Original article:

Correlation between neck shaft angle of femur with age and anthropometry: A radiographic study

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Abstract

Introduction: Neck shaft angle of femur (NSA) and body mass index (BMI) are important determinants of fracture neck femur which is considered to be a health burden of our society.

Methods: In this study fifty people aged more than fifty years were selected consecutively after interview and examination in department of Radio diagnosis, Medical College, Kolkata. Neck shaft angle was measured on the skiagrams at the right side in twenty-five cases and at the left side for rest of the cases. Age, weight, height were recorded and BMI was calculated. Correlations between NSA and different parameters were determined after statistical analysis with Epi-info 3.5.1.

Observations & Result: Moderate correlation between NSA and BMI was found in cases with right sided skiagrams whereas strong correlation of NSA with weight was obtained for left sided cases. Moderate correlation was also seen between NSA and BMI in persons with normal BMI and with height in persons with high BMI. No correlation was found with age. Moderate to strong correlation was obtained between NSA and anthropometric parameters but not with age.

Conclusion: This study establishes correlation between neck shaft angle of femur and different anthropometric parameters. Moreover, any of them can be predicted if another variable is known.

Key words: Neck shaft angle, Body mass index, Correlation coefficient.

Introduction:

There are metric differences in skeletal components among populations and these variations are related to genetic and environmental factors. Several studies have found significantly greater femoral neck-shaft angles in hip fracture patients than in controls, whereas other has not [1, 2]. Moreover, body mass index (BMI) [Weight in kg/Height in meter^2] is also an important determinant of fracture neck of femur as well as nutritional status of a person [3]. So, we opted to find out correlation of neck shaft angle with different anthropometric parameters (weight, height, BMI) and age among the study population.

Material and Methods :

We conducted an observational descriptive study with cross-sectional design of data collection where patients were selected from the O.P.D. of Radio diagnosis, Medical College & Hospital, Kolkata. One day in a week was selected randomly and it came out to be Wednesday. Persons above 50 years of age coming for x-ray during study hours (10am-1 pm) were selected as study population. Every alternate patient was sent for right and left femur skiagram respectively. The first person was sent for right femur skiagram which was obtained randomly. Consent of the patient was taken in each case. Thereafter, interview of the patient was taken and thorough examination was performed to

exclude the diseases which could modulate the outcome of the study (Injury of the study part of limb, metabolic bone diseases, malignancy, renal failure, coxarthrosis). Total final sample size was 50 following inclusion and exclusion criteria. The study duration was from June 2010-May 2011.

Pelvic radiograms were taken with 15-30 degrees of internal rotation of the hips in the supine position. The beam centered on the symphysis pubis with a film-focus distance of 100 cm. 15 inch×12 inch films were used in this study. 100-120 KV with 80-90 mAs was applied for pelvic radiograms according to the physical status of the person.

Baseline values were recorded including weight, height, sex, age and body mass index. For measuring the weight the scale was placed on a hard, flat and even surface. The person was requested to stand atop the scale. He/she was asked to remain still for accurate calculation. No recording was taken until the dial stopped moving. The procedure was done thrice and average value was calculated. For measuring the height patient was asked to remove bulky clothing, including shoes and hair ornaments. The person was requested to stand against a wall facing outwards and look straight ahead with the Frankfurt plane. His or her head, shoulders, rear end and heels touched the wall. A ruler was gently pressed down on the top of the head. The spot was marked where the ruler touches the wall with a pencil. The person was asked to step away from the wall and a tape was used to measure the vertical height. Body mass index was calculated as weight (kilograms) divided by the square of height (metres). For measuring angle, femoral neck axis and axis of the shaft of femur were drawn over the radiogram and the angle was measured in between them by a protractor (Fig-1). Points of the lines were selected by the help of a transparent film having one longitudinal and few perpendicular lines (1 cm apart) on it. All the measuring techniques conformed to the existing literature [2, 4-8]. Collected data was tabulated in Microsoft excel 2007 spread sheet and was analyzed by Epi-info 3.5.1. Software.

Observations :

We conducted a study among 50 persons which included 17 males (34%) and rest females. Half of the femur x-rays were of right side and rest were of left side. Among the study population, 17 were normal weight (male 29.4%) whereas 28 were overweight (males 35.7%) and rest were grade II obese (male 40%). Mean age of the study population was 59± 4.63 years. Fig-2 & 3 shows distribution of study population acoording to NSA and different parmeters. Mean± standard deviation of different parameters of the study population were recorded as follows: weight (71.02 ±9.16 kg), height (1.64±0.06 meter), BMI (26.43±3.7 Kg/meter^2), NSA (125.04 ± 2.06cm). Table I & II shows mean ± SD of various parameters according to sex and type of femur respectively. 'P value < 0.05' indicates that the result is statistically significant.

