

A Study of Femoral Neck Shaft Angle in Adults of Islamabad and its Clinical Implications

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Abstract

Objective: To determine mean femoral neck shaft angle (NSA) in local adult population of Islamabad Pakistan.
Study settings & duration: A Descriptive cross-sectional study was conducted in the Department of Orthopedics, Pakistan Atomic Energy Commission General Hospital Islamabad from June 2017 to December 2017.
Methodology: Using consecutive (non-probability) sampling technique 200 patients who met inclusion criteria were selected and their antero-posterior pelvic radiographs were taken. Hand held goniometer was used to measure NSA in both femurs under supervision of an expert orthopedic surgeon. Statistical analysis was done on SPSS 21.
Results: The total of 400 femoral necks were evaluated for NSA from 200 adult patients which were 114 males and 86 females. Mean NSA on right for males was found to be $130.90^{\circ} \pm 5.05$ and mean NSA on left was $131.01^{\circ} \pm 4.87$. Mean NSA for females on right was $129.94^{\circ} \pm 4.31$ and for left was $130.48^{\circ} \pm 4.52$. Effect of increasing age was also analyzed. These results are comparable to studies already published in the literature.
Conclusion: Our study provided an updated report on the local population NSA and found out that these are different in males, females but this difference was not found statistically significant. However increase in age conferred statistically significant change in NSA in local adult Pakistani population living in Islamabad, the capital city of Pakistan.
Key words: Neck shaft angle, proximal femoral geometry, implants, postoperative complications, goniometer, radiographs, laterality.

Introduction

The femur is the strongest and longest bone of the human skeleton and consists of various components which include the femoral head, shaft and condyles. There is articulation between acetabulum and the femoral head and the femoral neck joins the head with the long axis of the femoral shaft at a certain angle. This angle is known by many names, including neck-shaft angle (NSA), Collodiaphyseal angle (CDA), diaphysio-femoral

neck angle, angle of the neck of femur, angle of inclination, cervicodiaphyseal angle and column diaphyseal angle.¹ Being very important component of proximal femoral geometry (PFG) clinically it is defined as the angle of intersection of the proximal femoral shaft axis and femoral neck axis. This angle allows the femoral shaft to swing clear the pelvis off the ground during bipedal gait.² This angle also known as Mikulicz angle has important role in anatomic measurement for the assessment of hip biomechanics.³ The NSA is critical in the control of lateral balance during walking.⁴

It has been found that this collodiaphyseal angle (NSA) shows marked variation among modern human beings and earlier hominins, even though the population sample may be small. The values of NSA are highest in the infants and it then eventually decreases with age.⁵ There exists a range for values in modern human adults that is generally between 120° and 140° , although values of $< 120^{\circ}$ and $> 140^{\circ}$ are also not rare and are known as coxa vara and coxa valga, respectively. However, region wise reliable data of average Neck

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Authors Contribution

SNJ & KH conceptualized the project. SNJ & EN did the data collection. Literature search was done by SNJ & SK. SK & SF performed the statistical analysis. Drafting, revision & writing of manuscript were also done by KH & EN.

Shaft Angle among modern human groups is quite limited; this might be partly due to the issues in measurement.⁶ The neck shaft angle is very important to orthopedic surgeons especially in choosing the optimal implant while treating fractures of the proximal femur especially femoral neck fractures.⁷ Limited studies on the subject were conducted in Pakistani population and they also had limited sample size. Moreover, analysis is inadequate regarding the effects of variables like age, sex, and body laterality on the proximal femoral geometry parameters. Hence this limited proximal femoral geometry information in Pakistani population creates a need for an updated report having an indepth analysis stratified by age, sex, and body laterality on a larger sample size. This study was therefore planned to determine the value of the NSA of Pakistanis living in the Islamabad, the capital city of Pakistan.

Methodology

It was a Descriptive cross-sectional study conducted in Department of Orthopedics, Pakistan Atomic Energy Commission General Hospital Islamabad from June 2017 to December 2017. All patients above 18 years to 70 years of age presenting to OPD undergoing Pelvic X Rays regarding hip & spine related complaints, and all admitted trauma patients undergone skeletal survey according to ATLS protocols were enrolled in the study. Before commencement of study formal approval from the hospital ethical review committee was sought. All trauma patients presenting with bilateral proximal femur fracture and patients with previous surgery of proximal femur either one or both sides were excluded from the study. Informed written consent was first obtained on consent performa and all patients included in the study were allotted hospital ID numbers. The patient was informed on the purpose and benefits of the study and that this study was being done entirely for research and for publication of data. A detailed history was taken and subjects were thoroughly examined to exclude conditions mentioned in exclusion criteria to control confounders and bias in the results of study. Pelvic radiographs were obtained for the purpose of measurement of femoral neck shaft angle which were already done as an initial investigation of the study participants for their presenting complaints. All the measurements were taken by using handheld goniometer under the supervision of experienced orthopedic surgeon. The information collected by above mentioned protocol was recorded in predesigned performa.

