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Anatomic and morphometric study of proximal end of dried adult human femur: clinical and medicolegal importance

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ABSTRACT

Introduction: The morphology of human femur is essential to clinical success of surgical interventions, as well as of medicolegal importance in determination of sex, stature, and even the race of a deceased person when such determinations have to be made from remnants of the bone or the intact bone.

Objective: To measure the head diameter and femur length and provide a baseline for the anthropometric measurements of proximal femur in the population of Khyber Pakhtunkhwa province of Pakistan.

Materials & Methods: One hundred and twenty unpaired adult human femora, sixty each from both right and left sides, of unknown sex were examined in March 2024 from the bone bank of Anatomy department of Khyber Girls Medical College, Peshawar. Bones with typical anatomical characteristics were selected, while broken ones, or bones with gross deformities were not included in the analysis. Femoral length was measured using the osteometry board while vernier caliper was used to measure the head diameter.

Results: The femoral length ranged from 38.20 - 58.20 cm (Right = 38.30 to 58.20 cm and Left = 38.20 – 52.80 cm), with a mean of 43.19 cm (Right – 43.85 cm and Left – 42.54cm). The femoral head diameters ranged from 19 to 45 mm (Right = 19 – 45 mm and Left = 31–46 mm), with a mean of 39.58 mm (Right = 39.86 mm and Left = 39.30 mm).There was no significant difference between the values of left and right femoral parameters.

Conclusions: The morphometric values of proximal end of femur in Pakistani population are different as compared to other countries and may differ for different provinces due to racial differences. The various measurements of the proximal femur are crucial for radiologists and orthopedic surgeons to diagnose and plan treatment, as well as for anthropologists and medico-legal practitioners to determine sex.

Keywords: Orthopedics; Osteology; Forensic Anthropologist; Femur Head; Femur Neck.

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INTRODUCTION

In the human body, the femur is considered as the longest and strongest bone. Its strength is related to muscular forces and weight, and its length to a striding gait. It is composed of a lower end, a shaft, and a proximal end. The femur's greater and lesser trochanters, neck, and head are all located in its proximal region. The head, which faces antero-supero-medially to join the acetabulum to form hip joint, is little more than half the spherical. Its center is smooth, but a tiny, rough fovea interrupts it postero-inferiorly.[1]

The morphology of proximal femur plays a crucial role in designing and development of implants since improper implant size and design can impact surgical outcomes and lead to known problems such as stress shielding, micro motion, and loosening.[2] Modified patella femoral stresses and changed soft tissue tensioning may result from undersized or overhanging femoral implants.[3] When just one fragment of the proximal femur is available, bony markings such as the head and neck of the femur may be utilized to establish the femoral length, and the needed size of the neck's length can be calculated to build prosthesis which will help in restoration of normal neck shaft angle.[4] When undergoing a total hip replacement, the proximal femur's anatomy must be matched in terms of both design and size of the femoral component. Hip dislocation and implant fractures are clinically very common if the implant is not fitting properly.[5]

The regression equation for estimating stature in various demographic groups was derived using intact long bones of the lower extremity. Occasionally, forensic anthropologists are faced with these bodies in varying levels of fragmentation, which causes derived equations to become unstable. This must make it necessary to evaluate the value of measuring long bone pieces for the purpose of estimating height.[6]

Understanding the morphometric properties of the proximal femur is crucial for achieving prosthesis alignment and reducing the risk of problems from surgical operations performed in the region due to vascular, traumatic, or metabolic reasons.[7]

The majority of orthopedic surgeons in Pakistan now believe that implant sizes should be changed to better meet the needs of the local population.[8]

Thus, this work will be very beneficial not only to orthopedic surgeons but also to Anatomists, anthropologists, Radiologists, and Forensic specialists. Furthermore, no data is available on the morphometric study of proximal femur in the population of KPK Province.

MATERIALS & METHODS

In this cross-sectional study which was of one month duration from 1st March 2024 to 31st March 2024, one hundred and twenty unpaired dried adult human femora of both sides but of unknown sex were examined from the bone bank of Anatomy department of Khyber Girls Medical College Peshawar. Sixty of them came from the right side and the other sixty from the left. Every femur was examined and bones with typical anatomical characteristics were selected. Broken bones and bones with gross deformities were separated and were not included in the analysis.

Femoral Length (FL)

By inserting the femur on the osteometric board, the distance between the highest point on the head of femur and lowest point of medial condyle will be measured. The measurement will be made in centimeters (cm) as shown in Figure 1.

