Original article:

Sex determination using mastoid process of dry skull

[1]Dr Sachendra Kumar Mittal, [2]Dr S Jaleswararao*, [3]Dr Jaswant Goyal, [4]Dr. Leena Mittal, [5]Dr Barkha Goyal

[1]Tutor, Anatomy, JNU IMSRC Jaipur. Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, Rajasthan.

[2]Professor & Head, Anatomy, Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, 302017, State Rajasthan

[3]Assistant Professor, Pharmacology, Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, 302017, Rajasthan

[4]Assistant Professor, Physiotherapy, JNU IMSRC Jaipur. Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, Rajasthan, India

[5]Tutor, Biochemistry, JNU IMSRC Jaipur. Jaipur National University Institute of Medical Sciences and Research Centre (JNUIMSRC), Jaipur, Rajasthan, India

Corresponding author*

Abstract

Background: Cranial Morphometry is used for human studies like age estimation, stature, and ethnicity.. The mastoid process can be used as a marker of sex as well as ancestry of individuals and populations. The aim of this study was to evaluate the use of mastoid process as a tool for sex determination in unidentified skeleton. The mastoid region is favorable for sex determination as it is one of the most protected region and resistant to damage due to its anatomical position at the base of the skull. Also, mastoid process is one of the most dimorphic trait, females have smaller mastoid than males.

Objectives: To determine the sex by using parameters related to mastoid process

Materials and Methods: A total of 38 dried human adult skull (20 Male, 18 Female) were collected from the Department of Anatomy, Jaipur National University Institute for Medical Sciences And Research Centre (JNUIMSRC) Jaipur were used for this study. Mastoid length was recorded on the right and left mastoid process in each skull. Measurements were made with a vernier caliper.

Results:. In this study the mean mastoid length of right side in male skulls was 34.82mm with Standard Deviation 4.4 and the mean mastoid length of left side in male skulls was 35.64mm with Standard deviation 2.87. Mean mastoid length of right side in female skulls was 24.36mm with Standard Deviation 3.6 and the mean mastoid length of left side in female skulls was 26.73mm with Standard deviation 3.1. The calculated P-value for right side mastoid process in both sex is 0.01 and P value for left side mastoid process is 0.04. which is very significant because it is less than 0.05.

Conclusion: From the present study conducted on 38 dry skulls (20 male and 18 female) of known sex and the statistical analysis of P value which showed to be very significant, it is concluded that mastoid length is a reliable indicator for sexual dimorphism in mastoid process of skulls

Keywords: Mastoid length, Mastoid process, Sexual dimorphism, Skull, Forensic medicine

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.[1] 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 [2] The mastoid region is favorable for sex determination as it is one of the most protected region and resistant to damage due to its anatomical position at the base of the skull. Also, mastoid process is one of the most dimorphic trait, females have smaller mastoid than males.[2,3] Paiva & Segre (2003) introduced a easy technique for sex determination starting from the temporal bone, with a small observational error and with a high predictability degree.[4] The present study aims to select the mastoid measurement that has maximum sex discriminatory power among all mastoid variables via Discriminant function analysis And also it was conducted to validate the mastoid length as a parameter for determination of sex of fragmentary skeletal remains

Objectives

To determine the sex by using parameters related to mastoid process

Materials and Methods

Present study was conducted in Department of Anatomy at Jaipur National University Institute for Medical Sciences and research Center, Jaipur. A total of 38 dry skulls (20 Male, 18 Female) held by the Department of Anatomy were used in the study to determine the role of mastoid length as a metric parameter in sexual dimorphism.The osteological collection consisted of disarticulated skeletons that had been selected 3 years previously for educational and research purposes. The skulls, of known sex with no apparent deformity or diseases, were included in the study. Senile and juvenile skulls were excluded from the study. The mastoid dimensions were attained with a vernier caliper to the closest millimeter. The mastoid measurements were taken on both sides of the both (Male and Female) skull and the average was calculated. After average then it was contemplated for statistical analysis. All the measurements were taken after undertaking biometric training and done by single observer to avoid any inter-observer error.

The length of the mastoid process was calculated from a point on the Frankfurt plane vertically downwards to the tip of mastoid process.[3] the fixed arm of the Vernier caliper was positioned tangentially on the upper border of the auditory meatus in the Frankfurt plane (Fig. 1) and pointing to the lowest point on the border of the orbit by visual sighting. The calibrated bar lies perpendicular to the Frankfurt plane of the skull. The measuring arm was shifted until it lied at the same level with the tip of the process. The mastoid length was noted from this line to the tip of the mastoid (Fig. 2). The measurements of right and left sides will be recorded separately.