The collected data was entered and analyzed in software SPSS version 21.0. Descriptive statistics were used to calculate mean and standard deviation of age and femoral neck shaft angle. Frequency and percentage were calculated for categorical variables like gender and age groups. Stratification of NSA by age, gender and sides was done to control for the effect modifiers. Tables and charts were used to present the results. Post stratification independent T test was applied. p value ≤ 0.05 was considered to be significant statistically.

Results

A total of 200 subjects that met eligibility criteria were randomly selected for the evaluation of femoral neck shaft angles. Of this number, 114 (57%) were males and 86 (43%) were female.

Age of study population ranged from 18 to 70 years. The study population was stratified into five groups according to their ages (group 1=18-28 years, group 2=29-39 years, group 3=40-50 years, group 4=51-61 years, group 5=62-70 years). Maximum number of patients (28%) were found in group 4. Frequency and percentage of each group in relation to gender is shown in Figure.

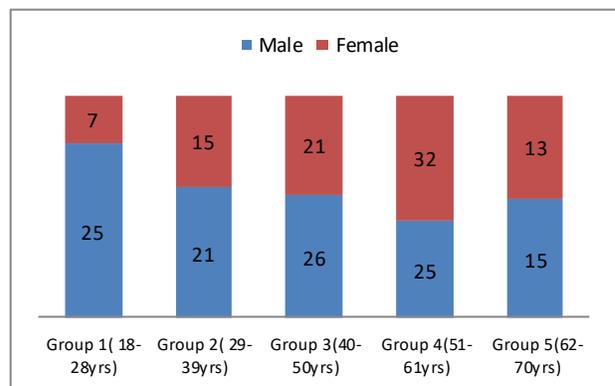


Figure: Gender frequency distribution among age groups.

The Mean \pm SD for the right and left femoral neck shaft (NSA) angles were 130.49 \pm 4.76 $^\circ$ and 130.79 \pm 4.72 $^\circ$ respectively. Baseline characteristics of study population are shown in Table-1.

Effect modifier analysis was done by considering Independent student t-test as test of significance with $p < 0.05$ as statistically significant. After considering gender as an effect modifier for right femoral neck shaft angle the results showed mean \pm SD 130.49 \pm 4.76 ($p = 0.158$) and for the left femoral neck shaft angle mean \pm SD 130.79 \pm 4.72 (p

=0.434) which were non-significant as shown in Table-2 & 3.

Table 1: Baseline characteristics of study sample.

| Parameter | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|----------------------------------|---------------|---------|------------|-------------|---------|
| Age distribution (yrs.) | 18 -28 | 29-39 | 40-50 | 51-61 | 62-70 |
| Frequency(n) | 32 | 36 | 48 | 56 | 28 |
| Percentage (%) | 16 | 18 | 24 | 28 | 14 |
| Gender distribution (n)% | | | | | |
| Male | (25)78 | (21)58 | (26)54 | (25)45 | (15)54 |
| Female | (7)22 | (15)42 | (22)46 | (31)55 | (13)46 |
| Mean neck shaft angle (mean± SD) | Right Left | | 130.49±4.7 | 130.79±4.72 | |

Table 2: Relationship of Rt. femoral NSA with gender.

| Gender | Rt. Femoral NSA | | p-value |
|--------|-----------------|-------------|---------|
| | n | Mean±SD | |
| Male | 114 | 130.90±5.05 | 0.158 |
| Female | 86 | 129.94±4.31 | |
| Total | 200 | | |

Table 3: Relationship of Lt. femoral NSA with gender.

| Gender | Lt. Femoral NSA | | p-value |
|--------|-----------------|-------------|---------|
| | n | Mean± SD | |
| Male | 114 | 131.01±4.87 | 0.434 |
| Female | 86 | 130.48±4.52 | |
| Total | 200 | | |

Table 4: Relationship of both sided femoral NSA in different age groups among adult population.

| Age groups | n | Right Femoral neck shaft angle Mean±SD | Left Femoral neck shaft angle Mean±SD | p-value |
|---------------------|----|--|---------------------------------------|---------|
| Group 1 (18-28)yrs. | 32 | 131.0±3.26 | 130.1±3.83 | 0.030 |
| Group 2 (29-39)yrs. | 36 | 129.8±4.68 | 130.6±4.47 | 0.000 |
| Group 3 (40-50)yrs. | 48 | 130.4±5.79 | 130.0±5.48 | 0.000 |
| Group 4 (51-61)yrs. | 56 | 130.6±4.39 | 130.5±5.02 | 0.000 |
| Group 5 (62-70)yrs. | 28 | 130.57±5.31 | 131.75±4.06 | 0.005 |

Considering different age groups as effect modifier for comparing mean femoral neck shaft angles of right and left side has shown a significant difference in all age groups. Our results shows the mean value of FNS angle in group 1; right femoral NSA mean±SD 131.0±3.26 and left femoral NSA

mean±SD 130.1±3.83 ($p=0.030$), in group 2; right femoral NSA mean± SD 129.8±4.68 and left femoral NSA mean ± SD 130.6±4.47 ($p=0.000$), in group 3; right femoral NSA mean± SD 130.4±5.79 and left femoral NSA mean±SD 130.0±5.48 ($p=0.000$), in group 4; right femoral NSA mean±SD 130.6±4.39 and left femoral NSA mean±SD 130.5±5.02 ($p=0.000$), in group 5; right femoral NSA mean±SD 130.57±5.31 and left femoral NSA mean±SD 131.75±4.06 ($p=0.005$) as shown in Table-4.

