

# Measurement of Collo-diaphyseal Angle and Femoral Neck Anteversion Angle of Femur Bone

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## Abstract

**Introduction:** The femur is the weight-bearing typical long bone of lower limb which extends from the pelvis to the knee. Anthropometry provides scientific method and technique for taking various measurements in different geographic regions and races.

**Aim:** The purpose of the study was to measure the average collo-diaphyseal angle (CDA) and femoral neck anteversion (FNA) of dry fully ossified femur bones.

**Materials and Methods:** The present study was carried out on 80 dry fully ossified femur bones (40 right and 40 left). The result obtained were statistically analyzed.

**Results:** In the present study, average CDA was found to be  $126.10 \pm 6.56$  and  $126.20 \pm 5.23$  on the right and left sides, respectively. The average anteversion recorded was  $19.75 \pm 7.75$  and  $15.75 \pm 7.13$  on the right and left sides, respectively.

**Conclusion:** Any increase or decrease in the CDA and FNA angles is associated with various clinical conditions. The present study will be useful for various orthopedic procedures and diagnoses, in the fields of general human osteology and forensic anthropology.

**Key words:** Anthropology, Femoral neck anteversion, Femur, Forensic, Osteology

## INTRODUCTION

The femur is the largest and strongest bone in the human body. Its proximal part and the pelvis constitute the hip joint, and its distal part constitutes part of the knee joint. It forms the skeleton of the thigh, bears body weight in an erect posture, supports the movements of legs, provides attachment to muscles, forms blood cells, and acts as storehouse for calcium and phosphate.<sup>1,2</sup> Therefore, the femur is widely researched in the fields such as physical and forensic anthropology, human kinematics, and orthopedics. The anatomical knowledge of different dimensions of the femur is very essential in anthropological and medico-legal practice for sex determination and as well as to

radiologists, rheumatologists, and orthopedic surgeons for diagnosis and planning of treatment. As the femur is composed of hard tissue, they are the best-preserved part of skeleton after death, and in many times, they are the only available parts for forensic examination.<sup>2</sup> The femoral normative values are also essential to plastic and reconstructive surgeons in their reconstruction and medical rehabilitation. Femoral neck anteversion (FNA) angle is widely recognized as an important factor for hip stability since anatomists and orthopedics have long been interested in this. It is multifactorial result of evolution, hereditary, fetal development, intrauterine position, and mechanical forces.<sup>3,4</sup>

## MATERIALS AND METHODS

This was an observational descriptive type of study which was performed on 80 fully ossified human femur bones (40 right sided and 40 left sided) collected from Department of Anatomy, SGT medical college, Gurgaon, Haryana. Instruments used for taking measurement were white

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paper, pencil pen, scale, osteometric board, and goniometer. Statistical analysis was done using service provisioning system software (Version 20.0).

### Parameters Studied Were

#### Collo-diaphyseal angle (CDA)

The collo-diaphyseal angle is the angle between the longitudinal axis of the neck and the longitudinal axis of the shaft.

#### FNA

It is the angle formed by the femoral condyles 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 angle of torsion is called anteversion. The specimen is placed 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 will be 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 anteversion is measured with the help of the axis of the head of the femur. The angle subtended will be recorded.

## RESULTS

In the present study, average CDA was found to be  $126.10 \pm 6.56$  and  $126.20 \pm 5.23$  on the right and left sides, respectively. The average anteversion recorded was  $19.75 \pm 7.75$  and  $15.75 \pm 7.13$  on the right and left sides, respectively (Table 1).

## DISCUSSION

The average CDA is greater at birth, on average 160 and decreases along the skeletal growth, reaching an average of 135 of the adults. This average value is used as reference for the manufacture of orthopedic implants used in synthesis or substitution in the proximal femur.<sup>4</sup> In the present study, the average CDA was found higher on the left sides than right sides similar to the finding of Da Silva *et al.*,<sup>5</sup> Subhash *et al.*,<sup>6</sup> but not resembling to the findings of Hoaglund and Low<sup>7</sup> and Shakil and Saheb.<sup>2</sup> The findings of the present study were nearly equal to the findings of Parsons,<sup>8</sup> Isaac *et al.*,<sup>9</sup> and Ravichandran *et al.*<sup>10</sup> Table 2 shows the comparison of the findings of the present study with the findings of previous authors.

