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Femoral Neck Shaft Angle in an Adult Population in Southeast Nigeria

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The Neck Shaft Angle is an important morphological feature of the proximal femur. It plays an important role during walking. It is also an important parameter during the orthopaedic evaluation of the proximal femur especially when planning for total hip replacement. This angle has been found to vary among individuals of different race, ethnicity, age groups and gender. The aim of this study is to establish the normal value of femoral neck shaft angle among the Igbos in Enugu, Southeast Nigeria. This cross-sectional study involving the retrospective assessment of 109 normal hip radiographs of 49 males and 60 females aged between 25 and 80 years was done at the University of Nigeria Teaching Hospital Ituku-Ozalla Enugu. Using a handheld goniometer, the angle formed by the intersection of the longitudinal axis of the neck with that of the longitudinal axis of the femoral shaft was measured. The Neck Shaft Angle for both sexes ranged from 127-144° with a mean of 135.16±3.86°. The mean value in the males (135.94±4.42°) was greater than the mean in females (134.52±3.42°) though the difference was not statistically significant (p=0.055). The study established the normal NSA among the Igbos of Southeast Nigeria which will be helpful during the clinical assessment of patients and serve as a guide when choosing orthopaedic implants.

Keywords: Femoral neck shaft angle, proximal femur, regional variation, Southeast Nigeria

INTRODUCTION

The proximal femur is prone to many paediatric and adult disorders and researchers have continually worked on several parameters that define the proximal femoral geometry (PFG) and the relationship between the femoral neck and shaft (Ravichandrain et al., 2011). Parameters that define this relationship include the Neck-Shaft Angle (NSA), Femoral Head Diameter and Neck Version (Patron et al., 2006).

The femoral neck shaft angle (NSA), also referred to as collodiaphyseal angle, diaphysio-femoral angle, angle of the neck of femur, angle of inclination or Mikulicz angle is formed by the long axis of the proximal femoral shaft and femoral neck axis. (Jiang et al., 2015; Pathak et al., 2016,). This angle is of importance during walking, since it is required to allow the femoral shaft swing clear of the pelvis and also to control gait. (Adekoya-Cole et al., 2016). It is an important clinical tool in the clinical assessment of the hip and proximal femur and also an essential parameter during orthopaedic procedures. It can be useful when planning for surgeries like fixation of

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femoral neck surgeries and designing of orthopaedic implants and hip prosthesis (Boese et al., 2016; Jiang et al., 2015; Pathak et al., 2016). In addition, it helps in detecting hip fractures (Adekoya-Cole et al., 2016; Pajarinen et al., 2004)

Adult values for the normal NSA for humans generally fall within a range between 120° and 140°. Any deviation from the normal values indicates pathology or fracture of the femoral neck. An NSA of greater than 140° (Coxa Valga) is often associated with increased risk of proximal femoral fracture, genu varum and knee arthritis while coxa vara, an NSA of <120° is associated with conditions like greater trochanteric pain syndrome, Paget's disease of bones, osteogenesis imperfect and others.(Gilligan et al., 2013; Sankar et al., 2009; Sharma et al., 2018)

Femoral neck-shaft angle has been reported to display population variations. In a study on East Africans, the mean value of the NSA was found to be different among Kenyans, Ugandans and Malawians (Igbigbi 2003). Such inter-population difference of the NSA has been attributed to varying human activity levels and genetic makeup. Other factors like sex, diet and lifestyle have also been implicated. (Gilligan et al., 2013; Jiang et al., 2015)

The NSA changes during early development. It is noted to be higher in neonates and decline during childhood. It assumes adult values by adolescence, after which it remains stable, although there may be a minor further decline with advancing age (Gilligan et al., 2013)

Since regional variation in the value of Neck Shaft angle exists, it is imperative to study the NSA in the population under study as this information will enable orthopaedic surgeons to predict more accurately especially in the pre-operative selection of implants and in procedures like fixation of femoral neck fractures. It will also be useful in determining the gender of individuals from skeletal remains especially for medico-legal issues (Adekoya-Cole et al., 2016).

To the best of the researcher's knowledge, the normal value of this important parameter has not been established among the Igbos in Southeast Nigeria. The present study, therefore, is aimed majorly at establishing the normal value of femoral neck shaft angle in Enugu, Southeast Nigeria.