Discussion

The femoral neck shaft angles have been studied by various authors in various parts of the world. Variations in neck shaft angle have been found and this can be attributed to varying levels of activity, genetics, race, diet and lifestyle.^{8,9} Detail assessment of neck shaft angle for the designing and bioengineering orthopedic implants and hip prosthesis might change longevity and efficiency of implants and make fixation of proximal femoral fractures more convenient and accurate.

In this study femoral necks were evaluated to determine the mean femoral neck shaft angle in local adult population comprising of both male and female patients presenting to outpatient and emergency department of orthopedics

Firstly, we have found the mean neck shaft angle of 130.49° ±4.76 on right and 130.79° ± 4.72 on the left side. An Indian study has also reported the values of femoral neck shaft angles which are very close to our findings (mean right sided femoral neck shaft angle of 129.6°±4.61 and mean left angle of 129.1°±4.8).¹⁰ In another study Minakshi Verma et al reported mean neck shaft angle of 128.90±4.49° in Indian population.¹¹ These findings might be because of same geographic location. Contrary to our results a retrospective analysis of 466 healthy Chinese adults showed the mean neck shaft angle of 133.02° in Chinese population.¹² Similarly Unnanuntana et al has stated that the average femoral neck-shaft angle in American population was 133°¹³ and Merle et al in his retrospective study on 597 German patients came up with average neck shaft angle of 125° ±6.0°.¹¹ A study on Italian population revealed mean neck shaft angle of 125.3°±4.9°.¹⁴ whereas Ho-Jung Cho et al studied Korean population using CT scans found the mean NSA of 130.27°.¹⁵ This data consolidated our belief that femoral neck shaft angle varies with the geographical location and other variables. Umer et al states that the morphology of the proximal femur in Pakistani population differs significantly from those in western population, indicating regional variation.¹⁶

Secondly, our results have also shown that the right and left femoral neck shaft angles are strongly correlated but their difference is insignificant statistically. These results are comparable to other studies,^{1,2,10,12} already published in the literature which shows that the value of neck-shaft angle is not associated with laterality whereas a Brazilian study came up with opposite results.¹⁷

Thirdly, this study has revealed that the neck shaft angle in males (right femoral neck shaft angle was found to be $130.90^{\circ} \pm 5.05$ and left was $131.01^{\circ} \pm 4.87$) is slightly greater than females (right angle was $129.94^{\circ} \pm 4.31$ and left was $130.48^{\circ} \pm 4.52$) but it was unable to find any statistically significant difference between gender. The published data from a study conducted in South-Western Nigeria also revealed higher mean neck shaft angles for males than for females, although it was statistically insignificant much similar to that of our findings.¹⁸ Similarly, studies from India¹⁰ and China¹² also had same results. Another study also states that there is no consistent pattern of sexual or side differences across human population. In contrast to our findings Akbar and Kalimullah⁴ in Pakistan, have reported that the values of female neck shaft angle was larger than that of the male in both limbs, while other researchers^{1,2} have reported findings much similar to that of our study and did not show any statistically significant gender difference. This difference might be because of smaller sample size, difference of angle measuring technique, varying levels of activity, genetics, etc.

Fourthly, we have determined the effect of age on the values of femoral neck shaft angle and found that it is associated with increasing age. A retrospective analysis conducted on healthy Chinese adults showed that the value of neck-shaft angle is associated with age¹² a finding that is similar to what we reported.

This wide variation in values shows that there is a strong need for population-based study of this important variable of proximal femoral geometry. It is expected that this updated report will help us in improving our preoperative planning by choosing the implant in consistent with the local population's anatomy as opposed to considering European data^{14,19,20} which is significantly different from the Pakistani population.

This information will be further incorporated in various researches to understand the various diseases like Hip Osteoarthritis, proximal femoral fracture dynamics etc. Data generated in this study can be utilized by other Asian countries as we share the same geographical location.

In conclusion, the present study has demonstrated that with increase in age the neck shaft angle of both sides shows increasing variability. It has revealed that there was no demonstrable difference in right and left neck shaft angles of femur with respect to the gender. Furthermore, the study also implies that the hip implants for right and left femoral neck shaft should be different with the increasing age due to angle variation on both sides.

Conflict of interest: None declared.

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