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Morphometric Study of Head and Neck of Human Femur and Its Clinical Significance

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Abstract
BACKGROUND: *The proximal femur is a critical component of the hip joint, and its morphometric characteristics play an essential role in maintaining joint stability, biomechanics, and weight transmission. Accurate knowledge of the dimensions of the femoral head and neck is fundamental for the diagnosis and management of hip disorders, prosthesis design, fracture fixation, and reconstructive orthopaedic procedures. Since femoral morphology varies among differ.*
Materials and Methods: *A cross-sectional observational study was conducted on fifty dry adult human femora of unknown sex obtained from the Department of Anatomy. The femora were examined for morphometric parameters including femoral length, head circumference, vertical and transverse diameter of head, anterior and posterior neck length and neck-shaft angle using a digital Vernier calliper, circumference measuring tape and goniometer.*
Results: *The mean length of femur was* ***[420.76 ± 23.546 mm]****, while the mean vertical diameter of head, transverse diameter of head, head circumference, anterior neck length, posterior neck length and neck-shaft angle were* ***[39.342 ± 3.367 mm]****,* ***[41.272 ± 3.384 mm]****,* ***[137.36 ± 10.680 mm]****,* ***[28.994 ± 4.557 mm], [34.434 ± 5.006 mm]*** *and* ***[118.18 ± 4.923^0]*** *respectively. The observed morphometric values demonstrated variation when compared with previously reported data from other populations.*
Conclusion: *This study provides valuable morphometric data on the human femoral head and neck for orthopaedic surgeons, prosthesis design and forensic experts. It may also contribute to improve implant design, enhanced preoperative planning, and better clinical outcomes in hip arthroplasty, fracture fixation, and reconstructive procedures.*
Keywords: *Human femur; Femoral head; Femoral neck; Morphometry; Neck-shaft angle; Hip arthroplasty; Prosthesis design; Forensic anthropology.*

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I. INTRODUCTION

The femur is recognized as the longest and strongest bone in the human body. It has a proximal rounded head, a neck and a shaft, with its head articulating with the acetabulum in a spheroidal rather than truly spherical form. The femoral measuring approximately 5cm in length and being narrowest at its midpoint while widest laterally. Femur plays a critical role in hip stability, which make fractures in this region particularly common, while the neck-shaft angle average about 127 degrees. Distally the femur widens into a more robust structure that terminates in two condyles that articulate with tibia, and a thorough understanding of these anatomical details essential for the effective design of prosthetic implants.

II. MATERIALS AND METHODS

This cross-sectional study was carried out on dry human femur at the Department of Anatomy, RIMS, Imphal.
Study Design: Cross-sectional study
Sample size: 50 (25 of each side) dry human femur bones
Source: Department of Anatomy, RIMS, Imphal.
Parameters:
Length of Femur: It was measured between the highest point of head and the lowest point of medial condyle of femur.
Head circumference: Head circumference was measured by winding flexible tape around circumference of head along its articular margin.
Vertical diameter of Head: It was measured as distance between most superior and inferior point on articular margin of head in vertical plane.

Transverse diameter of Head: It was measured as maximum distance of femoral head on articular margin in horizontal plane.
Anterior neck length: It was measured between the base of head midpoint of intertrochanteric line anteriorly.
posterior Neck length: Measured as the distance between the base of head and midpoint of intertrochanteric crest posteriorly.
Neck-Shaft angle: It is an angle between the long axis of shaft of femur and axis of neck of femur
Tools: Measuring tape, Digital Vernier Calliper, and Goniometer

INCLUSION CRITERIA:

- Femur from adult individuals of various age groups
- Femur free from deformities

EXCLUSON CRTERA:

- Femur with damaged, incomplete, deformed and eroded were excluded.

Fig. 1: Length of Femur

Fig. 2: Head circumference

Fig. 3: Transverse diameter of Head

Fig. 4: Vertical diameter of Head

Fig. 5: Posterior Neck length

Fig. 6: Anterior neck length

Fig. 7: Neck Shaft angle

CLINICAL SIGNIFICANCE

This anatomical data holds significant clinical value as it not only assists in the design of hip implants and prostheses and guides orthopaedic reconstruction procedures but also proves useful in assessing fracture patterns and serves as critical in forensic identification

III. RESULTS

Table 1: Different parameters of femur

Parameters(mm)	Right Femur (Mean ± SD)	Left Femur (Mean ± SD)	Total (Mean ± SD)
Length of Femur	419.80 ± 23.666	421.72 ± 23.874	420.76 ± 23.546
Vertical Diameter of Head	39.388 ± 3.561	39.296 ± 3.234	39.342 ± 3.367
Transverse Diameter of Head	41.300 ± 3.488	41.244 ± 3.348	41.272 ± 3.384
Head Circumference	137.44 ± 11.583	137.28 ± 9.935	137.36 ± 10.680
Anterior Neck Length	29.280 ± 3.639	28.708 ± 5.385	28.994 ± 4.557
Posterior Neck Length	33.884 ± 3.898	34.984 ± 5.948	34.434 ± 5.006
Neck Shaft Angle	118.80 ± 4.153	117.56 ± 5.606	118.18 ± 4.923

