some of the reported conditions like children with cerebral palsy having excessive angle of femoral torsion. Thus, the clear understanding of femoral torsion has become essential for the treatment of pathologic conditions of hip joint, skeletally mature patients and also for growing children.[10] Thus, not only the FNA but also the AFT do have an association with many clinical problems regarding the surgical treatment in femur, which could be a reason for parents concern for children future, and prosthesis, hip and knee replacement in adults. Thus, present study is basically concern on determining the angle of femoral torsion in cadaver's dry femur by standard measurement process and finding the correlation of shaft length, mid-circumference with angle of femoral torsion.

## MATERIALS AND METHODS

This is a cross-sectional study carried out at the Department of Anatomy, Nobel Medical College & Teaching Hospital, Biratnagar, Nepal from April 2017 to December 2017. Femur bone of Nepalese origin of either sex and age available at the department of Anatomy of Nobel Medical College were used for the study.

The total of 60 unpaired dry femora without any gross abnormality were included which were well preserved. All 60 femora of unknown gender were, first separated as right sided (n=30) and left sided (n=30) according to the standard anatomical landmarks observed. Damaged and deformed bones were excluded from the study. The length and mid shaft circumference of each bone was measured with the help of measuring tape.

Angle of torsion was measured by Kingsley Olmsted method[11] by placing specimen at the edge of a plane horizontal table so that femoral condyles rest on the flat surface. Then horizontal limb of a goniometer was fixed at the edge of the experimental table. The vertical limb was held parallel along the axis of head and neck of the femur. The vertical limb was passing through the center of head of femur extending from a point where transverse diameter is maximum to the center point on greater tuberosity of femur. The horizontal limb axis was taken as line passing between the centers of two epicondyles of femur. The angle subtended between the horizontal axis (transcondylar plane) with the axis of head and neck of the femur was measured and recorded from the goniometer. To improve the observer's reliability the whole procedure was repeated by different investigator for the same collected samples.

### Data analysis

Descriptive Analysis of different variables was done. The means and standard deviation (SD) with 95% confidence intervals (CI) of the angle of femoral torsion for all the femursas well as the length and mi-circumference for each were recorded. The independent sample t-test was used to check for significant differences (p<0.05) between the right and left femora were analyzed. Also, the Pearson Correlation of angle of femoral torsion with length and mid-circumference were analyzed. SPSS software version 25 was used for statistical analysis of variables.

## RESULTS

The total of 60 unpaired dry femora without any gross abnormality of either sex which were well preserved were included in the study. After segregating as right or left side according to standard anatomical criteria the subtended angle was recorded.

The Table 1 showed the average (mean± SD) angle of torsion in 60 dry femora were observed 16.73±3.095° for right side and 16.67± 2.963° for left side. The mean length and mid-circumference of right sided femora were observed as 39.367 ±0.9185° and 7.933 ± 0.6661°respectively. The mean length and mid-circumference of left sided femora were observed as 38.917 ± 0.8914° and 7.933 ± 0.5833° respectively.

Table 2 shows statistical analysis by unpaired "t" test (Levene's Test) assuming the equal variance, there was no

### Table 1: Descriptive analysis of anthropometric variables of femora

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum | Mean | Std. deviation |
| ATFr | 30 | 10 | 22 | 16.73 | 3.095 |
| LFr | 30 | 38.0 | 41.0 | 39.367 | 0.9185 |
| MCFr | 30 | 7.0 | 9.0 | 7.933 | 0.6661 |
| ATFl | 30 | 10 | 22 | 16.67 | 2.963 |
| LFl | 30 | 38.0 | 40.0 | 38.917 | 0.8914 |
| MCFl | 30 | 7.0 | 9.0 | 7.933 | 0.5833 |
| Valid N (listwise) | 30 | | | | |

ATFr=Right side femoral angle of torsion, LFr=Length of femur of right side, MCFr=Midshaft circumference of right side, ATFl=Left side femoral angle of torsion, LFl=Length of femur of left side, MCFl=Midshaft circumference of left side

significant difference between right and left femoral torsion angle, length and mid circumference.

