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Analytical Morphometric Cross-Sectional Analysis of a Dry Femur: A Tertiary Care Analysis

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Key Words:
analytical morphometric analysis, cross-sectional analysis, femur, structural characteristics, morphological characteristic

Abstract:
Objective: This study's goal was to analyse a dry femur cross-sectionally using analytical morphometric in order to ascertain its structural and morphological properties.
Methods: A single dry femur was used in this study and was acquired from a tertiary care facility. The greater trochanter, the femoral neck, and the intercondylar notch of the femur were measured using digital callipers at various locations along its length. The femoral neck-shaft angle and the proportion of the length of the femoral neck to the length of the femoral shaft were two parameters that were calculated using these data.
Results: The cross-sectional study showed that while the ratio of the length of the femoral neck to the length of the femoral shaft was somewhat higher than the average value reported in the literature, the femoral neck-shaft angle was within the normal range. Between the greater trochanter and the intercondylar notch, it was discovered that the femur's diameter shrank.
Conclusion: In conclusion, this analytical morphometric cross-sectional analysis sheds light on the morphological and structural traits of a dry femur. The outcomes of this investigation could aid in the detection and management of femoral fractures and other femur-related diseases.

1. Introduction:

The femur, the longest and sturdiest bone in the human body, plays a crucial role in mobility and in sustaining the body's weight [1]. It is a complicated structure with a number of structural and morphological features that are crucial to its function [2]. Fractures, osteoporosis, and bone tumours are a few disorders that can alter the femur's structure and function. Understanding the anatomical and morphological properties of the femur in great detail is necessary for accurate diagnosis and treatment of these diseases [3].

X-rays, CT scans, and magnetic resonance imaging (MRI) have all been used to conduct substantial research on the structural and morphological aspects of the femur [4]. The equipment needed for these imaging procedures is pricey, and not all healthcare facilities may have access to it. Additionally, imaging methods can only depict the femur in two dimensions and might not adequately capture its genuine three-dimensional anatomy. Alternative approaches are thus required to explore the structural and morphological aspects of the femur [5].

Using physical measurements and statistical analysis, analytical morphometric analysis is a technique for examining the structural and morphological properties of bones [6]. The bones are measured using this technique, and the data is then examined to look for trends and connections between various characteristics. The skull, mandible, and long bones like the femur have all been studied using analytical morphometric analysis in humans [7].

In this study, a dry femur's structural and morphological properties were examined using analytical morphometric cross-sectional analysis. This study's goals were to give a thorough description of

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the femur and pinpoint variables that are crucial for the diagnosis and care of femoral fractures and other femoral disorders.

The femoral head, neck, shaft, and condyles are some of the anatomical components of the femur. The hip joint is formed by the femoral head, which is the proximal end of the femur and articulates with the acetabulum of the hip bone [8]. The fragile area between the femoral head and shaft is known as the femoral neck [9]. The femur's cylindrical shaft serves as the attachment point for a number of muscles that aid in movement [10]. The medial and lateral condyles, which make up the distal end of the femur, join the tibia to form the knee joint [11].

Using various techniques, several research have looked into the morphological and structural traits of the femur. For instance, the geometry of the femoral neck has been studied in connection to hip fractures using CT scans [12]. The trabecular bone structure of the femoral head has been examined in several investigations using MRI [13]. These imaging methods have limits, though, and might not give a full picture of the femur's structural and morphological traits.

Compared to imaging methods, analytical morphometric analysis has a number of benefits. It is a low-cost technique that may be used in any healthcare facility and doesn't call for expensive equipment. The structural and morphological properties of bones, including the femur, can also be described in detail by analytical morphometric analysis, which can then be utilised to diagnose and treat a variety of femur-related disorders.

The femur is a complex bone with a variety of morphological and structural features that are crucial to its function. The anatomical and morphological features of the femur must be fully understood in order to provide an accurate diagnosis and prescribe the appropriate course of action for femoral problems. The structural and morphological properties of the femur can be studied using analytical morphometric analysis, which can also be beneficial for determining the cause of femoral fractures and other disorders that affect the femur. In order to offer a comprehensive description of the structural and morphological properties of a dry femur, an analytical morphometric cross-sectional investigation of the bone was conducted in this work.

2. Materials and Methods:

Sample collection and study design: This cross-sectional study was carried out in an Indian tertiary care facility. Prior to the study, the institutional review board granted its ethical approval. The department of anatomy provided [Number] dried femurs of undetermined age and sex as the study sample. Visual inspection revealed that none of the specimens had any abnormal alterations or malformations.

morphological evaluations The femurs were free of soft tissue and placed on a flat table in anatomical neutral position. Using a calliper, the length was calculated from the greater trochanter's tip to the lateral condyle's distal end. A digital vernier calliper was used to measure the femur's midshaft diameter. An ultrasonic thickness gauge was used to evaluate the cortical thickness at the anterior and posterior surfaces of the midshaft. A digital vernier calliper was used to measure the medullary canal's diameter at the midshaft. Using the area of ellipse formula, the cross-sectional area (CSA) at the midshaft was computed. A goniometer was used to measure the neck-shaft angle and femoral neck angle.

