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An Anthropometric Study of Femoral Anteversion of West Bengal Population

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Abstract:

Background: Femoal anteversion is defined as the angle formed between the transverse axis of the head and the transverse axis of the lower end of the femur. In the axial plane, the femoral neck is anteverted, i.e., rotated anteriorly compared to the femoral condyles as the neck of femur is not in the same plane as the shaft. It measures about 10˚ to 15˚ (adult) and is called Angle of Anteversion. The values of this angle vary between individuals and between the different racial population. Abnormal Femoral Neck Anteversion (FNA) affects the biomechanics of the hip. It may be associated with many clinical problems ranging from harmless intoeing gait in the early childhood to disabling osteoarthritis of the hip and the knee in the adults.

Objective: To evaluate the range of anteversion in adult femora of West Bengal Population.

Methodology: The present study was conducted on 300 dry adult femora (150 on the left and 150 on the right sides). The femora were selected according to the inclusion and exclusion criteria. Measurement of FNA was done following Kingsley Olmsted (KO) method.

Results: From the study it was found that the FNA was higher in Bengali population compared to other races of India and the mean FNA of right side (13.56) was less than left side (13.97). But it was not statistically significant as p value is 0.056.

Conclusion: This study establishes baseline data for the Femoral Neck Anteversion of West Bengal population. This will be helpful for orthopaedic surgeons and implant makers to properly design and treat patients with problems of the FNA.

Keywords: Femur, neck, version

Introduction:

The Femoral Neck Anteversion (FNA) also known as the femoral torsion or femoral version is defined as the angle by which femoral neck deviates forward from the axis of femoral condyles. It indicates the degree of twist of the femur. It was first identifiable at 7 weeks of gestation when it has been reported to be -10˚ [1]. This gradually increases with gestational age and is reported to be 0 degree at the third month, 12˚ just after the fourth month and 24.4˚ at birth. It changes throughout childhood and adolescence by detorsion until the adult average angle of 10˚-15˚ is reached. The value of FNA varies among individual and in different population. FNA 7˚-8˚ was recorded in

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Caucasian population [2] but it was much higher [>19˚] in African population [3]. The range of version varies from -25˚ to +37˚. In adults without pathology, the femur may be twisted in different direction. If the FNA has negative value, it is called Retroversion. The normal anteversion ranges from 12˚-15˚ and the value of Neutral Version is -1˚ to 1˚.

FNA affects biomechanics of the hip as the line of actions of the muscles around the hip joint is altered. Thus FNA was associated with alteration of gait and acted as a risk factor for osteoarthritis and slipped capital femoral epiphysis. [4]

The transition from quadruped to bipedal gait was a considerable biomechanical mile stone in the evolution of Homo sapiens. The biomechanical features of the human lower limb whose function is primarily to allow stance and bipedal propulsion are different from the lower limb of quadruped. FNA alters in human not only because of evolutionary process but it results from torsional stress passing through femoral neck during normal daily activities. [5] This angle facilitates bipedal mode of locomotion by reducing horizontal bending forces on the hip. This also plays vital role in proper positioning of implants in hip replacement surgery. And prevents loosening and impingement of implants. [6]

FNA is strongly affected by the mechanical load during any kind of movement. An increased FNA is associated with delayed or impaired locomotion, whereas diminished FNA angle in adolescents is often associated with slipped capital femoral epiphysis of the hip. The FNA angle in patients with slipped capital femoral epiphysis was 1 degree in the worst cases and 2.5 degree in moderate cases. Tonnis and Heinecke et al found decreased medial rotation and increased lateral rotation of hip were related to diminished FNA. [7] Children having increased FNA tend to seat with their feet outside them (W position) and walk with their toes turned in but those having decreased FNA can sit with their legs crossed and walk with their toes turned out. Because of reduced degree of FNA anterior margin of femoral neck comes closer to acetabulum causing external rotation of the leg during locomotion.

There are several methods to measure FNA like imaging (radiography, computed tomography, ultrasound, magnetic resonance imaging), clinical and intraoperative methods etc. Among these intraoperative method is considered to be most accurate. [8] As it is not always accessible osteometric method i.e estimation of anteversion on dry bone is also considered as standard and alternative method of FNA estimation. The present study is an attempt to evaluate the range of FNA in adult femora so that the figures may be applied for various orthopaedic diagnosis and procedures.

