Original Research Article

Sex determination of femur neck in the north Indian population

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Introduction

The thigh bone, or femur, is the body's longest and strongest bone. It supports the thigh's skeletal structure. It is made up of three parts: a proximal end, a shaft, and a distal end. The proximal end of the femur has a head, a neck, and two massive projections known as the greater trochanter and lesser trochanter on the upper part of the shaft.Its length corresponds to striding gait, while its strength corresponds to weight and muscular forces. Since it shows considerable variation between individuals, it is widely studied to establish stature and locomotion pattern in skeletal remains for sex recognition. It is most likely to withstand environmental effects and animal movements due to its robustness and strength.Bones are an integral part of determining a person's biological profile. The determination of sex is the first step in constructing a profile and defining an individual's identity, as subsequent methods of determining age and stature are highly sex dependent. The most sexually dimorphic bones are the skull and pelvis, but in their absence, sex must be determined from available bones. Long bones are often found in good condition. The femur is the most sexually dimorphic of the three. The causes for this may be numerous, including variations in pelvic morphology caused by greater pelvic width in females, which is affected by reproductive function. Body size and proportions are influenced by genetic variations, as are differences in musculature Female femora are normally shorter and have more obliquity than male femora. The typical male long bones are larger, longer, rougher, and more massive than the typical female long bones. The study of sexual dimorphism is based on the idea that the male's axial skeleton weight is comparatively and completely heavier than the female's, and that the femur bears the brunt of this weight in the transmission of body weight. As a result, in today's world of rising crime, fatalities, and mass disasters, witnessing human skeletal remains is becoming more common; the femur can play a key role in deciding sex.

The acetabulum of the pelvic bone articulates with the spherical head of the femur. It has a non-articular pit called the fovea on its medial surface that attaches to the round ligament of the femur head[1-5].

The femoral neck is a cylindrical bone spur that links the head to the femur shaft. The neck extends superomedially from the shaft and slightly forwards at an angle of approximately 125^0. Attachments to the muscles that drive the hip joint are given by the greater and lesser trochanters[6-8].The femur's neck is approximately 5cm long and links the head and shaft at an angle. The angle of inclination is also known as the neck-shaft angle, collo diaphyseal angle (CDA), or femoral cervico diaphyseal angle. In most instances, the right side's collo diaphyseal angle is less than the left side's, and there are no major variations between the sexes[9].Neck and trochanter fractures of the proximal end of the femur are extremely common. For these fractures, internal fixation with implants is critical for patient recovery and early mobilization. The implants are made to suit the dimensions of the upper end of the femur. Currently, the majority of orthopaedic surgeons need notification of implant measurements that meet Indian requirements[10].

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The Trochanters are influential processes that give the muscles that rotate the thigh on its axis leverage. There are two of them, a greater and a lesser. The Greater Trochanter is a broad, irregular quadrilateral eminence located at the intersection of the neck and the upper body. It's angled a little laterally and backward, and it's about 1 cm lower than the head in adults. The Lesser Trochanter is a conical eminence that projects from the lower and back part of the base of the neck and varies in size depending on the subject.The procedure for determining sex in unknown skeletal materials must be precise. It is normally determined by the scattered or isolated remains that are visible, as well as the age of the remains and the lack of standards[4]. Despite previous research on sexual dimorphism in the femur, it has been discovered that the extent of sex-related variations varies depending on the population. It is influenced by factors such as race, dietary patterns, lifestyle, cultural traditions, and so on[6,11]. India is a diverse country with a variety of geographical and climatic regions. As a result, there is a broad range of anthropometric measurements among different populations.As a result, each population needs its own collection of anthropometric determinants and baseline parameters. The aim of this study was to determine the femur's neck sex as well as to create demarcating and limiting values for femora from North India. Another aim was to perform a discriminant function study of sexual dimorphism using the femur as a model and provide norms for the North Indian population.

Material and methods

The present study sex determination of femur neck morphometric analysis different parametrs in the north Indian population was conducted on 300 femora of unknown sexof which 195 male bones and 105 female bones were found in the current study. The bones were already present in the Department and had been collected from dissected cadavers.

