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Relation of Femur Neck Shaft Angle with Hip Fractures: An Observational Retrospective Study

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Abstract

Introduction: Hip fractures are one of the most common fractures in adults encountered in orthopedics, posing a great deal of risk to patients' life. Hip fractures include subtrochanteric, intertrochanteric, and femoral neck fractures. The proximal femur's geometry has drawn more attention recently in relation to the etiology of hip fractures. Higher femoral neck-shaft angles (FNSAs) have been implicated in a predisposition to hip fractures.

Materials and Methods: A cross-sectional comparative study conducted at a tertiary care center in western part of India. Two groups of 50 individuals each created, matched for age range and gender, one control and the other with unilateral hip fracture.

Results: On conducting a binary logistic regression with absence or presence of fracture being the dependent variable and FNSA being covariate, an Odd's ratio of >1 identified, indicating the likelihood of higher FNSA values seen in fracture group than in control group. P value also found to be <0.05 hence significant. No significant difference was noted between the FNSA of males and female patients in fracture group. FNSA was higher in fracture group than in control group, mean FNSA 136.8 and 132.3°, respectively. We have noted an increased risk of hip fractures in patients with higher FNSA matched with their age and gender. This is confirmative of the findings noted in previous studies.

Conclusion: Hip fracture risk appears to be increased in those with higher FNSA. Although the precise cutoff value is yet unknown, this link could serve as the foundation for prevention in individuals whose values are high – that is, >136° – according to this study. Further, evaluation is needed for conclusive understanding of their relationship.

Keywords: Femur neck shaft angle, hip fractures, relative risk.

Introduction

Hip fractures are one of the most common fractures in adults encountered in orthopedics, posing a great deal of risk to patients' life [1]. Hip fractures include subtrochanteric, intertrochanteric, and femoral neck fractures. The majority of hip fracture instances involve elderly and are often low-energy injuries brought on by falls from a standing height [1]. These types of fragility fractures are most commonly seen in osteoporotic individuals, hence drawing a clear line between bone quality and risk of fracture [2]. Operative fixation is used to treat a sizable percentage of these fractures to promote early mobilization in this patient group. In Indian population, 1-year follow-up after hip fracture has shown 19% mortality with the highest mortality seen in above 80 [3].

Rehabilitation of such patients is a daunting task, and they may never recover fully or walk without an aid [4]. Under such circumstances, it is imperative that algorithms be developed to identify markers which increased risk of hip fractures. One of such algorithms is the FRAX model introduced by the World Health Organization collaborating center at Sheffield, UK, in 2008. The model, made up of basic data which are age, sex, body mass index, bone mineral density (BMD), and seven dichomatous clinical risk factors which include prior fragility fracture, parental hip fracture, smoking, systemic glucocorticoid use, excess alcohol intake, rheumatoid arthritis, and other causes of secondary osteoporosis needs to be calibrated for each country to account for regional differences in the normal ranges [5]. However, its limitations such as dose responders for risk factors, treating all previous fractures as equal, inability to segregate vertebral fractures healed with minor deformity from those with greater deformity among others limit its ability to truly predict risk of fracture [5].

The proximal femur's geometry has drawn more attention recently in relation to the etiology of hip fractures. Higher femoral neck-shaft angles (FNSAs) have been implicated in a predisposition to hip fractures [6]. As a person falls to the side,

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Figure 1: Patient position during radiographs.

Figure 2: 15° internal rotation to account for femur anteversion.

Figure 3: Measurements for femoral neck-shaft angle

With fracture		
Gender	Frequency	Percentage %
Male	22	44
Female	28	56
Without fracture		
Gender	Frequency	Percentage %
Male	22	44
Female	28	56

Figure 4: Gender distribution.

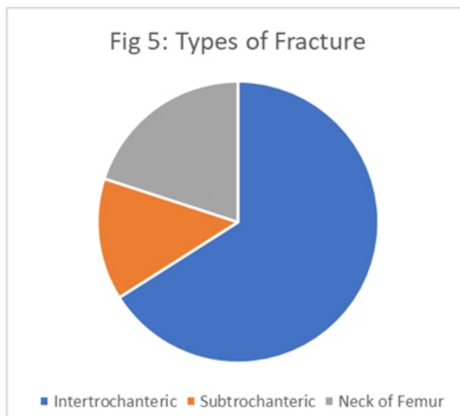

Figure 5: Types of fracture.

their body weight pushes downward on the femoral head, causing the greater trochanter of their femur to pivot. The body weight acts on a longer lever arm when FNSA is higher compared to a smaller FNSA [7]. A proximal femur fracture could result from this. Numerous research works have indicated a correlation between an elevated FNSA and the likelihood of hip fractures [8].

