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Original Research Article

Osteometric Dimension of Lower End of Femoral Bone among Bangladeshi Population

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Abstract

Introduction: The osteometric dimensions of the lower end of the femur have significant clinical implications, particularly in the context of total knee arthroplasty (TKA). Accurate measurements are crucial for the design of femoral components in TKA, which can influence surgical outcomes. This study aims to determine the measurements of different variables of the lower end of the femur, including femoral condylar width, intercondylar width and depth, and the depth of the medial and lateral condyles, in a Bangladeshi population. ***Methods:*** This cross-sectional study was conducted on 50 dried femurs collected from three medical colleges in Dhaka, Bangladesh. Measurements were obtained using digital sliding calipers and were rounded to two decimal places. Data analysis was performed using SPSS. ***Result:*** Statistical analysis revealed that 56% of the femurs were right-sided and 44% were left-sided. The mean femoral bicondylar width was 69.78 ± 5.38 mm, falling mostly in the "Above Average" range (30%). The mean intercondylar width was 23.77 ± 1.55 mm, with 50% falling in the "Medium" range. Other variables like femur medial condylar width had a mean of 31.05 ± 1.74 mm. ***Conclusion:*** Observationally, the study successfully delineates the osteometric dimensions of the lower end of the femur in a Bangladeshi cohort. The statistical results not only fulfill the study's initial aim but also provide a nuanced understanding of the osteometric variations. These findings are instrumental for clinicians in the design and customization of femoral components in TKA, thereby potentially enhancing surgical outcomes and patient satisfaction. The data also lay the groundwork for future research in this area.

Keywords: Knee, Osteometry, Femur, Femoral, Anthropology.

INTRODUCTION

The study of osteometric dimensions, also known as osteometry, is the quantitative analysis of bone size and shape. It is a subfield of physical anthropology that uses measurements of the skeleton to learn about human evolution, population variation, and individual identity [1]. The study of osteometric dimensions, specifically those related to the femoral bone, has been a subject of considerable interest across a range of scientific disciplines, including anthropology, forensic science, and biomechanics [2- 4]. Osteometry, defined as the scientific measurement of bones, serves as a cornerstone for various applications that extend beyond academic inquiry. It is a field that has practical implications, ranging from forensic identification to medical procedures, thereby making it a subject of both academic and real-world relevance. The femur, known as the longest and strongest bone in the human body, plays a pivotal role in human locomotion and weight-bearing [5]. Its anatomical features are not merely structural; they serve as biological markers that offer valuable insights into a range of factors, including population-specific traits, sexual dimorphism, and forensic identification [6, 7]. The osteometric dimensions of the femur can reveal information about an individual's age, sex, and even ancestral lineage, thereby serving as a critical tool in anthropological studies [8]. The lower end of the femoral bone, which comprises the femoral condyles and the intercondylar notch, holds particular significance. These dimensions are often employed in anthropological research for the estimation of age, sex, and stature. They

are also pivotal in forensic contexts for the identification of unknown human remains [9]. In the medical field, especially in orthopedics, understanding these dimensions is crucial for a range of procedures, including knee replacement surgeries. A slight deviation in these osteometric dimensions can significantly impact the surgical outcome, affecting both the success of the operation and the patient's quality of life post-surgery [10]. Despite the critical importance of these dimensions, there exists a noticeable gap in the literature, particularly concerning specific populations. Most existing studies have focused on Western or African populations, leaving a void in the understanding of these dimensions in other demographic groups, including the Bangladeshi population [11]. This lack of localized data can lead to significant inaccuracies when these dimensions are applied in various contexts, ranging from forensic identification to medical procedures. The implications of understanding the osteometric dimensions of the lower end of the femoral bone extend far beyond academic interest. In forensic science, these measurements can be the key to solving cases involving unidentified human remains. In anthropology, they can provide insights into human migration patterns, lifestyle, and health of ancient civilizations. In medicine, particularly orthopedics, these dimensions are indispensable for the design of implants and the planning of surgeries. Given the critical role that the morphological shape of the distal part of the femur plays in determining the shape, orientation, and kinematics of prosthetic total knee replacements, this study aims to provide a comprehensive analysis of the osteometric dimensions of the lower end of the femoral bone among the Bangladeshi population. Traditional prosthetic designs often incorporate symmetric femoral condyles with a centered trochlear groove. However, the success of total knee arthroplasty (TKA) is heavily dependent on a thorough understanding of the distal femoral morphology to minimize complications. Previous studies have highlighted the existence of sex and ethnic group differences in distal femoral morphology, leading to the development of female-specific femoral components that better accommodate anatomical variances. Therefore, this study seeks to fill the existing gap in localized data, offering insights that could potentially inform the design of more effective and tailored prosthetic components for diverse populations.

