

Sexual Dimorphism of Femur and its Clinical Significance

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Abstract

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. (50male, 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 determination.^[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).^[32] 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.^[4-8]

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 to 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 standing 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 (50males & 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]



Figure 1: Maximum length of Femur



Figure 2: Transverse diameter of head



Figure 3: Distal breadth



Figure 4: Head vertical diameter

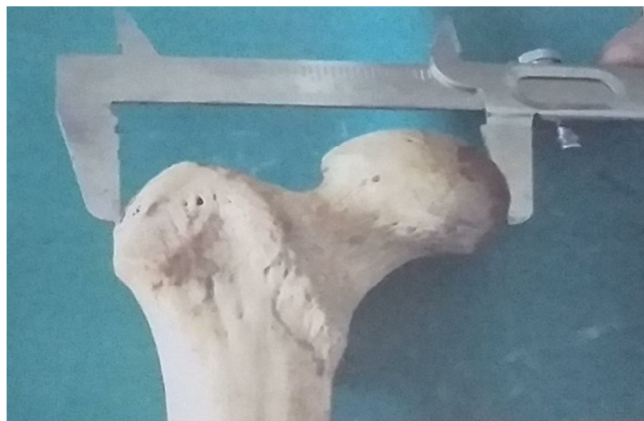


Figure 5: Proximal breadth

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 identify. 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 south Indian and North Indian populations.

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 King C.A.; Iscan et.al;(1998),^[19] Maximum Length was shown as 429.4mm in male and 397mm in female Thais. Purkait R.and Chandra H;(2002),^[14] reported Maximum Length was shown as 451.47mm in male and 403.2mm in female Indians. According to the study of Rashmi Srivastava, ph.D.et.al(2011)^[2] Maximum Length was shown as 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 almost similar to that of the author’s study and females are slightly lower than that of the author.

Umapathy Sembian et.al(2012),^[12] 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 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 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.

Transverse head diameter-

Rashmi Srivastava, ph.D. et.al (2011),^[2] reported 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 this study of Mall G, Gehring KD et.al (2000),^[21] 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 Rashmi Srivastava, ph.D. et.al (2011)^[2] Proximal breadth was shown as 85.72mm in males and 75.29mm in females. This study showed the same factor as 82.13mm in males and 74.27mm in females. The values found by this study are almost similar to that of the values of that of author's study.

Distal 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)²⁻ 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 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),^[21] reported distal breadth was shown as 84mm in males and 77mm in females. The values found by this study are different from that of the values of that of author's study.

According to the study of Purkait R. and Chandra H; (2002),^[14] Distal breadth was shown as 78.04mm in males and 67.13mm in females. The values of the males are slightly lower than that of the author and females are almost similar to that of author's study

Comparison of present findings with previous Authors

Maximum length

Authors	Maximum length	
	Male	Female
Parson ¹⁶ , 1914	More than 450mm	Lesser than 400mm
King C.A., Iscan M.Y and Loth	429.4mm	397mm

S.R ¹⁹ , 1998		
Mall G.Graw M. et.al ²¹ , 2000	464.0mm	434.0mm
Purkait R. and Chandra H ¹⁴ , 2002	451.47mm	403.2mm
Gargisoni et al ¹⁵ , 2010	439.57mm	410.60mm
Rashmi Srivastava et.al ² 2011	435.5mm	404.1mm
Pandya AM, Singel TC et al ³ 2011	Rt side 451.81 Lt side 453.35	Rt side 417.48 Lt side 420.44
Umapathy sembain et.al ¹² 2012	Rt. Side 406mm Lt. Side 40mm	Rt. side 388mm Lt. side 388mm
Hema Nidugala et.al ²⁸ 2013	421.11mm	431.90mm
Rajeswari.S. et.al ²⁹ 2013	Rt 406mm Lt 40mm	Rt 388mm Lt 388mm
Kalpna .R. et.al ²⁰ 2014	441.36mm	394.60mm
Pavel Timonov et.al ¹⁸	461.77mm	411.74mm
Rajeev vijay joshi et.al ¹⁷ 2017	436mm	421mm
Present study	444.7mm	402.9mm

Head vertical diameter

Authors	Head vertical diameter	
	Male	Female
Dwight ²⁶ , 1905	49.68mm	43.84mm
Parson ¹⁶ , 1914	More than 48mm	Lesser than 44mm
Pearson k, Bell J. ²² , 1917	More than 45.5mm	Lesser than 41.5mm
Stewart. TD ²⁷ , 1979	More than 47.5mm	Lesser than 42.5m
King C.A., Iscan M.Y and Loth S.R ¹⁹ , 1998	45.1mm	39.3mm
Mall G.Graw M. et.al ²¹ , 2000	49mm	44mm
Purkait R. and Chandra H ¹⁴ , 2002	44.28mm	38.39mm
K.S. Narayana Reedy ²⁴ , 2008	More than 47mm	Lesser than 45mm
Apurba nandy ²⁵ , 2010	45mm	41.5mm
Gargisoni et.al ¹⁵ , 2010	44.45mm	39.89mm
Rashmi Srivastava et.al ² , 2011	43.77mm	39.40mm
Hema Nidugala et.al ²⁸ 2013	39.85mm	41.75mm
Mohammed Laeeque et.al ³⁰ 2014	43mm	37mm
Rajeev vijay joshi et.al ¹⁷ 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 ²¹ , 2000	49mm	43mm
Rashmi Srivastava et.al ² , 2011	43.86mm	39.52mm
Hema Nidugala et.al ²⁸ 2013	35.31mm	36.81mm
Mohammed Laeeque et.al ³⁰ 2014	43mm	37mm
Rajeev vijay joshi et.al ¹⁷ 2017	42.0mm	41.7mm
Present Study	42.93mm	37.66mm

Proximal breadth

Authors	Proximal breadth	
	Male	Female
Rashmi srivastava et.al ² , 2011	85.72mm	75.29mm
Hema Nidugala et.al ²⁸ 2013	76.74mm	79.78mm
Present study	82.13mm	74.27mm

Distal Breadth

Authors	Distal breadth	
	Male	Female
Parson ¹⁶ , 1914	More than 75mm	Lesser than 70mm
Pearson k, Bell J ²² , 1917	More than	Lesser than 72mm

	78mm	
King C.A, Iscan M.Y and Loth S.R ¹⁹ , 1998	79.7mm	70mm
Mall G.Graw M, et.al ²¹ , 2000	84mm	77mm
Purkait R. and Chandra H ¹⁴ , 2002	78.04mm	67.13mm
K.S. Narayana Reddy ²⁴ , 2008	74 to 89mm	67 to 76mm
Apurba nandy ²⁵ , 2010	75mm	70mm
Gargisoni et.al ¹⁵ , 2010	76.27mm	69.26mm
Rashmi Srivastava et.al ² , 2011	76.83mm	68.28mm.
Umopathy Sembain et.al ¹² 2012	Rt.side 73.6mm Lt side 75.0mm	Rt side 68.3mm Lt side 68.4mm
Hema Nidugala et.al ²⁸ 2013	70.19mm	73.87mm
Rajeswari.S. et.al ²⁹ 2013	Rt side 73.6mm Lt side 75.0mm	Rt side 68.3mm Lt side 68.4mm
Mohammed Laeeque et.al ³⁰ 2014	76mm	65mm
Kalpana.R. et.al ²⁰ 2014	76.17mm	69.83mm
Pavel Timonov et.al ¹⁸ 2014	84.92mm	74.62
Present study	74.79mm	69.38mm

Conclusion

Asala SA., Mbajjorgu 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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