The majority of research that examined the relationship between hip fracture risk and FNSA were conducted in the western parts of the globe. In those regions, the FNSA is 125°–135° on average [9, 10]. In Indian population, the FNSA was found to be higher than western counterparts at 137.27 ± 7.23 for the right and 138.38 ± 6.65 for the left side [10]. Studies focused on Indian population to assess the risk of hip fractures and FNSA is lacking, and hence, this study would add valuable insight.

Materials and Methods

A cross-sectional comparative study conducted at a tertiary care center in western part of India. The study was conducted for 1 year starting from October 2022 and ending in September 2023 for a period of 12 months. The authors have obtained approval from the Institutional Ethics Committee and written informed consent from all patients included in the study.

Inclusion criteria included patients consenting for to study, who came to radiology department for pelvis with both hip X-rays, who were diagnosed with hip fractures, who had no fracture pathology, who were not previously operated on the unaffected side, who were skeletally mature.

Patients who were unwilling for the study, had bilateral hip fractures, and had underlying pathologies which altered proximal femur anatomy were excluded from the study.

Two groups created, one with hip fracture and another control group without fractures, matched for age in ranges of 10 years and gender.

Each radiograph was taken under same parameters. An anteroposterior plain radiograph of hip was taken with both hips visualized in same film. Cassette was placed directly underneath

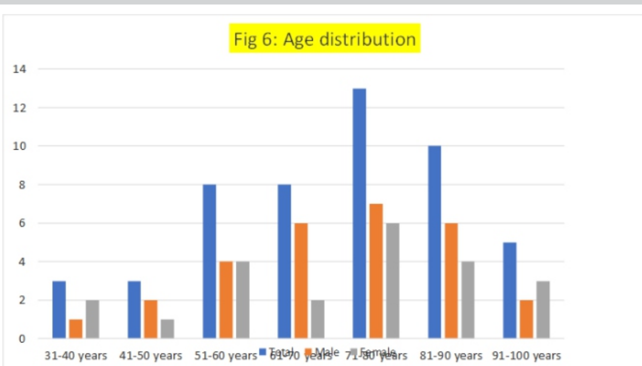

Figure 6: Age distribution.

Coefficients

	Estimate	Standard Error	Odds Ratio	z	Wald Test: Wald Statistic	Wald Test: df	Wald Test: p
FNSA	0.269	0.061	1.309	4.444	19.745	1	< .001

Note. Fracture level 'Yes' coded as class 1.

Figure 7: Logistic binary regression.

	Value
Sensitivity	0.760
Specificity	0.740

Observed	Predicted: No	Predicted: Yes	% Correct
No	37	13	74.000
Yes	12	38	76.000
Overall % Correct			75.000

Note. The cut-off value is set to 0.5

Figure 8: Performance metrics and confusion matrix.

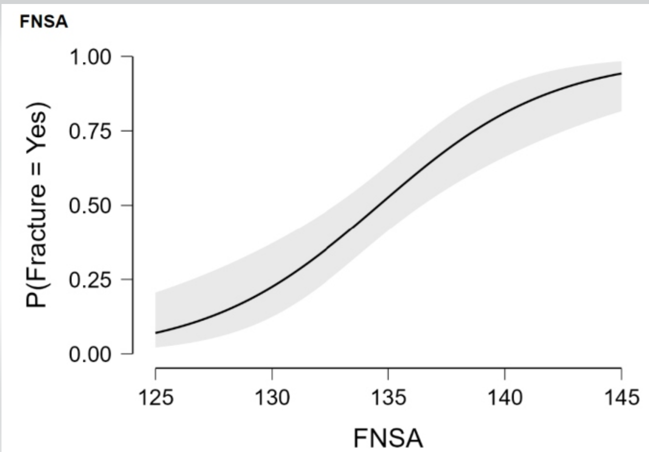

Figure 9: Estimate plot.

