Original Article

Indian Journal of Anatomy
Volume 8 Number 3, July - September 2019
DOI: http://dx.doi.org/10.21088/ija.2320.0022.8319.16

Morphometric Study of Femoral Neck-Shaft Angle in Kolar Population and Its Clinical Importance

Suresh NM[1], Sunitha R[2], Aruna N[3], Nalini JP[4]

Abstract

Background: The Neck Shaft Angle axis of the shaft and axis of neck of femur.the angle is also named as caput collum diaphysis or cervico diaphyseal angle. Anthropometric skeletal measurements are used to show regional diversity between different populations or even within the same population. Moreover, skeletal measurements and shape of the bones can offer a guide to clinicians for determining the risk factors for fractures. *Aim:* The present study was undertaken to analyse femur neck shaft angle in kolar population. The standard commercially available marked prosthesis sometimes may not be the best fit to the Indian patients because of wide anatomic variation which leads to complications due to mismatch like aseptic loosening, improper load distribution and discomfort. *Set up:* Department of anatomy, Sambhram Institute of Medical Science and Research**.** *Study Design:* The present study is a cross-sectional observational study. *Materials and Methods:* The materials for the present study comprised of 100 (50 right side and 50 left side adult dry femora. Neck shaft angle was measured with help of goniometer in degrees. Mean and standard deviation were calculated. The student *t*-test was applied and side wise comparison was done by a two-tailed student *t*-test. A level of significance of 5 percent ($p < 0.05$) was used for all analysis. *Results:* No significant side difference is noted in Neck Shaft Angle in degree on comparing both sides. Range of Neck Shaft angle on right side is 120–138° Range of Neck Shaft angle on left side is *122–137*°, *p*-value 0.21–not significant. Mean neck shaft angle of both the sides is *128.51*° *Conclusion:* The values obtained were greater in western world than in present study, there is regional variation among different regions of India. This study will encourage the biomechanical engineers to design and manufacture implants with a correct morphometric data to suit our Indian population and for an improvised surgical outcome with prevention of complication.

Keywords: Kolar; femur; neck shaft angle; implants.

How to cite this article:
Suresh NM, Sunitha R, Aruna N, *et al.* Morphometric Study of Femoral Neck-Shaft Angle in Kolar Population and Its Clinical Importance. Indian J Anat. 2019;8(3):226-232.

Introduction

The femur is largest and strongest bone in human body. It consists of proximal end, shaft and distal end. The proximal end of femur has much attention. The knowledge of its anatomy is important in the treatment of pathology conditions of hip and femur. The Neck-Shaft angle axis of the shaft and axis of neck of femur the angle is also named as Caput Collum Diaphysis or Cervico Diaphyseal angle (CCD).[1]

The neck axis is the line drawn from centre of femoral head to centre of femoral neck at the narrowest part of the neck. The shaft axis is the line drawn from the middle of femoral condyles to middle of the greater tronchanter, this corresponds to "Ideal Axis'' by Billing and long axis by Norman.[2,3]

There are metric differences in skeletal components among different population and these

Author's Affiliation: [1,3]Professor, [2]Associate Professor, [4]Professor Emiratus, Department of Anatomy, Sambhram Institute of Medical Sciences & Research, Kolar Gold Fields, Karnataka 563115, India.

Corresponding Author: Sunitha R, Associate Professor, Department of Anatomy, Sambhram Institute of Medical Sciences & Research, Kolar Gold Fields, Karnataka 563115, India.

E-mail: raghupathy.sunitha8@gmail.com
Received 20.05.2019 | **Accepted** 20.06.2019

variations are related to genetic and environmental factors also. Variations seen in human skeletal measurements also determine the racial characteristics of the populations.[4,5]

Anthropometric skeletal measurements are used to show regional diversity between different populations or even within the same population. Moreover, skeletal measurements and shape of the bones can offer a guide to clinicians for determining the risk factors for fractures. Femoral neck shaft angle has been related as one of the factor for mechanical strength of upper end of femur. Increased neck shaft angle associated with increased risk of fracture. There is difference of the anthropometry of upper end of femur between ethnics due to differences in lifestyle, physique, applied force and their distribution.

Another problem is implant-morphology mismatch that might cause difficulties during implant replacement and could lead to accelerated deterioration of implant life and thus affecting short-term and long term outcome of surgery. The Neck Shaft angle varies from within *125° to 132°*. Undersized or overhanging femoral implants could result in altered soft tissue tensioning and altered patella femoral stresses.

