Sexual Dimorphism of Femur and its Clinical Significance

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Introduction: Assessment of human sex from skeletal remains plays a key role in anthropological and medico legal studies. Hence this study was taken to assess the sex from an isolated bone i.e. femur, with as far as possible minimal parameters to ascertain the sex. Subjects and Methods: A study was conducted with 100 non pathological femora (50 male, 50 females) in different age groups of known sex. The present study was to determine the sex by using 5 parameters i.e. Maximum length, Head vertical diameter, Transverse head diameter, Proximal breadth, Distal breadth of the femur has been taken because it gives some useful data in medico legal cases. When only the remains of femur bone were left in deceased individuals. The measurements of femur bone were taken with the help of osteometric board and Vernier calliper.

Results: The readings were noticed. The readings were tabulated and subjected to statistical analysis. It was noticed that all the studied parameters were greater in males than in females.

Conclusion: The present study on the determination of sex of femora will be more reliable basis for the sex determination because it shows the values in this geographical region. This is believed to be more useful in the investigative procedures in the Forensic Medicine and also in the field of orthopaedics.

Keywords: Femur, sexual dimorphism, Maximum length, Head vertical diameter, Transverse head diameter, Proximal breadth, Distal breadth.

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Introduction

Determination of Sex is relatively easy if the entire skeleton is available for examination. Skull and pelvis are the most reliable bones for sex determinatination.[1] However in medico legal cases, one does not always have a complete pelvis or skull. Therefore it is important to be able to assess sex from the other parts of the skeleton also. Femur is the most useful of the long bone. Its length and massiveness themselves being significant in suggesting sex (Krishan Vij, MD, LLB Forensic Medicine and Toxicology 5th edition 2011).[2] On the whole, the bones of a male skeleton are heavier and larger, and markings for the muscular attachments are more pronounced than in the female. This helps in determining the sex of the deceased individual from examination of bones procured from the site.

Femur is widely studied to determine the stature and locomotion patterns, for sex identification in skeletal remains as it shows significant variation between individuals.[3-4] To find out the actual measurements of the femur basing on different variable factors in this geographical region and to obtain the results to the highest possible accuracy. The results of this study will certainly be useful in various ways such as

1. In Medico Legal cases – a) In forensic medicine, in determining the sex of the individual especially in case of fragmentation of the bone. The current practice whereby criminals dismember the remains of their victims in an attempt to make their identification difficult requires that simple methods of sex determination from fragmented skeletal remains are available to forensic anthropologists and skeletal biologists. The head of the femur is an example of such bone fragments. Identification and demarking points have been derived from the diameters of the head of the femur and used o determine the sex of individuals.[23] b) The distal end of the femur is the only epiphysis in which ossification consistently starts just before birth: the phenomenon therefore serves as a reliable indicator of the gestational maturity of the still born baby (Susan standring et al – text of Gray’s Anatomy-40th edition–2008).[31] 2. In understanding the biomechanics wherever the femur is involved, and also 3. In the Orthopaedic practice of bone reconstructive or replacement procedures.

Aim: The aim of the study was taken to assess the sex from an isolated bone that is femur, with various parameters to ascertain the sex.

Subjects and Methods
The present study was conducted in the department of anatomy in Guntur medical college, Guntur and katuri medical college, chinakondrupadu on 100 non pathological dried adult femora (50 males & 50 females) of known sex were used for the present study. All the bones had completed femoral growth as evidenced by the complete fusion of the proximal & distal femoral epiphysis. They were cleaned well without soft tissue or cartilage and were thoroughly dried. Some of the femora which were grossly deformed and fragmented were excluded.

Maximum length, Head vertical diameter, Transverse head diameter, proximal breadth, distal breadth of the femur were measured as mentioned below.

**Maximum length (ML)**- of femur was measured on osteometric board in such a manner that medial condyle touches the shot vertical wall, The moveable cross piece should touch the highest point of the head.

**Transverse diameter of head (TDH)**- Straight distance between the most laterally projected points perpendicular to the vertical diameter of head.

**Vertical diameter of head (VDH)**- The work piece of vernier calliper was placed as close to the surface of the head as possible ensuring perfect contact of the measuring surface with work piece, and the straight distance between the highest and lowest point of the head.

**Proximal breadth (PB)**- The distance from most medially placed point on the head to the most laterally placed point on greater trochanter was measured by using a vernier caliper.

**Distal breadth (DB) or Bicondylar breadth width (BB)**- Maximum distance between medial and lateral epicondyles in coronal plane at right angle to the long axis of femur was measured in millimetre with the help of vernier calliper.