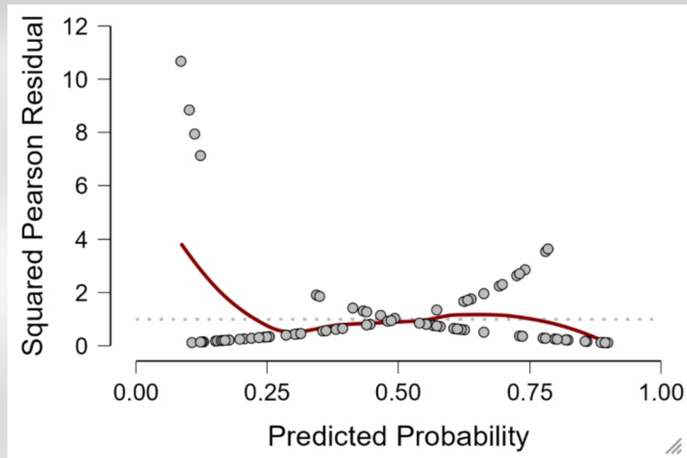

Figure 10: Squared Pearson residual plot.

Mean FNSA in fracture group	136.8
Mean FNSA in control group	132.3

Figure 11: femoral neck-shaft angle in both groups.

the pelvis with patient in supine position, to reduce magnification. Projection of X-rays was toward the middle of the line connecting the upper end of pubic symphysis to the line connecting both anterior superior iliac spines, at perpendicular. X-ray tube placed 1.2 m from the hip. Both knees extended with patella facing forwards and each limb internally rotated 15° to accommodate for femoral anteversion [11]. Internal rotation not done on fracture side (Figs. 1 and 2).

FNSA was measured on the unaffected side in patients with hip fractures. In control group, both sides were measured and their average taken. Central point at the proximal and distal ends of neck of femur were measured and these two points connected to form the mid axis line of neck of femur. Same process used to draw the mid diaphyseal line of femur shaft. Angle subtended by intersection of above two lines taken as FNSA (Fig. 3).

Binary logistic regression used to predict the probability of hip fractures using FNSA as independent variable. $P < 0.05$ was considered significant.

Results

Hundred patients were enrolled in the study, each group containing 50 patients (Fig. 4). Study characteristics shows no significant difference in the age and gender match control group to the fracture group. Intertrochanteric femur fracture was the most common hip fracture observed in the study population (Fig. 5).

Age distribution of the study group identifies 71–80 years as the modal group (Fig. 6).

On conducting a binary logistic regression with absence or presence of fracture being the dependent variable and FNSA being covariate, an odd's ratio of >1 identified, indicating the likelihood of higher FNSA values seen in fracture group than in control group. P value also found to be <0.05 hence significant (Fig. 7).

Sensitivity and specificity of FNSA as a prognostic tool for hip fracture may indicate a correlation between the two. According to the confusion matrix (Fig. 8), estimate plot (Fig. 9), and squared Pearson residual plot (Fig. 10), there appears to be a positive correlation between higher FNSA value and risk of femur fracture post-trauma.

No significant difference was noted between the FNSA of male and female patients in fracture group. FNSA was higher in fracture group than in control group (Fig. 11).

Discussion

We have noted an increased risk of hip fractures in patients with higher FNSA matched with their age and gender. This is confirmative of the findings noted in the previous studies [12, 13, 14, 15]. A study by Alonso et al. in Spanish population found that FNSA was significantly higher in fracture cases than in controls for both men and women [16]. They have noted that in logistic regression analysis adjusted by age, height, and weight, an increase of 1 SD in neck-shaft angle in men is associated with an odd's ratio of 2.45 in men and 3.48 in women. The use of FNSA with BMD value has been found to be a stronger predictor for risk of hip fractures than only BMD independently [17].

In a study in Iranian population, there was no significant association found between risk of hip fractures and FNSA [18]. Similar studies done in UK population have also not found an association between these factors [19].

In a study by Jung et al. [20], there was stronger fixation at the femoral head and neck in the valgus-reduced group due to a decrease in calcar referenced tip apex distance and an inferior location of the blade in the femoral neck using proximal femur nail antirotation for intertrochanteric fractures.

However, the associations found in this study are in a small sample size and further evaluation in larger study populations need to be conducted for conclusive evidence of FNSA as independent predictive factor for hip fractures. The study lacks long-term follow-up to assess if the controls chosen develop hip fractures and there is no conclusive method to identify if subjected to similar trauma as fracture group, they would not develop hip fractures.

Conclusion

Hip fracture risk appears to be increased in those with higher FNSA. Although the precise cutoff value is yet unknown, this link could serve as the foundation for prevention in individuals whose values are high – that is, >136° – according to this study. Further evaluation is needed for conclusive understanding of their relationship.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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