MATERIALS AND METHODS

This retrospective study was conducted at the University of Nigeria Teaching Hospital Ituku-Ozalla Enugu. It involved the measurement of NSA from archived plain AP pelvic radiographs. One hundred and nine plain radiographs of the pelvis of forty-nine adult males and sixty female plain pelvic radiographs archived in the radiology film were selected for the study. To qualify for selection, patients' age and gender must be available on the reports and the radiological report must be normal. All cases with evident pathology, poor patient positioning, presence of callus formation indicative of healing fracture and history of previous hip or femoral surgery were excluded. The patients selected were 25years and above. This was because this is the age ossification of the femora is normally completed. The radiographs reviewed were pulled from the departmental archives and were pelvic x-rays done between January 2013 and December 2015. A standard protocol for x-ray of the pelvis was adopted in producing the radiographs. This included supine position, 15-30° Internal rotation of the hips, film focus distance (FFD) of 100cm and central beam centred at the pubic symphysis. The study was approved by the Ethics Committee of the University of Nigeria Teaching Hospital.

Instruments for measuring the NSA included a viewing box and a hand-held goniometer. With the film mounted on the viewing box, the goniometer was used to measure the angle formed by the intersection of the longitudinal axis of the neck with that of the longitudinal axis of the femoral shaft. The longitudinal axis of the neck was obtained by joining two midpoints of the diameters of the neck and the head of the femur while the longitudinal axis of the shaft of the femur was drawn by joining the midpoints of two points on the proximal femoral shaft, distal to the lesser trochanter. The angle formed by the intersection of the two axes was read off as the femoral NSA (Figure 1). All measurements were done by two researchers independently and blinded to each other's findings. The average of their measurements was recorded.

The outcome of the measurement was recorded and analyzed using the Statistical Package for Social Sciences version 20.0. The mean, mode and standard deviation were calculated and Unpaired t-test was carried out at 5% level of significance.

RESULTS

The age range of the participants was 25-80 years. The mean age was 48.83±15.63years while the modal age group was above 60 years (26.6%). Males were 49 while 60 females participated in the study. (Male: Female ratio of approximately 1:1.2). The NSA ranged between 127-144^0 with mean of 135.16±3.86^0 for both sexes. Most of the participants had their femoral neck shaft angle lying between 131-135^0 as shown in Table 1.

The NSA in males ranged from 127-144°. The mean value for male NSA was 135.94°±4.24°. The value in females ranged from 130-142° while the mean value was 134.52°±3.42° for females. An unpaired t-test revealed no significant difference, $p = 0.055$ between the male and female NSA mean values. (Table 2)

The mean neck shaft angle for the different age groups is shown in Table 3 and Table 4. Comparing them, ANOVA revealed a significant difference, $F (4, 55) = 7.271$, $p < .001$. There was a weak positive relationship between the age and the femoral neck shaft angle of the participants, $r = .199$, $p = .038$ as shown in Table 5

DISCUSSION

The femoral neck-shaft angle is an important anatomic parameter especially in the evaluation of hip biomechanics. (Pathak et al., 2006). A high NSA of greater than 140 degrees (Coxa Valga) is often associated with increased risk of proximal femoral fracture, genu varum and knee arthritis while coxa vara,

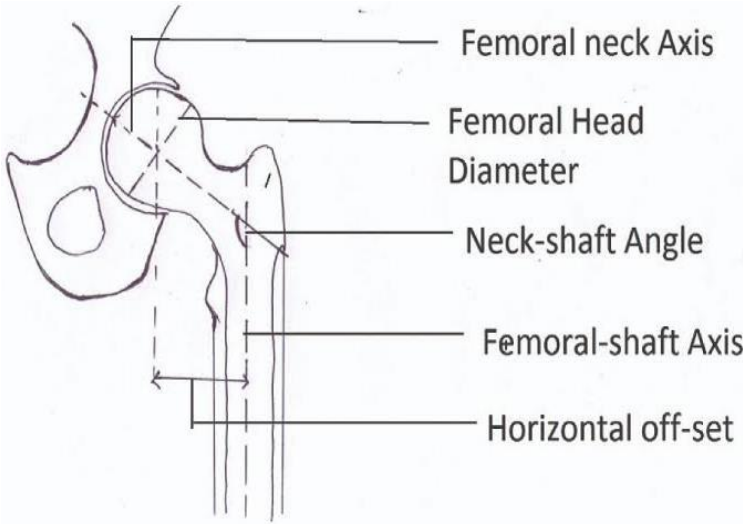

Figure 1: Measurement of the NSA

an NSA of <120 degrees is associated with conditions like greater trochanteric pain syndrome, Paget's disease of bones, osteogenesis imperfect and others. (Ravichandrian et al.,2011; Sharma et al., 2018). The NSA has been found to vary between populations (Lakati et al., 2017; Pathak et al., 2006), therefore establishment of regional ranges is necessary and beneficial to clinical orthopaedics.

The NSA for both sexes ranged from 127-144°, with a mean value of 135.16±3.86°. For the males, the mean value of 135.94±4.24° was obtained while 134.52±3.42° was obtained for the females. These values were observed to lie within the normal range reported by Lakati et al, (2017).