Photographs of femora showing the method of taking the above 5 parameters are displayed [Figure 1-5]
Results

By analyzing the present study the following parameters of femur in male –maximum length, head vertical diameter, transverse diameter of head, proximal breadth, distal breadth where more than female which are statistically significant (p value<0.001)

Five parameters were taken into consideration while undertaking the anthropometric study. These factors are of academic interest as they are very variable. This fact of variability is mentioned by almost all authors. As such these factors are mentioned in this study also as “variable factors”. The minimum value and maximum value mean, standard deviation and level of significance of all the five parameters of adult male and female femora were calculated using the standard statistical methods and the readings were tabulated as shown in the [Table 1 & 2]

Table 1: Minimum and Maximum values, Statistical analysis of all Five parameters of adult male femora

| Parameters          | Minimum (mm) | Maximum (mm) | Mean (mm) | S.D. | P value |
|---------------------|--------------|--------------|-----------|------|---------|
| Maximum length      | 403          | 482          | 444.7     | 19.45| <0.001  |
| Head vertical diameter | 38.1        | 45.3         | 42.08     | 1.93 | <0.001  |
| Transverse diameter of head | 39.2        | 46.2         | 42.93     | 1.82 | <0.001  |
| Proximal breadth    | 76.5         | 85.2         | 82.13     | 2.05 | <0.001  |
| Distal breadth      | 69.2         | 82.5         | 74.79     | 2.97 | <0.001  |

Table 2: Minimum and maximum values, Statistical analysis of all five parameters of adult female femora

| Parameters          | Minimum (mm) | Maximum (mm) | Mean (mm) | S.D. | P value |
|---------------------|--------------|--------------|-----------|------|---------|
| Maximum length      | 332          | 455          | 402.9     | 31.13| <0.001  |
| Head vertical diameter | 32.5        | 41.6         | 37.22     | 2.02 | <0.001  |
| Transverse diameter of head | 32.5        | 42.5         | 37.66     | 2.10 | <0.001  |
| Proximal breadth    | 71.5         | 76.5         | 74.27     | 1.81 | <0.001  |
| Distal breadth      | 65.2         | 72.5         | 69.38     | 1.63 | <0.001  |

Discussion

Sex determination from long bones or their fragments is often required to establish a possible identity. It is a common experience for the forensic expert to be confronted with poorly preserved or fragmentary bones. Due to the tubular structure of long bones they are often better preserved than other shorter bones. Thus data for long bone measurement will be more useful.

The values found in this study are in various manners when compared with the values found by the other authors. Therefore, the values are considered as per the following guidelines:

Values with variation of upto 5 percent-“almost similar to”
Values with variation of more than 5 and upto 10 percent-“slightly lower / higher than”
Values with variation of more than 10 percent-“different from”

According to Singh and shamer singh,[9,10] For determining the sex of adult femora, its length is the best guide; provided it has crossed a demarcating point, –the right femora measuring 445mm and above can be classified as in males and females 377mm. similarly left femora measuring 442mm and above can be classified as male and those below 372.5mm as females.

Enock prabhakar,[11] stated 430mm in males and 410mm in females in north Indian population. There is no marked difference between the same factor as 42.08mm in males and 37.22mm in females in north Indian population.

According to the study of Parsons, F.G.(1914),[16] Maximum Length was shown as more than 450mm in male and lesser than 400mm in female Americans. According to the study of Purkait R.and Chandra H;(2002),[14] reported Maximum Length was shown as 429.4mm in male and 397mm in female Thais.

Purkait R.and Chandra H;(2002),[14] stated 435.5mm in males and 404.1mm in females. This study showed the maximum length as 444.7mm in males and 402.9mm in females. The values found by this study are almost similar to the values of the above author’s in spite of the racial difference.

Mall G, Gehring KD et.al(2000),[21] stated that the maximum Length was shown as 464mm in males and 434mm in females. The present study values of the males are slightly higher than that of the author. The values of females are almost similar to the values of that of author’s study.

Head vertical diameter-

According to the study of Purkait R.and Chandra H;(2002),[14] reported maximum length on the right side in the males was 406mm and 388mm in females, on the left side in males was 40mm and in females it was found to be 388mm. The present study values of the males are slightly higher than that of the author. The values of females are almost higher than that of the author. The values of females are almost similar to the values of that of author’s study.

Head vertical diameter-

According to the study of Purkait R.and Chandra H;(2002),[14] Head vertical diameter was shown as 44.28mm in male and 38.39mm in female Indians. This study showed the same factor as 42.08mm in males and 37.22mm in...
females. The values found by this study are almost similar to that of the values of that of author’s study. Parson, F.G. (1914),[16] reported Head vertical diameter was shown as more than 48mm in male and lesser than 44mm in female Americans. The values found by this study are almost similar to that of author. The values of females are different from the values of that of author’s study.

**Transverse head diameter**

Rashmi Srivastava, Ph.D.et.al(2011),[2] Transverse head diameter in males was shown as 43.86mm and in females was 39.52mm. This study showed the same factor as 42.93mm in males and 37.66mm in females. The values found by this study are almost similar to the values of that of author’s study.

