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Role Of Morphometric Specially Mastoid Size For Determination Of Sex

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Abstract; **Background;** to determine the sex the skull and skeletal plays an important role for the archeologists, physical anthropologist, and forensic anthropologist. To gain by using the knowledge of osteology of human anatomy. Due to its anatomical position of mastoid process at basolateral region of skull so it is the most dimorphic bone which it is least damaged. The parameters of mastoid process are larger in males than in females. In present study to determine the sex in unidentified skulls an attempt has been made to evaluate the use of mastoid process measurements. For that to test the accuracy of sex determination using discriminant function analysis. **Material and Method;** this study is carried out in department of anatomy D.Y.Patil Medical college, Kolhapur. A total sample size is 100 adult human dry skulls (50 Male 50 Female) were studied to determine the accuracy of sex of mastoid process. The Mastoid length, antero-posterior diameter, medio-lateral diameter and to calculate the mastoid index. Also the distance between, asterion to mastoidale, asterion to porion, Porion to mastoidale [1] were studied. **Results;** in the present study we observed that, out of seven mastoid variables, six variables are more in males as compare to females. The difference observed for six variables if mastoid process was statistically significance ($p<0.005$). The discriminant function analysis revealed that mastoid process is correctly classified for the sex in 75% of left side skull and 60% of right side skull subjects[1]. And mastoid length, medio-lateral and antero-posterior diameter was found to be excellent discriminant factor for analysis of sex. The present study provides the baseline data for determination of sex of mastoid process of skull.

Key Words; Discriminant Function analysis; Mastoid process; Sex determination.

INTRODUCTION

The mastoid process is located postero-inferorly to the external acoustic meatus and it is prominent breast like projection inferiorly from the mastoid part of temporal bone [1]. It is often a difficult task to determination of sex in fragmented skulls, as no isolated characteristics of any particular bone can perfectly determine the sex of a skeleton. When the complete skeleton is available then highest accuracy in determination of sex is achieved [2]. The pelvic bone and pelvis is best assessed for sex than the skull, but complete and whole pelvis is not always available for analysis [3]. Several studies have been shown that cranium is also an excellent indicator for sexual dimorphism by morphometric analysis. For determination of sex skull is probably the second best region of the skeleton [4]. The measurement of skull is vary significantly in different population of the word. By the size and robustness the dimorphism in skull is based. The mastoid process is the most dimorphic bone of the skull which plays an important and significant role in sexual dimorphism. The mastoid process is most protected and resistant to damage because of its anatomical position at the basolateral region so it is favorable for determination of sex[5.] Commonly mastoid process is larger in males as compare to females. The morphometric study of mastoid process have been employed by pavia and sergre[6] (2003), Nagoaka[7] (2008), Sumati patnaik[8],(2010), and A D Gupta[9] (2012). Very few studies present on this so considering this entire scenario, present aims to evaluate the use measurements in mastoid process for determination of sex in unidentified human skeleton remains, decomposed and mutilated body. The present study intends to assess the dimorphic reliability of various morphometric parameters of mastoid process by using discriminant function analysis. The observation interpretation and sex discriminating functions obtained will be very useful for Anatomist, anthropologist, and forensic experts in individual homicidal cases, mass disaster, and multiple burials leaving mere charred and mixed incomplete remains to be recovred[10.]

MATERIAL AND METHODS

The present study was conducted in department of Anatomy, D Y Patil Medical College, and Kolhapur. 100 dry adult human skulls (50 Male 50 Female).To determine the validity of variables in mastoid process for sexual dimorphism. The skulls with no deformity, intact mastoid process attached Spheno-occipital junction were included in the study. Deformed and congenital anomaly skulls were excluded from the study. Measurements were taken on mastoid process by using digital Vanier caliper to the nearest millimeter (mm) as per standard anthropological convention. All the measurements were done by single observer to avoid inter-observer error.

Frankfort plane- a horizontal line passing through margin of external acoustic meatus and lower margin of orbital opening. The following measurements were taken on mastoid process of skull.

. Mastoid length: Measured from a point on Frankfort plane vertically downwards to the tip of mastoid process[11] .Facing the skull on one side towards the observer; to fix the one arm of Vernier Caliper on upper border of auditory meatus (fig.1).

. Medio-lateral diameter: Most lateral point of the mastoid process to the highest part of medial surface[11] (Fig.2).

. Antero-posterior diameter- (mastoid breadth): From the posterior border of the external acoustic meatus near its summit to the straight distance of posterior end of incisura mastoidea (PEIM) [11](Fig.3).

. Mastoid process index= Mastoid breadth/ Maximum mastoid lenghtx100

For the further mastoid process measurements the following points were used. Asterion (AST) meeting point of lambdoid, occipitomastoid, and parietomadtoid 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 reading was measured in millimeter.

