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Morphometryic Analysis of Proximal Femoral Neck and Head of Dry Femur in Madhya Pradesh

Vivek Kumar
Research Scholar, Department of Anatomy, RKDF Medical College Hospital & Research Center, Bhopal (M.P.)

Vivekanand Murlidhar Gajbhiye
Professor & Head, Department of Anatomy, RKDF Medical College Hospital & Research Center, Bhopal (M.P.)

***Abstract*---**Background: Femur is widely studied in the fields of orthopedics, anthropology, forensic and human kinematics. Mostly femoral fracture of upper end is involved. Most common cause of hip joint failure is osteoarthritis. Other conditions that are rheumatoid arthritis, osteonecrosis, avascular necrosis, trauma, and bone tumors lead to hip replacement surgery. Annually, about 800,000 artificial hip joint replacements are performed across the world. The prosthetic components are used in total hip arthroplasty. The present study was undertaken to investigate the variations in the morphometry of femur. The study was performed to enlighten the orthopedic surgeons and implant manufacturer about the geometry of upper end of femur. Objectives: The objectives of present study to measure the neck and head transverse and vertical diameter of femur. Material and Methods: The present study was performed on 200 dry femora in the department of anatomy RKDF Medical College Hospital & Research Centre, Bhopal, Madhya Pradesh. The measurements were taken of neck and head transverse and vertical diameter of femur by using Vernier Caliper. The mean value and range were calculated by using SPSS software. Results: The mean and standard deviation of neck transverse and vertical diameter of total femur are 24.33±2.84 mm and 28.49±3.49 mm respectively. The mean and standard deviation of head transverse and vertical diameter of total femur 40.56±3.42 mm and 40.17±3.18 mm respectively. There was no significant side difference between right and left femoral neck and head diameter. Conclusion: The investigation's findings show that the values obtained from the both side femora were not statistically significant. The results revealed that the characteristics of the proximal femur varied from those of the general population. These differences must be taken into

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***Corresponding author**: Kumar, V.;*
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consideration by the orthopedic surgeons and implant manufacturing units within the nation. This will lessen the impact of implant failure.

***Keywords*---**femoral shaft, cervico-diaphyseal angle, neck vertical diameter, neck transverse diameter, head vertical diameter, head transverse diameter.

Introduction

The femur is the longest and strongest bone in the body and lies in the thigh [1]. The most commonly fractured parts of the femur on its proximal ends are the trochanters and neck. Following serious fractures, internal fixation with implants is critical for the patient's recovery and early mobilization. The implants are constructed to meet the upper end of the femur's size. The majority of orthopedic doctors currently need notice of implant dimensions that comply with Indian norms [2].

The implants are used to repair proximal femur fractures, especially those that have a 135° cervico-diaphyseal angle in Caucasians [3]. Fractures of the neck of the femur are typically intracapsular, and the fracture disrupts the subsynovial intraarticular ring's cervical arteries. As a result, in such cases, the head of the femur may necrose, necessitating a complete hip replacement or hemiarthroplasty. Another form of hip joint fracture is the intertrochanteric fracture. In this situation, the femoral neck is unaffected, and the fracture line is usually seen between the greater and lesser trochanters [4].

Annually, about 800,000 artificial hip joint replacements are performed across the world [5]. Hip arthroplasties are to rise at the world's fastest pace from 2020 to 2026 [6]. Many arthroplasty implants have failed prematurely in the past, including threaded acetabular shells, metal-backed patellar components, first-generation ceramic heads, and titanium bearing surfaces [7-11].With the right approach to examining the morphometry of the proximal femur, the clinical effect of failure might be reduced [12]. This study will educate implant designers on how to adjust implant designs to the needs of Indian patients.

Objective

The objectives of present study to measure the neck vertical and transverse diameter and head vertical and transverse diameter of femur bones.