Table I: Various parameters of study population according to sex. (n=50)

Parameters	Sex		Test of significance
	Male (n=17)	Female (n=33)	
Height (meter)	1.63±0.06	1.65±0.05	T=1.16, p=0.25
Weight(Kg)	70.65±9.39	71.21±9.17	T=0.20, p=0.84
BMI	26.69±3.93	26.29±3.65	T=0.36, p=0.72
NSA (degree)	125.53±2.18	124.79±1.98	T=1.21, p=0.23
Age (years)	58.70±4.68	59.59±4.62	T=0.64, p=0.52

Table II: Various parameters of study population according to type of femur. (n=50)

Parameters	Type of femur		Test of significance
	Right (n=25)	Left (n=25)	
Height (meter)	1.64±0.06	1.64±0.05	T=0.38, P=0.71
Weight(Kg)	70.40±8.8	71.64±9.6	T=0.48, P=0.64
BMI	26.25±3.48	26.60±3.99	T=0.33, P=0.74
NSA (degree)	125.12±2.22	124.96±1.93	T=0.27, P=0.79
Age (years)	59.48±4.16	58.52±5.10	T= 0.73, P=0.47

The quantity *r*, called the linear correlation coefficient, measures the strength and the direction of a linear relationship between two variables. The value of r is such that $-1 \leq r \leq +1$. The + and – signs are used for positive linear correlations and negative linear correlations, respectively.

$r = \geq +0.8$ or $\leq - 0.8$ indicate strong correlation.

$r = - 0.79 – -0.3$ or $+0.3 -- +0.79$ indicate moderate correlation.

$r = \leq +0.29$ or ≥ -0.29 indicate less or weak correlation.

$r = 0$ indicate no correlation[4, 8].

We found that correlation coefficient for NSA with weight, height, BMI and age were 0.14, 0.22, 0.22 and 0.0 respectively. So, weak correlation was obtained with weight but moderate correlation was found with BMI and height. It was also found that BMI and height had equal correlation coefficient with NSA while no correlation was obtained with age. The coefficient of determination, r^2, is useful because it gives the proportion of the variance (fluctuation) of one variable that is predictable from the other variable. It is a measure that allows us to determine how certain one can be in making predictions from a certain model/graph. The coefficient of determination is a measure of how well the regression line represents the data. If the regression line passes exactly through every point on the scatter plot, it would be able to explain all of the variation. The further the line is away from the points, the less it is able to explain[4, 7, 8].The r^2 values as well as regression equation of different parameters were depicted in table-III. The r^2 was all the way low for NSA.

Table III: shows linear regression equations for prediction of femoral morph metric indices taking height, weight, age separately and in combination as BMI. (n=50)

Parameters	With height	With weight	With age	With BMI
NSA	=138.893-8.442X ht	=122.88+0.03X wt	124.087-0.016Xage	=121.409+0.137X BMI
	r^2= 0.05	r^2= 0.02	r^2=0.00	r^2= 0.06

We then tried to find out the correlation coefficient for neck shaft angle with height, weight and BMI separately among males & females; among normal BMI persons & high BMI persons and right & left femur of the study population. The results are depicted in the table IV.

Table-IV: correlation coefficient for neck shaft angle in different groups.

	Among sex group		Among BMI groups		Among type of femur	
	Males (n=17)	Females (n=33)	Normal BMI(n=17)	High BMI (n=33)	Right (n=25)	Left (n=25)
NSA with BMI	0.173	0.283	**0.316**	0.265	**0.316**	0.173
NSA with height	0.265	0.173	0.265	**0.412**	0.20	0.265
NSA with weight	0.00	0.2	**0.447**	0.1	0.173	**0.819**

For NSA with BMI: only moderate correlation was obtained with normal BMI individuals and in right sided cases. Poor correlation was found with both males and females. So, neck shaft angle (NSA) is not a good parameter for calculating BMI although in normal BMI individuals and in right sided cases it shows moderate correlation.For NSA with height: poor correlation was found in both sexes. Only moderate correlation was obtained in high BMI individuals. Poor correlation was also found in both right and left sided cases. So, neck shaft angle is not a good predictor for height except in high BMI cases. For NSA with weight: strong correlation was found in left sided cases. Moderate correlation was obtained with normal BMI individuals. Poor correlation was found in both sexes. So, in normal BMI individuals weight is a good predictor for NSA but it is the best predictor in left sided cases.

Discussion:

For the hip fracture of the femoral neck, the shape of the proximal femur can be considered as an important risk factor, irrespective of bone mass or bone strength. A bone can get fractured when it is subjected to stress more than its bearable ultimate strength[9]. The stress within a bone depends on its geometric arrangement and its composition along with the direction and amount of the force applied [10- 12]. The risk of hip fracture is predictable using some factors, like body mass index (BMI), bone mineral density (BMD), the direction and severity of the fall, body habitus, muscle

strength, family history of inherited bone disorders and lifestyle factors [2, 4, 8].