According to the study of Rashmi Srivastava, Ph.D.et.al(2011),[2] Transverse head diameter in males was shown as 49mm and in females was 43mm. The values of the present study are different from that of the values of that of author’s study.

**Proximal breadth**

According to the study of Parson, F.G. (1914),[16] Distal breadth was shown as more than 75mm in male and lesser than 70mm in female Americans. Rashmi Srivastava, Ph.D.et.al(2011) reported distal breadth was shown as 76.83mm in males and 68.28mm in females. This study showed the same factor as 74.79mm in males and 69.38mm in females. The values found by this study are almost similar to that of the values of that of author’s study.

According to the study of King C.A;Iscan et.al.;(1998),[19] Distal breadth was shown as 79.7mm in males and 70mm in females. The values of the present study males are slightly lower than that of the author. The values of females are almost similar to that of author’s study.

Mall G, Gehring KD et.al(2000),[10] reported Head vertical diameter was shown as more than 48mm in male and lesser than 44mm in female Americans. The values found by this study are different from the values of that of author’s study.

Pearson K.Bell (1917),[22] stated that the Head vertical diameter was shown more than 45.5mm in male and lesser than 41.5mm in female Americans. The values of this study showed the males are slightly lower than that of author. The values of females are different from the values of that of author’s study.

**Comparison of present findings with previous Authors**

| Maximum length | Male | Female |
|----------------|------|--------|
| Parson, 1914   | More than 450mm | Lesser than 400mm |
| King C.A;Iscan M.Y and Loth | 429.4mm | 397.7mm |

**Head vertical diameter**

| Authors                     | Head vertical diameter |
|-----------------------------|------------------------|
| Male                        | Female                 |
| Dwight, 1905                | 49.60mm | 43.84mm |
| Parson, 1914                | More than 48mm | Lesser than 44mm |
| Pearson K.Bell J. 1917      | More than 45.5mm | Lesser than 41.5mm |
| Stewart, T.D. 1979          | More than 47.5mm | Lesser than 42.5mm |
| King C.A;Iscan M.Y and Loth 1998 | 45.1mm | 39.3mm |
| Mall G.Graw M.et.al 2000    | 49mm | 44mm |
| Parulk R. and Chandra H. 2002 | 44.28mm | 38.39mm |
| K.S. Narayana, Reddy 2008   | More than 47mm | Lesser than 45mm |
| Apurba nandy 2010           | 45mm | 41.5mm |
| Gargisoni et.al 2010        | 44.45mm | 39.89mm |
| Rashmi Srivastava et.al 2011 | 43.77mm | 39.40mm |
| Hema Nidugala et.al 2013    | 39.85mm | 41.75mm |
| Mohammed Laeeque et.al 2014 | 43mm | 37mm |
| Rajeep vijay josh et.al 2017 | 42.0mm | 41.7mm |
| Present Study               | 42.08mm | 37.22mm |

**Transverse head diameter**

| Authors                     | Transverse diameter of head |
|-----------------------------|----------------------------|
| Male                        | Female                     |
| Mall G.Graw M. et.al 2000   | 49mm | 43mm |
| Rashmi Srivastava et.al 2011 | 43.86mm | 39.52mm |
| Hema Nidugala et.al 2013    | 35.31mm | 36.81mm |
| Mohammed Laeeque et.al 2014 | 43mm | 37mm |
| Rajeep vijay josh et.al 2017 | 42.0mm | 41.7mm |
| Present Study               | 42.93mm | 37.66mm |

**Proximal breadth**

| Authors                     | Proximal breadth |
|-----------------------------|-----------------|
| Male                        | Female          |
| Rashmi srivastava et.al 2011 | 85.72mm | 75.29mm |
| Hema Nidugala et.al 2013    | 76.74mm | 79.78mm |
| Present study               | 82.13mm | 74.27mm |

**Distal Breadth**

| Authors                     | Distal breadth |
|-----------------------------|---------------|
| Male                        | Female        |
| Parson, 1914                | More than 75mm | Lesser than 70mm |
| Rajeep vijay josh et.al 2017 | More than 75mm | Lesser than 72mm |

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**Conclusion**

Asala SA., Mbaigjorgu FE, Papandro B.A. (23) opined that the determination of the sex of an individual basing on a single factor is a more difficult task. Therefore, this study was conducted by taking a wider spectrum of the parameters (variable factors), ie, five factors, into consideration. The accuracy of the sex determination of the individual increases greatly due to this. Thus, the present study on the determination of sex of femora will be more reliable basis for the sex determination because it shows the values in this geographical region. This is believed to be more useful in the investigative procedures in the Forensic Medicine and also in the field of orthopaedics.

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