Methodology:

The study was carried out on 300 dry adult femora. It was a cross-sectional analytical study conducted at the Department of Anthropology, Ballygunge Science College, Kolkata and KPC Medical College and Hospital, Kolkata. Permission from the Institutional Ethical Committee, KPC Medical College was obtained for the study. 150 right femora and 150 left femora were selected for the study. The side was determined as per the guidelines mentioned in the standard reference book of Anatomy. [9] The sample was obtained by simple random method over 6 months. Femora that were intact with well-preserved landmarks and devoid of any arthritic changes were selected for the study. Bones with fracture, decay and deformity or incompletely ossified bones were excluded from the study. FNA was measured by Kingsley Olmsted (KO) Method.

Each dry femur was placed on a smooth horizontal surface (a glass sheet on a table). Two smooth blocks, 1cm in thickness, were then placed one beneath the femoral condyles and the other beneath the posterior aspect of the greater trochanter. The antero-posterior width of the neck was

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determined at proximal and distal ends of the neck of femur by vernier calipers. The centre points of these two ends were then marked. A 1mm thick Kirschner wire was then placed along these two points using clay adhesive, representing the central axis of the neck. This line was then continued to the surface supporting the bone. A devised protractor with a long metal arm was mounted on a base whose thickness was exactly the same as the block on which the femur was placed. By manipulating this metal arm of the protractor to the same level as the anteversion Kirschner wire under vision, when both of these appear overlapping, the angle was read on the protractor to estimate the true angle of anteversion.

Results:

A total of 300 adult dry femora were studied. Following table shows frequency and percentage of FNA of both sides. 28 dry bones were found to have FNA ranging from 10.1˚-11˚, 45 bones were in the range 11.1˚-12˚, 59 bones were in the range of 12.1˚-13˚. Only 2 bones were showing FNA from 14.1˚-15˚. 166 bones had FNA more than 15˚.

Kingsley Olmsted Method (KO) (F.N.A)	Frequency	Percentage
10.1˚-11˚	28	9.3%
11.1˚-12˚	45	15.0%
13.1˚-14˚	59	19.7%
14.1˚-15˚	2	0.7%
>15˚	166	55.3%
Total	300	100.0%

Table/Fig 1 Showing frequency and percentage of FNA of both sides

From the study it was found that mean FNA of right side (13.56) was less than left side ((13.97). But it was not statistically significant as p value is 0.056.

Side		Kinsley Olmsted Method(KO) (FNA)
Right	Mean	13.56
	Std Deviation	1.92
Left	Mean	13.97
	Std Deviation	1.77
Total	P value	0.056
	Significance	Not significant

Table/Fig 2 Showing Mean and Standard deviation of FNA of both sides

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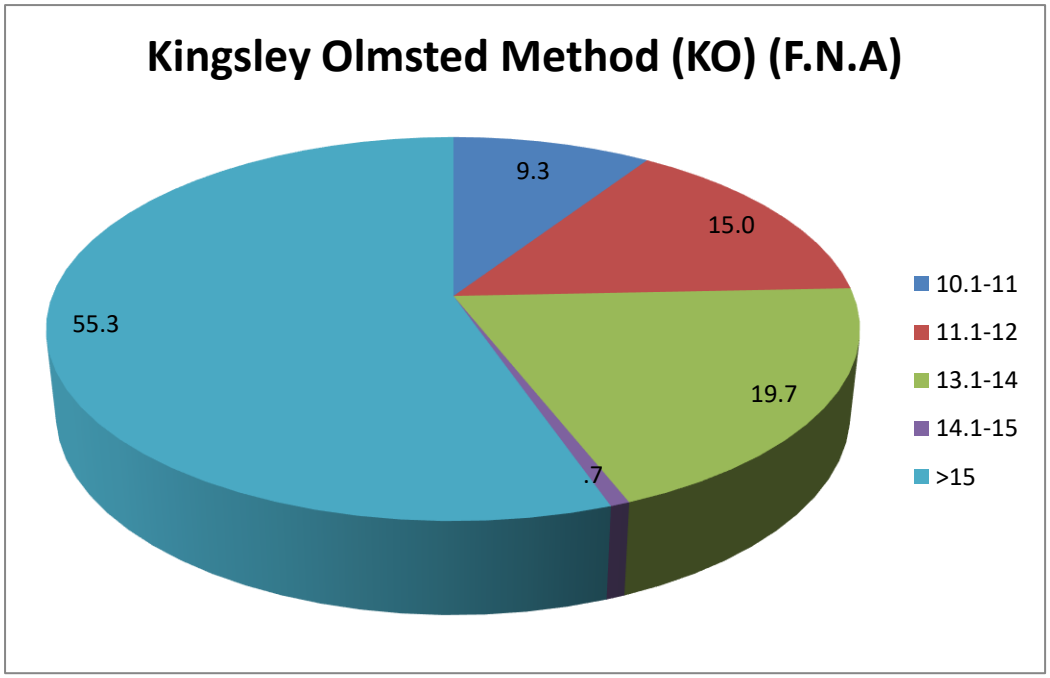