Table 2: Comparisons of study

Parameters (mm)	AK Dwivedi et al[2] (2019)	G Viney et al[3] (2020)	Katchy et al[4] (2021)	SK Sinha et al[7] (2022)	J Agarwal et al[5] (2023)	HM Hafezji et al[6] (2024)	Present study (2025)
Length of Femur	412.56±30.3	431.5±29.8		435.8±26		409.88±29.3	420.76±23.5
Vertical dia. of Head	40.53±3.51		44.64±3.13	40.97±3.37	40.89±4.26	40.15±3.53	39.342±3.367
Transverse dia. of Head	40.44±3.47	40.90±3.50	44.55±3.37	41.74±2.76	37.96±4.20	39.75±3.28	41.272±3.38
Head circumference	126.69±10.5			133.25±11.57			137.36±10.6
Anterior Neck length	29.92±4.04	26.40±3.70	31.86±5.38	29.75±5.30			28.994±4.55
Posterior Neck length	35.23±4.22		22.23±5.52	35.03±4.87			34.434±5.00
Neck Shaft Angle		120.13±5.72	132.15±7.3	125.96±6.10	129.03±6.53	124.99±2.56	118.18±4.92

IV. DISCUSSION

The present study demonstrated variations in the morphometric parameters of the femur when compared with the previous studies. The mean femoral length 420.76±23.5 mm of the present study was higher than the values reported by Dwivedi et al, and Hafezji et al. The vertical diameter of the femoral head 39.342±3.367 mm was slightly lower than the most reported values, whereas the transverse diameter 41.272±3.38 mm was comparable with the previous studies. The head circumference 137.36±10.6 mm was higher than the values reported by Dwivedi et al. and Sinha et al. The mean anterior and posterior neck lengths in the present study were 28.994±4.55 mm and 34.434±5.00 mm, respectively, showing close values with the previous studies. However, the neck- shaft angle 118.18 ± 4.92^0 which was lower than the values reported in the comparative studies.

V. CONCLUSION

The present study provides morphometric data on the head and neck of the femur and demonstrates considerable variation in its dimension. The mean femoral length was 420.76±23.5 mm while the vertical and transverse diameters of the femoral head were 39.342±3.367mm and 41.272±3.38mm, respectively. The mean head circumference was 137.36±10.6 mm. The anterior and posterior neck length were 28.994±4.55mm and 34.434±5.00mm, respectively, with a mean neck-shaft angle of 118.18 ± 4.92^0. .

Morphometry of femur shows mild variations and provides valuable data for orthopaedic and Forensic use.

LIMITATIONS

The limitation of this study included small sample size unknown age and sex of the individual and unknown pairing of femurs from the same individuals.

REFERENCES

[1]. Standring S, Ellis H, Healy J, Johnson D, Williams A, Collins P, Wigley C. Gray's anatomy: the anatomical basis of clinical practice. American journal of neuroradiology. 2005 Nov;26(10):2703.

[2]. Dwivedi AK, Airan N, Bhatnagar R. Estimation of length of femur from its proximal segment in Maharashtrian population. International Journal of Anatomy, Radiology and Surgery. 2019;8(1).

[3]. 3.Vinay G, Naveen Kumar B, Kalpana T. Morphometric study of proximal end of femur in Telangana population. Int J Anat Res. 2020;8(1.1):7247-50.

[4]. Katchy AU, Nto NJ, Agu AU, Ikele IT, Chime SC, Ugwu AU. Proximal femoral geometry analysis of igbos of South East Nigeria and its clinical application in total hip replacement and hip surgeries: A dry bone study. Nigerian Journal of Clinical Practice. 2021 Mar 1;24(3):369-79.

[5]. Agarwal J, Sharan A, Pant MK. THE PROXIMAL END OF THE FEMUR: EXPLORING ITS CLINICAL SIGNIFICANCE, IMPLICATIONS IN ORTHOPEDICS. Int J Acad Med Pharm. 2023;5(5):1175-8.

[6]. Hafezji HM, Parmar ND, Neeraj T. Master and Deepa S. Gupta, 2024. A Study of Morphometric Analysis of Proximal End of Femur and its Clinical Implications. Res. J. Med. Sci. 2024 Dec 25;18:633-8.

[7]. Sinha SK, Suman S, Prasad S, Hayat SB. Study of Dimensions of Head and Neck of Human Femur and its Clinical Significance. Int J Anat Res. 2022;10(2):8359-62.

[8]. Singh V. Textbook of Anatomy-Abdomen and Lower Limb, Volume 2-E-Book. Elsevier Health Sciences; 2023 May 30.

[9]. Rajila Rajendran H, Raamabarathi K, Sundaramurthi I, Gnanasundaram V, Balaji T. Anthropometric analysis of femur in South Indian population. Biomedical and Pharmacology Journal. 2020 Mar 28;13(1):167-73.

[10]. Dalley AF, Agur AM. Moore's clinically oriented anatomy. Lippincott Williams & Wilkins; 2023 Mar 24.

[11]. Chaudhary PN, Shirol VS, Virupaxi RD. A morphometric study of femoral length, anterior neck length, and neck-shaft angle in dry femora: A cross-sectional study. Indian Journal of Health Sciences and Biomedical Research kleu. 2017 Sep 1;10(3):331-4.

[12]. Gujar S, Vikani S, Parmar J, Bondre KV. A correlation between femoral neck shaft angle to femoral neck length. Int J Biomed Adv Res. 2013;4(5):295-8.

[13]. Gullapalli A, Kumar Inuganti A. Morphometric study of femoral neck shaft angle and its clinical significance. Int J Anat Res. 2017;2:4261-4.