

Sex determination using mastoid process measurements of dry skull bone: A Descriptive Analysis

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Abstract—Study on human skeletal for sex determination has been a topic of interest among researchers. It appears to be the main reliable bone exhibiting sexually dimorphic traits, specially the mastoid region. Present study aims to determine the difference in mastoid morphometry between male and female bone for sex differentiation.

Material and methods: A descriptive observational study was conducted at Department of Anatomy, SMS Medical College, Jaipur between April- December 2014. Forty dry macerated adult Human skulls of age group above 18-25 yrs of known sex were included in which suture between the basiocciput and basisphenoid were united. Vernier Caliper was used for measurements of Mastoid process in Frankfurt's Plane.

Results: Mastoid length was significantly larger in males as compared to females on both sides (p value <0.05). Cut-off of right mastoid length of 32.39mm and left Mastoid length of 31.71mm were highly accurate in differentiating male and female skull.

Conclusion: The parameters like mastoid process length can be used as predictors to determine gender and could be of immense use in forensic medicine and anthropology and will also serve as a future framework for estimating the craniofacial dimensions of other Indian population.

Key word: Mastoid Length, Sex Differentiation, Sex Determination.

I. INTRODUCTION

Study on human skeletal remains for sex determination has been a topic of interest among researchers. Skeletal remains have been used for sexing the individual as bones of the body are last to perish after death, next to enamel of teeth. Almost all bones of the human skeleton show some degree of sexual dimorphism.

Often fragmentary remains are available, instead of, complete skeletons for forensic identification. In the skull, the temporal bone is highly resistant to physical damage; thus it is commonly found as remainder in skeletons that are very old; of this, the petrous portion has been described as important for sex determination. Moreover, in case of burning, petrous part of temporal bone is generally preserved because of its compact structure and protected position at the base of skull^{1,2}

Sex is best assessed from the pelvis but it is very often damaged³. Skull requires the most frequent sexing in medico legal cases. It appears to be the main reliable bone exhibiting sexually dimorphic traits, because skull has a high resistance to adverse environmental conditions over time, resulting in the greater stability of dimorphic features as compared to other skeletal bony pieces⁴. Mastoid region is one of the most dimorphic traits^{5,6};

Earlier traditional studies by nonmetrical methods were centred on morphological traits which were not reliable because more features depends on occupation, nutrition, race, geographical regions and visual impressions change from person to person. Subsequently trends changed to morphometry and statistical methods⁷. Osteometric studies using individual bones exhibiting sexual dimorphism have been reported among different populations⁸.

Present study aims to determine the difference in mastoid morphometry between male and female bone and to determine the critical cut-off point for these measurements for sex differentiation.

II. METHODOLOGY

A descriptive observational study was conducted at Department of Anatomy, SMS Medical College, Jaipur between April- December 2014.

For study purpose 40 dry macerated adult Human skulls of age group above 18-25 yrs of known sex were included in which suture between the basiocciput and basisphenoid were united. Skulls without deformity or craniofacial defects were excluded from study. Ethical clearance was taken from the institutional ethical review committee before the initiation of the study.

Measurements will be taken after putting the skull in Frankfurt's Plane. Vernier Calipers (figure 1) was used for measurements of Mastoid process. The measurements of right and left sides will be recorded separately. Two readings were taken for each measurement and average of these readings was taken to reduce the error of measurements. All measurements were recorded to the nearest millimetre.

Figure 1
Measurement of Mastoid Process Length



Data was collected using predesigned proforma and entered into MS Excel worksheet. Morphometric measurements were expressed as Mean and standard deviation and were analyzed using unpaired-t- test. Significance level was taken at P value <0.05. All analysis was done using 'Primer' software and SPSS trial version chiago USA.

III. RESULTS

In present study twenty male and 20 female adult skulls were included. Both the right and left mastoid length were significantly higher in males as compared to females (Table 1). Mastoid length was significantly more in males as compared to females on both sides (p value <0.05).