The correlation between angle of torsion and mid-shaft circumferencewas inversely proportional though it was statistically non-significant. Similarly, the angle of torsion and the length of the femur was estimated to be directly proportional but statistically non-significant (Table 3).

## DISCUSSION

The present study is an attempt to evaluate the normal angle of torsion with dry femora collected from the Anatomy laboratory of Nobel Medical College for documenting the normal range of angle of femoral torsion from cadavers. This study would be useful in orthopedic surgery for various hip pathologies.

The normal data obtained from the present study showed that the minimum value of angle of torsion was 10 cm and the maximum was found to be 22 cm for both right and left. The mean value recorded from the study was 16.73±3.095°for right side and 16.67± 2.963°for left side. A study done among population of Maharashtra in unpaired 280 dry adult femora by Dwivedi and Bhatnagar[12] also estimated average anteversion in males to be 11.23° and 13.39° on left and right sides, respectively and in female femora 13.23° and 16.21° on the left and right sides, respectively. According to Deswal et al[13] measurement of angles of femur bone was observed to be 19.75 ± 7.75° on right side and 15.75 ± 7.13° on left sides. The result of present study concurs with the findings of the study by Dwivedi and Bhatnagar.

The median torsion angle for Caucasians was 14.2° (IQR 8.1–20.3°); the median torsion angle for Asian was 14.7° (5.5–21.4°) in a study by Maximilian J. Hartel in Germany.[7] The observed value of Asian were found to be similar with our recorded mean value which is 16.73° for right sided and 16.67° for left sided femora.

One of the studies in BPKIHS, Dharan Nepal, the estimated mean length of femoral boneand mid shaft circumference were calculated to be 41.93 ± 2.47 cm, 8.31 ± 0.59 cm respectively.[14] Femur length recorded in our study were; right side= 39.367 ± 0.9185 cm, left side=38.917 ± 0.8914 cm and measurement of mid-circumference for right side= 7.933 ± 0.6661cm, left side=7.933 ± 0.5833 cm.

The results of the study in Tamil Nadu, India by S Dhivya, V Nandhini,[15] the mean length of femur was 41.66 cm (left femur was 41.88 cm and right femur was 41.29 cm). The result of present study where right-sided shaft length was observed as 39.120±0.9560 cmand left sided shaft length as 38.890 ± 0.8765 cm which seems to be comparable with the above study.

## CONCLUSION

Documenting the femoral angle of torsion in normal dry femora of cadaver has been considered to be of great importance for Orthopedic surgeons in particular. Knowledge of not only the angle of torsion but also the shaft length as well as the mid-shaft circumference is quite applicable in planning for hip replacement and other prosthetic surgeries. The study concludes that the anatomy of the femur structure among the Asians are quite similar in measurement.Thus, the present study provides the valuable information for orthopedic surgeons.

**Table 2: Independent sample "*t*" test assuming equal variance for right and left femora**

| Variables (*n*=60) | *t* value | Sig (2-tailed), *P* value | 95%confidence interval | |
|---|---|---|---|---|
| | | | Lower | Upper |
| ATF (right+left) | 0.085 | 0.932 | -1.499 | 1.633 |
| LF (right+left) | 1.926 | 0.059 | -0.0178 | 0.9178 |
| MCF (right+left) | 0.000 | 1.000 | -0.3237 | 0.3237 |

ATF=Femoral angle of torsion, LF=Length of femur, MCF=Midshaft circumference

**Table 3: Correlation of angle of torsion with length and mid circumference of femoral shaft**

| Variables | Variables | Pearson correlation (r) | *P* value |
|---|---|---|---|
| ATF | MCF | -0.075 | 0.571 |
| | LF | 0.153 | 0.244 |

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**SKY-** Concept and design of the study, manuscript preparation, statistically analyzed and interpreted, critical revision of the manuscript; **SACS-** Critical revision of manuscript and review of the study; **RY-** reviewed the literature, collected data.

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