ORIGINAL ARTICLE

FEMORAL NECK ANTEVERSION: IS THE SIDE WISE DIFFERENCE SIGNIFICANT?

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ABSTRACT

Background: Femoral anteversion is one of the most important parameter of femur anatomy and geometry having important clinical implications. The objective of this study was to determine the side wise variation in femoral neck anteversion angle in adult dry femora of a local Pakistani population.

Material & Methods: We studied 211 dry adult femora, free of disease, by Kingsley Olmsted method to determine femoral anteversion angle. The angle of femoral neck anteversion was determined by measuring the angle between the long axis of the neck of femur in horizontal plane and the transverse retrocondylar line taken as the plane of the axis of shaft of femur in coronal plane.

Results: Out of 211 femora, right and left side distribution was 103 (48.8%) and 108 (51.2%) respectively. The mean femoral neck anteversion angle in degrees for right femur was 8.4° ± 8.9° (-19 to 27) with a range 46.0 and for left femur it was 7.8° ± 10.5° (-27 to 35) with a range of 62. The difference between the two femora was non significant statistically (p=0.642).

Conclusion: Right vs left side variation for the femoral neck anteversion angle was non significant in our population.

KEY WORDS: Femoral neck anteversion; Retrocondylar line; Femoral neck axis; Coronal plane; Horizontal plane.

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INTRODUCTION

Femur bone is one of the most studied bones of human being both by anatomists and orthopedists measuring its different parameters of anatomy because of its relation to different clinical conditions.[1-3] Femoral neck anteversion (FNA) is one of the most important parameter of femur anatomy and geometry having important clinical implications[2, 3]. Its consideration and correction is considered a crucial step in total hip arthroplasty and hemiarthroplasty.[2,4]

A review of the global literature reveals a wide range of normal FNA angle with racial and geographic variation. This variation is expected to exist because of genetic composition and social needs of different nations. Differences in the mean FNA value for right and left sides and gender wise have been documented by a lot of studies.[2,4] It can be measured by various methods but measurement on dry femur is the gold standard.[3] There is no study done on this important topic in our region.

Knowing the side to side differences for a particular population is of extreme importance as a lot of studies through out the world have shown right vs. left femoral anteversion angle differences.[2, 4-15] Knowing right vs. left FNA mean value and difference if any for our population will help in planning arthroplasty and correcting different deformities about hip and understanding normal from abnormal in different clinical conditions of the hip e.g. developmental hip dysplasia, perthes disease, slipped capital femoral epiphysis, coxa vara, rickets and lower leg deformities like intoeing etc.[2-4]

The objective of this study was to determine the side wise variation in femoral neck anteversion angle in adult dry femora of a local Pakistani population.

MATERIAL AND METHODS

This cross-sectional study was conducted at the Department of Orthopaedics, Hayatabad Medical Complex, Peshawar, Pakistan from August 2010 to February 2011. A sample of 211 unpaired dry skeletally mature human adult femora from heirless

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dead bodies was collected from anatomy musea of Khyber Medical College, Gandahara Medical College and Khyber Girls Medical College, Peshawar. Broken bones, immature unossified (children) bones, and those having deformity (e.g. bowing) or malshaped by disease (e.g. osteoarthritis) were excluded.

The femoral anteversion angle was measured by Kingsley and Olmsted method which is considered to be the most accurate method because of standardization of the procedure.[5] The femur specimen was placed at the horizontal smooth experimental table. Two smooth blocks of equal thickness were placed one each under proximal and distal ends of the femur so that proximally posterior aspect of the greater trochanter was rested on the block and distally posterior aspect of both femoral condyles was rested on the other block. (Figure 1)

The blocks were used for the retroverted femora, if any, to allow for downward rotation of the head of the femur in space when placed on a horizontal surface, as the table surface will block the rotation of the head in retroverted femora which is angling downward in these femora when placed on horizontal surface. The longitudinal axis of the neck of the femur in horizontal plane was determined by bisecting the anteroposterior diameter of the neck both at proximal and distal ends with the help of Vernier calipers (Figure 2) and to make it easy, a small sized smooth K-wire was mounted along the proximal and distal bisecting points. Angle of the femoral anteversion was determined with the help of goniometer. The horizontal limb of a goniometer was fixed at the surface of the experimental table. The vertical limb was held parallel along the longitudinal axis of neck of the femur (i.e. along the K-wire). The horizontal surface represents the axis of the shaft of femur in coronal plane and the plane of reference against which the anteversion is measured along the axis of neck of femur in horizontal plane (Figure 2). The angle subtended was recorded. Each femur was studied by two examiners for accuracy.