Table/Fig 3 Pie chart showing distribution of FNA among study group

Discussion:

Many individuals are found (both male and female) with unusual gait in our population. Femur is a key bone and may be one of the reasons for this faulty gait. An increased or decreased FNA has been associated with a variety of lower extremity problem in people of all age groups. FNA describes the normal torsion or twist present in the femur. It is thought to result from medial rotation of the limb bud in early intrauterine life. In post natal development a reduction of FNA usually occurs during growth. The FNA diminishes 1˚-1.5˚ a year until about 15 years of age.In adults without pathology, the femur is twisted so that the head and neck of the femur are angled forward between 15˚-20˚ from the frontal plane of the body. In some instances the FNA is directed forward or backward well beyond this angle. Severely decreased FNA was defined as the angle less than 10˚. Moderately increased FNA was considered when angle ranges from 21˚-25˚. When angle is greater than 25˚ it was known as severely increased FNA. The purpose of the study is to assess the average FNA of west Bengal population and compared the results with the previous studies done by different research workers on different races.

Various studies done earlier found different values of FNA. Study done by Jain in Delhi,[10] Zalawadia in Gujrat,[11] Srimathi in Chennai,[12] reported much less FNA compared to present study whereas Badjatiya [13] showed much higher value in their study conducted in Udaipur. Following table showed different values obtained from different research workers.

Author	Place of study	Year	Method	Mean FNA
Jain et al[10]	Delhi	2003	Kingsley olmsted	8.1˚
Zalawadia et al[11]	Gujrat	2010	Kingsley olmsted	9.0˚
Srimathi et al[12]	Chennai	2012	Kingsley olmsted	9.8˚
Badjatiya et al[13]	Udaipur	2014	Kingsley olmsted	18.67˚

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Present Study	West Bengal	2015	Kingsley olmsted	13.76˚

Table/Fig 4 Table showing mean FNA in different races

From the available literature it was found that racial variation of FNA exists because of different social needs of the different races. Since Indians especially Bengalis are more apt to floor level activities they rotate their hips externally and use extreme range of motion. This would certainly make our hips to be evolutionally and morphologically different from western counterparts. Very few comprehensive study had been reported on the value of FNA on Indian population which constitutes about 1/6th of the world's population. Few studies were found where FNA was measured by different methods on Indian population living in different region. The present study was conducted to find out the average value of FNA of West Bengal population and compare those values with previous studies, to get an idea whether any differences are present or not among Indian adults living in different regions. The study revealed higher values in Bengali population. It was known that femur has to undergo more torsion anteriorly in the people involved in different ground level activities to keep femoral head in position. This probably explains the higher anteversion values in Bengalis. [14, 15] Thus the results can be applied in the field of orthopaedics to diagnose various lower limb pathology and in planning different procedures specially for Bengali population. The data will also be helpful to make proper hip prosthesis for impingement free range of motion.

CONCLUSION:

Racial variation is expected to exist because of different races. No comprehensive study has been reported on the normal value of femoral neck anteversion on Indian population. Therefore this prospective study has been undertaken to ascertain and correlate the average femoral neck anteversion in femoral adults. It may be applied for various orthopaedic and diagnostic procedures.

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ISSN: 0975-3583,0976-2833 VOL15, ISSUE 05, 2024

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