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Original Article

Anatomy Section

# A Study of Sexual Dimorphism in Femora of Rural Population of South Tamilnadu, India

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## ABSTRACT

**Aim:** Assessment of human sex from skeletal parts is of particular importance in forensic osteology and relies heavily on up-to-date techniques to provide accurate information to medico- legal system. Hence this study was taken to assess the sex from an isolated bone ie femur, with as far as possible minimal parameters to ascertain the sex.

**Materials And Methods:** This descriptive study was done in the department of anatomy CMCH&RC, Trichy and SRU, Chennai with 200 dry femur of both sexes of which 100- males( 50 right side and 50 left side) and 100 – females ( 50 right side & 50 left side). Meticulous care was taken to include bones from a homogenous population and all the bones were well documented for sex, race and all belonged to the residents of rural population of south Tamilnadu. All the bones were cleaned from soft tissue and cartilage and were thoroughly dried. Bones exhibiting obscuring pathologies were excluded from study and all the bones studied had completed femoral growth as evidenced by the complete fusion of the proximal & distal femoral epiphysis.

Six Anthropometric measurements were taken on each femur: Maximum Length, Maximum Diameter Of The Head Of Femur, Mid-Shaft Circumference, Maximum Antero- Posterior Diameter Of Femoral Shaft, Antero-Posterior Of Both (Medial& Lateral) Epicondyles, Bicondylar Width.

**Results:** All the parameters were more in the male femora than in the female femora except the medial epicondyle.

**Conclusion:** Average width of medial epicondyle in females is more. Average width of lateral epicondyle in males is more but statistically not significant. This study will be useful in the field of Forensic Osteology and Anthropometry for the identification of skeletal remains.

**Key Words:** Femur, Anthropometry, Forensic osteology.

## INTRODUCTION

Assessment of human sex from skeletal parts is of particular importance in forensic osteology and relies heavily on up-to-date techniques to provide accurate information to medico-legal system.

With time the assessment had a shift from visual analysis to anthropometric measurements which when processed through modern statistical techniques has made sex determination more objective. Determination from skeletal remains which forms an important component in the identification procedure sometimes becomes a difficult task for the Forensic expert especially in the absence of the pelvis. In the field of Forensic osteology determination of sex from Analysis of human skeletal remains has been an age old problem, especially if it is from an isolated bone. Even though analysis of human skeletal remains, remain a well studied field with broad ranging application extending beyond Forensic Anthropology into Archaeology, Paleo-anthropology and comparative Anatomy.

Therefore most of the long bones, either individually or in combination have been subjected to statistical and morphological analysis for the purpose of determining sex. But many of the traditional anthropological methods suffer from certain fundamental deficiencies for example: traditional methods of measurements on the bone are done without any reference as to how the bone lies approximately in anatomical position in the living, this in turn is liable to deprive the worker of the identity of the points of the stress and strain which leave their imprints on the bone. It has also been observed by various authors(Pearson and Bell [1]; Ingalls [2]; Martin and Saller [3]; Krogman and Iscan [4]; Singh and Bhasin [5]) that certain lines can be drawn on the bone to represent the axis by mere “eye judgment”. This study is based upon the logic that axial skeleton weight of male is relatively and absolutely more than that of female [6]. Therefore based on the above argument an attempt to investigate the sexual dimorphism of the femur was taken, which requires as minimal as possible osteometric measurements.

## AIM

The aim is to establish a method of discrimination, that could provide an accurate means of distinguishing between males and females and does so requiring the fewest osteometric measurements, so that to help the Forensic expert to come to a conclusion from the skeletal remains.

## MATERIALS AND METHODS

The present study was conducted in the department of anatomy CMCH&RC, Trichy, SRMC&RI, Chennai with 200 dry femur of both sexes of which 100–males(Right-50, Left-50) and 100 - females(Right-50, Left-50). Meticulous care was taken to include bones from a homogenous population. All the bones were well documented for sex; race & all belonged to the residents of rural population of sourthern Tamilnadu, India. They were cleaned well without soft tissue or cartilage & were thoroughly dried. All the bones had completed femoral growth as evidenced by the complete fusion of the proximal & distal femoral epiphysis.

