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Anatomy

MORPHOMETRIC ANALYSIS OF HUMAN MASTOID PROCESS IN UDAIPUR ZONE

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KEYWORDS :

INTRODUCTION

The mastoid process is a prominent breast like inferior projection from the mastoid part of temporal bone and is located postero inferiorly to the external acoustic meatus[1].Determination of sex in fragmented remains is often a difficult task, as no isolated characteristic of any particular bone can perfectly determine the sex of a skeleton. The highest accuracy in sex determination is achieved when complete skeleton is available [2]. The sex is best assessed from the pelvic bones and pelvis than the skull, but whole and complete pelvis is not always available for analysis[3]. Several studies have shown that cranium is also an excellent indicator for sexual dimorphism by morphologic and morphometric analysis.

Skull is probably the second best region of the skeleton to determine sex[4]. The measurements of the skull vary significantly in different populations of the world.Dimorphism in skull is based on its size and robustness.The mastoid process is the most dimorphic bone of the skull which plays significant role in sexual dimorphism.Due to its anatomical position at the basolateral region ofthe skull, this part is most protected and resistant to damage, so that the mastoid region is favourable for sex determination[5]. Usually mastoid process is larger in males than in females. Hoshi H_6 analyzed the morphology of mastoid process non-metrically and specified 3 main types by the direction of the tip of mastoid process. But it is subjective and it cannot be relied. The osteometric studies of mastoid process have been employed by Paiva and Segre[7] (2003), Nagaoka[8](2008), Sumati Patnaik[9] (2010), and A D Gupta[10] (2012). Very few works have been done on this in Udaipur region of Rajasthan.

Considering this entire scenario, the present study aims to evaluate the use of mastoid process measurements indetermination of sex in unidentified human skeletal remains, decomposed and mutilated body. It is expected that the observations, inferences and sex discriminating functions thus obtained will be very useful for anatomist, anthropologist, and forensic experts in solitary homicidal cases, mass-disaster and multiple burials leaving mere charred and mixed incomplete remains to be recovered [11]

MATERIAL AND METHODS

The present study was conducted in the department of Anatomy, Geetanjali medical college and hospital and R.N.T. government medical college, Udaipur on 60 dried adult human skulls of known sex (30 Males and 30 Females).The skulls were studied to determine the validity of the mastoid process variables in sexual dimorphism. Skulls with no apparent deformity, intact mastoid process and already synostosed spheno-occipital junction were included in the study. Deformed skulls were excluded from the study. The mastoid measurements were taken on the skull by using sliding vernier caliper to the nearest millimeter (mm) as per standard anthropological conventions. All the measurements were done by single observer to avoid inter-observer error.

Frankfort plane was chosen and marked on the skull. It is a horizontal plane passing through upper margin of external acoustic meatus and the lower margin of the orbital opening. The following measurements were taken on the mastoid process of skull.

1. Mastoid length: It was measured from a point on the Frankfort plane vertically downward to the tip of the mastoid process[12]. The skull was placed on one side facing towards the observer; the fixed arm of the vernier caliper was positioned tangentially on the upper border of auditory meatus.
2. Antero-posterior diameter (Mastoid breadth): It was measured as a straight distance from the posterior end of incisura mastoidea (PEIM) to the nearest point on the posterior border of the external acoustic meatus[12].

For further mastoid measurements following points were used. Asterion (AST): is the meeting point of lambdoid,occipitomastoid and parietomastoid sutures. Porion (Po):Superior point of external acoustic meatus. Mastoidale(Ms): is the tip of mastoid process. The points were located and marked . The following readings were measured in millimeters.

RESULTS

Total 60 dried adult human skulls (30 Male, 30 female) with intact and measurable mastoid process taken from department of anatomy G.M.C.H. Udaipur and R.N.T. medical college Udaipur Rajasthan were studied.

The univariate analysis revealed that, the mean of mastoid variables like mastoid length in males (25.21) and that of female (21.73), medio-lateral diameter,i.e. breadth male (14.77) and that of female (12.46), antero-posterior diameter in males (18.01), and females (15.13) and are more in males than that of in females. All the mastoid measurements differ significantly among males and females and the measurements were statistically significant ($p<0.005$). The data obtained was tabulated and analysed . Univariate analysis was obtained for all the above parameters by calculating mean, standard deviation in Udaipur region population. It is expected that the observations, inferences and sex discriminating functions thus obtained will be very useful for anatomist, anthropologist, and forensic experts in solitary homicidal cases, mass-disaster and multiple burials leaving mere charred and mixed incomplete remains to be recovered

TABLES 1 : Group statistics for male mastoid measurements

	MEAN	SD
Mastoid length	25.21	2.45
Mastoid breadth	14.77	2.18
A-P Diameter	18.01	1.61

TABLE 2 : Group statistics for female mastoid measurements

	MEAN	SD
Mastoid length	21.73	1.760
Mastoid breadth	12.46	2.52
A-P Diameter	15.13	2.97

TABLE 3: Mean mastoid length of skulls of male and female individuals (present study compared to earlier published data)

Authors	Males	Females	Region of study
Keen	29.3	26.5	Cape coloured population
Giles and Elliot	28.067	25.20	Whites negroes
Present study	25.213	21.73	Udaipur region

DISCUSSION

The present study has provided a baseline data for sex determination of skulls of Udaipur region from the fragmentary piece of skull bone, mastoid process.