The FNA angle is roughly about 30-40 at birth and decreased gradually as a result of hereditary factors, torsional forces on the diaphysis created by the contraction of the muscles acting on hip joint, and the development of

normal walk.<sup>4</sup> In the present study, the mean values of FNA were higher on the right side than the left side similar to the findings of Ingalls.<sup>12</sup> The present study showed higher FNA than the findings of previous authors Pick *et al.*,<sup>13</sup> Jain *et al.*,<sup>14</sup> Shrikant *et al.*,<sup>15</sup> and Zalawadia *et al.*<sup>16</sup> Table 3 shows the comparisons of findings of the present study with the previous studies.

## CONCLUSION

The knowledge of normal femoral anteversion is of extreme importance in the selection of patients for prosthesis and pre-operative planning for total hip replacement surgery and anthropological studies. In India, with the increasing demand for total hip replacement, this anteversion angle becomes more significant. Knowledge of

**Table 1: Comparative results of CDA and FNA of right and left femurs**

| Parameter | Mean $\pm$ SD     |                   | P value |
|-----------|-------------------|-------------------|---------|
|           | Right femur       | Left femur        |         |
| CDA       | 126.10 $\pm$ 6.56 | 126.20 $\pm$ 5.23 | 0.958   |
| FNA       | 19.75 $\pm$ 7.75  | 15.75 $\pm$ 7.13  | 0.115   |

CDA: Collo-diaphyseal angle, FNA: Femoral neck anteversion, SD: Standard deviation

**Table 2: Comparison of CDA measured on dry bones of present study with the previous researchers**

| Authors                                    | Sample size | CDA                                      |
|--|-------------|--|
| Parsons <sup>8</sup>                       | 134         | 126.3 $\pm$ 5.1                          |
| Hoaglund and Low <sup>7</sup>              | 108         | R-136.0, L-135.0                         |
| Isaac <i>et al.</i> <sup>9</sup>           | 171         | 126.7                                    |
| Siwach and Dahiya <sup>11</sup>            | 150         | 123 $\pm$ 4.3                            |
| Da Silva <i>et al.</i> (2003) <sup>5</sup> | 66          | R-122.55 $\pm$ 4.9, L-125.61 $\pm$ 6.6   |
| Ravichandran <sup>10</sup>                 | 578         | 126.55                                   |
| Subhas Gujar (2013) <sup>6</sup>           | 250         | R-136 $\pm$ 6.68, L-136.6 $\pm$ 5.45     |
| Shakil and Saheb <sup>2</sup>              | 250         | R-137.3, L-136.9                         |
| Present study (2017)                       | 80          | R-126.10 $\pm$ 6.56, L-126.20 $\pm$ 5.23 |

CDA: Collo-diaphyseal angle

**Table 3: Comparison of FNA measured on dry bones of present study with the previous researchers**

| Authors                               | Sample size | FNA                                    |
|---------------------------------------|-------------|--|
| Ingalls <sup>12</sup>                 | 100         | R-12.6, L-10.3                         |
| Pick <i>et al.</i> <sup>13</sup>      | 152         | 14.0                                   |
| Siwach and Dahiya <sup>11</sup>       | 150         | 13.7 $\pm$ 7.9                         |
| Jain <i>et al.</i> <sup>14</sup>      | 138         | 8.1 $\pm$ 6.6                          |
| Shrikant <i>et al.</i> <sup>15</sup>  | 288         | 8.7 $\pm$ 6.6                          |
| Zalawadia <i>et al.</i> <sup>16</sup> | 92          | 12.4 $\pm$ 18.4                        |
| Shrimathi <i>et al.</i> <sup>17</sup> | 162         | 9.8                                    |
| Present study <i>et al.</i> (2017)    | 80          | R-19.75 $\pm$ 7.75, L-15.75 $\pm$ 7.13 |

FNA: Femoral neck anteversion

neck-shaft angle in this region would therefore be useful to the surgeon during internal fixation of fractured neck of the femur and also in determining the sex of the individuals from skeletal remains for medico-legal reasons.

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