Any femora exhibiting obscuring pathologies such as cortical bone deterioration or extreme osteophytic activity were excluded from the study.

## METHODS

**A set of six anthropometric measurements were taken on each femur:**

1. Maximum length,
2. Maximum diameter of the head,
3. Mid-shaft circumference,
4. Maximum antero posterior diameter of femoral shaft,
5. Antero posterior diameter of epicondyles ie ( both medial & lateral epicondyles),
6. Bicondylar width These parameters were recorded using divider, calipers, measuring tape, measuring scale and thread.

**Measurement of Maximum Length:** The bone is kept in the anatomical position [7], the highest point on the head was identified and marked as point A and a plumb line drawn from highest point in coronal plane wherever it cut the lower extreme articular margin of the lower end of femur was taken as point B. The points A and B were measured using a measuring tape.

**Measurement of Maximum Antero posterior diameter of the Head and Shaft:** The maximum antero posterior diameter of the head was measured by following technique, given by Brauer [8], Maclaughlin and Bruce [9]. The maximum antero posterior diameter of the head was taken marking a point on the anterior aspect of the head of femur to a point posterior to the head of femur. Measurement of maximum antero-posterior is the diameter of the shaft between the inferior margin of gluteal tuberosity and at the point where the two lips of Linea Aspera divides to form the supracondylar lines.

**Measurement of Mid Shaft Circumference:** After the maximum length was taken a mid point was marked and at that level the mid shaft circumference was taken using a thread and measured with a measuring tape.

| S.No | Parameter femur | | Male [50] | Female [50] | P-Value |
|---|---|---|---|---|---|
| 1 | Length | R [50] | 40.6 ± 2053 | 38.8 ± 1.2 | 0.0001* |
| | | L [50] | 40±1.06 | 38.8 ± 1.2 | 0.001* |
| | | | | | |
| 2 | Max.Diameter of Head | R [50] | 4.6±0.36 | 3.82±016 | 0.001* |
| | | L [50] | 4.76±.21 | 3.82±.06 | 0.001* |
| | | | | | |
| 3 | Mid shaft circumference | R [50] | 8.0±0.28 | 7.19±0.16 | 0.001* |
| | | L [50] | 7.78±0.27 | 7.16±0.2 | 0.001* |
| | | | | | |
| 4 | Max A-P Diameter | R [50] | 3.02±0.22 | 2.60±0.18 | 0.001* |
| | | L [50] | 2.90±.23 | 2.60±0.18 | 0.001* |
| | | | | | |
| 5 | Bicondylar width | R [50] | 7.36±0.21 | 6.83±0.2 | 0.001* |
| | | L [50] | 7.50±0.2 | 6.84±0.23 | 0.001* |
| | | | | | |
| 6 | A-P Diameter of M-Epicondyle | R [50] | 1.68±0.3 | 2.06±0.3 | 0.001* |
| | | L [50] | 1.84±0.16 | 2.06±0.3 | 0.001* |
| | | | | | |
| 7 | A-P Diameter of L-Epicondyle | R [50] | 1.69±0.2 | 1.66±0.2 | 0.412 |
| | | L [50] | 1.79±0.14 | 1.77±0.13 | 0.462 |

**[Table/Fig-1]:** Statistical Analysis Of Parameters

**Measurement of Maximum antero posterior diameter of the epicondyles:** Medial and Lateral epicondyles were identified and their maximum antero posterior diameter was measured using a divider and measuring scale.

**Measurement of Bicondylar Width:** The distance is measured between the most projected points on the epicondyles( Martin and Saller [3], method). Data were analysed statistically using SPSS 15.0, discriminate analysis employing measurements was used to determine the optimal combination of variables for assessing sex.

## OBSERVATION

By analyzing my study the following parameters of femur in male - length, Maximum diameter of head, Mid shaft circumference, Max Antero-Posterior Diameter of medial& lateral epicondyl & Bicondylar width were more than female which are statistically significant (P Value <0.05).