Following Parameters were Measured for each Bone[3]

1. **Femoral Neck Length (FNL);**is the distance between the lower end of the intertrochanteric line and the inferior portion of the base of the femoral head.
2. **Femoral Neck Diameter (FND):** the distance between the upper and lower ends of the anatomical neck of the femur in the craniocaudal direction in a straight line.
3. **Neck Shaft Angle (NSA):** The angle produced by the axis of the neck and the axis of the shaft is known as the neck shaft angle (NSA). The line joining the two center points on the anterior surface of the neck and the line joining the two center points on the anterior surface of the shaft were used to determine the axis of the neck and the axis of the shaft, respectively.

Results

This was observed that the average (Mean ± SD) of femoral neck length was found in male 3.78 ± 0.44 and in female 3.50 ± 0.45.The Mean ± SD of femoral neck diameter was found in male 3.27 ± 0.23 and in female 2.76 ± 0.30 and the Mean ± SD of neck shaft angle was found in male 133.30^0 ± $5.70^0$and in female 129.66^0 ± 5.41^0.The femoral neck length, femoral neck diameter and neck shaft angle was found significantly higher in male comparison to that in the female, with a p value of < 0.001.

Table 1: Comparison offemoral neck length, femoral neck diameter and neck shaft angle. All the values are mean ± SD.

Variable	Male	Female	p – Value
	Mean ± SD	Mean ± SD	
Femoral neck length	3.78 ± 0.44	3.50 ± 0.45	0.001
Femoral neck diameter	3.27 ± 0.23	2.76 ± 0.30	0.001
Neck shaft angle	133.30^0 ± 5.70^0	129.66^0 ± 5.41^0	0.001