METHODS

This cross-sectional observational study was conducted in three medical colleges in Dhaka, Bangladesh: Bangladesh Medical College, Holy Family Red Crescent Medical College, and Anwer Khan Modern Medical College. A total of 50 dried femurs were collected based on specific inclusion and exclusion criteria from the Department of Anatomy of the participating colleges. Ethical approval was secured from the respective institutional research ethics committees. All osteometric measurements, defined in terms of bicondylar width, medial and lateral condylar depths, intercondylar notch width, and intercondylar notch depth, were obtained using digital sliding calipers and rounded to two decimal places. A single author performed all measurements to ensure consistency. Data were recorded in a preformed sheet and analyzed using SPSS for Windows. One-way ANOVA was used to test for significant differences between genders and sides of the body. Each measurement was repeated thrice, and the mean value was recorded. Measurement error was assessed following the method described by White and Folkens for osteometric studies.

RESULTS

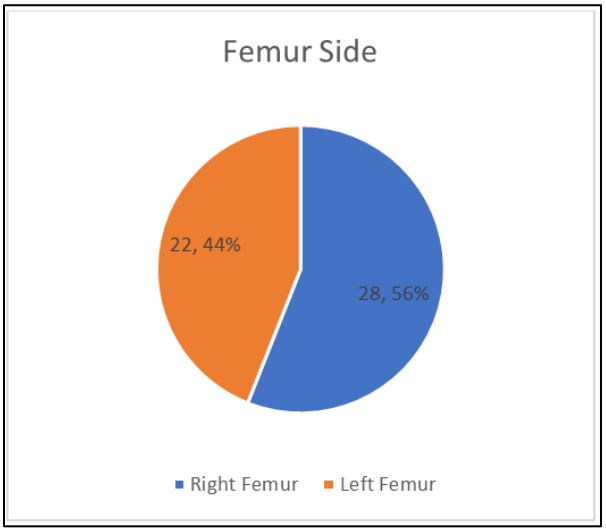

Figure 1: Distribution of femur by identification of femur side

Out of the 50 femurs analyzed in this study, 28 were identified as right femurs, constituting 56% of the sample. Conversely, 22 were left femurs, making up the remaining 44% of the sample.

Table 1: Distribution of femur by femoral bicondylar width

Femoral Bicondylar Width	Frequency	Percentage
Below Average (<65 mm)	14	28%
Average (65 - 70 mm)	9	18%
Above Average (70 - 75 mm)	15	30%
High (75 - 80 mm)	12	24%
Mean ± SD	69.78 ± 5.38	
Range	62.20-79.12 mm	

Table 1 outlines the distribution of femurs based on femoral bicondylar width. The sample of 50 femurs was categorized into four groups: Below Average (<65 mm) with 14 femurs (28%), Average (65 - 70 mm) with 9 femurs (18%), Above Average (70 - 75 mm) with 15 femurs (30%), and High (75 - 80 mm) with 12 femurs (24%). The mean femoral bicondylar width was found to

be 69.78 mm with a standard deviation of 5.38 mm, and the range spanned from 62.20 mm to 79.12 mm.

Table 2: Distribution of femur by femoral intercondylar width

Femoral Intercondylar Width	Frequency	Percentage
Low (< 23 mm)	13	26%
Medium (23 - 25 mm)	25	50%
High (> 25 mm)	12	24%
Mean ± SD	23.77 ± 1.55	
Range	20.10-26.70 mm	

Table 2 details the distribution of femurs based on femoral intercondylar width. The 50 femurs were divided into three categories: Low (< 23 mm) with 13 femurs (26%), Medium (23 - 25 mm) with 25 femurs (50%), and High (> 25 mm) with 12 femurs (24%). The mean femoral intercondylar width was calculated to be 23.77 mm, with a standard deviation of 1.55 mm. The range for this parameter extended from 20.10 mm to 26.70 mm.

Table 3: Distribution of femur by femur medial condylar width

Femur Medial Condylar Width	Frequency	Percentage
Low (< 30 mm)	14	28%
Medium (30 - 32 mm)	15	30%
High (> 32 mm)	21	42%
Mean ± SD	31.05 ± 1.74	
Range	28.00-34.53 mm	

Table 3 illustrates the distribution of femurs based on femur medial condylar width. The sample was categorized into three groups: Low (< 30 mm) with 14 femurs (28%), Medium (30 - 32 mm) with 15 femurs (30%), and High (> 32 mm) with 21 femurs (42%). The mean femur medial condylar width was determined to be 31.05 mm, with a standard deviation of 1.74 mm. The range for this measurement spanned from 28.00 mm to 34.53 mm.

