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# A RADIOLOGICAL ANTHROPOMETRY STUDY ON FEMORAL NECK SHAFT ANGLE

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**ABSTRACT**

**Objective:** To determine the femoral neck shaft angle in a Pakistani population.

**Study Design:** Cross sectional study

**Place and Duration:** This Single center study was conducted at JPMC Karachi, a tertiary care center located in Karachi for period of six months.

**Methods:** The study was conducted by the Department of Orthopedic, JPMC Karachi. Once an eligible patient was identified, the study details were carefully discussed and informed consent attained. A total of 150 patients were selected by Consecutive non-probability sampling technique. After attaining the consent, an anteroposterior view of pelvis with both hip joints was obtained. Data was entered and analyzed using SPSS version 21.0. Mean ± SD was computed for age, height and weight and femoral neck shaft angle.

**Results:** Total study population of 150 was included, among the study participants n=88 were males (58.7%) and n=62(41.3%) were females; mean age of participants was 41.4 years. The mean femoral neck shaft angle was found to be 129.8 degrees. Mean FNSA in males was 129.5 while in females it was 130 degrees. No significant difference was found between males and females NSA. Thirty participants had NSA of 135 degrees

**Conclusion:** The next generation of femoral hip stem designs for total hip replacement will benefit from this study. This study found that FNS angles in patients' femurs are changing with age, so a hip stem with a modular neck may be better. Shaft angle of our population to minimize complications like malunion, non-union and cut out leading to increased morbidity and multiple surgeries.

**Keywords:** Femoral neck shaft angle, anteroposterior view of pelvis and Mean FNSA.

## INTRODUCTION

The angle between the femoral neck and shaft centers is the femoral neck shaft angle (FNSA). FNSA is also known as collodiaphyseal angle (CDA), diaphysio-femoral neck angle, femur neck angle, inclination angle, cervicodiaphyseal angle, and collum diaphyseal angle[1-2]. The longitudinal axes of the femoral neck should intersect at body weight in normal hips following the FNSA. FNSA at the hip joint grows during development, reaching 135-140◦ at birth. Neck-shaft angle changes no more after growing. Femoral neck shaft angle values vary by gender, side, race, and age, even within the same age group[3-4]. Females have a smaller NSA angle due to their broader pelvis and higher femoral shaft inclination on the neck. Femoral NSA is usually 125°, however it might be 120° or 140° in females and males. FNSA values not only have an impact on the orthopedic implants but also on the planning of osteotomies around hip and placement of femoral stem in total hip replacement[5-6]. Along with this, an increase (Coxavulga) or reduction (Coxavara) in FNSA can imply pathology especially hip fractures. The aged population is more prone to fracture of the femoral neck due to osteoporosis, however with an addition of the pathological FNSA, the risks of the femur neck fracture is even greater[7-8]. Femoral neck-shaft angle can be calculated by a number of ways including fluoroscopy, radiography, computed tomography (CT), and magnetic reasoning imaging (MRI). Due to the wide variation in health infrastructure in a developing country, it may not always be possible to measure the femoral neck-shaft angle by CT and MRI[9-10]. Adeoya-Cole et all found in a study in South-Western Nigeria is 130.77° ± 6.03° with a mean value of 131.57° ± 5.66° for male and 129.97° ± 6.33° for female. Gilligan et al also similar results in their study in 2013.Cheng et found average value of 125’ (8.5) with no difference among genders[11]. Hogland et al did a radiographic study on Hong Kong Chinese vs. Caucasians and found Caucasian FNSA more than Hong Kong Chinese[12]. In a local study by Akbar et al values of female NSA larger than that of the male, in both limbs. Thus, variations exit in literature based on different factors and it’s important to know this variation so that better planning and execution of plan can be carried out[13].

## METHODS

This Single center study was conducted at JPMC Karachi, a tertiary care center located in Karachi for period of six months. Once an eligible patient is identified, the study details were carefully discussed and informed consent attained. A total of 150 patients were selected by Consecutive non-probability sampling technique.