Materials and Methods

The present study was performed on 200 dry femora (100 right femora and 100 left femora) in the department of anatomy, RKDF Medical College Hospital & Research Centre, Bhopal, Madhya Pradesh. The measurements were taken of neck transverse diameter (NTD) and neck vertical diameter (NVD) and head transverse diameter (HTD) and headvertical diameter (HVD) of femur by using Digital Vernier Caliper. Any femora having gross deformities or damage were excluded from this study.

Transverse diameter of neck: Transverse diameter of neck is measured; minimum diameter of the neck of the femur in antero-posterior direction is measured using a Digital vernier caliper (figure-1).
Neck vertical diameter: The vertical diameter of the neck is the minimum diameter of the neck of the femur at supero-inferior direction and it is measured by using a Digital Vernier Caliper (figure-2).

Fig -1

Fig -2

Transverse diameter of head: Transverse diameter of head is measured; maximum diameter of the head of the femur in antero-posterior direction is measured using a Digital vernier caliper (figure-3).
Head vertical diameter: The vertical diameter of the head is the maximum diameter of the head of the femur at supero-inferior direction and it is measured by using a Digital Vernier Caliper (figure-4).

Fig-3

Fig-4

Statistical analysis was done by using SPSS (version 20.0). The results were presented as Mean, standard deviation and range values. To compare right and left femora, t-test was used.

Results

		Right Side	Left Side	Total Femur (n=200)
Neck transverse diameter in mm	Mean±SD	24.10±2.45	24.58±3.19	24.33±2.84
	Range	19-30	18-35	18.01-35.38
Neck vertical diameter in mm	Mean±SD	28.96±3.18	28±3.73	28.49±3.49
	Range	23-35	23-46	22.53-46.42
Head transverse diameter in mm	Mean±SD	40.90±3.44	40.21±3.37	40.56±3.42
	Range	33-48	34-46	33.48-47.72
Head vertical diameter in mm	Mean±SD	40.49±3.19	39.84±3.16	40.17±3.18
	Range	34-47	34-46	33.61-46.92

The mean and standard deviation of neck transverse diameter of total femur 24.33±2.84 mm, right and left side are 24.10±2.45 mm and 24.58.43±3.19 mm respectively. The mean and standard deviation of neck vertical diameter of total femur 28.49±3.49 mm, right and left side are 28.96±3.18 mm and 28±3.73 mm respectively. No significant side difference between right and left femora.

The mean and standard deviation of head transverse diameter of total femur 40.56±3.42 mm, right and left side are 40.90±3.44 mm and 40.21±3.37 mm respectively. The mean and standard deviation of head vertical diameter of total femur 40.17±3.18 mm, right and left side are 40.49±3.19 mm and 39.84±3.16 mm respectively. No significant side difference between right and left femora.

Discussion

The mean and standard deviation of neck transverse and vertical diameter of total femur are 24.33±2.84 mm and 28.49±3.49 mm respectively. Amongst the authors, our results were comparable with Siwach RC [13] found transverse diameter of neck (NTD) 24.9 mm which is similar to our study (24.10 mm) and vertical diameter (NVD) 31.8 mm slightly higher from our value (28.96). Murlimanju BV [14] reported neck transverse diameter was 23.9 mm and neck vertical diameter was 30.2 mm and Meenakshi V et al [15] mean NTD 24.01 and NVD 33.02 mm which is almost similar to transverse diameter but slightly higher vertical diameter in our findings. Foreign workers Ziylan T et al [16] and Linwei et al [17] reported comparatively higher findings from our study Table -2.

Table 2
Comparison of NTD and NVD with Indian and Foreign studies (in millimeter) (T- Total, R-right, L-Left, T- Transverse V-Vertical, M- Male, F- Female)