Determination of sex using mastoid process had been done in different parts of world as follows: **Klaatsch** observed that female skulls generally preserve infantile type of small mastoid process, while the male present great variability.**Hoshi** classified the mastoid processes into three main types, viz. M, N and F type (M-male, N-neutral, F-female type), based on the direction of the mastoid process in relation to a vertical plane as assesses visually. He also suggested that when skulls were placed on the flat surface, the male skulls rests on the mastoid processes while female skulls on occipital condyles or other portions of the skull.**Larnach and Macintosh** calculated size of mastoid process and divided it into five grades (very small, small, medium, large or very large). They concluded from their consecutive studies that females have predominantly very small to small sized mastoids in comparison to males who have predominantly medium to large sized mastoids.**Williams and Rogers** identified mastoid size as one of the high quality trait (> = 80% accuracy and <10% intraobserver error) for sex determination in comparison to Rogers who proved it to be of tertiary consideration.**Keen, Giles and Elliot** observed that mean mastoid length was more in skulls of male individuals as compared to skulls of female individuals irrespective of race or region.**De Moulin and Sarangi** et.al concluded subsequent to their study on French and Indian sample that value of mastoid module was extremely significant for sex determination.

Patil and Mody studied lateral cephalometric radiographs of Central Indian individuals and selected 10 cephalometric variables that helped in sex determination. These cephalometric variables included mastoid height and mastoid width. A discriminant function equation based on 10 cephalometric variables has also been derived.

Sumati, Patnaik VVG, Ajay Phatak found that the mean values of mastoid length, breadth, antero-posterior diameter and size of mastoid process was more in males as compared to females and all four mastoid variables were significant for sex determination.**Sarawut Sujarittham**, et.al focused on developing criteria for sex identification by using a broken or incomplete skull. The mastoid , which is fixed to posterior cranial base, is often a well preserved part of the fragmentary crania. As a result six functions were found that had a percentage of correct classification of more than 80% in the functional group. These functions comprises one, two and four variables, such as f(h), f(H), f(w,h), f(W,H), f(h,H) and f(w,W,h,H). In comparison to other studies that used the mastoid to identify sex, the use of width and height of the mastoid in this study has better level of accuracy than using mastoid triangle area.

Tomohito Nagaoka, Akio Shizushima, et.al. The study stated that despite the limitations, it is safe to say that the mastoid process measurements are good discriminators of sex.**Jigyasa Passey,** et.al studied the use of mastoid process as a tool for sex determination in unidentified skeleton.. The mean of mastoid lengths in males was significantly larger than the female mean.**Janaki Sivakumar**, et.al states in their study through practical method that triangle area (based on anthropometric techniques) of mastoid process is useful in gender identification. In this study they concluded that Skull is the major biometric to determine the gender.Importance of mastoid process for the purpose of gender identification.Mastoid triangle area is significantly more in males as compared to females.The related statistical values to mastoid process obtained by anthropometric techniques that better demonstrate dimorphism between the genders.Multiple measurements will give effective evolution rather than isolated measurements.Accuracy of gender classification obtained from mastoid process is better than previous works.Easy to execute, gives fast results and confidence up to 90%.**Swati Shah, Pratik Patil** carried out study to based on craniometric dimensions of mastoid part of skull..The mean value of male skulls were found significantly high on both sides in comparison to that of female skulls.**Ivan Claudio Suazo Galdames**, et. Higher values were obtained in females only in Porion-mastoidale, porion-Asterion and the area of left mastoid triangle. When contrasting the equality hypothesis among the means, only porion- mastoidale, the area of right mastoid triangle and total area was higher and more significant in males.**Kristen A. Bernard, Peer H**., et.al found clearly that there is variation in the size of the mastoid processes among males and females as demonstrated by descriptive statistics.. For each measurement, the male mean is slightly larger than the female mean.**Albin Babu M Wilson,** et.al. From this study the areas of the male CT measurements of mastoid is greater than female mastoid.**A. Das Gupta, Arindom Banerjee**, et.al measured mastoid length, mastoid medio lateral diameter and antero-posterior diameter of mastoid process. Amongst the sex discriminatory function of mastoid variables ranking stands as follows: mastoid length > mastoid antero-posterior diameter > mastoid size > mastoid mediolateral when considered individuall. **Shabana Bowsiya** studied 50 skulls and examined parameters such as length of mastoid **Bhagya B, Hema** N,et.al calculated total mastoid area by adding the right and left triangular areas defined by three distinct craniometric points: the asterion, porion and the mastoidale. In this study they found that mean total area of male skull is higher as compared to female skull.**Araine Kemkes, Tanja Gobel**, et.al It is hypothesized that differences in the expression of sexual dimorphism as well as population specific variability of the asterion location undermine the value of the mastoid triangle as a sex determinant.**Vineeta Saini, Rashmi srivastava**. All the parameters were higher in males as compared to females.**Deepali Jain, OP Jasuja**. Analysis of data reveals that the male crania exhibit greater values for all measurements except the angle right mastoidale-opisthion-left mastoidale.**Rajendra Kumar, D Virupaxi**, et.. In this study they concluded that mastoid length in females is significantly less as compared to males at right as well as left.In the current study the mean of mastoid length, breadth and antero-posterior diameter is measured in male and female skull of Udaipur region. The mean and Standard deviation of length, breadth and antero-posterior diameter was calculated by M.S. excel. The mean length of male mastoid process is 25.21 and that of female mastoid process is 21.73. The mean breadth of male mastoid process is 14.77 and that of female mastoid process is 12.46. The mean of antero-posterior diameter of male mastoid process is 18.01 and that of female mastoid process is 15.13.

The standard deviation for male mastoid length is 2.45 and that of female mastoid process is 1.70. The standard deviation of male mastoid breadth is 2.18 and that of female mastoid process is 2.52. The standard deviation of antero-posterior diameter of male mastoid process is 1.61 and that of female mastoid process is 2.9

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