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Original research article

A Study on Femoral Neck Anteversion and its Radiological Correlation in Population of North Bihar

Dr. Pallavi Priyavadini[1], Dr. Neha Nupur[2], Dr. Dr. Rashmi Kumari[3], Dr. Seema Tabassum[4], Dr. G. K. Mishra[5]

[1]3rd year PG, Department of Anatomy DMCH Darbhanga

[2]3rd year PG, Department of Anatomy DMCH Darbhanga

[3]3rd year PG, Department of Anatomy DMCH Darbhanga

[4]Associate Prof. Department of Anatomy DMCH Darbhanga

[5]Prof. & Head, Department of Anatomy DMCH Darbhanga

Corresponding Author: Dr. Seema Tabassum

Abstract

Background and Objective: Anatomists and orthopaedics have long been interested in the femoral neck anteversion angle (FNA) since it is widely recognised as an important factor for hip stability. To study radiological correlation with the morphometric Femoral neck anteversion angle.

Method: The cross sectional study with purposive sampling. 100 Dry Femora of known sex and side available at Department of Anatomy, The study was conducted after receiving approval from the Ethical Committee of DMCH Darbhanga. Study duration of Two years.

Conclusion: In the present study, the mean FNA angle measured Physically and Radiologically were 13.22° and 15.65° with Standard Deviation of 4.20 and 4.65 respectively. The range was from 5°-27° on physical measurement and from 6°-29° on radiological measurement. **Keywords:** FNA**,** dysplasia, congenital dislocation of the hip.

Introduction

Anatomist and orthopaedics have long been interested in the femoral neck anteversion angle (FNA) since it is widely recognised as an important factor for hip stability[1-4]. It is multifactorial result of evolution, heredity, foetal development, intrauterine position, and mechanicalforces[1]. Abnormal FNA sometimes can be associated with many clinical problems ranging from harmless intoeing gait in the early childhood, which could be a reason for parents concern for children future, to disabling osteoarthritis of the hip and the knee in the adults[1]. The femoral neck anteversion (FNA) is the inclination of the axis of the femoral neck with reference to the knee axis i.e. intercondylar axis, projected on a plane perpendicular to the shaft axis. A line passing through the centre of the femoral head & neck (bisecting the cervical cortex) and meeting the shaft axis at right angle represents the axis of the femoral neck. The coronal line passing through the femoral condyles represents the knee axis. The FNA describes the normal torsion or twist present in the femur measured as the angle between these two axes[5]. Femoral anteversion is a physiological condition, within certain variations in degrees and differences depending on age[1,8]. The normal values given for the FNA for children and adults differ considerably in the available literature. Different techniques of examination, as well as different population, may explain the different results. Torsion is extension of a normal developmental process of lower limb. Negative torsion in human embryonic femurs has much variations. There is an initial negative torsion of up to

26°, followed by the development of positive femoral anteversion averaging 25°–31°, at birth. No histological changes have accounted for the torsion, but there may be a tendency for sidedness, especially in females. Most torsional abnormalities are the result of intrauterine moulding, and are extreme manifestations of normal development. Determination of femoral torsion by radiographic methods is useful when surgical correction is contemplated. Accuracy of 5°-10° is believed to be clinically sufficient. There are several radiographic methods for measuring femoral torsion. Most are based on geometric and trigonometric calculations. The fluoroscopic method is not a precise and reproducible one. The orientation of the femoral neck is well suited to be depicted by transverse sections obtained by computed tomography (CT). Compared with the anatomic reference, CT imaging is an accurate and valid technique for measuring the femoral anteversion. In contrast biplane radiography demonstrated significant inconsistencies in the measurement as seen by Y. Kuoet al[9].
In our study, we have measured the FNA in dry femora physically as well as by biplane radiography. Physical measurement is done by Kingsley Olmsted method.

Objectives
*To study the Femoral neck anteversion (FNA) angle in dry femora.
*To study radiological correlation with the morphometric Femoral neck anteversion angle.

Material and Method
The cross sectional study with purposive sampling. 100 Dry Femora of known sex and side available at Department of Anatomy, The study was conducted after receiving approval from the Ethical Committee of Darbhanga medical College and Hospital Darbhanga, Laheriasarai. Study duration of Two years.
Femoral neck anteversion angle (FNA) bears a clinical importance ranging from intoeing gait to osteoarthiritic neck femur fracture. Determination of FNA angle required for selection of prosthesis of different hip arthroplasty. Knowledge on FNA angle can be better utilized for early intervention like lifestyle modification in the vulnerable population where FNA angle is altered.

