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SEX DETERMINATION FROM PROXIMAL END OF THE TIBIA AMONG MAHARASHTRA POPULATION

Dr. Harika	Assistant Professor at S.R.M.C , Nandyal
Dr. Swati Pandhare	Associate Professor at B.J.G.M.C, Pune
Dr. Anjana Gaikwad	Professor & Head at G.M.C, Alibugh
Dr.Vaishali Paranjape	Associate Professor at B.J.G.M.C, Pune
Dr. Anjali Patil	Professor & Head at B.J.G.M.C, Pune

ABSTRACT The identification of dead and skeletal remains is of paramount importance. The anthropometric remains is of paramount importance. The anthropometric study of bones is important to determine the race and also in medicolegal cases for determination of stature, age and sex. Several bones show sexual dimorphism and suitable for sexing skeletons with high accuracy, among them long bones have played an important role in determination of sex. As one of the major loads bearing elements in human body, tibia exhibits sexual dimorphism. As the proximal end of tibia are subjected to heavy stress may have a sexual component and proximal end of tibia should be useful in determining sex of an individual. **Objective:** To study the importance of proximal end of tibia for sex determination. **Methods:** A total of 52M & 30F dry tibial bones were measured by using osteometry board, vernier calipers. Bones were obtained from Department of Anatomy from different medical colleges. **Result:** Proximal end of tibia gives 63% in M & 37% in F accuracy in sex determination. **Conclusion:** The various proximal end of tibial parameters – 1) Biarticular breadth ,2) Medial condyle articular width, 3) Medial condyle articular length, 4) Lateral condyle articular width, 5) Lateral condyle articular length ,6) Maximum proximal epiphyseal diameter at highest convexity of tibial tuberosity may be of value in skeletal identification.

KEYWORDS : Sex determination, Proximal end of tibia, sexual dimorphism.

INTRODUCTION

The identification of the living, dead and skeletal remains is of paramount importance in the routine forensic practice. Sex estimation is one of the Prime factors which is employed to establish the identify of a person [1,2,3]. Without an accurate determination of sex, we cannot accurately estimate age at death, as rates of growth, development, and degeneration vary by sex as well as population. There are many sex estimation methods that can be applied to human remains. Methods vary from visual assessments to metric analyses of sexually dimorphic traits. Methods also may vary in elements used. Many bones of the human skeleton have been analyzed to assess the degree of sexual dimorphism and accuracy in sex estimation [4]. Determination of sex from analysis of human skeletal remains has been a well-studied field with broad ranging applications extending beyond forensic anthropology, into archaeology, Paleoanthropology, and comparative anatomy. Osteometry methods constitute a reliable approach for sex estimation and considering the variation of sexual dimorphism between and within populations, standards for specific populations are required to ensure accurate results [5].

Morphometrical methods for sexing from bone in addition to providing simplicity also allow no individual variations and are entirely objective assessment. Sex determination is relatively easy if the entire skeleton is available, pelvis and skull are most reliable bones for this purpose [6,7,8]. Percentage accuracy, for adult material is about entire skeleton 100%, Skull bone- 90%, Pelvis bone- 95%, Skull plus pelvis- 98%, long bones alone 80%, long bones plus skull- 90-95%, long bones plus pelvis- 95% [9,10].

As one of the major load bearing elements in human body, the tibia exhibits sexual dimorphism. Not only is it called upon to support the body's weight, but the proximal end is subjected regularly to greater stress than many other joints in the skeleton [11,12]. As the ends of tibia are subjected to heavy stress during an individual's life, and because the stress may have a sexual component, and proximal end of tibia should be useful in determining sex [13]. The knee joint requires high motor function, as it is one of the most complicated joints in the human body. With the aging of society, the incidence of knee arthritis is gradually increasing. Total knee arthroplasty is safe and efficacious procedure for patients with severe arthritis who have persistent symptoms despite use of drug therapy. Precise matching of implant and resected bony surface i.e., proximal end of the tibial surface is crucial to the successful surgery. Tibial component loosening has been more common than Femoral component loosening. Under sizing of the component will lead to the prothesis subsidence, especially when the component cannot cover the middle of the tibia. Mismatch between prothesis and resected bony surface will lead to operation failure [14].