Table 1
Comparison of mastoid length in Male and female skull

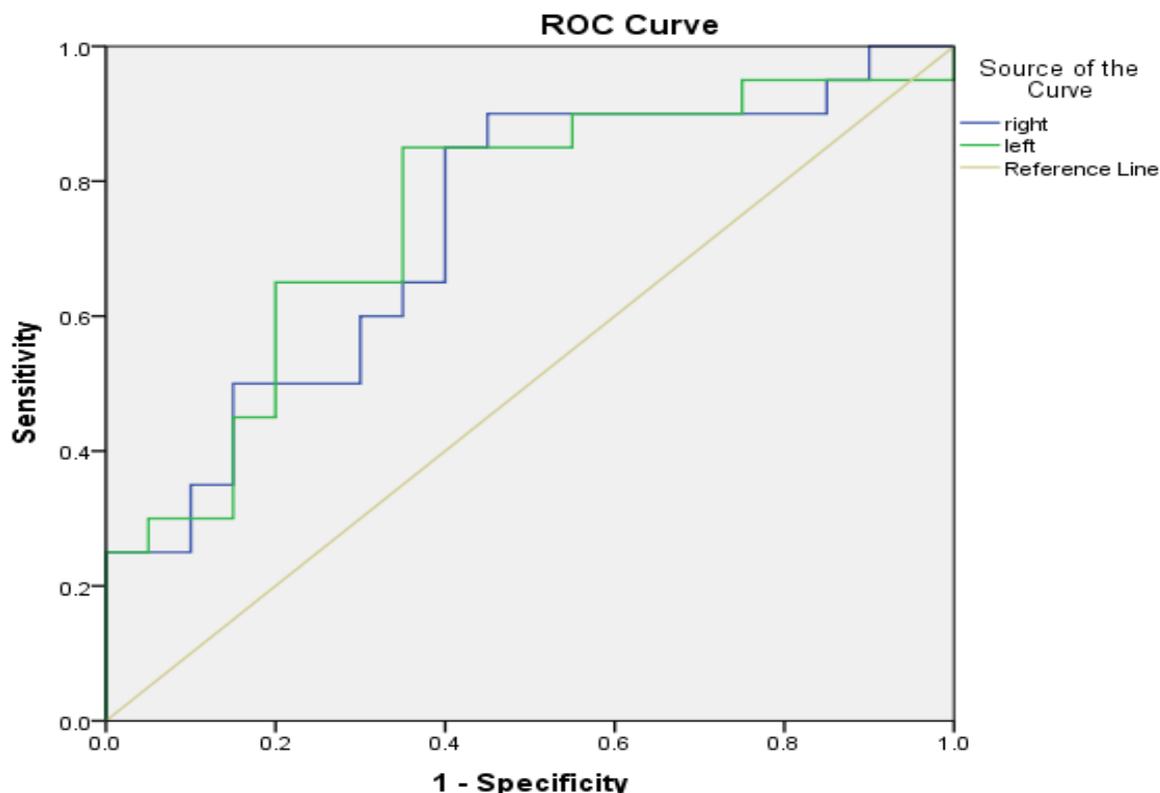
PARAMETERS	MALE		FEMALE		P VALUE*
	MEAN	SD	MEAN	SD	
Mastoid length right	34.90	2.7	32.59	2.54	0.006
Mastoid length left	34.13	3.10	31.21	2.78	0.002

**P* value calculated using unpaired *t* test

AUC for right mastoid length = 0.730 (95% CL = 0.72-.888) $p=0.13$ indicates that mastoid length is a good predictor for sex determination (Graph 1). Critical cut-off point right mastoid length was found to be 32.39 mm (sensitivity 90% and specificity 55%).

AUC = 0.750 (95% CL = 0.595-.905), $p=0.007$ indicates that mastoid length is a good predictor for sex determination (Figure 2). Critical cut-off point right mastoid length was found to be 31.74 mm (sensitivity 85% and specificity 65%)

Figure 2
ROC curve of mastoid length for sex determination



IV. DISCUSSION

Today many unidentified human remains are sexed through DNA analysis, but a number of situations remain in which morphological approaches are preferred. These situations include cases of genocide or mass fatality where the cost of bio-molecular analysis might be prohibitive, cases of ancient human remains where the material may be too degraded to yield amplifiable DNA, and cases where invasive analysis is impermissible on legal or ethical grounds. Morphometric methods are more objective than visual methods. Present study found that male mastoid length was significantly higher as compared to females. Findings of other studies from different geographical areas involving different ethnic groups show variability in mastoid length but all studies found significantly higher mastoid length among males in accordance to result of our study (Table 2).

Table 2
Mastoid process length in different studies

Authors	Male	Female	Region of Study
Giles and Elliot (1963) ⁹	28.067	25.213	Whites
	30.320	26.347	Negroes
Passey J et al. ¹⁰	29.7	24.5	Kanpur
Sumati et al. ¹¹	28.3	23.18	
Vidya C S et al. ¹² (2012)	Right 35.3	Right 34.2	Mysore
	Left 35.4	Left 33.6	
Present Study	Right 34.9 Left 34.13	Right 32.59 Left 31.21	Jaipur (Rajasthan)

V. CONCLUSION

Sex could be determined very well from the cranium using Anthropometry. Parameters like mastoid process length can be used as predictors to determine gender. Gender differences in cranial morphology emphasize the significance of applying data to an individual subject in a given population. Such knowledge is not only applicable to forensic scientists but also in plastic surgery and oral surgery with craniofacial deformity.

The result of this study will be of immense use in forensic medicine and anthropology and will also serve as a future framework for estimating the craniofacial dimensions of other Indian population.

CONFLICT

None declared till date.

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