Inclusion criteria:
*Dry adult Femora.
*Femora of known sex.

Exclusion criteria:
*Femora with deformity.
*Femora with osteoarthiritic change.
*Non adult femora.
Selection of bone (femur): 100 dry femora (55 left and 45 right) were selected among which 45 bones are of female and 55 bones are of male. Bones were examined for any deformity. Bones without deformity were measured for FNA angle. Measurement of neck anteversion angle: FNA angle are measured by Kingsley Olmsted (KO) method. FNA was measured thrice for each bone and the average is taken to alleviate bias. Radiograph of the dry Femora: Biplanar radiography were done for each femur by Digital X-ray machine after keeping the bone in a flat firm surface. Radiological measurement of anteversion angle: Radiological measurement of FNA were taken for each bone by using the console of Digital X-ray.
Dry femora in good condition and of known sex, according to inclusion criteria were selected. 45female bones and 55 male bones were taken. Side determination of the bones were done: 55 left and 45 right. Bones were then labelled by marker pen for side and sex.

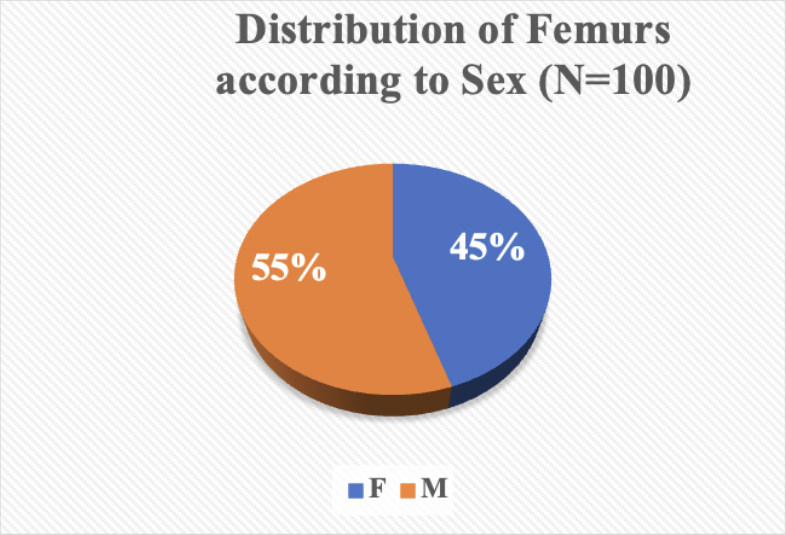
Measurement of neck anteversion angle (FNA) of those femora done according to Kingsley Olmsted method.

Statistical Analysis

At the end of study, changes of all the parameters from their baseline values was calculated & presented in tabular form for each study group. All the data were copied into Microsoft Excel and contingency tables were prepared for qualitative data.

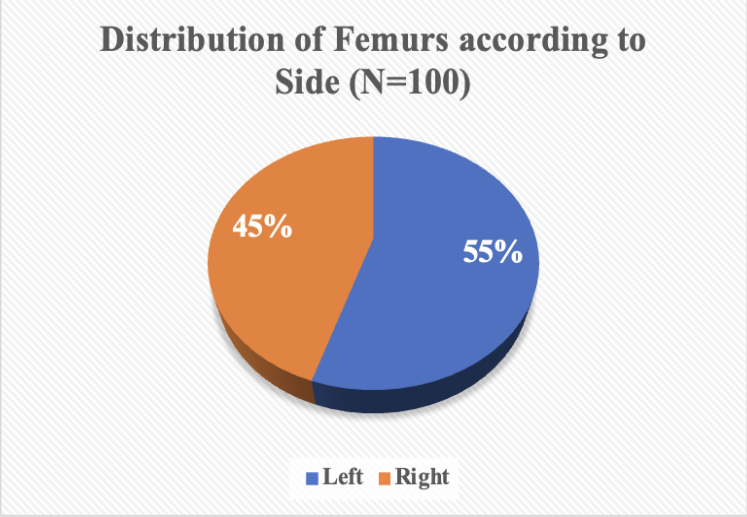
Results

Distribution of femurs according to Sex (N=100)



distribution of femurs according to sex: 55% are Male femurs and 45% are Female femurs.

Distribution of femurs according to Side (N=100)



distribution of femurs according to side: 55% are Left sided femurs and 45% are Right sided femurs.