Table 4: Distribution of femur by femur lateral condylar width

Femur Lateral Condylar Width	Frequency	Percentage
Low (< 26 mm)	18	36%
Medium (26 - 29 mm)	19	38%
High (> 29 mm)	13	26%
Mean ± SD	27.32 ± 2.46	
Range	20.15-31.50 mm	

Table 4 provides an overview of the distribution of femurs based on femur lateral condylar width. The 50 femurs were segmented into three categories: Low (< 26 mm) with 18 femurs (36%), Medium (26 - 29 mm) with 19 femurs (38%), and High (> 29 mm) with 13 femurs (26%). The mean femur lateral condylar width was found to be 27.32 mm, accompanied by a standard deviation of 2.46 mm. The range for this particular measurement extended from 20.15 mm to 31.50 mm.

Table 5: Distribution of femur by intercondylar depth

Intercondylar Depth	Frequency	Percentage
Low (< 26 mm)	16	32%
Medium (26 - 28 mm)	17	34%
High (> 28 mm)	17	34%
Mean ± SD	26.99 ± 1.67	
Range	24.12-30.44 mm	

Table 5 delineates the distribution of femurs based on intercondylar depth. The sample was divided into three groups: Low (< 26 mm) with 16 femurs (32%), Medium (26 - 28 mm) with 17 femurs (34%), and High (> 28 mm) with 17 femurs (34%). The mean intercondylar depth was calculated to be 26.99 mm, with a standard deviation of 1.67 mm. The range for this variable extended from 24.12 mm to 30.44 mm.

DISCUSSION

The central aim of this study was to meticulously evaluate the osteometric dimensions of the lower end of the femur, focusing on parameters such as femoral condylar width, intercondylar width and depth, and the depth of the medial and lateral condyles. These dimensions are not merely anatomical data points; they hold significant clinical implications, particularly in the realm of total knee arthroplasty (TKA). Our study found a considerable range in femoral bicondylar widths, with a mean of 69.78 ± 5.38 mm. This is in line with the findings of Mahfouz *et al*., who emphasized the importance of bicondylar width in designing femoral components for TK [12]. The width directly impacts the stability and kinematics of the knee joint post-surgery, and an inaccurate measurement could lead to complications such as joint instability and increased wear [13, 14]. The intercondylar width and depth, with means of 23.77 ± 1.55 mm and 26.99 ± 1.67 mm respectively, are also of critical importance. These dimensions are vital for the design of the intercondylar notch in femoral components, which has been shown to influence the risk of anterior cruciate ligament (ACL) impingement post-TKA [15]. Our data on the depth of the medial and lateral condyles, with means of 31.05 ± 1.74 mm and 27.32 ± 2.46 mm respectively, offer additional insights. These dimensions are crucial for the design of femoral components in TKA, particularly in gender-specific prostheses. Yue *et al*., highlighted that a better understanding of these dimensions could lead to more anatomically accurate prosthetic designs [16]. This is particularly relevant given the increasing trend towards personalized medicine and custom prostheses in orthopedics. Moreover, our study adds to the limited body of research on osteometric dimensions specific to the Bangladeshi population. Ethnic variations in these dimensions have been noted, and our findings could serve as a reference for prosthetic designs tailored to this demographic [17]. The dimensions we have identified are critical variables that can significantly influence the outcome of surgical procedures like TKA. Further studies could delve deeper into the influence of these dimensions on surgical outcomes, prosthetic longevity, and the potential for customization, thereby contributing to the advancement of personalized medicine in orthopedics [18- 20].

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

In conclusion, this study provides a comprehensive analysis of the osteometric dimensions of the lower end of the femur, specifically targeting the Bangladeshi population. The data collected serves as a valuable resource for clinicians and researchers alike, particularly in the context of total knee arthroplasty (TKA). The dimensions assessed, including femoral condylar width, intercondylar width and depth, and the depth of the medial and lateral condyles, are not merely anatomical variables; they hold significant clinical implications. Accurate measurements of these parameters are crucial for the design of femoral components in TKA, which in turn can significantly influence surgical outcomes and prosthetic longevity. Our findings contribute to the existing body of knowledge and offer a foundation for future research, particularly in the realm of personalized medicine in orthopedics. Given the increasing trend towards custom prostheses, understanding these dimensions in specific populations becomes even more critical. This study, therefore, not only fulfills its initial aim but also opens avenues for further investigation into the customization of orthopedic prostheses, thereby potentially improving surgical outcomes and patient satisfaction.

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CONFLICT OF INTEREST: None declared

ETHICAL APPROVAL: The study was approved by the Institutional Ethics Committee

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