A-P Diameter of Medial epicondyle was more in female than male femur which is also statistically significant (P Value <0.05).But the A-P Diameter of Lateral epicondyle, though more in males than females it is not statistically significant (P Value >0.05).

## DISCUSSION

Personal identity is to determine the individuality of a person. The best way of identification is by the fingerprint system and DNA test. Sex determination may be made out from the distinguishing marks of the male and female bones & is accurate in ninety percent of cases in case of adult pelvis or skull.

According to Singh and Shamer Singh [10,11] for determining the sex of the adult femora, its length is the best guide; provided it has crossed a demarcating point- the left femora measuring 44.5cm and above can be classified as male bone and those below 37.7cm as females, similarly right femora measuring 44.2cm & above can be classified as male and those below 37.25cm as females. However, for identifying the left femora, bicondylar width is the best useful mearsurement, and the average is 7.12cm±0.4 [12].

Kete [13] working on femora from different regions of India, found that the values showed a regional variation & also a downward gradient from North to South. He recommended that in giving a medico-legal opinion, the average of that particular region should be considered for comparison. He also said from his study of 50 femora in wet & dry conditions, that the articular cartilage adds 2.8mm on an average, with a range of 1 to 4mm.

The length of the femur in the present study 37-48cm in males and 37-44cm in females whereas in North Indian population, Enock Prabhakar [14] stated that 43cm in males and 41cm in females. There is no marked difference between the south Indian and North Indian populations.

The measurement in the present study on the antero posterior diameter of the shaft of femur revealed 2.5-3.6cm in males whereas in the females it was 2.3-3.1cm, hence there is no sufficient data available as for as the Indian population is concerned, as mentioned by Ruma Purkait [15]. Therefore the finding in the present study is a new entity. The measurement in the present study on the mid shaft circumference showed 7.1-8.7cm in males but in females it was 6.1-7.7cm, which has revealed no marked difference between the males and females. This is also a new finding not hitherto reported.

The present study on the antero-posterior diameter of the medial epicondyle revealed marked differences. The medial epicondyle in

the males on the left side was 1.83±.15cm whereas in the females it was 2.06±.26cm, on the other hand the diameter of the medial epicondyle on right side in the males it was 1.68±.30cm and in the females it was 2.06±.26cm. The measurement of the medial epicondyles in the female is quite larger than the males on both the sides. This may be due to the wider pelvis in the females.

The lower end of the femur is inclined medially. During weight transmission this inclination helps the body weight to be kept closer to the center of gravity. In females wider pelvis increases this inclinity so that the weight is transmitted along a line passing through the medial epicondyle and medial condyle of the femur. Probably because of this mode of weight transmission the medial epicondyle is wider in females, although other measurements in females are comparably lesser than the measurements found in males.

The average bicondylar width in the present study on the left side in the males was 7.5± .18cm and 6.8±.23cm in females, on the right side in the males it was 7.3± .21cm and in females it was found to be 6.8±.19cm. this is statistically significant. In north Indian population bicondylar width was found by Enock Prabhakar [14] to be 7.8cm in males and 7.2cm in the females. It was more in the north Indian population than in the south Indian population.

Apart from the above discussed points for determination of sex there is a very important feature in the femur which is noteworthy, that is the femur ossifies from five centers of ossification one each for the shaft, head, greater trochanter, lesser trochanter and lower end. The head fuses with the rest of the bone at the fourteenth year in the females & seventeenth year in the males and finally the lower end at the sixteenth year in females and eighteenth year in the males [6].

The available literature on determining the sexual dimorphism of femur based on the measurement of the antero posterior diameter of epicondyles is very less.

## CONCLUSION

Although all measurements are more in males, on the contrary the average width of medial epicondyle in females is more. Average width of lateral epicondyle in males is more but statistically not significant. This study will be useful in the field of Forensic osteology and Anthropometry for the identification of skeletal remains. This study has a great limitation because of the less amount of samples studied.

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