A smaller Neck Shaft angle means that a Dynamic Hip Screw (DHS) inserted through the classical entry portal using angled guide will either go into the superior quadrant or pull fracture in valgus both of which are harmful. The incidence of intraoperative complications like splintering and fractures ranges from 4 to 21%. These are due to oversized implants available that have been manufactured basically with western parameters.[6]

The present study was undertaken to analyse femur neck shaft angle in kolar population. The standard commercially available marked prosthesis sometimes may not be the best fit to the Indian patients because of wide anatomic variation which leads to complications due to mismatch like aseptic loosening, improper load distribution and discomfort. There is no study regarding femoral Neck Shaft angle in Kolar population, so this data will be useful in the designing of appropriate implants to suit femora of Kolar population giving information to Biomedical engineers an Orthopaedicians alike in the development of implants and practice related to hip joint.

Materials and Methods

The materials for the present study comprised of 100 (50 right side and 50 left side adult dry femora from Department of Anatomy and Department of Forensic Medicine, Sambhram Institute of Medical Science and Research**.**

Inclusion Criteria

Adult human dry femur bones of both sexes 50 right side and 50 left side.

Exclusion Criteria

Bones with visible osseous pathologies like tumors; deformities; fracture; trauma.

Instruments

Goniometer, Scale

Parameters

Neck Shaft Angle

It was measured on the anterior surface of the femur as the Obtuse angle between the long axis of neck and long axis of proximal part of the shaft of the femur. Neck axis is drawn in the center of the neck of the femur by joining two points equidistant from the superior and inferior surface of the femoral neck and parallel to it.

The femoral shaft axis is defined by the line drawn through the centre of the medullary canal along the axis of the femur. It is measured with help of goniometer in degrees[7] (**Fig. 1**).

The present study is a cross-sectional observational study. Parameter-Neck Shaft angle of femur belonging to both right and left sides were tabulated; mean and standard deviation were calculated. The student *t*-test was applied and side wise comparision was done by a two-tailed student *t*-test. A level of significance of 5 percent ($p < 0.05$) was used for all analysis.

Results

No significant side difference is noted in Neck Shaft angle in degree on comparing both sides (**Table 1**).

Range of Neck Shaft angle on right side is *120–138°*.

Range of Neck Shaft angle on left side is *122–137°*.

p-value 0.21-Not significant.

Mean Neck Shaft angle of both the sides is *128.51°*.

Fig. 1: Measurement of Femur Neck Shaft Angle using Goniometer

Table 1: Comparison of Mean and SD of Neck Shaft Angle (NSA)

Side	Sample Size	Mean	SD	*p*-Value	Inference
Right	50	129.04	4.47	> 0.05	Not significant
Left	50	127.98	4.01		

Discussion

Comparison of neck shaft angle in various studies in **Table 2.**

The Neck-shaft angle also shows gender difference, smaller in females due to wide pelvis. There is a racial difference owing to the morphology of head, neck and shaft of femur. Normal range of Neck-shaft angle varies from *120° to145°* with an average value of *135°* [20]Anatomical study of femur bone serves helpful data to understand different aspect of clinical disease conditions, including common site of fracture, changes in osteoporosis, associated congenital anomalies as well as medicolegal cases.

Table 2: Showing comparison of Neck Shaft Angle in various studies

Author	Ethnic Group	Mean Value in Degrees
Horacio Osario[8]	Chile	124.17
Rubin *et al.*[9]	Swiss	122.9
Husmann *et al.*[10]	France	129.2
Isaac B *et al.*[11]	Thai	126.9
Toogood Paul[12]	White and American	126.7
Noble *et al.*[13]	caucosids	125.4
Aparna *et al.*[14]	Andra Pradesh, India	121
Amit R *et al.*[15]	India	121.2
Christoph Kolija Boese *et al.*[16]	Germany	163
Radha Pujari *et al.* [17]	Raichur, India	127.5
PF Umebese 2005[18]	Nigeria	121
Vipin Sharma *et al.*[19]	Subhimalaya, India	126.9
Present study	Kolar, India	128.51

Table 3: Showing comparison of Neck Shaft Angle with commonly used implants[6]