Laterality, femoral neck anteversion angle in degrees and categories of femoral neck anteversion angle were the three research variables. Femoral neck anteversion angle was categorized broadly as A: Anteverted (all femora having +ve FNA value including those having zero value and B: Retroverted (all femora having –ve FNA value). Category A was further divided into i: Mildly anteverted (0 to 5°), ii: moderately anteverted (6 to 15°), iii: severely anteverted (16 to 25°), iv: markedly anteverted (> 25°). Similarly category B was further divided into i: mildly retroverted (-1 to -5°), ii: moderately retroverted (-6 to -10°), iii: Severely retroveted (-11 to -15°), iv: markedly retroverted (< -15°).

Data collected on a proforma was entered and analyzed in statistical software SPSS V.16 (SPSS., Inc, IL,USA). The data of laterality was nominal, and of category of femoral neck anteversion angle was ordinal, hence descriptive statistics were presented as frequency (number) and relative frequency (%). The data of femoral neck anteversion angle in degrees was ratio (quantitative), hence descriptive statistics were presented as mean, SD, minimum, maximum, and range. The inferential statistics for femoral neck anteversion angle were carried out by applying independent sample *t* test. Alpha value of 0.05 was considered as statistically significant.

RESULTS

Out of 211 femora, right and left side distribution was 103 (48.8%) and 108 (51.2%) respectively. The mean femoral neck anteversion angle in degrees for right femur was 8.4° ± 8.9° (-19 to 27) with a range of 46.0, and for left femur it was 7.8° ± 10.5° (-27 to 35) with a range of 62.0. The difference of means of femoral neck anteversion angle between the

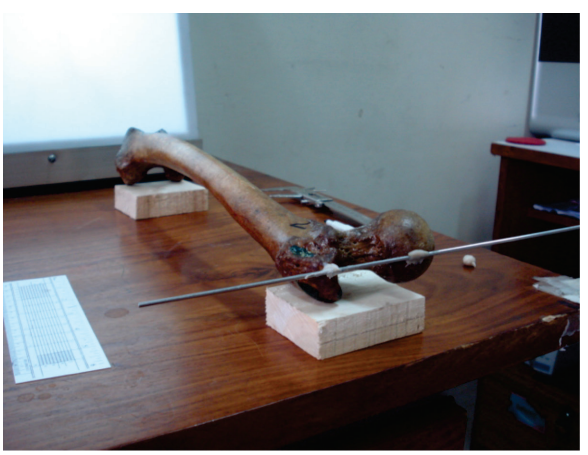

Fig. 1: Femur placed for Femoral Neck Anteversion Angle Measurement.

Fig. 2: Femoral Neck Anteversion Angle Measured by Goniometer.

Table 1: Categories of Side wise distribution of femoral neck anteversion angle.

Category	Subtype	FNA	Rt Femur		Lt Femur	
			Frequency	%	Frequency	%
A	i. Mildly Anteverted	0 to 5°	23	22.3	8	7.4
	ii. Moderately Anteverted	6 to 15°	38	36.9	47	43.52
	iii. Severely Anteverted	16 to 25°	24	23.3	23	21.3
	iv. Markedly Anteverted	> 25°	2	1.94	2	1.85
B	i. Mildly Retroverted	-1 to -5°	11	10.7	15	13.89
	ii. Moderately Retroverted	-6 to -10°	3	2.9	8	7.4
	iii. Severely Retroveted	-11 to -15°	1	0.97	3	2.78
	iv. Markedly Retroverted	< -15°	1	0.97	2	1.85
	Total	-	103	100	108	100

Table 2: Side wise inferential statistics for femoral neck anteversion angle.

Side	n	Mean	SD	t-value	DF	p-value (2-tailed)	CI 95%
Right	103	8.4	8.9	.465	209	.642	-2.02 to 3.27
Left	108	7.8	10.5				

right and left femora was statistically non significant (p=0.642). (Table 1)

DISCUSSION

Studies to find the average anteversion in normal population are available mainly by direct observations on dry bones. The angle of anteversion of the neck of the femur varies through a wide range, thus making it extremely difficult to determine normal range for a society. The pioneering studies by western authors found it to range from -25° to +50° with the mean angle varying from 8 to 28°.[4-8] According to Gray's anatomy, the average value is 10 to15°[16] and orthopedics books quote it to range from 10° to 30°.[17]

The prototype study is that of Kingsley and Olmsted in this regard who have standardized the procedure to measure the actual FNA angle. The overall FNA mean value and higher mean value on right side very closely matches this study (8.02° overall mean and 8.54° and 7.47° for right and left femora respectively in Kingsley and Olmsted study).[5] These authors have not applied any test of significance so that we do not know whether the difference was significant or not.