S. No	Authors	Year	Population	Neck diameter (mm)
1.	Ziylan T et al [16]	2002	Turkey	Mean T- Right = 26.3 ± 3.1 Mean T- Left = 25.5 ± 2.7 V- Right = 45.2 ± 4.0 V- Left = 43.4 ± 3.2
2	Linwei et al [17]	2012	Chinese	A (66-70 yr) = 34.81 ± 3.26 B (71 -75 yr) = 37.21 ± 2.65
3	Siwach RC et al [13]	2003	Rohtak	Mean T- 24.90 ± 2.94 V- 31.87 ± 2.91
4	Ravichandran et al [18]	2011	Salem	Mean T- 30.99
5	Manjumurali.V et al [14]	2011	Karnataka	Mean T- 23.9 ± 2.9 V- 30.2 ± 2.5
6	Meenakshi verma et al [15]	2017	Delhi	Mean T- 24.01 ± 3.05 T- R- 24.15 ± 3.04 T- L- 23.86 ± 3.09 Mean V- 33.02 ± 4.22 V- R- 34.23 ± 4.39 V- L- 31.73 ± 3.66
7	Present study	2022	Madhya Pradesh	Total Mean T- 40.56±3.42 (T)- Right = 24.10 ± 2.45 (T)- Left = 24.58 ± 3.19 Total Mean V- 40.17±3.18 (V)- Right = 28.96 ± 3.18 (V)- Left = 28.00 ± 3.73

The mean and standard deviation of head transverse and vertical diameter of total femur 40.56±3.42 mm and 40.17±3.18 mm respectively. Amongst foreign workers Ziylan T et al and Linwei et al reported higher femoral head diameter. Indian authors of different regions reported higher findings from our study. Whereas Nidugala et al [20] findings show comparatively lower values. The study shows that medium size femur present in current study population.

Table 3
Comparison of head transverse and vertical diameter with Western & Indian studies (in millimeter) (R-right, L-left, T-transverse, V-Vertical M- Male, F- Female)

S. No	Authors	Year	Population	Head Diameter (mm)
1.	Ziylan T et al [16]	2002	Turkey	Mean T- Right = 44.7 ± 4.1 Mean T- Left = 44.3 ± 3.3
2.	Linwei et al [17]	2012	Chinese	A (66-70 yr) = 47.64 ± 1.7 B (71 -75 yr) =48.87 ±2.1
3.	Siwach RC et al [13]	2003	Rohtak	Mean 43.95 ± 3.06
4	Manjumurali. V et al [14]	2011	Karnataka	Mean 41.5 ± 2.8
5	Rawal B et al [19]	2012	New Delhi	Mean 45.41 ± 3.66
6	Nidugala et al [20]	2013	South Indian	T- Right = 35.31 ± 2.90 T- Left = 36.81 ± 3.79 V- Right = 39.85 ± 3.55 V- Left = 41.75 ± 3.48
7	Sanchita Roy et al [21]	2014	Kolkata	Mean M- Right = 46.3 ± 4.6 Left = 46.7 ± 5.2 Mean F- Right = 44.2 ± 4.6 Left = 44.6 ± 4.1
8	Meenakshi V et al [15]	2017	Delhi	Total Mean V 42.32 ± 4.11 V-Right = 42.51 ± 3.72 V-Left = 42.11 ± 4.53
9	Present study	2022	Madhya Pradesh	Total Mean T 40.56±3.42 (T) Right = 40.90 ± 3.44 (T) Left = 40.21 ± 3.37 Total Mean V 40.17±3.18 (V) Right = 40.49 ± 3.19 (V) Left = 39.84 ± 3.16

Conclusion

In the present study there were no significant side differences of both side femoral neck and head diameter. The results revealed that the characteristics of the proximal femur varied from those of the general population. These differences must be taken into consideration by the orthopedic surgeons and implant manufacturing units within the nation. This will lessen the impact of implant failure.

References

1. Noussios G, Theologou K, Chouridis P, Karavasilis G, Alafostergios G, Katsourakis A. A Rare Morphological Study Concerning the Longest Bone of the Human Anatomy in the Population of the Northern Greece. J Clin Med Res. 2019 Nov; 11(11):740-744.