Result and discussion

In this study the mean mastoid length of right side in male skulls was 34.82mm with Standard Deviation 4.4 and the mean mastoid length of left side in male skulls was 35.64mm with Standard deviation 2.87. Mean mastoid length of right side in female skulls was 24.36mm with Standard Deviation 3.6 and the mean mastoid length of left side in female skulls was 26.73mm with Standard deviation 3.1.The calculated P-value for right side mastoid process in both sex is 0.01 and P value for left side mastoid process is 0.04. which is very significant because it is less than 0.05. (Table 1).

Statistics shows distinct differentiation between male and female mastoid process. In out of 38 (20 male and 18 female) skulls noted that, the lineal dimension of the mastoid length was higher in males than in females. Dr Sunil Poonia et al Found that In their 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 . Mastoid length was significantly more in males as compared to females on both sides (p value<0.05) [1]

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As per studies conducted on Cape population [8] the mean calculated in males was 29.3mm and 26.5mm in females. In Caucasian population [6] the mean mastoid length in male and female skulls was evaluated as 28.06mm and 25.21mm respectively while in the studies conducted on Negroes [6] the mean mastoid lengths determined were 30.32mm and 26.34mm in male and female skulls respectively.

Klaatsch observed that female skulls generally preserve infantile type of small mastoid process, while the male present great variability.[9] Hoshi classified the mastoid processes into three main types, viz. M, N and F type (M- male, Nneutral, F- female type), based on the direction of the mastoid process in relation to a vertical plane as assessed visually. He also suggested that when skulls were placed on flat surface, the male skulls rest on the mastoid processes while female skulls on occipital condyles or other portions of the skull.[7] In the present study, 38 adult human skulls (20 male and 18 females) were studied to know the accuracy of mastoid process in sex determination. It was found that the mean values of mastoid length was more in males as compared to females and all four mastoid variables were highly significant for sex determination as revealed from its 'p' value.

The mean of mastoid length in males was significantly larger than the female mean. p-values much less than 0.05. Therefore the present study validates the use of mastoid length as a reliable metric parameter for the role of mastoid process as a tool for sex determination.

Table 1:- Comparison of mastoid length in Male and female skull

Parameters	Male		Female		P value
	MEAN	SD	MEAN	SD	
Mastoid length Right	34.82	4.4	24.36	3.6	0.01
Mastoid length Left	35.64	2.87	26.73	3.1	0.04

Table 2:- Mastoid process length in different studies

AUTHOR	MALE	FEMALE	REGION OF STUDY
Vidya C S et al.[5] (2012)	Right 35.3 Left 35.4	Right 34.2 Left 33.6	Mysore
Sunil poonia et al [1 (2016)]	Right 34.9 Left 34.13	Right 32.59 Left 31.21	Rajasthan
Giles and Elliot (1963) [6]	Right 28.067 Left 30.320	Right 25.213 Left 26.347	Whites Negroes
Present Study	Right 34.82 Left 35.64	Right 24.36 Left 26.73	Jaipur (Rajasthan)

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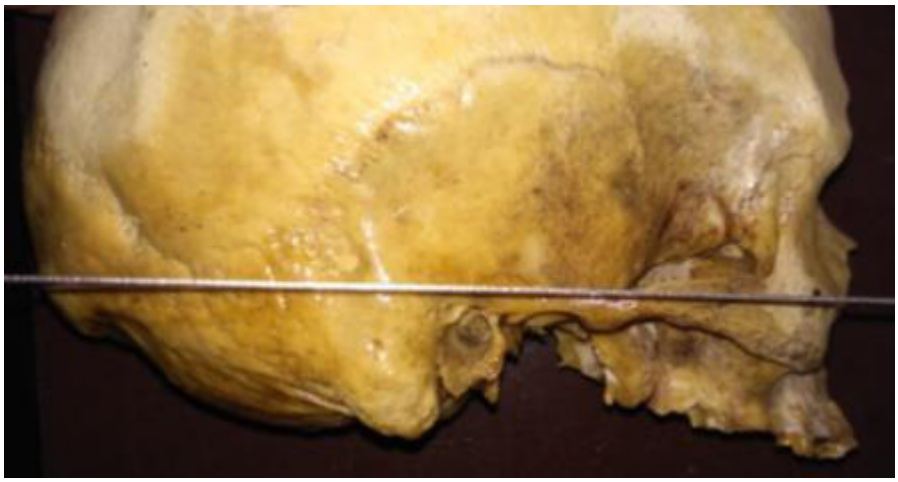

Figure 1: Frankfurt plane: A horizontal plane passing through the upper margin of the external acoustic meatus and the lower margin of the orbital opening

Figure 2: Mastoid Length measured from a point on the Frankfurt plane vertically downwards to the tip of mastoid process (Red arrow)

Conclusion

From the present study conducted on 38 dry skulls (20 male and 18 female) of known sex and the statistical analysis of P value which showed to be very significant, it is concluded that mastoid length is a reliable indicator for sexual dimorphism in mastoid process of skulls. Moreover, by comparing our data with other studies conducted worldwide, it can be concluded that mastoid length is higher in males than in females.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

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