Original Article

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Study of Different Parameters for Sex Determination of Human Skull

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Abstract

Introduction: Identification of skeletal remains plays a major role in forensic medicine. Sex determination is the most important and initial step in individual identification. Almost all bones of the human skeleton show some degree of sexual dimorphism. However, skull and pelvis are used to permit the diagnosis of sex with high accuracy. The skull is important in this regard as it resists adverse environmental conditions over time. The present study aims to determine sexual dimorphism in 200 skulls (100 male and 100 female). *Method:* Adult human dry skull of known sex (100 male and 100 female) were obtained from different medical colleges of Maharashtra. The Parameters like weight, maximum skull length, maximum skull breath, maximum bizygomatic diameter were studied. *Result:* Mean values of all parameters are more in males than in females. *Conclusion:* Amongstthe parameters, maximum bizygomatic diameteris more reliable for determination of sex with 95% accuracy by using the demarcating point.

Keywords: Sexual Dimorphism; Skull; Parameters.

Introduction

Sex determination is major challenge for forensic anthropologist in the medicolegal context. Anthropological knowledge of human osteology is one of the important stepin identification of age, sex, living stature and ancestry [1]. According to Krogman [2], the degree of accuracy in sexing adult skeletal remains is 100% when entire skeleton was present; pelvis alone 95%; skull alone 92%; pelvis plus skull 98%; long bones 80%; long bone plus pelvis 98%. Sexual differences are marked in pelvis and skull in all population [3]. Traditionally skull is most studied bone in physical anthropology [2]. Traditional studies by non-metrical methods were not reliable. So morphometry and statistical methods were introduced [4]. The aim of the present study to determine sexual dimorphism of skull by multivariate analysis of anthropometric data which will be helpful in anthropometric and medicolegal studies.

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Materials and Methods

This study was conducted on 200 adult skulls of known sex (100 male and 100 female) collected from different medical colleges of Maharashtra. Ethical clearance was taken from the institutional ethical review committee before the initiation of the study. The following measurements were taken after placing the skull in Frankfurt's horizontal plane. Instruments used are sliding vernier caliper, spreading caliper, scale, weighing machine.

The following parameters used for the study are:

Weight- It was taken by weighing machine. It was recorded in grams.

Maximum skull length (Figure 1) - Maximum distance between the glabella and opisthocranion. It was measured with spreading caliper. It was recorded in millimeters.

Maximum skull breadth (Figure 2) – Maximum transverse breadth at the level of parietal eminences. It was measured by sliding vernier caliper. It was recorded in millimeters.

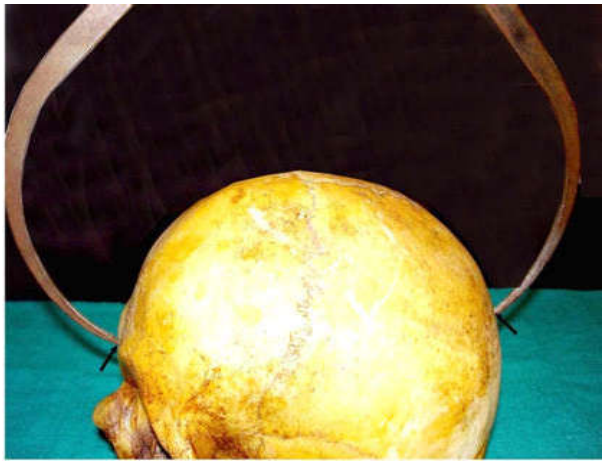

Fig. 1:

Fig. 2:

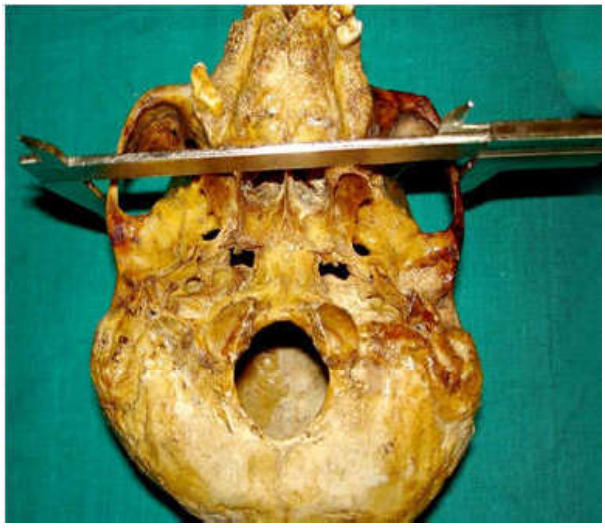

Fig. 3:

Maximum bizygomatic diameter (Figure 3)- width between lateral surfaces of two zygomatic arches. It was measured with sliding vernier caliper. It was recorded in millimeters.

After completing measurements, Mean, standard deviation, t value, p value were calculated for each parameter. Demarcating points (D.P.) were obtained for each parameter and also the percentage of bones crossed the demarcating points were obtained. To determine the demarcating point that is the point which will find whether the skull is of male or female, mean±1.96 SD (standard deviation) range was obtained. Considering the range of male, female demarcating point was determined while considering the range of female, male demarcating point was determined.