Though the NSA values reported in this current work lie within the normal range, the mean values differ from values reported within and outside the African continent as seen in the findings of previous researchers (Adekoya-Cole et al., 2016; Gilligan et al., 2013; Igbigbi, 2003; Jiang et al., 2015; Lakati et al., 2017; Otsianyi et al., 2011; Pathak et al., 2016; Ravichandrain et al., 2011). Factors responsible for these variations include age, sex, laterality and ethnicity. Clothing peculiarities and lifestyle are also thought to influence the NSA. (Jiang et al, 2015).

The mean value obtained in this study is slightly higher than the value reported by authors of similar works in Nigeria. Adekoya-Cole in Lagos, South-Western Nigeria reported a mean NSA value of 130.77±6.03°. Udoaka and Agi (2010) reported a range of 130.3-133.7 in a South-Southern Nigeria population. These inter-ethnic variations may be as a result of different cultural and dressing habits (Elbuken et al., 2012; Tahir et al., 2001). Elbuken et al (2012) are also of the opinion that ethnic differences in NSA are possible as a result of the ethnic differences in body size and shape which can affect the mechanism of the hip. Otsianyi et al (2011) studied many ethnic groups in Kenya and reported significant differences in the mean NSA among the different ethnic groups. The authors observed that highland farmers had lower NSA values than the nomads and attributed this to their varying activities. Climatic factors and adaptation, as well as habitual activity patterns, are possible factors which may also cause variations in the NSA (Gilligan et al., 2013; Sharma et al., 2018). Gilligan et al., (2013) reported that NSA is higher in warmer regions and that sedentary or mobile lifestyle influence the NSA value being lower among the sedentary individuals while people who are engaged in greater physical activity having higher values.

Like findings of other authors, the mean NSA in males reported in this study was greater than the mean in females (Adekoya-Cole et al., 2016; Nwoha, 1991; Tahir et al., 2001; Udoaka and Agi., 2010) Findings from this study reported no significant difference between sexes even though the males tended to have higher values than females. The lower values observed in women could be attributed to their wider pelvis, shorter femur and greater bi-condylar angle (Adekoya-Cole et al., 2016).

This study reported a weak positive relationship between the age and the femoral neck shaft angle of the participants, (r = .199). This is consistent with findings of other researchers (Boese et al., 2016; Elbuken et al., 2012; Tahir et al., 2001). The NSA is reported to decrease progressively, reaching adult value at adolescence even though a little further decline is observed with advancing age (Sharma et al., 2018).

Table 1: Characteristics of the Subjects n = 109

		f	%	
Age (years)	≥30	17	15.6	
	31-40	20	18.3	
	41-50	26	23.9	
	51-60	17	15.6	
	> 60	29	26.6	
	Range			18-80
	M±SD			48.83±15.63
Sex	Male	49	45.0	
	Female	60	55.0	
FNSA	$\leq 130^0$	18	16.5	
	$131\text{-}135^0$	51	46.8	
	$136\text{-}140^0$	33	30.3	
	$> 140^0$	7	6.4	
	Range			127-144
	M±SD			135.16±3.86

FNSA: Femoral neck shaft angle

Table 2: Gender Difference in Femoral Neck Shaft Angle (n = 109)

Sex	n	Range	Mean	Mean Difference	T	df	p-value
Male	49	127-144	135.94±4.24	1.422	1.938	107	.055
Female	60	130-142	134.52±3.42				

Table 3: Age and Femoral Neck Shaft Angle of Males (n = 49)

	n	Range	Mean	F	df	p-value
≤ 30 years	6	130-135	131.67±1.97	14.809	4, 44	< .001
31-40 years	11	127-140	132.36±3.70			
41-50 years	9	134-139	135.67±1.66			
51-60 years	7	130-140	136.71±3.86			
> 60 years	16	134-144	139.81±2.59			

Table 4: Age and Femoral Neck Shaft Angle of Females (n = 60)

	n	Range	M±SD	F	df	p-value
≤ 30 years	11	131-140	136.27±2.53	7.271	4, 55	< .001
31-40 years	9	131-140	134.44±2.65			
41-50 years	17	130-142	136.24±3.70			
51-60 years	10	130-139	134.20±3.05			
> 60 years	13	130-135	131.08±1.55			

Table 5: Relationship between Age and Femoral Neck Shaft Angle (n = 109)

	n	M±SD	Pearson Correlation	p-value
Age	109	48.83±15.63	.199	.038
FNSA	109	135.16±3.86		

CONCLUSION

The study has determined the normal femoral neck shaft angle among the Igbos of Southeast Nigeria. This will be particularly useful in the diagnosis and management of the disorders of the hip and proximal femur and the design of hip implants and prosthesis.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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