AIMS AND OBJECTIVES:

1. To study the importance of Proximal end of tibia for determination of sex.
2. To compile the morphometric data related to various parameters of proximal end of male and female tibia among Maharashtra population.

MATERIALS AND METHODS:

For the present study, 82 adult human dried tibiae of known sex (52 Male and 30 Female) were produced from skeletal collection of various Medical Colleges in Maharashtra. Damaged bones those with pathological changes, implants as well as which showed fractures are excluded from the study. Instruments that were used in this study are Osteometry board, vernier calipers, Thread, Chalk, Marker Pens and Gloves. A total of 7 tibial parameters were taken for each specimen. The measurements were taken twice and average of them has taken to ensure the accuracy. All the measurements were taken in cm.

Parameters:

1. Maximum proximal epiphysial diameter at highest convexity of tibial tuberosity (MPEDAHCTT): Measurement has to be taken from a point just posterior to the intercondylar eminence to the highest convexity of tuberosity of the tibia i.e., the epiphyseal line.
2. Maximum proximal epiphysial diameter at proximal end of tibial tuberosity (MPEDAPETT): Measurements has to be taken from point just posterior to the intercondylar eminence to the proximal end of tuberosity of the tibia.
3. Biarticular breadth (BB): Maximum breadth of proximal articular surface of the tibia as measured from the lateral edge of the lateral condyle to the medial edge of the medial condyle. This is not the maximum breadth of the proximal tibia, but rather the maximum breadth of the articular surface. Calipers should be placed only on the articular surfaces of the condyles.
4. Medial condyle articular width (MCAW): Maximum transverse width of the medial condyle as measured from the lateral to the medial edges. The surface of the condyle generally circumscribed by a slight rim, and the calipers should be placed on this rim.
5. Medial Condyle articular length (MCAL): Similar But perpendicular to the width. Measurements should record the maximum length from anterior edge of the medial condyle to the posterior margin.
6. Lateral condyle articular width (LCAW): Similar to the width measurement made on the medial condyle but made on the lateral condyle.
7. Lateral condyle articular length (LCAL): Maximum length of lateral condyle as measured in a manner similar to that for medial condyle articular length.

Statistical Analysis:

Statistical analysis was done using SPSS software. The descriptive statistics mean and standard deviation were used to summarized the continuous skew data among male and female. We compared the variables among male and female using the unpaired t-test, to find the relation between sex and outcome variables. We used Linear regression coefficient.

RESULTS:

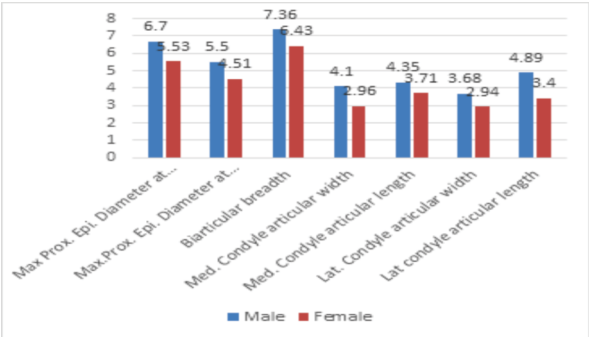
A total of 82 bones, 52 male and 30 females were subjected to morphometric analysis. Table shows the mean, standard deviations and regression coefficient values when compared female with male for all measurements. The p values for all the measurements were found to be statistically highly significant for difference between the sexes. The result indicate that the Biarticular Breadth is the best parameter among all the measured variables and second-best parameter is Maximum proximal epiphysial diameter at highest convexity of tibial tuberosity. The results show the constant and correctly classified for all the variables.

Table 1: Table showing the mean value and SD value in male and female along with linear regression coefficient value, (SD, $p<0.0001$ highly significant).