Determination of Demarcating Point: Mean and standard deviation were calculated for each parameter of both the sexes. Using these values 'calculated range' was arrived at by the formula 'mean ± 1.96 SD'.

For a given male, calculated range of 'p to q' and female calculated range 'r to s', values of 'p' (minimum in male range) and 's' (maximum in female range) were chosen as 'demarcating points' for females and males respectively. According to Jit and Singh (1966), [5] skull with measurement lesser than 'p' was identified as female skull and greater than 's' as male skull.

When the formula "mean±3SD" was applied, very less percentage of bones could be sexed correctly. So we apply the formula "mean± 1.96SD".

Results

Parameters were studied and analyzed statistically using a standard computer program. The analyzed data was tabulated as follows –

Statistical analysis of the parameters shows p value for weight, maximum skull length, maximum skull breath, and maximum bizygomatic diameter was less than 0.001, so these parameters were significant.

Table 1 shows that weight, maximum skull length, maximum bizygomatic diameter are more reliable in male skulls while in female skulls maximum bizygomatic diameter is more reliable for determination of sex with 95% accuracy when compared with other parameter by using the demarcating point.

Therefore we can conclude that amongst the parameters maximum bizygomatic diameter is more

Table 1: Statistical analysis of different parameters

Parameters	Gr	N	Mean	S.D.	Mean± 1.96SD	D.P.	% of bones identified by D.P.	t value	p value
Weight	M	100	572.90	75.75	424.43-721.37	>623.78	23	7.209	<0.001
	F	100	502.35	61.95	380.92-623.78	<424.43	7		
Maximum skull length	M	100	171.04	6.85	157.62-184.46	>175.70	23	8.544	<0.001
	F	100	162.98	6.49	150.26-175.70	<157.62	15		
Maximum skull breadth	M	100	128.33	4.68	119.15-137.51	>132.64	15	6.588	<0.001
	F	100	124.12	4.35	115.60 - 132.64	<119.15	11		
Maximum bizygomatic diameter	M	100	125.11	4.04	117.20 - 133.02	>126.10	33	12.039	<0.001
	F	100	118.27	3.99	110.44 - 126.10	<117.20	24		

Table 2: Comparison between Previous and present study on weight.

Author's name	Males Mean	Females Mean	p. value	Statistical significance
Keen JA (1950) [6]	618	572	>0.05	Not significant
Deshmukh and Devershi (2006) [4]	526	494	>0.05	Not significant
Talokar SA and Lade SH (2015) [7]	511.79	500.32	0.054	Not significant
Present study	572.90	502.35	<0.001	Significant

Table 3: Comparison between Previous and present study on maximum skull length

Author's name	Males Mean	Females Mean	p. value	Statistical significance
Deshumukh and Devershi (2006) [4]	173	166	<0.001	Significant
Chimmalgi etal. (2007) [9]	171.51	165.57	<0.001	Significant
Zavando et al. (2009) [10]	184.09	178.81	<0.05	Significant
Talokar SA and Lade SH (2015) [7]	174.31	163.63	0.000	Significant
Saini R. and Saini V. (2016) [11]	180.6	171.4	0.000	Significant
Present study	171.04	162.98	<0.001	Significant

Table 4: Comparison between Previous and present study on maximum skull breadth

Author's name	Males Mean	Females Mean	p. value	Statistical significance
Deshumukh and Devershi (2006) [4]	131	127	<0.001	Significant
Zavando et al. (2009) [10]	140.86	137.66	0.040	Significant
Talokar SA and Lade SH (2015) [7]	133.05	124.85	0.000	Significant
Saini R. and Saini V. (2016) [11]	126.72	124.29	0.000	Significant
Present study	128.33	124.12	<0.001	Significant

Table 5: Comparison between Previous and present study on maximum bizygomatic diameter

Author's name	Males Mean	Females Mean	p. value	Statistical significance
Deshumukh and Devershi (2006) [4]	126	121	<0.001	Significant
Chimmalgi et al. (2007) [9]	126.75	119.08	<0.001	Significant
Zavando et al. (2009) [10]	127.02	119.67	<0.001	Significant
Saini R. and Saini V. (2016) [11]	125.07	116.86	0.000	Significant
Present study	125.11	118.27	<0.001	Significant

reliable in both male and female skulls for determination of sex.

Discussion

Although adult skull shows a few non-metrical and metrical differences, there is paedomorphic tendency in human skull of either sex. Each parameter is discussed by comparing them with the findings of previous workers. Present study correlates with findings of previous workers. Only the findings of present study on weight do not coincide with Keen JA study (1950) [6], Deshmukh and Devershi study (2006) [4], Talokar SA and Lade SH study (2015) [7]. According to them, weight is not a statistically significant parameter. But in present study, weight is found statistically significant. So present study on weight go in favour of Sahana [8]. According to sahana, size

and weight of skull is larger and heavier in male than in female. Tables 2-5 show comparative study of different workers.

Conclusion

1. Mean values of all parameters are more in males than in females.
2. All parameters are statistically significant. ($p<0.001$)
3. Amongst all parameters, maximum bizygomatic diameter is more reliable in both male and female skulls for determination of sex.

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