The most important point in our study was that the mean FNA on right side was more than the left side but the difference was not statistically significant. Right to left side differences in femoral anteversion have been documented in several studies including Western, African and Indian ones. Some studies have found significantly higher values of FNA value for right bones and some have found the other way round. Still some studies have negated any significant difference as has been shown by our study.[4-15, 19]

One other important aspect of our study was that majority of the femora (82.5 % femora on right and 72 % on left side) showed an angle between zero to 25. The other striking feature is that more left sided femora showed retroversion than right side (28 left femora vs 16 right femora).

Overall our mean value of FNA was not only different from English and Western society but also different and lower as compared to African and other Asian populations. It was very close to the Indian studies with which we share environment and social way of life as follows.

Schachar et al did a very important study in this regard which seems to be very convincing as they have done a polyethnic study by measuring FNA angle on dry bones of three different races, namely European, African and two Asian groups using same method and same setting. This study shows gross differences between the mean FNA values of different races. Their result showed 15.7° mean FNA value for African, 11.1° for European, 23.0° for Asian and 33.4° for the Inuit group which was a subpopulation of Asian group. This study sounds as the bias of different technique of measurement was eliminated.[18]

Similarly a study conducted by Eckhoff and colleagues demonstrated a higher value of FNA mean on dry femora in African skeletal population

as compared to the present study (19° vs. 8.1°) with a significant variation between right and left sides (21° vs. 17° respectively). They concluded that increased anteversion complements previous reports in African society.[9]

The lower angle in our society matching more closely to the Indian population may be a racial characteristic or it may be of developmental origin. The smaller angle in our population and the Indians, can be attributed to similarity in genetic composition, diet and social activities. Kate and Robert (1963) have suggested that it may be associated with the squatting and floor level activities requiring extreme of lateral rotation at the hip.[8]

The important reason for the great disparity between different studies of the same populations may also be due to different methods adopted to measure the angle. Different investigators have used different axes at proximal and distal end of femur to define the FNA which are going to produce different results.[19, 20]

Jain et al (Indian-2005) measured FNA value on 300 dry femora by same Kingsley method and their overall FNA mean also was exactly the same as ours i.e. 8.1° but the mean FNA value for right bones was significantly lower (1.7°) than left side, this difference being statistically significant[2]. Zalawadia et al (Indian-2010) studied 92 dried femora and the mean value of FNA found was 12.4°. They found a statistically significant difference between the right and left side femora in both sexes being 6.4° higher on left side.[13]

Parson (1914- English femora) study also showed increased FNA mean of 15.3° with increased FNA mean on right side.[11] Kate (1976) studied 108 dried femora belonging to Indian nationality and the mean of the sample was very close to the present study (8.8°). The right side bones showed higher mean than left side (9.0° and 8.6° for right and left side respectively); although Kate did not apply test of significance to see whether the difference was statistically significant or not.[12] Greater anteversion for right side has also been calculated by Le Damany (1903)[15] in Caucasians.

Verlekar et al studied 200 dried femora in India and there was a higher mean (15.8° and 18.1° for males and females respectively) for FNA with a statistically significant differences between FNA means of right and left femora (16.1° and 15.7° respectively) value being higher for right side femora as compared to left side.[14] Ramos in India did a very important study and his study revealed more FNA mean for left side femora against the right femora with narrower range for right femora in contrast to left bones (-9 to -29 for right and -20 to -36 for left bones).[4] Similarly Rokade did his study on 144 dry femora and the mean for the left side was calculated to be significantly higher.[10]

On the contrary Yoshioka and colleagues[19] (1987) studied paired femora and found no statistical difference between right and left sided femora, although there were differences in the angle between the right and left sides of the same individual.

Now it is clear that some studies have shown the mean FNA angle more on right side, some have shown it more on left side and still some studies like ours have proved no statistically significant differences between the right and left sides. Most of the authors noting differences in side to side FNA angle and mentioned here, have not used paired femora which may be more important for the true difference between right and left sides than unpaired femora.[5] Further more majority of these studies have shown a very large standard deviation and range in their studies for FNA angle which needs a very large number of right and left side femora to be studied to draw a very authentic conclusion.

As it is not only important to know FNA mean value for our society but also to clarify the concept of FNA differences on both sides, further studies are needed especially on paired femora. It is also very important to standardize the procedure for the measurement of FNA on dry bones, as different procedures may lead to different results.

It is a small scale study but it will lay a foundation for further studies to reach at a firm conclusion regarding the side variation of FNA value in our society.

CONCLUSION

Right vs left side variation for the femoral neck anteversion angle was non significant in our population.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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