Implant	Value in Degrees
Dynamic hip screw (DHS)	125–155
Commonly used DHS	135
Condylar blade plate	95–130
Commonly used condylar blade plate	95–110
Present study	128.5

Its shaft is almost cylindrical. It has a proximal rounded articular head projecting medially from its short neck. The femoral neck length is approximately 5*cm* long and connects the head to shaft at an average angle of *135*°. This angle facilitates movements at the hip joint, enabling the limb to swing clear of the pelvis.[21] Osteoporosis is generally considered to be a condition affecting women, but up to 30% of fragility fractures occur in men.[21] Many methods are available for measuring the femoral Neck-shaft angle which include fluoroscopy, radiography, computed tomography (CT), and Magnetic Reasoning Imaging (MRI). Due to the wide variation in health infrastructure in our country, it may not always be possible to measure the femoral Neck-shaft angle by CT and MRI. Mean NSA right side 127.02 left side125.71.[19]

The mean Neck-shaft angle of study by Shivashankarappa *et al.* was *138.3* + *5.67*°, the right femur Neck-shaft angle *138.3* + *5.67*° and the left was *138.3* + *5.67*°.[20] Ravichandran *et al.* study, in their study the Neck-shaft angle was *126.55*°,[6] Study of Subhash Gujar, the average Neck-shaft angle was *136.2*°.[21] In Siwach RC study it was *123.50*°.[22] The mean Neck-shaft angle of Shakil *et al.* study *137.1*°, the right Femur Neck-shaft angle *137.3*° and the left was *136.9*°. [23]

In the study by Smirti the mean Neck-shaft angle in the femora was *131.48* ± *5.005*° in the right femora *131.44* ± *4.72*°and in the left femora *131.53* ± *5.29*°. The mean Neck-shaft angle of the left femora was feebly higher than the right side, which was satistically non-significant ($p > 0.05$).[24] This was very similar to the earlier South Indian study by Singh (1986) who found mean neck shaft angle for the left femora *131.3*±*3.9*° and for the right femora 131.0 ± 3.6°.[25] Similarly Subhash Gujar (2013) also found 136.6 ± 5.45° for left femora and 136 ± 6.68° for the right femora.[21] In another study by Issac (1997) in South Indian population the mean Neck-shaft angle found on the left side 126.5° and on the right side 126.9°.[11] The Shakil Mohammad (2014) found mean neck shaft angle of right femora was 137.44° and of left femora was 136.9°. [23]

When angle is < 120°, it is known as coxa vara. The angle of femoral neck is reduced with age. In early infancy the Neck-shaft angle is about 150°, in childhood 140°, in adult about 125° and in elderly about 120°.[5] The clinical importance of neck shaft angle of femur lies in the diagnosis, treatment and follow up of fractures of the neck of femur, trochanteric fractures, slipped upper femoral epiphysis, development dysplasia of the hip and neuromuscular disorders of the lower extremity. The knowledge of normal asymmetry of right and left Neck-shaft angle of femur may be of great value in evaluation of patient with known or assumed pathological conditions and in correctional osteotomies in case of femoral fractures.[11]

Conclusion

The Neck-shaft angle of femur allows greater mobility of the femur at the hip joint. All the clinician must be familiar with normal Neck-shaft angle for better comprehension of clinical and pathological states of hip joint. The Neck-shaft angle, is important to design prosthesis for hip replacement. Considering the above mentioned importance the present study was conducted to assess the Neck-shaft angle of femur, its variation with respect to side.

In the present study the mean Neck-shaft angle in the femora was *128.51°*, in the right femora 129.04° and in the left femora 127.98°. The mean Neck-shaft angle of the right femora was feebly higher than in the left femora but statistically not significant ($p > 0.05$). So there is no significant difference between mean neck shaft angle of right and left femora. Femor Neck-shaft angle was measured in all femur and statistical analysis of each parameter by side wise comparison was made. The values obtained were compared with those reported in the literature. And the values were compared with dimensions of commonly used implants in the field of orthopaedics.The values obtained were greater in Western World than in present study showing regional variation among different regions of India. This study will encourage the biomechanical engineers to design and manufacture implants with a correct morphometric data to suit our Indian population and for an improvised surgical outcome with prevention of complication.

