

Determination of Sex from the Tibia in the Punjab Zone

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ABSTRACT

Aims and Objectives: Sex determination is an important aspect of forensic science and it is 100% possible when all the skeletal bones are available.

Material and Methods: In the present study, 96 tibia of known sex (62 males and 34 females) were considered.

Results and Conclusion: The weight, length, midshaft circumference and the widths at the upper and the lower end of the

tibia were noted. The demarking points for the identification of sex from the various measurements of the tibia were calculated. None of these measurements can identify the sex of the tibia with 100% certainty. However, weight is the best discriminant factor for the identification of the male tibia and the width at the upper end is the best discriminant factor for the identifying the female tibia.

Key Words: Sex, Skeleton, Midshaft circumference, Demarking points

INTRODUCTION

The tibia is an ideal long bone of the limb which is used for sex determination, as it resists the erosive forces which act and it remains unaffected even after the burial of the body [1]. The identification of the living, dead and the skeletal remains is of paramount importance in the routine forensic practice [2,3]. Sex estimation is one of the prime factors which is employed to establish the identity of a person [4]. The anthropometric study of bones is important to determine the race and also in medico-legal cases for the determination of stature, age and sex [5]. The tibia is an ideal bone as it resists the erosive forces and keeps its anatomical shape for a long time even after the body is buried [6]. Sexual dimorphism in the tibia indicates not only the general growth and the musculo-skeletal activity, but also the genetic structure of the population [7]. Different populations show a variability in the osteometric dimensions and the standards which are specific for the population which is under study, which should be used for the sex determination [8].

MATERIAL AND METHODS

96 human tibia of known sex (62 males and 34 females) were procured from the Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah (Amritsar). The ages of these tibia were between 18-55years. They were dried, cleaned and numbered. The bones which showed fractures or any other pathologies were discarded. These were studied for various measurements as follows:-

1. Weight was measured using a single pan which was sensitive to 0.1g.
2. Length was measured on an osteometric board.
3. Mid shaft circumference was measured with a measuring tape at the mid point of the bone.
4. The widths at the upper and the lower end were measured with sliding calipers to the nearest millimetre.

The results were analyzed by using Jeet and Singh Formula [9] according to which we found the demarking points for the various parameters of the tibia in males as well as in females.

RESULTS

Weight of the Tibia Bone

The weights of the right and the left tibia of the males and females were measured. The weight of the right male tibia ranged from 123–341g with a mean of 234.26 ± 48.043 , whereas the weight of the right female tibia ranged from 109–236 g with a mean of 163.91 ± 38.59 . In the female right tibia, the maximum weight was 236 g and so we called it as the Identification Point (IP). We classified the right tibia which had a weight of more than 236g as the male right tibia. The lightest male right tibia was of weight 123g and so we classified the male right tibia which had a weight of less than 123g as the female tibia. With this formula, 42% of the right tibia can be assigned as male tibia and 20% can be assigned as female tibia. The standard deviation was calculated for the above range and from this the calculated range (mean $\pm$ 3SD) was drawn, which

Sr. No.	Measurement (gm)	Right		Left	
		Male	Female	Male	Female
1.	Range	123-341	109-236	120-365	103-227
2.	Mean	234.26	163.91	224.81	157.25
3.	Standard Deviation	48.043	38.59	50.06	35.78
4.	Calculated Range (mean $\pm$ 3SD)	90.131-378.38	48.14-278.77	74.63-374.99	49.91-264.59
5.	Identification Points	>236	<123	>227	<120
6.	%from calculated range	42	20	56	19
7.	Demarking points (DP)	> 278.77	<90.131	>264.59	<74.63
8.	% age beyond DP	16	2	27	3

[Table/Fig-1]: Measurement of Weight (in gm) of tibia

led to the Demarking Points (DP). But with the Demarking Points, the percentage which was identified came down to 16% as male right tibia and 2% as female right tibia [Table/Fig-1]. Similar points were noted on the left side and similarly the percentages dropped down from the Identification Points to the Demarking Points. The length, mid-shaft circumference and the widths at the upper and the lower end of the tibia were noted. Also the IP and the DP for the above measurements were found out and they have been shown in the [Table/Fig-2 and 5]. We have compared the percentages of the tibia which were identified by the IP and the DP for various measurements [Table/Fig-6].

