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Original Research Article

A STUDY OF FEMORAL NECK ANTEVERSION IN SOUTH INDIAN POPULATION AND ITS CLINICAL SIGNIFICANCE

Srivatsa R [1], Anupama K *[2], Shailaja Shetty [3].

[1] Intern, M S Ramaiah Medical College. Bangalore, Karnataka, India.

[*2] Assistant professor, Department of Anatomy, M S Ramaiah Medical College. Bangalore, Karnataka, India.

[3] Professor and Head, Department of Anatomy, M S Ramaiah Medical College. Bangalore, Karnataka India.

ABSTRACT

Background: The femoral neck anteversion (FNA) also known as femoral torsion can be defined as the angle formed by the femoral condylar plane and a plane passing through the centre of the femoral neck and head. The change in the angle of femoral anteversion is associated with various clinical conditions. The data established in this study will be useful for various orthopedic procedures like arthroplasties, evaluation of pathologic conditions of the hip.

Aim: To measure the angle of anteversion of femoral neck and determine the variation of this angle on both the sides.

Materials and Methods: 90 dry femora 45 right and 45 left devoid of any gross pathology were obtained from the department of anatomy, M S Ramaiah Medical College. The angle of femoral neck torsion was measured using goniometer in 90 dry bones were measured by Kingsley Olmsted method. The results obtained were tabulated and statistically analyzed.

Results: The mean femoral neck anteversion angle for right femur was 12.09° ± 4.56°, and for left femur it was 12.53° ± 3.28°. Statistical analysis revealed the difference of means of FNA angle between the right and left femora was statistically non significant (p=0.65). Femoral anterversion was observed in 72.22% of bones while 27.77% bones showed retroversion.

Conclusion: The morphology of proximal end of femur is of special interest because of susceptibility of this area to numerous disorders in adults and in paediatric age group and the treatment needs a detailed anatomical knowledge of angle of femoral neck torsion.

KEY WORDS: Femoral neck anteversion, Hip replacement surgeries, Osteotomies of femur.

Address for Correspondence: Dr Anupama K, Assistant professor, Department of Anatomy, M S Ramaiah Medical College, MSRIT Post, MSR Nagar, Bangalore- 560054, Karnataka, India. Phone No: 9449249001/ 9845442019 **E-Mail:** dranukodial@yahoo.co.in

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INTRODUCTION

Femur bone is one of the most frequently studied bones in human being both by anatomists and orthopedicians. Different parameters of femoral anatomy are studied because of its corelation with many clinical conditions. Femoral neck anteversion (FNA) is one of the most important parameter of femur anatomy as it is

considered a crucial step in total hip arthroplasty and hemiarthroplasty [1]. The femoral torsion or FNA can be defined as the angle formed by the femoral condylar plane (bicondylar plane) and a plane passing through the centre of the femoral neck and head. If the axis of the neck incline anterior to the transcondylar plane, the angle of torsion is called anteversion which is commonly seen and if it is posterior to the transcondylar plane it is called retroversion and if it is in the same plane it is called neutral version [2].

The average angle of lateral rotation of neck with respect to the shaft is 10-15°. The values of this angle vary between individuals and between populations [3]. Le Damany (1903) quoted it to range from –25 to +37 degrees. It is multifactoral result of evolution, heredity, fetal development, intrauterine position, and mechanical forces. A detailed understanding of anatomy of the area is essential as it is susceptible to numerous pediatric and adult disorders. Many of these disorders are caused due to variations in the morphology and its treatment dependent on the knowledge of the regional anatomy [2].

The knowledge of normal femoral anteversion is of extreme importance in selection of patients for prosthesis and preoperative planning for total hip replacement surgery, evaluation of pathological conditions of the hip and planning corrective osteotomies of femur and anthropological studies [4,5]. This angle also plays an important role in reduction and fixation is selected as a method of treatment [3]. Although newer methods using computed tomography (CT), Magnetic resonance imaging (MRI) and ultrasound have been shown to be ±1° accurate, there is no universal consensus for locating the femoral neck axis and the femoral condylar axis [2,6]. Hence estimation of anteversion on dry bone is still considered the most accurate method.

A review of the global literature reveals a wide range of normal FNA angle with racial and geo- graphic variation. This variation is expected to exist because of genetic composition and social needs of different nations. Western studies results are not applicable in Indian population because femoral anteversion differs in both the population. Therefore, our study was undertaken to ascertain the average angle of anteversion of the femoral neck in Indian subjects.

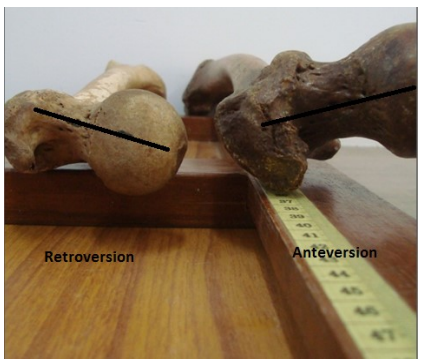
Aim: To measure the angle of anteversion of femoral neck and determine the variation of this angle on both the sides.

MATERIALS AND METHODS

90 unpaired adult human femura, devoid of any gross pathology were used to measure the femoral neck angle (FNA). The angle of anteversion was measured by Kingsley Olmsted method after placing the specimen at the edge of a horizontal surface so that the condyles of the inferior end rest on the surface. The axis of head and neck is determined by marking the center of maximum anteroposterior diameters of head and neck of femur and a line drawn by joining these 2 centers. The anteroposterior diameters were measured using vernier caliper. The horizontal limb of a goniometer was fixed at the edge of the experimental table. The vertical limb was held parallel along the axis of the head and neck of the femur. The horizontal surface represents the retrocondylar axis and the plane of reference against which the anteversion is measured with the help of the axis of head and neck of the femur. The angle subtended was recorded.