- Asterion to Mastoidale (AST-Ms)
- Asterion to Porion (AST-Po)
- Porion To Mastoidale (Po-Ms)

The data obtained was tabulated and analysed using IBM SPSS 21.0.0 version software. Univariate analysis was obtained for all the above parameters by calculating mean, standard deviation and p value. Then discriminant function analysis was performed with each single variable.

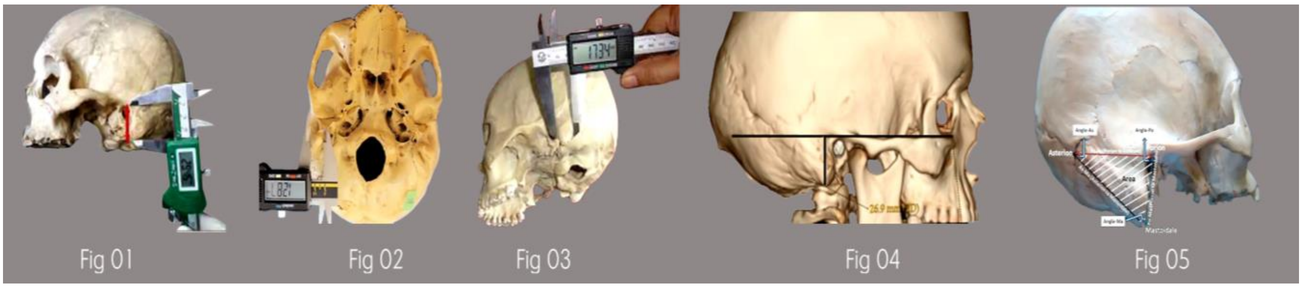

Fig.1. Length of Mastoid process

Fig.2. Medio-lateral Diameter

Fig.3. Antero- posterior Diameter

Fig.4. Frankford's plane

Fig.5.Mastoid triangle

Results: Total 100 dry adult human skulls (50 Male,50 Female) with measurable and intact mastoid process were studied. The univariate analysis revealed that the mean of mastoid variables like mastoid length male (37.21) Female (33.77), medio-lateral diameter male (6.21) Female (4.99), antero-posterior diameter male (23.72) female(21.62), Mastoid size male (55.76) female (38.87) were more in males than females and the measurements was statistically significant (p<0.005). The mean of mastoid index was found less in males (67.78) than in females (70.98).

Table 1: Statistical analysis for mastoid measurements right side (n=100)

Sr. no	Mastoid variable	Male (n=50)Right		Female (n=50) Right		SEM (Male)	SEM (Female)	95% Cl	t value	P value
		Mean	SD	Mean	SD					
1	ML	37.21	8.72	34.68	7.00	1.23	0.99	5.07	1.6	0.11
2	APD	23.19	4.89	21.00	4.33	0.92	0.92	0.36-4.03	2.37	0.019**
3	MLD	6.36	1.84	4.77	2.06	0.26	0.26	0.81-2.36	4.07	P<0.001 **
4	MI	64.81	15.84	62.11	14.82	2.24	2.09	3.39-8.78	087	0.38
5	MS	56.22	27.48	37.94	28.04	3.88	3.96	7.25-29.29	3.29	P<0.001 **
6	MA	539.66	77.12	494.06	106.49	11.01	15.06	517.49-561.84	2.43	0.016**

All measurements were in millimeters (mm); * significant; ** highly significant

Table 2: Statistical analysis for mastoid measurements left side (n=100)

Sr. no	Mastoid variable	Male (n=50) Left		Female (n=50) Left		SEM (Male)	SEM (Female)	95% Cl	t value	P value
		Mean	SD	Mean	SD					
1	ML	37.47	9.10	32.87	7.25	1.28	1.05	11.77-5.38	2.78	0.003**
2	APD	24.24	4.11	22.23	5.54	0.58	0.78	.07-3.94	2.05	0.04*
3	MLD	6.06	1.44	5.22	2.35	0.2	0.33	0.068-1.62	2.16	0.033*
4	MI	67.78	17.53	70.92	25.06	2.47	3.54	11.77-5.38	0.73	0.46(NS)
5	MS	55.30	20.49	39.80	25.37	2.89	3.58	6.34-24.64	3.35	P<0.001**
6	MA	513.06	135.69	465.77	112.16	19.38	15.86	474.05-552.07	1.88	0.06(NS)