DISCUSSION

Sex determination from the long bones or their fragments is often the most important step for the identification of a person. Usually, the poorly preserved or the fragmentary bones are recovered from the crime site. The long bones are often better preserved than the other shorter bones. The sex determination of the skeletons is of utmost importance to the physical and the forensic anthropologists [10]. A lot of studies have been done for sexing the long bones

Sr. No.	Measurement	Right		Left	
		Male	Female	Male	Female
1.	Range	33.8-43.1	31.6-39.2	34.1-43.0	29.6-40.6
2.	Mean	38.11	33.94	37.47	35.06
3.	Standard Deviation	1.9	2.18	1.97	2.11
4.	Calculated Range	32.41-43.81	27.4-40.48	31.56-43.38	28.73-41.39
5.	Identification points	>39.2	<33.8	>40.6	<34.1
6.	% age identified	41	16	47	19
7.	Demarking points	> 40.48	<32.41	>41.39	<31.56
8.	% age beyond DP	17	1	21	5

[Table/Fig-2]: Measurement of Length (in cm) of tibia

Sr. No.	Measurement	Right		Left	
		Male	Female	Male	Female
1.	Range	6.3-9.2	5.1-8.0	6.3-8.9	5.3-7.8
2.	Mean	7.53	6.11	7.59	6.61
3.	Standard Deviation	0.53	0.567	0.519	0.52
4.	Calculated Range	5.94-9.12	4.409-7.811	6.033-9.147	5.05-8.17
5.	Identification points	>8.0	<6.3	>7.8	<6.3
6.	% age identified	16	23	28	12
7.	Demarking points	> 7.811	<5.94	>8.17	<6.033
8.	% age beyond DP	8	17	20	11

[Table/Fig-3]: Measurement of Mid-shaft circumference (in cm) of tibia

Sr. No.	Measurement	Right		Left	
		Male	Female	Male	Female
1.	Actual Range	4.3-5.6	3.2-5.1	4.0-5.7	3.5-4.9
2.	Mean	4.91	4.32	4.81	4.33
3.	Standard Deviation	0.413	0.30	0.66	0.27
4.	Calculated Range	3.671-6.149	3.42-5.22	2.83-6.79	3.52-5.14
5.	Identification points	>5.1	<4.3	>4.9	<4.0
6.	% age identified	19	8	24	6
7.	Demarking points	> 5.22	<3.671	>5.14	<2.83
8.	% age beyond DP	8	2	18	1

[Table/Fig-4]: Lower end width (in cm) of tibia

Sr. No.	Measurement	Right		Left	
		Male	Female	Male	Female
1.	Actual Range	6.3-8.3	5.1-7.5	6.4-8.5	5.6-7.3
2.	Mean	7.35	6.41	7.13	6.51
3.	Standard Deviation	0.359	0.47	0.269	0.43
4.	Calculated Range	6.273-8.427	5.0-7.82	6.323-7.937	5.22-7.8
5.	Identification points	>7.5	<6.3	>7.3	<6.4
6.	% age identified	17	33	24	11
7.	Demarking points	> 7.82	<6.273	>7.8	<6.323
8.	% age beyond DP	8	24	11	6

[Table/Fig-5]: Measurement of Upper end width (in cm) of tibia

Measurements	Right				Left			
	Male		Female		Male		Female	
	IP	DP	IP	DP	IP	DP	IP	DP
Weight	42	16	20	2	56	27	19	3
Length	41	17	16	1	47	21	19	5
Upper End Width	17	8	30	24	14	11	11	6
Lower End Width	19	8	8	2	24	18	6	1
Mid Shaft Circumference	16	8	23	17	28	20	12	11

[Table/Fig-6]: Comparison of percentages of tibia by Identification Points (IP) and Demarking Points (DP)

of the body [1,11,12]. This study which involved some measurable characteristics of the tibia can help in identifying the sex of the tibia. The percentages which were identified by the Identification Points were found to be very high as compared to the Demarking Points. But a 100% accuracy can be drawn from the Demarking Points. Weight was found to be the best discriminating factor for the male tibia and the width at the upper end for the female tibia. Midshaft circumference is also a good criterion for sex determination. But length and the width at the lower end gave little accuracy. For sex determination, any single Demarking Point is required to be crossed by the corresponding bone (right or left). From various previous studies [12,13] it has become clear that the Demarking Points of one race may not apply to another and those of one zone may not apply to another zone. These are due to regional and racial variations. Therefore, it is customary to evolve separate Demarking Points for different zones. Identification of sex from the long bones has been studied in various populations [14]. The average predictive accuracy is different for all. In one study on tibia, it was found to be 82.8% (87.5% for males and 72.2% for females). Comparison with the other races is not possible as different methods are used in different studies.

CONCLUSION

From the present study, it was clear that certain parameters of the tibia could help in sex determination from fragments of the tibia also. The sexual dimorphism in the tibia is not only due to the general growth and the musculoskeletal activity, but also due to the genetic structure of the population. The present study considered weight as the best discriminant factor for the identification of the male tibia and the width at the upper end for the identification of the female tibia in the Punjab region.

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