### Inclusion Criteria:

- Individual without any pre-existing hip or pelvic injuiry (assessed on history)
- Age ≥ 20 years to 70 years.
- Patients of either gender
- Patients giving informed consent

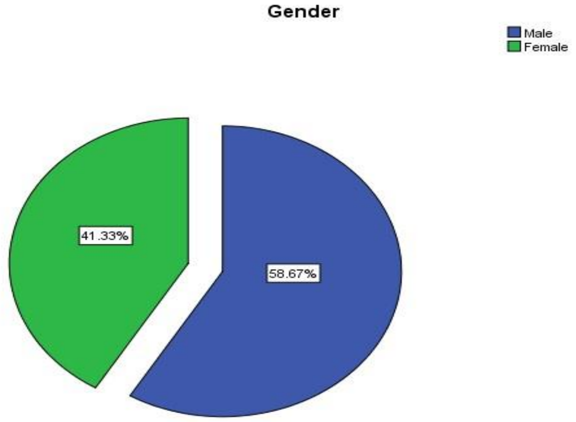
### Exclusion Criteria:

- Patient having previous hip injuries.
- Patients with known disease of joints and bones.
- Patients with metabolic diseases or renal failure,
- Not giving consent

The study was conducted by the Department of Orthopaedic, JPMC Karachi. After attaining the consent, an anteroposterior view of pelvis with both hip joints was obtained. Data was entered and analyzed using SPSS version 21.0. Mean ± SD will be computed for age, height and weight and femoral neck shaft angle. Frequency and percentage had been computed for gender, co-morbid. Independent t-test and ANOVA test was applied as appropriate to assess difference between Age, BMI, gender and femoral neck shaft angle. P-value< 0.05 will be considered significant.

**RESULTS**

Total study population of 150 was included, among the study participants n=88 were males (58.7%) and n=62(41.3%) were females; mean age of participants was 41.4 years.