All measurements were in millimeters (mm); * significant; ** highly significan

Table no 3. All Variables on Right Side

Variable	Wilkis lambda	Canonical correlation	Structure Matrix	Centroid Value	Average Accuracy
ML	0.974	0.160	1.00	F= -0.160 M= + 0.160	Over all 55% F= 56% M= 54%
APD	0.945	0.233	1.00	F= - 0.238 M= + 0.238	Over all = 56% F= 62% M= 50%
MLD	0.855	0.381	1.00	F= - 0.407 M = + 0.407	Over all = 68% F= 72% M= 62%
MS	0.9	0.316	1.00	F= - 0.329 M = + 0.329	Over all =65% F= 80% M=50%
All Variable	0.809	0.437	ML= 0.333 APD= 0.494 MLD= 0.847 MS = 0.684	F= - 0.481 M= +0.481	Over all= 68% F= 64% M= 72%

Model Y= - 4.544+ (0.126) x ML

Y= -4.473+ (0.216) x APD

Y= -2.85 + (0.511) x MLD

Y = -1.696 + (0.036) x MS

All variable = Y= - 10.138+ (0.103) x ML+ (0.202) x APD+ (0.855) x MLD –(0.063)x MS

Table no 4. All Variables on Left Side

Variable	Wilkis lambda	Canonical correlation	Structure Matrix	Centroid Value	Average Accuracy
ML	0.926	0.271	1.00	F= -0.279 M= +0.279	Overall= 60% F= 70% M= 50%
MS	0.897	0.321	1.00	F= -0.336 M= + 0.336	Overall= 69% F= 74% M= 65%
MI	0.994	0.074	1.00	F= + 0.074 M= - 0.074	Overall= 53% F= 44% M= 62%
All variable	0.886	0.338	ML= 0.784 MS= 0.946 MI= 0.208	F= - 0.335 M= + 0.335	Overall= 66% F= 70% M= 62%

Models

ML= Y= - 4.273+ (0.121) x ML

MS= Y= - 2.062+ (0.043) x MS

MI= Y= -3.208 + (0.046) x MI

All= Y= -3.429 + (0.052) x Ml + (0.031) x MS+ (0.002) x MI

Table no. 4: Discriminant Analysis only for MA on Right Side

Variable	Wilkis lamda	Canonical correlation	Structure matrix	Centroid value	Accuracy
MA	0.949	0.226	1	F= - 0.230 M= + 0.230	61%

Discriminant function D=MA x (0.011) – 5.511

Table no. 5: Discriminant Analysis only for MA on Left side

Variable	Wilkis lamda	Canonical correlation	Structure matrix	Centroid value	Accuracy
MA	0.969	0.177	1	F= - 0.178 M= + 0.178	56%

Discriminant function D=MA x (0.008) – 3.915

Discussion

The analysis of mastoid process is important in the discrimination of sex for forensic and anthropological purpose. Many researchers agree that qualitative aspect, such as their size, ruggedness for muscular attachment inclination or mastoid process inclination are very good indicators of sexual dimorphism; however from the quantitative point of view their utility is discussed because on the one hand, there does not exist consent about the parameters to determine the height, width, and antero-posterior diameter of the mastoid process. Even in fragmented skull the mastoid process is well preserved and protected. The present study gives baseline data for determination of the sex of the skull in Western Maharashtra population, the mean values os mastoid length, medi-olateral diameter and antero-posterior diameter were more in males as compare to females. And it is statistically significant for determination of sex. Single mastoid parameter is discussed by comparing them with the findings of previous workers.

Table no. 6: Comparison between current study and previous workers for mastoid length, medio-lateral and antero-poasterior diameter

Author	Population studied	No. of skulls	Mastoid length (mm)	Medio-lateral diameter (mm)	Antero-posterior diameter (mm)
Sumati et al (2010)	North India	M= 30 F= 30	M= 28.3± 4.0 F= 23.18± 4.2	M= 11.46± 2.7 F= 8.68± 2.6	M= 17.52± 4.69 F= 13.69± 3.67
Gupta AD et al. (2012)	South India	M= 35 F= 35	M= 29.23± 2.42 F= 22.44± 3.77	M= 11.24± 2.0 F= 8.59± 1.5	M= 16.55± 3.82 F= 15.78±2.47
Vineeta saini et al. (2012)	North India	M= 104 F= 34	M= 35.82±3.55 F= 31.86± 3.32	-	M= 25.58± 1.89 F= 22.77± 2.37
Nidugala H (2013)	South India	M= 40 F= 40	M= 35.63± 3.91 F= 30.55± 4.09	-	M= 21.97± 2.60 F= 20.03± 2.74
Shobha verma et al. (2015)	UP Population	M= 50 F= 50	M= 28.62± 0.63 F= 23.92± 1.54	M= 12.33± 0.86 F= 12.38± 1.56	M= 17.36±1.03 F= 15.39± 1.81
Present study (2024)	Western Maharas-htra	M= 50 F= 50	M (Rt)= 37.21±8.72,(Lt) = 37.47±9.10. F(Rt)= 36.68±7.00,(Lt) = 32.87±7.25	M(Rt)=6.36±1.84, (Lt)=6.06±1.44. F(Rt)= 4.77±2.06, (Lt)=5.22±2.35	M(Rt)=23.19±4.89,(Lt)= 24.24±4.11. F(Rt)= 21.00±4.33,(Lt)= 22.23±5.54