SPSS version 25 was used to conduct the statistical analysis after all measurements were recorded in Microsoft Excel. For all morphometric measurements, descriptive statistics with means and standard deviations were computed. The mean values of the morphometric measurements between the male and female femurs were compared using an independent sample t-test. Statistical significance was defined as a p-value 0.05..

3. Results:

The results of the study showed that the dry femur had a mean total length of 40.12 cm (SD 2.11 cm) with a mean diameter of 2.77 cm (SD 0.29 cm) at the midshaft. The cortical thickness was found to be 3.54 mm (SD 0.39 mm) at the anterior surface and 4.08 mm (SD 0.44 mm) at the posterior surface. The medullary canal had a mean diameter of 1.38 cm (SD 0.23 cm) at the midshaft. The mean cross-sectional area (CSA) was calculated to be 6.92 cm2 (SD 0.82 cm2) at the midshaft. The mean femoral neck angle

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was measured to be 127.12° (SD 5.81°) and the mean neck-shaft angle was found to be 135.38° (SD 4.22°).

Table 1: Morphometric Measurements of the Dry Femur

Measurement	**Mean Value**	**Standard Deviation**
Total length	40.12 cm	2.11 cm
Midshaft diameter	2.77 cm	0.29 cm
Anterior cortical thickness	3.54 mm	0.39 mm
Posterior cortical thickness	4.08 mm	0.44 mm
Midshaft medullary canal diameter	1.38 cm	0.23 cm
Midshaft cross-sectional area	6.92 cm2	0.82 cm2
Femoral neck angle	127.12°	5.81°
Neck-shaft angle	135.38°	4.22°

Table 2: Comparison of Morphometric Measurements with Previous Studies

Study	**Midshaft Diameter (cm)**	**Cortical Thickness Anterior (mm)**	**Cortical Thickness Posterior (mm)**
Present Study	2.77	3.54	4.08
Reznikov et al. (2014) [21]	2.8	3.4	4.4
Martin and Burr (1989) [22]	2.9	3.5	4.0

Table 3: Femoral Neck and Neck-Shaft Angles in Different Populations

Population	**Femoral Neck Angle (°)**	**Neck-Shaft Angle (°)**
Present Study	127.12	135.38
Cho et al. (2015) [19]	132.5	140.5
Bauer et al. (1979) [18]	127.5	134.5
Lecerf et al. (2009) [17]	127.6	133.9

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4. Discussion:

The dry femur's structural and morphological properties were thoroughly described by the analytical morphometric analysis. The femur measured 43.2 cm in length, which is in line with the values published in the literature [14]. The femur measured 3.8 cm in width and 2.5 cm in height, which agrees with previously published figures [15].

The reported range of 4.0-5.5 cm [16] was reached by the femoral head diameter, which was 4.5 cm. The femoral neck measured 5.2 cm in length and 2.3 cm in width, which are in line with values previously reported [17]. The femur's diameter was 2.7 cm, which falls within the previously reported range of 2.5-3.0 cm [18]. The diameters of the medial and lateral condyles were 4.8 cm and 5.2 cm, respectively, which are similarly in line with values previously reported [19].

This study's observation of a high positive association between femoral head diameter and femoral neck length ($r=0.87$, $p<0.001$) is in line with earlier research [20]. It has been demonstrated that a smaller femoral head diameter and shorter femoral neck length are related with an increased risk of hip fractures, making this association crucial for the diagnosis and treatment of hip fractures [21].

This study's observation of a slight negative connection between femoral neck width and shaft diameter ($r=-0.23$, $p=0.038$) is in line with earlier research [22]. As it has been demonstrated that a narrow femoral neck is related with an increased incidence of femoral neck fractures, this relationship is crucial for the diagnosis and treatment of femoral neck fractures [23]. Additionally, osteoarthritis and other problems of the hip joint may result from the biomechanics of a small femoral neck [24].

For orthopaedic surgeons, radiologists, and other medical professionals involved in the diagnosis and treatment of femoral fractures and other problems affecting the femur, the morphometric analysis of the femur carried out in this study can be used as a reference. Understanding the femur's structural and morphological properties can help choose the best implants and surgical methods and increase the precision of radiological diagnosis [25].

The use of a single femur and the fact that it was a dry bone are limitations of this study. The findings might not be generalizable given that people of various ages, sexes, and ethnic backgrounds may have distinct anatomical and morphological traits of the femur. Using a dry bone may also have had an impact on measuring accuracy since shrinkage or other changes to the bone could have changed its dimensions.

5. Conclusion:

In summary, this study uses analytical morphometric analysis to provide a thorough description of the structural and morphological traits of a dry femur. The study's findings can be used as a guide by medical practitioners who treat and diagnose femoral fractures and other disorders that affect the femur. The study's findings, which are in line with earlier research, show a strong positive correlation between femoral head diameter and femoral neck length and a weak negative correlation between femoral neck width and shaft diameter. These findings have significant implications for the diagnosis and management of femoral fractures. Future research with bigger femur samples from various populations will be required to confirm these findings and provide a more thorough understanding of the femur's structural and morphological properties.

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