Range of distribution of FNA angle measured physically by KO method. 26% femurs have FNA angle in the range of 5°-10°. Maximum 59% femurs have FNA angle in the range of 11°-16°. FNA angle in the range of 17°-22° and 23°-27° were present in 11% and 4% femurs respectively. range of distribution of FNA angle measured radiologically by Bi-plane X-ray method. 17% femurs have FNA angle in the range of 6°-11°. Maximum 54% femurs have

FNA angle in the range of 12°-17°. FNA angle in the range of 18°-23° and 24°-29° were present in 20% and 9% femurs respectively.

Mean and Standard Deviation of Physically Measured FNA and Radiologically measured FNA

		Physical FNA	Radiological FNA
N	Valid	100	100
	Missing	0	0
Mean		13.22	15.65
Median		13	15
Mode		12	16
Std. Error of Mean		0.4201	0.4657
Std. Deviation		4.201	4.657
Variance		17.65	21.68
Coefficient of Variation		0.3178	0.2975
Range		22.00	23.00
Minimum		5	6
Maximum		27	29
Percentiles	25	10	12
	50	13	15
	75	15	18

Mean FNA by Physical measurement (KO Method) is 13.22° with SD of 4.201 and Mean FNA by Radiological measurement is 15.65° with SD of 4.657.

Comparison of Physically Measured FNA and Radiologically Measured FNA in both sex.

	SEX	N	Mean	Std. Deviation	Std. Error Mean
Physical FNA	Male	55	13.76	4.333	0.5843
	Female	45	12.56	3.98	0.5934
Radiological FNA	Male	55	16.4	4.817	0.6496
	Female	45	14.73	4.33	0.6454

Statistical significance of the Physical FNA value for sex was tested by Independent Sample t test and the two tailed p-value is 0.1535. By conventional criteria, the difference is not statistically significant at $p<0.01$.

Comparison of Physically Measured FNA and Radiologically Measured FNA in both sides.

	SIDE	N	Mean	Std. Deviation	Std. Error Mean
Physical FNA	Left	55	13.35	3.748	0.5053
	Right	45	13.07	4.736	0.706
Radiological FNA	Left	55	15.45	4.154	0.5601
	Right	45	15.89	5.245	0.7819

P value and Statistical significance (Physical measurement):

Statistical significance of the Physical FNA value for side was tested by Independent Sample t test and two-tailed P value equals 0.7431. By conventional criteria, this difference is considered to be not statistically significant at $p<0.01$.

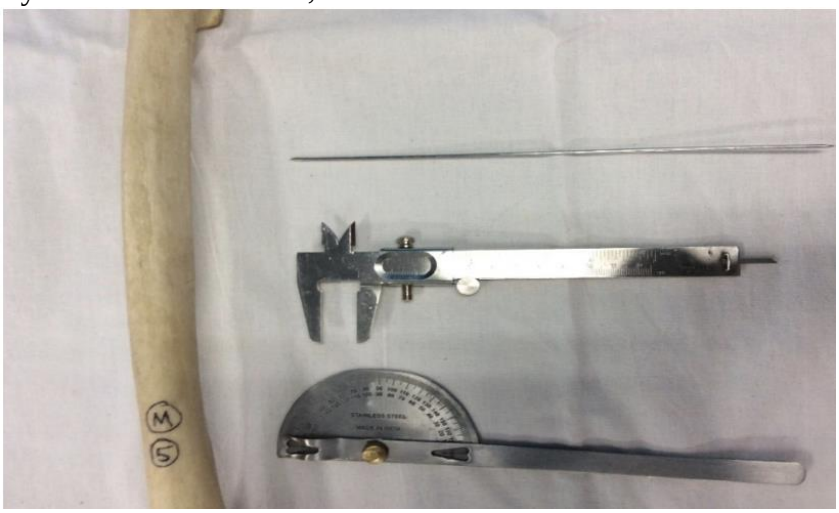
Correlation between Physical & Radiological FNA in Male bones

		Mean	N	Std. Deviation	Std. Error Mean
Male Femur	Physical FNA	13.76	55	4.33	0.58
	Radiological FNA	16.40	55	4.82	0.65

Paired Samples Correlations				
		N	Correlation	Sig.
Male Femur	Physical FNA & Radiological FNA	55	.889	0.000

P value and Statistical significance:

The two-tailed P value is <0.0001
By conventional criteria, this difference is considered to be extremely statistically significant.