Table 1:

Parameters	Mean		SD		P Value	Regression Coefficient (Compared Female with Male)
	Male (cm)	Female (cm)	Male	Female		
MPEDAHCTT	6.70	5.53	1.16	0.56	<0.0001	1.16
MPEDAPETT	5.50	4.50	0.99	0.21	<0.0001	0.99
BB	7.36	6.43	0.93	0.33	<0.0001	0.93
MCAW	4.10	2.96	1.14	0.19	<0.0001	1.14
MCAL	4.35	3.71	0.63	0.29	<0.0001	0.63
LCAW	3.68	2.94	0.74	0.31	<0.0001	0.74
LCAL	4.89	3.40	1.48	0.15	<0.0001	1.48

The graph shows that the parameters taken in the present study shows marked differences between male and female in Maharashtra population.



DISCUSSION:

The purpose of the study was to determine which variable of upper end of tibia is best for metric diagnosis of sex. The result obtained are compared with available literature in the table 2.

Table 2: M-Male, F-Female, SD-Standard Deviation

Parameters	Present study (cm)				Thomas D. Holland study (cm)				Rai N, Nair S, et al study (cm)				Ankur Z Zalwadia & Shailesh Patel study			
	M	F	SD		M	F	SD		M	F	SD		M	F	SD	
			M	F			M	F			M	F			M	F
MPEDAHCTT	6.7	5.5	0.4	0.5	-	-	-	-	-	-	-	-	-	-	--	-
MPEDAPETT	5.5	4.5	0.4	0.2	-	-	-	-	-	-	-	-	--	-	--	-
BB	7.3	6.4	0.9	0.3	7.6	6.7	0.3	0.28	6.9	6.1	0.4	0.4	7.4	6.7	0.2	0.2
MCAW	4.1	2.9	0.2	0.1	3.3	2.8	0.2	0.2	3.2	3.0	0.4	0.4	2.8	2.6	0.3	0.1
MCAL	4.3	3.7	0.3	0.2	4.8	4.2	0.3	0.2	4.1	3.6	0.3	0.4	4.4	3.9	0.2	0.2
LCAW	3.6	2.9	0.2	0.3	3.4	2.9	0.2	0.1	3.2	3.0	0.4	0.3	2.7	2.9	0.2	0.1
LCAL	4.8	3.4	5.5	0.1	4.2	3.6	0.3	0.2	3.9	3.4	0.4	0.3	3.8	3.5	0.2	0.2

In this study we have selected seven morphometric parameters of proximal end of tibia and data collected by using vernier caliper by direct observation.

Biarticular breadth (BB):

In Thomas Dean Holland studies, the mean value of total sample for biarticular breadth found in male 7.7cm and in female 6.7 cm. The standard deviation was found in male is 0.3 cm and in female 0.2 cm [11]. In Rai N, Nair S, Bankwar V, Rai N, Thanduri K study the Biarticular breadth (BB) of male is 6.9 cm and in female 6.1cm and standard deviation in male is 0.45cm and in female 0.47cm [1]. In Murphy study the Biarticular breadth (BB) in male is 7.1cm and in female 6.2 cm [15]. In Ankur Z Zalwadia & Shailesh Patel study the Biarticular breadth of male is 7.4cm and female is 6.7cm and standard deviation of male is 0.2 and in female is 0.2 [16].

In the present study the biarticular breadth (BB) mean value in male is 7.3 cm and in females 6.4 cm. The standard deviation found in males 0.98 and in females 0.3. The bicondylar breadth of tibia is significantly greater in male than females ($p<0.0001$) and Regression coefficient tibia is 0.93 times

higher in males. When compared to Thomas Dean Holland, Rai N, Nair S, Bankwar V, Rai N, Thanduri K, Murphy and Ankur Z Zalwadia & Shailesh Patel studies the Biarticular breadth (BB) of the Tibia is similar to the prsent study.

Medial condyle articular width (MCAW):

In Rai N, Nair S, Bankwar V, Rai N, Thanduri K study the mean value in male is 3.2 cm and in female 3.0 cm and the standard deviation in male is 0.44 cm and in female 0.45 cm [1]. In study done by Thomas Dean Holland the MCAW mean value in male is 3.3 cm and in female 2.8 cm and the standard deviation value in male is 0.22cm and in female 0.2cm [11]. In Ankur Z Zalwadia & Shailesh Patel study the mean value of male is 2.8cm and in female 2.6cm, the standard deviation of male is 0.3 and in female is 0.1 [16]. In the present study the medial condyle articular width (MCAW) mean value in male is 4.1cm and in female 2.9cm. The standard deviation found in male 0.2cm and in female 0.1cm. The medial condyle articular width of tibia is significantly greater in male than females ($p<0.0001$) and Regression coefficient is 1.14 higher in males. When compared to Thomas Dean Holland, Rai N, Nair S, Bankwar V, Rai N, Thanduri K, and Ankur Z Zalwadia & Shailesh Patel studies the Medial Condyle articular width (MCAW) of the Tibia is similar to the present study.