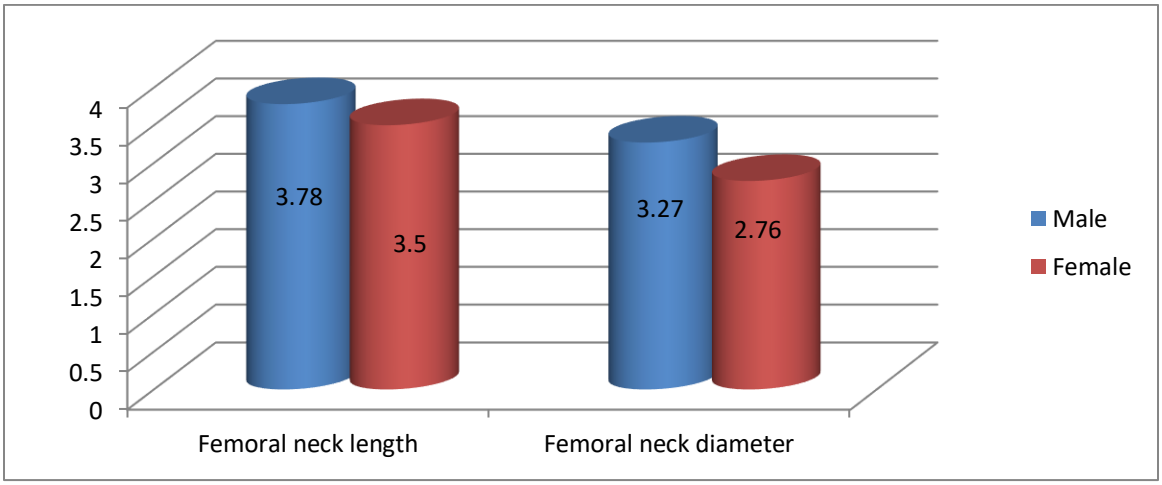

Fig 1:Comparison of femoral neck length and femoral neck diameter

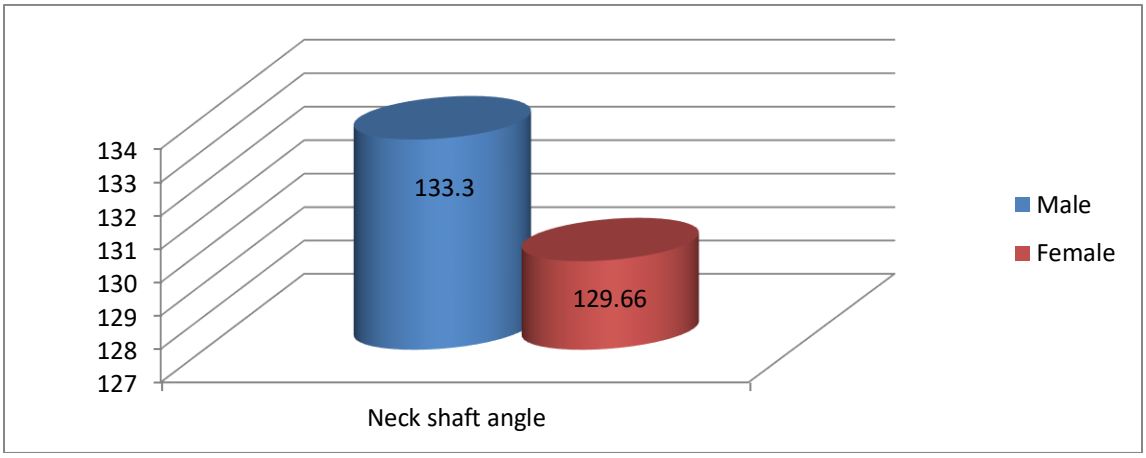

Fig 2:Comparison ofneck shaft angle

Discussion

The mean ±SD concentration of femoral neck length, femoral neck diameter and neck shaft angle was found significantly higher in male comparison to that in the female, with a p value of < 0.001.These findings were concordant with the results of the studies, which were previously done by de Fariasa et al., (2015)[12], Sikka A et al (2016) [13] and Sultan et al.,(2018)[14] studied the key measurements length of the femoral neck, width of the femoral neck, neck shaft angle on the proximal femur. It was shown that there was a statistically significant mean gap between men and women for all factors.

Conclusion

The current study clearly shows that males have significantly higher statistical values for all parameters when compared to females. These characteristics are valuable not just in medico-legal practice, but also to anatomists and orthopaedic surgeons.The findings of this investigation clearly demonstrate the femur's considerable sexual

dimorphism.The current study shows that all statistical methodologies are useful in determining sex, both individually and collectively. The development of standards for femur ends was given special consideration so that sex could be confirmed even if only fragmented bones were available. The accuracy of categorization improves as the number of parameters grows. Furthermore, the study's demarcating and limiting results can be used to establish baseline criteria for sex determination in the North Indian population.

References

1. Standring S, Borley NR, Coliins P, et al. Gray's anatomy the anatomical basis of clinical practice. In: Girdle P, Region G, Thigh. 40th ed. Spain, Elsevier Churchill Livingstone. Ch 80. 2008:1360-5.
2. Hema N, Bhagya B, Sucharitha S, et al. Metric assessment of femur using discriminant function analysis in south Indian population. Int J Anat Res 2013;1(2):29-32.
3. Rashmi S, Vineeta S, Rajesh KR, et al. A study of sexual dimorphism in the femur among north Indians. J Forensic Sci 2011; 57(1):19-23.
4. Krogman WM, Thomas CC, Springfield. The human skeleton in forensic medicine. AJO-DO 1963;49(6):474.
5. Black TK. A new method for assessing the sex of fragmentary skeletal remains: femoral shaft circumference. Am J Phys Anthrop 1978;48:227-32.
6. Igbigbi PS, Msamati BC. Sex determination from femoral head diameters in black malawains. East Afr Med J 2000;77(3):147-51.
7. Purkait R, Chandra H. Sexual dimorphism in femora: an Indian study. Forensic Sci Commun 2002;4(3):1-6.
8. Gray's Anatomy. 2nd edition, edited by Drake.L.R, Vogl.A.W, Mitchell.A.W.M, congress cataloguing in publication 2010; 529-32.
9. Nallathamby.R, Avadhani.R, Jacob.M, Babu.B. Cervico-diaphyseal angle of femur- a comparative study in South Indian population.Int J of Cur Res 2013; 5(8): 2249-51.
10. 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.
11. Pavel T, Antoaneta F, Dobrinka R, et al. A study of sexual dimorphism in the femur among contemporary Bulgarian population. Euras J Anthropol 2014;5(1):46-53.
12. de Fariasa THS, Borgesa VQ, de Souzaa ES, Mikib N, Abdalaa F. Radiographic study on the anatomical characteristics of the proximal femur in Brazilian adults. r e v b r a s o r t o p . 2 0 1 5; 5 0(1):16–21.
13. Sikka A, Jain A. Sex determination of femur: a morphometric analysis in the North Indian population. J. Evolution Med. Dent. Sci. 2016; 5(59):4056-9.
14. Sultan SI, Joshi DS and Diwan CV. Proximal femoral geometry and its clinical relevance in Indians - A radiological study. Indian Journal of Clinical Anatomy and Physiology 2018; 5(1); 107-111.

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