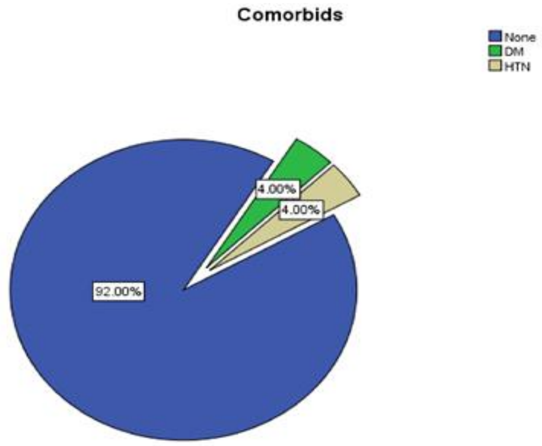


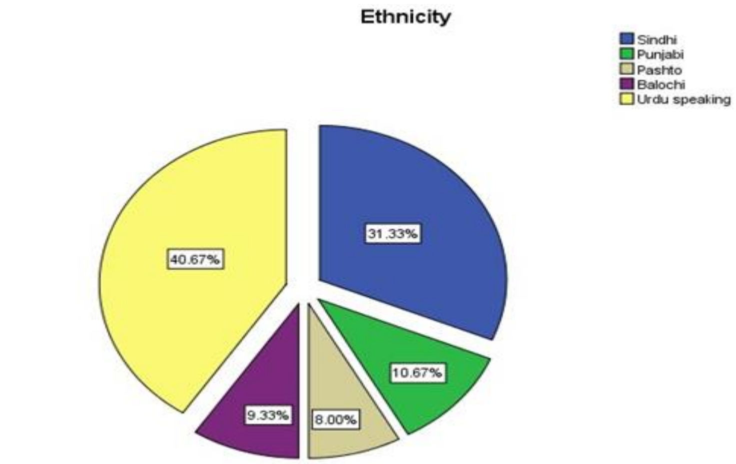

**Statistics**

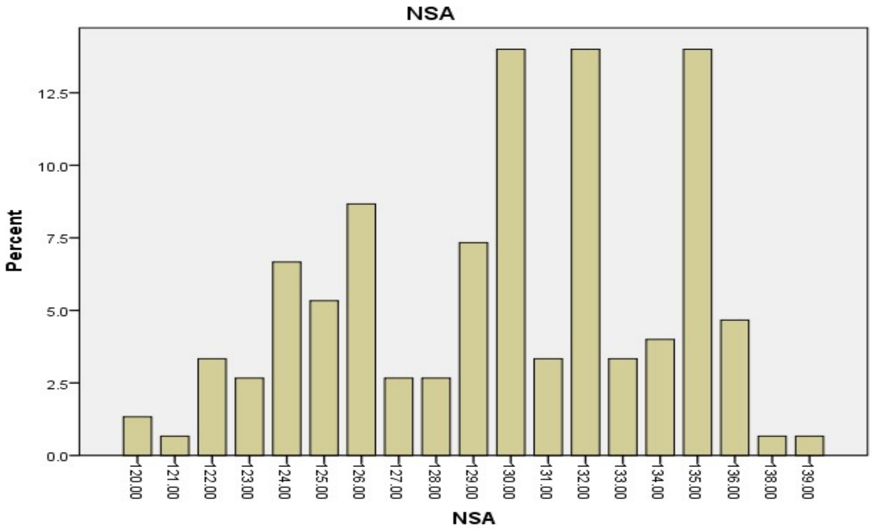
| | | Gender | Age | BMI | Comorbids | Ethnicity | Maritalstatus | NSA |
|---|---|---|---|---|---|---|---|---|
| N | Valid | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | | 1.4133 | 41.4800 | 28.1533 | 1.2000 | 3.1733 | 1.1933 | 129.8000 |
| Std. Error of Mean | | .04034 | 1.09278 | 1.38634 | .06554 | .14307 | .03235 | .35230 |
| Median | | 1.0000 | 38.5000 | 26.0000 | 1.0000 | 3.5000 | 1.0000 | 130.0000 |
| Mode | | 1.00 | 28.00 | 26.00 | 1.00 | 5.00 | 1.00 | 130.00[a] |
| Std. Deviation | | .49408 | 13.38371 | 16.97916 | .80268 | 1.75226 | .39624 | 4.31479 |
| Variance | | .244 | 179.124 | 288.292 | .644 | 3.070 | .157 | 18.617 |
| Range | | 1.00 | 47.00 | 211.00 | 4.00 | 4.00 | 1.00 | 19.00 |
| Minimum | | 1.00 | 22.00 | 18.00 | 1.00 | 1.00 | 1.00 | 120.00 |
| Maximum | | 2.00 | 69.00 | 229.00 | 5.00 | 5.00 | 2.00 | 139.00 |

a. Multiple modes exist. The smallest value is shown

The mean femoral neck shaft angle was found to be 129.8 degrees. Mean FNSA in males was 129.5 while in females it was 130 degrees. No significant difference was found between males and females NSA. Thirty participants had NSA of 135 degrees. Independent t-test was applied and no significant difference was found between different ethnicities, gender, BMI and marital status with femoral neck shaft angle.






**NSA**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 120.00 | 2 | 1.3 | 1.3 | 1.3 |
| | 121.00 | 1 | .7 | .7 | 2.0 |
| | 122.00 | 5 | 3.3 | 3.3 | 5.3 |
| | 123.00 | 4 | 2.7 | 2.7 | 8.0 |
| | 124.00 | 10 | 6.7 | 6.7 | 14.7 |
| | 125.00 | 8 | 5.3 | 5.3 | 20.0 |
| | 126.00 | 13 | 8.7 | 8.7 | 28.7 |
| | 127.00 | 4 | 2.7 | 2.7 | 31.3 |
| | 128.00 | 4 | 2.7 | 2.7 | 34.0 |
| | 129.00 | 11 | 7.3 | 7.3 | 41.3 |
| | 130.00 | 21 | 14.0 | 14.0 | 55.3 |
| | 131.00 | 5 | 3.3 | 3.3 | 58.7 |
| | 132.00 | 21 | 14.0 | 14.0 | 72.7 |
| | 133.00 | 5 | 3.3 | 3.3 | 76.0 |
| | 134.00 | 6 | 4.0 | 4.0 | 80.0 |
| | 135.00 | 21 | 14.0 | 14.0 | 94.0 |
| | 136.00 | 7 | 4.7 | 4.7 | 98.7 |
| | 138.00 | 1 | .7 | .7 | 99.3 |
| | 139.00 | 1 | .7 | .7 | 100.0 |
| | Total | 150 | 100.0 | 100.0 | |