Source: Department of Anatomy bones and instrument

Funding: No

Acknowledgement: Management of Sambhram Institute of Medical Science & Research, KGF

References

1. Reikeras O, Hoiseth A. Reigstad A, *et al.* Femoral neck angles. Acta orthop. Scand. 1982;53:775–79.
2. Billing, L. Roentgen examination of the proximal femur-end in children and adolescents. Actu Radiol. 1954;Suppl.110.
3. Norman, O. Matning av collumante-versionsvinkeln. En principiell diskusjon. Nord Med. 1969;75:318.
4. Igibigi. Sex determination from femoral head diameters in black Malawians. East African Medical Journal. 2000;77(3):147–51.
5. Gray's Anatomy. Susan Standring, 40th edition. Churchill Livingstone; pp.1360–390.
6. Ravichandran D, Muthukumaravel N, Jaikumar R. Proximal femoral geometry in Indians and its clinical applications. J Anat Soc India. 2011;60(1):6–12.
7. Olav R, Arne H, Astor R, *et al.* Femoral Neck-angles: A specimen study with special regard to bilateral differences. Acta Orthop Scand. 1982;53:775–79.
8. Horacio O, Karl S. Proximal femoral ephiphysis anatomy in Chilean Population. Orthopaedic and Forensic Aspects. Int Jour of Morphology. 2012;30(1):258–62.
9. Rubin PJ, Leyvraz PF, Aubaniac JM. The morphology of the proximal femur. A three-dimensional radiographic analysis. Bone Joint Surg Br. 1992;74:28–32.
10. Husmann O, Rubin PJ, Leyvraz PF, *et al.* Three-dimensional morphology of the proximal femur. J Arthroplasty. 1997;12:444–50.
11. Issac V, Prasad J, *et al.* Prediction of the Femoral Neck-shaft angle from the length of the femoral neck. Clin Anat. 1997;10:318–23.
12. Toogood PA, Skalak A. Cooperman proximal femoral anatomy in the North-eastern Region population. Clin Orthop Relat Res. 2009;467:876–85.
13. Noble PC, Alexander JW, Lindahl LJ, *et al.* The anatomic basis of femoral component design. CORR.1988;148–65.
14. Gullapelli A, Inuganti AK. Morphometric study of Femoral Neck-shaft angle and its clinical significance. Int J Anat Res. 2017;5(3.2):4261–64.
15. Amith R. Morphometry of femoral NSA in dry femora of South India by computer assisted image analysis method, Int J Anat Res. 2017;5(2.1):3753–58.
16. Kolja BC. The modified Femoral Neck-shaft angle: Age and sex- dependent reference values and reliability analysis. Journal of Biomedical Research International. 2016; Article ID 86475627:7
17. Pujari R, Shankar G Ravi. Evaluation of Neck-shaft angle of femur or dry bones. Journal of evaluation of medicals dental sciences. 2015;4(32):5518–522.
18. Umebese PF, Adeyekun A, Moin M. Radiological assessment of Femoral Neck-shaft and anteversion angles in adult Nigerian HIPS. Niger Postgrad Med J. 2005 Jun;12(2): 106–9.

19. Sharma V, Kumar K, Kalia V, *et al.* Evaluation of Femoral Neck-shaft angle in Sub-Himalayan population of North-west India using Digital Radiography and Dry Bone Measurements. Journal of the Scientific Society. 2018 January-April;45(1).
20. Shivashankarappa A, Prasad NC and Havaldar PP. A study on Femur Neck-shaft angle and its clinical importance. IJOS. 2017;3(4):755–57.
21. Gujar S, Vikani S, Parmar J, *et al.* A correlation between Femoral Neck-shaft angle to Femoral Neck-length. IJBAR. 2013;04(05).
22. Siwach RC, Dahiya S. Anthropometric study of proximal femur geometry and its clinical application. Indian journal of Orthopaedics. 2003;37(4):247–51.
23. Mohamad KS, Hussain SS. Study on Neck-shaft angle and Femoral length of South Indian Femurs. Int J Anat Res. 2014;2(4):633–35.
24. Jha S, Prasad R, Dubey AK. Study of right and left Asymmetry in Neck- shaft angle and neck length of Femur in Jharkhand Population. IOSR-JDMS; 2016 September;15(9 Ver IV):19–21.
25. IP Singh, GJ Ekandem, EO Ani. Identification of sex from the head of the femur- demarking points for Calabar, Cross-River State Nigeria. West Afr J Anat. 1986;1:16–23.