Morphometric study of femoral neck-shaft angle and its implications

R. Bharathi1, K. Yuvaraj Babu2, Karthik Ganesh Mohanraj2*

ABSTRACT

Introduction: The head of the femur articulates with the acetabulum in the pelvic bone forming the hip joint, while the distal part of the femur articulates with the tibia and kneecap forming the knee joint. By most measures, the femur is the strongest bone in the body. The femur is also the longest bone in the body. Using the AP view of the hip joint, the angle formed by the axis of femoral shaft and line drawn along the axis of femoral neck passing through the center of head of femur form the femoral neck-shaft angle (NSA). At birth, the femoral NSA is 140°. In adult, the femoral NSA is 120–135°. We analyzed the femoral NSA in 50 dry human femur bones. Materials and Methods: A total of 50 dry femur bones of unknown sex were used for this study. The bones were obtained from the Department of Anatomy, Saveetha Dental College and Hospitals. Two points of axis were noted on the femur, one median vertical line (shaft axis) and one horizontal line perpendicular to it (neck axis), and then the NSA angle was taken with goniometer by keeping the goniometer parallel to shaft axis. Results: The change in the femoral NSA may lead to the change in the standing posture of the person and serve as an important criterion during hip surgeries. An overall mean for these parameters was calculated using the data obtained. Values were found for the right and left acetabulum. The raw data obtained were statistically analyzed. Range, mean, standard deviation, and standard error of mean were determined for each parameter. All values were compared with series of other workers to draw the conclusions. Conclusion: The sexual dimorphism of the hip bone is a special adaptation in the females for childbearing. Therefore, awareness of the average dimensions of the hip bone in both the sexes will also help in early detection of disputed sex by forensic experts.

KEY WORDS: Coxa valga, Coxa vara, Femoral neck shaft angle, Femur, Neck axis, Shaft axis

INTRODUCTION

The femur is the largest and strongest bone in the human body which forms the bone of the thigh region. It consists of two ends: The proximal end and the distal end with the intermediate shaft. Although the femur bone is structurally and functionally important in all of its parts, the proximal end of the femur has much more attention than other parts. A thorough knowledge of its anatomy is very important in treating pathological conditions of the hip and femur bones. In humans, the neck of femur is well developed, with an anatomical orientation of facing upward obliquely and anteriorly. During the one-legged stance of the walking cycle, the femoral neck is subjected to important biomedical constraints, and to ensure posture and economic bipedal gait, a proper three-dimensional orientation is the key. Any change in the three-dimensional orientation may be associated with problems in the loading of the hip joint, and it may result in premature wear of the joint and non-economic gait.[1] The worst osteoporotic fracture with regard to cost and adverse consequences is the hip fracture. The important goal is that we have to check for the related fracture risk factors. The main risk factor for hip fracture is recognized as low bone mineral density. The other characteristic bone parameter such as proximal femur geometry is also the growing evidence in determining the risk profile for hip fracture.[2]

For the prevalence of fracture neck femur, hip osteoarthritis and other hip joint ailments are increasing nowadays. Definite treatment for these patients is the arthroplasty. Skeleton of the thigh

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is formed by the femur. The femur supports the leg movements and provides muscle attachment. This femur bone carries the whole body weight. Environment factors, race, lifestyle, and sex affect the morphology of bones to a greater extent. Geometric indices of bone strength in the proximal femur are influenced also by the factors of lifestyle. Nearly half of all hip fractures occur due to femoral neck fractures with the vast majority occurring after simple falls in elderly patients. Non-elderly patients have good bone quality. Due to their high functional demands, preservation of the natural hip mechanics and anatomy is a priority. For replacement procedures, the young age people preclude their candidacy. Only 3–10% of these fractures take place in younger adults.

One of the most frequently applied measures of hip anatomy is the femoral neck-shaft angle (NSA). The NSA which is relative to the angle of the femoral neck varies totally among modern humans and earlier species of hominins, even when we consider only small population samples. Adult values generally fall within a range between 120° and 140° for modern humans, even though values of <120° and >140° are not uncommon which is known as coxa vara and coxa valga.

### MATERIALS AND METHODS

A total of 50 dry femur bones of unknown sex were used for this study. The bones were obtained from the Department of Anatomy, Saveetha Dental College and Hospitals. Two points of axis were noted on the femur, one median vertical line (shaft axis) and one horizontal line perpendicular to it (neck axis), and then, the NSA angle was taken with goniometer by keeping the goniometer parallel to shaft axis.

### RESULTS

In the present study, we analyzed NSA in a total of 50 specimens, of which 25 are left, and 25 are right [Table 1]. The mean femoral NSA in the left and right femur was 124° ± 7.43° and 120° ± 9.24°, respectively. The difference and gender discrimination of the femur bone was not assessed though the right and left sides of the bones were clearly analyzed to find the NSA falls under coxa vera or coxa valga. All the observed values are depicted in Figures 1 and 2.

### DISCUSSION

The angle of inclination in FNA was approximately 122°. This angle is essential in the diagnosis of various pathological conditions of hip and femur including developmental dysplasia of the hip and cerebral palsy in children. According to Christoph Kolja Boese, the mFNA on right side is 163.50° and on left side is 162.20°. The FNA in children and in early fetal life is 160°. The FNA in newborn is almost equal to adult. The average is 126.50°. The average is 106–151 according to Kate BR. If the angle of inclination is >125°, it is termed as coxa valga or Alsberg’s angle. If the angle is decreased, then it is termed as coxa vara. According to Laville, the angle is greater in females than males.

### Table 1: The femoral NSA in the left and right femur with mean±SD

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>Mean±SD</th>
<th>Left femur</th>
<th>Right femur</th>
</tr>
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<tbody>
<tr>
<td>25</td>
<td>124±7.43</td>
<td>120±9.24</td>
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</tbody>
</table>

NSA: Neck-shaft angle, SD: Standard deviation

![Figure 1: Photograph showing femoral neck-shaft angle in (a) left and (b) right femur](image)

![Figure 2: The mean femoral neck-shaft angle in left and right femur](image)
According to Gilligan et al., the FNA shows significant differences among ethnic groups, sexes, and even between ages. Toogood studied FNA among dry bone using digital method among American population and observed FNA to be 129.20° which is higher than the present study which may be due to racial variations among the two different populations. The FNA is very high in neonatal age, and then gradually, it decreases during development and reaches adult values.\textsuperscript{[15]} In the present study, the mean FNA of the dry femur was observed on the left side of femur to be 124° and on the right side 122°, wherein these values correlated with Amith and Umebese.\textsuperscript{[16-18]} The femoral neck-shaft angle is of utmost clinical significance for orthopedicians and trauma surgeons.\textsuperscript{[6]} Furthermore, the examined cohort was retrospectively analyzed and the reference values are only valid in a similar cohort of ethnic background and age.\textsuperscript{[19]} Thus, reference parameters should be generated for other groups as well.

CONCLUSION

Knowledge of the anatomical parameters of the acetabulum is of immense importance to the orthopedic surgeons. Hip surgery being one of them requires more detailed knowledge, about the complex acetabular measurements to fulfill the need for verifying the validity of various surgical procedures under practice.

REFERENCES


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