Figure 1: Measurement of Femoral Length on Osteometric Board

FEMORAL HEAD DIAMETER (FHD)

With the use of a digital vernier caliper, the distance in a straight line between the upper and lower ends of the femoral head in the cranio-caudal axis will be measured. The measurement unit is millimeters (mm) as shown in Figure 2.

Figure 2: Measurement of Femoral Head diameter using vernier caliper

RESULTS

A total of 120 femora were examined, sixty on the left and sixty on the right. Tables 1 and 2 provide the distribution on the left and right sides of the parameters as well as the overall range, mean, standard deviation(SD), and standard error of the mean (SEM). The results showed that the femoral length ranged from 38.20 - 58.20 (Right = 38.30 to 58.20 cm and Left = 38.20 – 52.80 cm), with a mean of 43.19 cm (Right – 43.85 cm and Left – 42.54cm).

Table 1: Femoral length of right and left femur in cm (n=120).

Side	Range	Mean	SD	SEM	p value
Right	38.30 – 58.20	43.85	3.60	0.51	0.07
Left	38.20 – 52.80	42.54	3.00	0.39	
Total	38.20 - 58.20	43.19	3.30	0.44	

The femoral head diameters ranged from 19 to 45 mm (Right = 19 – 45 mm and Left = 31–46 mm), with a mean of 39.58 mm (Right = 39.86 mm and Left = 39.30 mm). There was no significant difference between the values of left and right femoral parameters.

Table 2: Femoral head diameter of right and left femur in mm (n=120).

Side	Range	Mean	SD	SEM	p value
Right	19 – 45	39.86	3.62	0.51	0.211
Left	31 – 46	39.30	4.24	0.59	
Total	19 – 46	39.58	3.90	0.58	

DISCUSSION

Numerous researchers have thoroughly examined two parameters; the head diameter used and the femoral length. The osteometric board, vernier caliper, and computed tomography were used to measure these parameters. In our study, 120 dry adult human femora from the KPK population, sixty each from the left and right side were.

The results showed that the femoral length ranged from 38.20 - 58.20 (Right = 38.30 to 58.20 cm and Left = 38.20 – 52.80 cm), with a mean of 43.19 cm (Right – 43.85 cm and Left – 42.54cm). The femoral head diameters ranged from 19 to 45 mm (Right = 19 – 45 mm and Left = 31–46 mm), with a mean of 39.58 mm (Right = 39.86 mm and Left = 39.30 mm).

Kumar V et al[9] conducted a study on 250 femora, measuring 446.2 + 26.39 mm for the femur length, 446.6 + 26.66 mm for the right, and 445.8 + 26.12 mm for the left side.[9] Furthermore, the assessed femur length in the Manzoor et al.[11] study was 43.55 cm with SD = 2.283.

Madadi S, et al[10] examined 200 ossified femora from bones with known age, sex, and height. The femur was separated into five pieces, and the mean total length was discovered to be 43.93 cm. They established a correlation between the maximum number of femur segments and the overall femur length, enabling a reasonably accurate estimation of height even in the case of a limited femur segment.

The mean values for the several parameters in the study conducted by Manzoor et al on sixty (60) dried femora were as follows: The femur measured 44.78 ± 1.29 cm in length and the head measured 42.19 ± 3.24 mm in diameter.[11]

In a study by Desai et al[12] on south Indian population, 592 adult dry femurs were examined. The average femur length was 447.1+28.94 mm (right femur: 447.9 +28.72 mm, left femur: 446.2 + 29.12mm).

In a study by Mukhia et al[13] on Nepalese population, the mean femoral length for was 42±2.81 cm, and FHD was 30.05±0.9 mm.

A study by Gurpreet et al[14] on 100 dry femora showed that the femoral length ranged from 38.5 to 58.8 cm, with a mean of 43.93 cm. The femoral head diameter ranged from 20 to 47 mm, with a mean of 39.35 mm (Right = 39.86 mm and Left = 38.84 mm).

This investigation aligned with results of Gurpreet et al[14] and Desai et al[12]. The present study's values are lower than those cited by Khan et al.[8] who studied the population of South India.

The mean femoral head diameter of the femur, as shown in this study, is 39.58 mm, which is almost in line with the findings of the Desai et al.[12] Studies have been done on populations other than Pakistani, such as the population of Nepal by Mukhia et al.[13] Because Pakistanis are taller and more muscular than Nepalese, the mean length of the right and left femurs in this research is greater than that of the Nepalese population.

CONCLUSION

The morphometric values of proximal end of femur in Pakistani population are different as compared to other countries. The values differ also for different provinces which may be due to racial difference. The various measurements of the proximal femur are crucial for radiologists and orthopedic surgeons to diagnose and plan treatment, as well as for anthropologists and medico-legal practitioners to determine sex.

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