## DISCUSSION

Several writers discovered significant changes in the neck-shaft angle, resulting to judgment mistakes and consequences[14]. The neck–shaft angle is utilized for diagnosis, preoperative planning, and treatment, however there is no consensus on thresholds or reference ranges. Sex and age relationships are also described, but other putative associations have rarely been studied. Our investigation found a mean neck shaft angle of 129.8 degrees, similar to Umer et al.'s Pakistani study[15]. Correctly assessing the NSA is questionable. NSA assessment on radiographs is only accurate to within 100 with an internally rotated femur, while outward rotation will distort and overestimate. NSA assessment errors would have overestimated NSA values, and the study population may have had lower NSA levels than documented. Thus, radiographed varus femoral necks were true varus. Note that proximal femoral fracture patients are frequently older and confused. In clinical practice, radiographs with completely internally rotated femora are rare, hence these estimates represent operating surgeons' pre-operative planning experience. Over reduction of the femoral neck into valgus can help implant lag screws. This study employed a 1308 fixed angle IMHS and used this approach most commonly. To allow lag screw placement without over-reducing the fracture, a 1258 fixed angle IMHS may be better[16]. This implant is not sold; hence this argument is unsupported. NSAs were found in 20.8% of the study population. Several writers examined femoral NSA investigations using radiography, CT scans, or cadaveric bones. Some investigators discovered significant variance in this angle between countries, regions, and ethnicities. Classic anatomy textbooks state the NSA as 120°, which may be 110° to 140°[17]. Standring et al. report an average adult NSA of 128°[18]. Ferrario et al. found that people had asymmetry between the right and left femoral NSA and that long bones have mathematical weight, length, and shape asymmetry[19]. Our study found no significant difference in right and left femoral NSA in the total population (p=0.09) and in males (p=0.32), but in females (p=0.03), the mean NSA of the right side is higher than the left side[20]. It suggests increased right-lower-limb weight bearing. Chaubber and Singh found greater NSA values on the left femur than the right. Aasis Unnanuntana et al. found gender differences in proximal femoral NSA[21]. Male femoral NSA averaged higher than female. The results of Professor F.G. Parsons' examination of medieval English dry bones showed 126° in men and 125° in females[22]. Our investigation found no substantial difference between men and women. Nelson and Magyesi found gender-specific implants necessary due to bone architecture variances by race and gender.

Yi Jiang et al. found that correlation analysis supported their conclusion that NSA may decrease and AA may increase with age[23]. Additionally, gender inequalities in PFG changes with age may arise. The stratified study by gender showed statistical differences in male NSA, AA, and FNL. Females had substantial disparities in FND, FNL, FV, and AA. The stratified analysis by body laterality demonstrated statistical variations in NSA and AA among age groups on both sides, which matched the outcomes for everyone. Yi Jiang et al. found that NSA may decrease with age, which is consistent with Wang et al.'s three-generation study of female proximal femoral bone development and aging. Grandmas had the narrowest NSA. We thought this NSA move might affect areal BMD[24]. Age-related declines in areal BMD may lead to lower proximal femur support strength and NSA. We also discovered that AA may increase with age, which Stem et al. validated in a retrospective review of 100 pelvic CT scans. We thought age-related alterations in AA may be linked to hip and spinal illnesses such hip osteoarthritis and kyphosis, which are more common in older people. Stem et al. found that higher AA may increase hip osteoarthritis risk due to changing acetabular orientation[25]. A positive link between NSA and age and a negative association between AA and age were verified by correlation analysis. Past studies have assessed femoral neck-shaft (FNS) angles, also known as caput-collumdiaphyseal (CCD) angles, to determine human variation. Orthopedic manufacturers have used data from research like this for decades to produce hip stem designs with different neck angles to restore the hip's anatomic center. Few studies have examined age-related FNS angles in adults[26].

## CONCLUSION

The next generation of femoral hip stem designs for total hip replacement will benefit from this study. Most orthopedic femoral hip stems are monolithic with fixed neck/shaft angles. Each monolithic hip stem design has several neck/shaft angles to serve patients with different FNS angles, which increases manufacturer inventory. This study found that FNS angles in patients' femurs are changing with age, so a hip stem with a modular neck may be better. Data from this study can be used for manufacturing of local implants like DHS according to neck Shaft angle of our population to minimize complications like malunion, non-union and cut out leading to increased morbidity and multiple surgeries.

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