Table no.6 shows various parameters of mastoid process by various workers in different areas. The mastoid length is more in males as compare to females and this compare to our study. If the skull is kept on flat surface, if it is lies on mastoid process then it is the skull of male. If it is lies on occipital condyles then it is female. This statement indirectly confirms that male skulls having more length.

Medio-lateral diameter and Antero-posterior diameter of mastoid process [9 10 14 15 16.] The parameters of these was calculated by previous workers noted that these parameters were more in males as of females. The current study coincides with previous workers. The mastoid process index on right and left side[13] studied separately and concluded that the mastoid process index was significantly more in females than that of males. In current study the mastoid process index was more in females (66.550) than in males (66.30), but it is insignificant. Very little study is done on mastoid process index, so the mastoid index is help to sex the skull. **In the current study the new finding is mastoid size (55.76) is more in males as in females (38.87) The area of mastoid process in male right side (539.66±77.12), left side (513.06±135.69), and for female right side (494.06±106.49), left side (465.74±112.16). The area of mastoid process is more in males as compare to females. By this parameter we confirm the skull is of male or female.**

CONCLUSION;

In our study the mastoid length is the best discriminant factor for determination of sex. **73% on right side (p>0.001) and 76% on left side (p>0003) highly significant**. New parameter that is Mastoid size is also statistically significant (p>0.001) for discriminantion of sex . **The right side mastoid area (p>0.016) and for left side (p>0.06). The right side mastoid Area of male is highly significant and for left side is border line significant**.

REFERENCES

1. Gray's Anatomy the anatomical basis of clinical practice 40th edition. Susan Standering. Elsevier Churchill Livingstone.2008: p1223.
2. Krogman WM. The human skeleton in forensic medicine. Springfield, IL: Charles C Thomas,1962.
3. Phenice TW. A newly developed visual method of sexing the os pubis. American Journal of Physical Anthropology 1969;30: 297-301.
4. Bass WM. Human Osteology: A Laboratory, field Manual of the Human Skeleton. Special Publications of the Missouri Archeological Society, Columbia 1971.
5. Kalmey JK, and Rathbun TA. Sex determination by discriminant function analysis of petrous portion of temporal bone. J Forensic Sci 1996; 41:865-867.
6. Paiva LAS, Segre M. Sexing the human skull through the mastoid process. Rev Hosp CI_ n Fac Med Sao Paulo 2003;58(1):15-20.
7. Nagaoka T, Shizushima A, Sawada J. Tomo S, Hoshino K, Sato H, et al. Sex Determination using mastoid process measurements: standard for Japanese human skeletons of the medieval and early modern periods. Anthropol Sci 2008;116(2):105-13.
8. Sumati, Patnaik VVG, and Phatak A. Determination of sex from mastoid process by discriminant function analysis. J Anat Soc Indian 2010;59(2):222-28.
9. Gupta AD, Banerjee A, KUMAR a, Rao SR, and Jose J. Discriminant Function Analysis of Mastoid Measurements in Sex Determination. J Life Sci 2012;4(1):1-5.
10. Introna F Jr, Di Vella G, Campobasso CP. Sex determination by discriminant analysis of patella measurements. Forensic Sci Int 1998;95:39-45.
11. Laranch SL, Macintosh NWG. The craniology of the arborigines of coastal New South Wales. The Oceania Monographs No.13.196;43-4.
12. Vineeta S, Rashmi S. Rajesh KR, Satya NS, Tej BS and Sunil KT. Sex estimation from the Mastoid process among North Indians. J Forensic Sci 2011;1-6.
13. Nidugala H, Avadhani R, Bhaskar B. Mastoid process A tool for sex determination, an anatomical study in south Indian skulls, International J Biomed Res 2013;04(2):106-10.
14. Verma Shobha, Ramesh Babu C.S. sex determination by mastoid process in western U.P. population. Journal of research in human Anatomy and Embryology2015;1(1):1-5.
15. Ghule SB, Mahajan AA, Wagh KB, Ambali MP. Sexual dimorphism in foramen magnum and mastoid process. International jr of recent trends in science and technology 2014;12(1):56-9.
16. Kemkes A, Gobel T. Metric assessment of the “mastoid triangle” for sex determination: a validation study. J Forensic Sci 2006;51:985-9.