Medial condyle articular length (MCAL):

In Thomas Dean Holland study, the MCAL mean value in male is 4.8cm and in female 4.2 cm. The standard deviation in male is 0.3 cm and in female 0.2 cm [11]. In Rai N, Nair S, Bankwar V, Rai N, Thanduri K study the mean value of MCAL in male is 4.1 cm and in female 3.6 cm. The standard deviation in male is 0.38 cm and in female 0.4 cm [1]. In Ankur Z Zalwadia & Shailesh Patel study the mean value of male is 4.4cm and in female 3.9cm, the standard deviation of male is 0.2 and in female is 0.2 [16]. In present study the medial condyle articular length (MCAL) mean value in male is 4.3 cm and in female 3.7cm. The standard deviation found in male 0.34 cm and in female 0.29 cm. The medial condyle articular length of tibia is significantly greater in male than females ($p<0.0001$) and Regression coefficient is 0.63 times higher in males. When compared to T Rai N, Nair S, Bankwar V, Rai N, Thanduri K, and Ankur Z Zalwadia & Shailesh Patel studies the Medial Condyle articular length (MCAL) the mean value and standard deviation of male is similar. when compared to Thomas Dean Holland studies the mean value and standard deviation of male is similar but female mean value is lower in the present study.

Lateral condyle articular width (LCAW):

In Thomas Dean Holland study, the mean value of male is 3.4cm and in female 2.9 cm. The standard deviation in male is 0.2cm and in female 0.1cm. In Rai N, Nair S, Bankwar V, Rai N, Thanduri K study the mean value in male is 3.2cm and in female is 3.0 cm. The standard deviation found in male is 0.4cm and in female 0.3 cm. In Ankur Z Zalwadia & Shailesh Patel study the mean value in male is 2.7 cm and in female is 2.9 cm, the standard deviation in male is 0.2 and in female is 0.1 [16]. In present study the lateral condyle articular width (LCAW) mean value in male is 3.6 cm and in female 2.9 cm. The standard deviation found in male is 0.27 and in female 0.31. The LCAW of tibia is significantly greater in male than females ($p<0.0001$) and Regression coefficient is 0.74 times higher in males. When compared to Rai N, Nair S, Bankwar V, Rai N, Thanduri K, Thomas Dean Holland and Ankur Z Zalwadia & Shailesh Patel studies the mean value and standard deviation values of Lateral Condyle Articular Width (LCAW) both male and female is similar to the present study.

Lateral condyle articular length (LCAL):

In Rai N, Nair S, Bankwar V, Rai N, Thanduri K study the mean value found in male is 3.9 cm and in female is 3.4 cm. The standard deviation found in male is 0.42 cm and in female is 0.37 cm [1]. In Thomas Dean Holland study, the mean value found in male is 4.2cm and in female is 3.6cm. The standard deviation found in male is 0.3cm and in female is 0.2 cm [11]. In Ankur Z Zalwadia & Shailesh Patel study the mean value in male is 3.8cm and in female 3.5cm, the standard deviation in male is 0.2 and in female is 0.2 [16] In present study the lateral condyle articular length (LCAL) mean value in male is 4.8 cm and in female 3.4 cm. The standard deviation found in male is 5.5 cm and in female 0.15 cm. The LCAL of tibia is significantly greater in male than females ($p<0.0001$), Regression coefficient is 1.48 times higher in males. When compared to Rai N, Nair S, Bankwar V, Rai N, Thanduri K, Thomas Dean Holland and Ankur Z Zalwadia & Shailesh Patel studies the mean value and standard deviation values of Lateral Condyle Articular Length (LCAL) both male and female is similar to the present study.