Instruments used for measurement of FNA angle

Measurement of the midpoint of neck of femur

Transcondylar line

Discussion

The femur twists from torsional forces applied perpendicular to the epiphyseal growth plate. Wolff's Law explains the remodelling in adult bone. It states that every change in the form and the function of a bone is followed by changes in the bone's internal and external architecture in accordance with mathematical laws. Femoral Neck Anteversion also may develop because of changes in the stress placed on the adult femur diaphysis by torsional forces. Muscle, by either its passive elastic connective tissue or its contractile force, contributes the greatest stress on bones[3] and adds the torsional force on the femur. At birth, anteversion is about 40 degrees. During first year of life, it decreases by about 8 degrees, thereafter 1 degree per year until in the adult it is an average of 10-15 degrees[4]. It is multi-factorial as a result of evolution, heredity, foetal development, intrauterine position, and mechanical forces.

A precise measurement of femoral neck anteversion is important in various orthopaedic diagnosis and procedures[1-10]. It is important to know the angle of anteversion in a particular population and this should be documented by a method that is accurate, easily available and reproducible. The accurate estimation of femoral neck anteversion in living subjects has always been difficult with lots of shortcomings and lack of reproducibility[1]. Estimation of anteversion on dry bone is considered to be the most accuratemethod[1]. But their greatest drawback is that involvement of femora from some of the skeletons with pathologic conditions having extreme range of values cannot be ruled out and then they may influence the statistical analysis. It is also assumed that though it may give a profile of the sample population, it may not be relevant for clinical practice since clinical measurement of the angle of anteversion may be different from those obtained on dry femora. However, it is still worthwhile to conduct this study and compare the data with various races and document the range of normal FNA and the existent racial variation. To know the different relationship between the various measurements this study was conducted to estimate the FNA using Physical measurement of Dry bones and biplane X-ray methods. In this study, 100 nos. of dry femora were taken and FNA angle was measured physically by Kingsley Olmsted method as well as by Bi-plane Radiography using Digital X-ray Machine. The average adult femoral anteversion has been documented to range between 7°-16° in multiple skeletal surveys (Elfman, 1945; Takai et al, 1985; Yagi and Sasaki, 1986; Yoshioka et al, 1987) whereas Le

Damany (1903) quoted it to range from - 25° to + 37°. The Gray's Anatomy states that the transverse axis of the head of the femur makes an angle of approximately 15° with the transverse condylar axis and orthopaedics books quote it to range from 10°-30°.

Comparative analysis of mean FNA angle in femurs of both sex in different Studies.

Author(s)	**Mean FNA**
Parson FG et al	15.3°
Kingsley PC et al	8.02°
Kate BR et al[11]	8.8°
Ankur Zalawadia et al	12.4°
Jain AK et al	8.9°
Siwach RC et al	13.68°
Study	**13.22°**

So, the findings of this study corroborates with the clinical findings as well as different skeletal surveys. The mean FNA angle measured physically by Kingsley Olmsted (KO) method in 55 male femurs in this present study was 13.76° with Standard Deviation (SD) of 4.333 and Standard error of mean was 0.5843. In the present study FNA angle of 100 femurs were also measured radiologically by taking bi-plane X-ray of the bones followed by measurement of the angle from the console by using specified tools present in the console. By radiological measurement the mean FNA angle of male and female bones were 16.4° and 14.73° with SD of 4.817 and 4.33 respectively. The mean of the same angle of left and right sided bones on radiological measurement were 15.45° and 15.89° with SD of 4.154 and 5.245 respectively. The difference of angle between sex as well as for sides in radiological measurement were not statistically significant. The difference in measurement of FNA angle between physical method (KO method) and radiological method (Bi-plane X-ray method) in respect to side and sex were statistically significant.

Jain AK et al have obtained the mean FNA angle by X-ray as 11.5° with SD of 5.4 in their study. The mean of males by X- ray was11.5° with SD of 5.9and mean of females was 11.4° with SD of 4.7 in the study. The mean of right side was 10.6° with SD of 5.3and of left side was12.3° with SD of 5.4 by X-ray in the same study. Statistically significant difference has been found between the right side and the left side (p= 0.001), but there was no such significant difference found between the two sexes (p= 0.86). In the present study, 59% bones are in the range of 11°-16° of FNA angle while measured physically. 26% bones are in 5°-10° range and 11% and 4% are in the range of 17°-22° and 23°-27° respectively.

Conclusion

In the present study, the mean FNA angle measured Physically and Radiologically were 13.22° and 15.65° with Standard Deviation of 4.20 and 4.65 respectively. The range was from 5°-27° on physical measurement and from 6°-29° on radiological measurement. 59% bones are in the range of 11°-16° of FNA angle while measured physically. 26% bones are in 5°-10° range and 11% and 4% are in the range of 17°-22° and 23°-27° respectively. Measurement in dry femora may be helpful for further advancements of prosthesis and treatment outcome for those conditions.

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