2. Ravichandran D, Muthukumaravel N, Jaikumar R, Das H and Rajendran M (2011). Proximal femoral geometry in Indians and its clinical applications. J of AnatSoc of Ind2011; 60: 6-12.
3. Torquato DF, Bordini AF, Ferreira G, Takata ET, Trigueiro G, Basile R. The Correct Implant Choice For Transtrochanteric Fracture In Brazil. *Acta Ortop Bras*. 2016; 24(6):327-329. doi:10.1590/1413-785220162406158264
4. Gray's Anatomy. 2nd edition, edited by Drake.L.R, Vogl.A.W, Mitchell.A.W.M, congress cataloguing in publication 2010; 529-32.
5. Baharuddin.M.Y, Kadir.M.R.A, Zulkifly.A.H, Saat.A, Aziz.A.A, Lee.M.M. Morphology study of the proximal femur in Malay population. Int J Morphol 2011; 29(4): 1321-25.
6. https://axiommrc.com/product/1735-joint-replacement-market-report. Accessed 4 June 2020.
7. [Last accessed on 2013, September 6]. Available from: http://www.biomed.brown.edu/Courses/BI108/BI108_2007_Groups/group 05/pages/sulzer.html .
8. [Last accessed on 2013 June 9]. Available from: http://www.rcseng.ac.uk/surgeons/research/surgical-research/docs/An%20Investigation%20of%20the%20Performance%20of%20the%203M%20Capital%20Hip%20System%20Report%202001.pdf .
9. Bernthal NM, Celestre PC, Stavrakis AI, Ludington JC, Oakes DA. Disappointing short-term results with the DePuy ASR XL metal-on-metal total hip arthroplasty. *J Arthroplasty*. 2012;27:539–44. [PubMed] [Google Scholar]
10. [Last accessed on 2013 June 9]. Available from: http://www.asrrecall.depuy.com/countries_list .
11. De Steiger RN, Hang JR, Miller LN, Graves SE, Davidson DC. Five-year results of the ASR XL acetabular system and the ASR hip resurfacing system: An analysis from the Australian orthopaedic association national joint replacement registry. *J Bone Joint Surg Am.* 2011;93:2287–93. [PubMed] [Google Scholar]
12. Verma M, Joshi S, Tuli A, Raheja S, Jain P, Srivastava P. Morphometry of Proximal Femur in Indian Population. *J Clin Diagn Res*. 2017;11(2):AC01-AC04. doi:10.7860/JCDR/2017/23955.9210
13. Siwach RC and DahiyaS.Anthropometric study of proximal femur geometry and its clinical application. Ind J of Ortho 2003; 37 :247-51.
14. Manjumurali.V, Latha.V,Prabu, Mangala.M, Kumar.B.M. Morphological and topographicalanatomy of nutrient foramina in human upper limb long bones and their surgical importance. Rom J MorpholEmbryol2011; 52(3):859-62.
15. Verma M, Joshi S, Tuli A, Raheja S, Jain P, Srivastava P. Morphometry of Proximal Femur in Indian Population. *J Clin Diagn Res*. 2017;11(2):AC01-AC04. doi:10.7860/JCDR/2017/23955.9210
16. ZiylanT.An Analysis of Anatolian Human femur Anthropometry, Turkey Jl of MedSci 2002; 32: 231-35.
17. LinweiLv, GuangweiMeng, Weimin Zhu, He Gong, Dong Zhu, Xizheng Zhang. Relationships between the three-dimension morphologic parameters of proximal femurs. Intern Con on BioEng and Info. 2012; 511-13.
18. Ravichandran D, Muthukumaravel N, Jaikumar R, Das H and Rajendran M (2011). Proximal femoral geometry in Indians and its clinical applications. J of AnatSoc of Ind2011;60: 6-12.

19. Rawal B, Ribeiro R, Malhotra R, et al. Anthropometricmeasurementstodesignbest-fitfemoralstemfortheIndianpopulation. IndianJ Orthop.2012;46:46–53.
20. Nidugala.H, Bhaskar.B, Suresh.S, Avandhani.R. Metric assessment of Femur using discriminant function analysis in South Indian population.Int J Anat Res 2013; 1(2):29-32.
21. Roy S, Kundu R, Medda S, et al. Evaluation of proximalfemoral geometry in plain anterior-posterior radiograph ineastern-Indian population. J Clin Diagn Res. 2014;8:C1–C3.