This evidence suggests that neck shaft angle, may be an important factor in determining hip fracture risk. However, there are discrepancies concerning the effect of neck shaft angle on fractures. These discrepancies may be due to racial differences in proximal femoral morphometry among populations [13, 14]. Geometry of the femur is also involved in the resistance of bone against impact, the highest values being found in races with a higher incidence of hip fracture [9, 15, 16]. Some frequently described measurements that have been associated with an increased risk of fracture include a longer hip axis length of femur [6, 9, 17]; a larger femoral neck-shaft angle [5, 6, 9, 11, 17] and a larger femoral neck width [5, 6, 9, 17]. J. Irdesel and I. Ari (2006) found weak correlation between neck shaft angle and body mass index (BMI) [18]. In the present study, NSA has no significant correlation with weight, height, BMI and age. Moderate correlation was found with BMI in normal BMI individuals and in right sided cases. Moderate correlation was also found with height in high BMI cases and with weight in normal BMI cases. Strong correlation was obtained with weight in left sided individuals. So, it is the best predictor of NSA.

Conclusion :

So, the present study establishes the relation among neck shaft angle and sex, weight, height, BMI of the population. Moreover, if one variable is known, the other one can be predicted.

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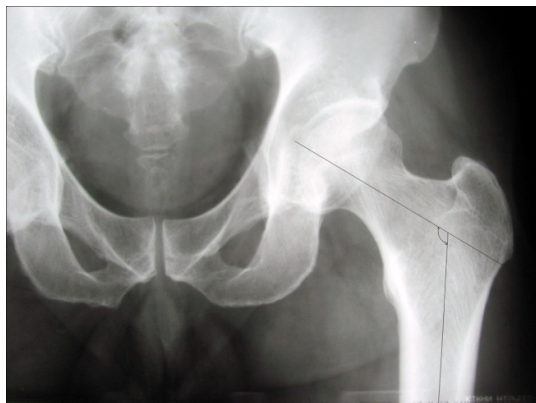
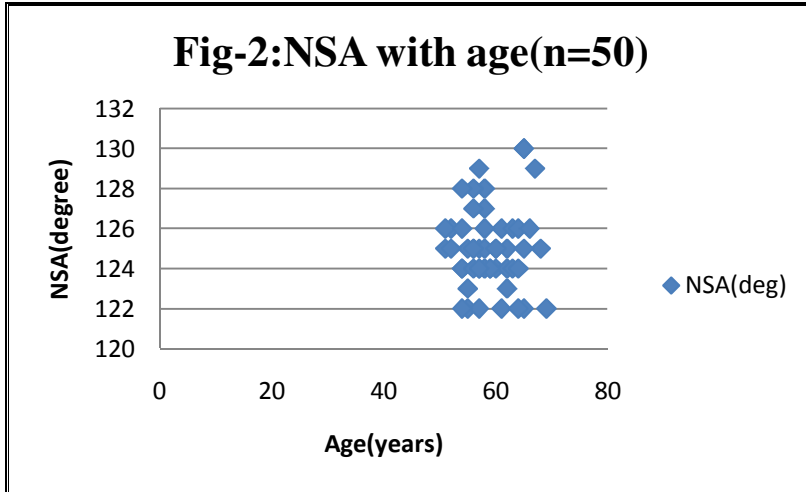**Fig-1:** Antero-posterior skiagram of left hip joint showing neck shaft angle of femur.

Fig-2: scatter diagram showing distribution of study population according to NSA (degree) and age (years).
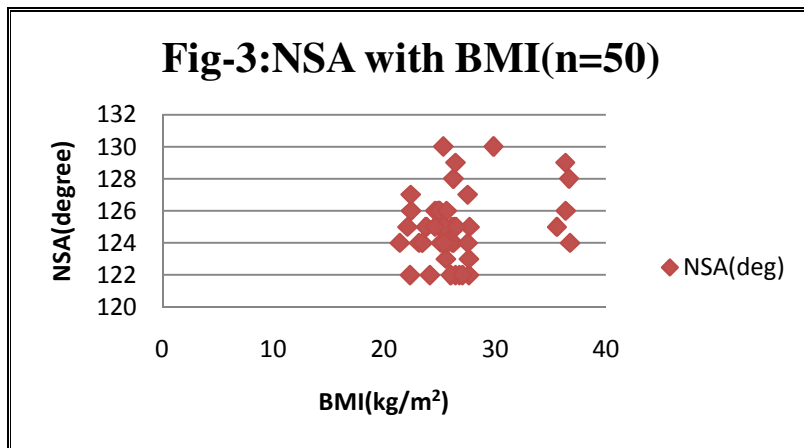

Fig-3: Scatter diagram showing distribution of study population according to NSA (degree) and BMI (kg/m^2).