Fig. 1: Showing the measurement of angle of torsion of femoral neck.

Fig. 2: Showing the plan passing through head and neck of femur.



RESULTS

Table 1: Showing the side wise distribution of femoral neck angle of torsion.

Category	Subtype	FNA (Femoral neck anteversion)	Right femur		Left femur	
			Frequency	%	Frequency	%
A	Mildly anteverted	$0\text{-}5^0$	1	1.11	1	1.11
	Moderately anteverted	$6\text{-}15^0$	28	3.11	25	2.77
	Severely anteverted	$16\text{-}25^0$	5	0.55	4	0.44
	Markedly anteverted	$>25^0$	1	1.11	0	0
B	Mildly retroverted	49	3	0.33	4	0.44
	Moderately retroverted	94	7	0.77	10	11.11
	Severely retroverted	$-11\text{-}15^0$	-	-	1	1.11
	Markedly retroverted	$<15^0$	-	-	-	-
Total			45		45	

Table 2: Showing the comparison of FNA in various studies [2, 4-6, 9-12].

Researcher	Mean FNA on right side	Mean FNA on left side	Average FNA
Merkel	-	-	17.9^o
Lange	-	-	18.6^o
Kingsley PC et al	-	-	7.88^o
Parson F G et al	15.5^o	14.5^o	15.3^o
Kavita Badjatiya	19.51^o	18.49^o	18.61^o
Nagar M et al	-	-	13.65^o
AK Jain	7.3^o	8.9^o	8.10^o
Ankur Zalawadia	9^o	15.4^o	12.4^o
Srimathi et al	9.49^o	10.13^o	9.8^o
Ravichandran D et al	18.54^o	19.42^o	18.9^o
Present Study	12.09^o	12.53^o	12.31^o

Femoral anteversion was observed in 65 (72.22%) of bones while 25 (27.77%) bones showed retroversion.

The tabulated data was analysed using SPSS version 17. Out of 90 femora, 45 each on right and left side. The mean femoral neck anteversion angle for right femur was 12.09° ± 4.56°, and for left femur it was 12.53° ± 3.28°. The mean femoral neck Retroversion angle for right femur was 8.7° ± 3.9°, and for left femur it was 8.2° ± 4.3°.

Statistical analysis using Independent samples test revealed the difference of means of Femoral Neck angle of Anteversion and Retroversion between the right and left femora was statistically non significant with (p=0.65) and (p= 0.77) respectively.

DISCUSSION

Various theories have been put forth for the development of FNA: Wolff's law states that every change in the form and the function of a bone is followed by changes in its internal and external architecture in accordance with the mathematical laws. Remodelling of the upper end of femur occurs due to perpendicular forces applied to the epiphyseal growth plate. Femoral Neck Anteversion also may develop because of changes in the stress placed on the adult femur diaphysis by torsional forces produced by the muscle pull [4].

Its value is highly variable because it is multifactorial as a result of evolution, heredity, fetal development, intrauterine position, and mechanical forces [4].

Man has retained the femoral anteversion angle from the quadrupeds though he has evolved to a great extent. The FNA was present in all the simian and quadruped femora and ranged between 4° and 41° 5. In Quadrupeds anteversion gives biomechanical advantage against predominantly vertical forces whereas in man

the advantage of anteversion is against forces acting mainly in the horizontal plane [7].

Some studies have shown higher angle in females than in males on the left side compared to the right [2,4] whereas Toogood found that males had more abduction and anteversion compared to the females [8].

The FNA is less in the Indians compared to the western population due to the differing racial characteristics and different social needs. The hips of the Indians are evolutionally and morphologically different because of increased floor level activities requiring extreme lateral rotation of hip [9]. Thus, the same procedure produces a different outcome in our population [1,2,5]. Hence a population-specific protocol and assessment criteria must be devised to achieve the best surgical results. In India with the increasing demand for total hip replacement, this anteversion angle becomes more significant.

Femoral torsion starts developing from 4th gestational month onwards. Initially the values are negative in the earliest stages and reach the highest value of 35-40 degree in perinatal period. During 1st year of life it decreases by about 8 degree, there after 1 degree per year until in the adult it is at average of 10-15 degree [6].

The prevalence of retroversion in the present study was 27.77% which is higher than some of the previous studies like Kingley were 14.8% and Kate Roberts 7.7% A R Shrikant 9.37%. Retroversion is definitive feature seen in embryo which later changes to positive angle following birth upto 15 years of age. Retroversion probably occurs due to the arrest of development of the angle towards the anteversion. It may also result due to twisting of lower end of femur outwards instead of inwards as in case of some of the skeletal abnormalities [10].

Abnormal femoral neck anteversion sometimes can 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, slipped capital femoral epiphysis, Perthe's disease, coxa vara, rickets, congenital hip dysplasia, acetabular labral tears [1,3,13].

The increased angle of anteversion is associated with failure of treatment of congenital dislocation of hip, Perthes disease, cerebral palsy, anterior poliomyelitis, postural defects, apparent genu valgum, external tibial torsion, flat foot, and intoing. The decreased angle of anteversion is associated with toing out, rickets, chondrodystrophy [3,13,14].

CONCLUSION

The mean femoral neck anteversion angle for right femur was 12.09° ± 4.56°, and for left femur it was 12.53° ± 3.28° and the side wise difference was statistically insignificant (p=0.65). The present study adds to the preexisting data and the knowledge of anteversion is useful for orthopedic surgeons while correcting postural defects, to manufacture the hip prosthesis with more accurate angulations of femur neck, thus increasing its efficiency. It is also in the field of anthropology to determine the racial differences.

Conflicts of Interests: **None**

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