Maximum proximal epiphysial diameter at highest convexity of tibial tuberosity (MPEDAHCTT):

In the present study we have measured new parameter i.e., the maximum proximal epiphysial diameter at highest convexity of tibial tuberosity mean value was found to be 6.7 cm and in females 5.5 cm. The standard deviation found in males 0.4 cm and in females 0.5 cm. The MPEDAHCTT of tibia is significantly greater in male than females ($p<0.0001$), Regression coefficient is 1.16 times higher in males. No data is available about this parameter being used for sexing the tibia.

Maximum proximal epiphysial diameter at proximal end of tibial tuberosity (MPEDAPETT):

In the present study we have measured new parameter i.e., the maximum proximal epiphysial diameter at proximal end of tibial tuberosity (MPEDAPTT) mean value in males is 5.5 cm and in females 4.5 cm. The standard deviation found in males 0.4 cm and in females 0.2 cm. The MPEDAPETT of tibia is significantly greater in male than females ($p<0.0001$), Regression coefficient is 0.99 times higher in males. No data is available about this parameter being used for sexing the tibia.

CONCLUSION:

Sex determination cannot be done by using any single parameter. Although tibia is not an ideal bone meant for sex determination but as it is a long bone it can be used for sex determination. According to the Krogman long bones can be used for sex determination with 80-85% accuracy [10]. As per the values in the present study, from the table and graph the Biarticular breadth (BB) is considered as first best parameter and the second-best parameter is Maximum proximal epiphysial diameter at highest convexity of tibial tuberosity (MPEDAHCTT) among Maharashtra population.

REFERENCES:

1. Rai N, Nair S, Bankwar V, Rai N, Thanduri K. Sex determination of adult human tibia in central Indian population. International Journal of Medical and Health Research. 2017;3(5):82-4.
2. Singh G. Identification of sex from tibia. J Anat Soc Ind. 1975; 24:20-4.
3. Kirici Y, Ozan H. Determination of sex from the tibia of adult Turkish cadavers. Kaibogaku zasshi. Journal of anatomy. 1999 Oct 1;74(5):537-43.
4. Tabencki MU. Sex determination using the distal articular surface of the fibula.
5. Krishan K, Chatterjee PM, Kanchan T, Kaur S, Baryah N, Singh RK. A review of sex estimation techniques during examination of skeletal remains in forensic anthropology casework. Forensic science international. 2016 Apr 1; 261:165-e1.
6. Iscan MY, Steyn M. The human skeleton in forensic medicine. Charles C Thomas Publisher; 2013 Sep 1.
7. Pons J. The sexual diagnosis of isolated bones of the skeleton. Human biology. 1955 Feb 1;27(1):12.
8. De Villiers H. The skull of the South African Negro: a biometrical and morphological study. Witwatersrand University Press; 1968.
9. De Villiers H. Sexual dimorphism of the skull of the South African Banu-speaking Negro. South African Journal of Science. 1968 Feb 1;64(2):118.
10. Krogman WM. The human skeleton in forensic medicine. I. Postgraduate medicine. 1955 Feb;17(2): A-48.
11. Holland TD. Sex assessment using the proximal tibia. American Journal of Physical Anthropology. 1991 Jun;85(2):221-7.

12. Ruff CB, Hayes WC. Cross.sectional geometry of Pecos Pueblo femora and tibiae—A biomechanical investigation: II. Sex, age, and side differences. American journal of physical anthropology. 1983 Mar;60(3):383-400.
13. Singh S, Singh SP. Identification of sex from tarsal bones. Cells Tissues Organs. 1975;93(4):568-73.
14. Liu Z, Yuan G, Zhang W, Shen Y, Deng L. Anthropometry of the proximal tibia of patients with knee arthritis in Shanghai. The Journal of arthroplasty. 2013 May 1;28(5):778-83.
15. Murphy WA, Gantner GE. Radiologic examination of anatomic parts and skeletonized remains. Journal of Forensic Science. 1982 Jan 1;27(1):9-18.
16. Zalawadia AZ, Patel SM. Morphometric study of upper end of tibia in Gujrat region and its clinical implication in knee arthroplasty. Int J Anat Res. 2018;6(1.1):4871-5.