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Sex determination using mastoid process length in dry skulls of Nigerian population

Abstract

Introduction: Identification of an individual is very crucial in any medicolegal investigation. Age, sex and stature are the primary factors that help in the identification. Skull is important in this regard as it resists adverse environmental conditions over time. The present study aims to determine sexual dimorphism of mastoid length in Nigerian skulls.

Material and methods: One hundred adult dry skulls, (78 males, and 22 females) free from damage and deformities collected from eleven Departments of Anatomy in Nigerian Universities were used. Automatic digital caliper was used to measure mastoid length. Data was analyzed with Graph Pad Prism 5.03. The mean, coefficient of variation, correlation, linear regression, percentiles, sexual dimorphism ratio were computed.

Results: The left mastoid length (mm) of male and female skulls were 34.27±0.49 and 30.41±0.32mm respectively while the mean of right mastoid length (mm) of male and female were 35.48±0.37 and 31.25±0.36mm respectively. Male parameter was significantly higher than female atp<0.5. Correlation of craniometric parameters of Nigerian male/female population showed left female mastoid length versus right had no correlation {Y=0.02x+30.65(0.017)} and the fit line was straight while male mastoid length left versus right had positive significant correlation{Y=0.67x+12.62(0.59*) and the fit line sloped upward.

Conclusion: The result of this study will be of importance in providing new perspectives on human osteology and in sex determination in forensic anthropology.

Keywords: skull, sex determination, anthropometry, mastoid length

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Chinna Nneka Orish, Hakeem B Fawehinmi
Department of Anatomy, Faculty of Basic Medical Science, University of Port-Harcourt, Nigeria

Correspondence: Chinna Nneka Orish, Department of Anatomy, Faculty of Basic Medical Science, University of Port-Harcourt, Rives State, Nigeria, Tel +2347065446312, Email chinnaorih@yahoo.com

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Introduction

Anthropometry is an important part of physical anthropology that measures different parts of the human body whereas Craniometric is the measurement of skull. Skull is made of various bones which include frontal, temporal, occipital and parietal. Mastoid process and asterionare features of the temporal bone. The temporal bone which is highly resistant to physical damage can be used for sex determination.[1] Kalmey Paiva & Segre[1] calculated mastoid triangular area for sex determination using the following landmarks: porion, mastoidale, and asterion, in temporal bone. Although several studies have reported Caucasian data on mastoid length, there remain a paucity of information in Nigeria.[2–7] This study has characterized anthropometric features of mastoid of Nigerians and sexing of skulls by determining the relationship between the bilateral parameters.

Materials and methods

For this study100 adult dry skulls (78 males, 22 females), devoid of damage and deformity gotten from Departments of Anatomy in Nigerian Universities were used. The measurement was carried out with automatic Vernier calliper with a precision of 0.01mm and marker.

Mastoid length

Porion-Mastoidale

Mastoid length: The distance between Porion-Mastoidale was measured as skull was kept with Norma lateralis position facing the observer.

Porion: It is the uppermost lateral point of the external auditory meatus;

Mastoidale: It is the mastoid process lowermost point (Figure 1).

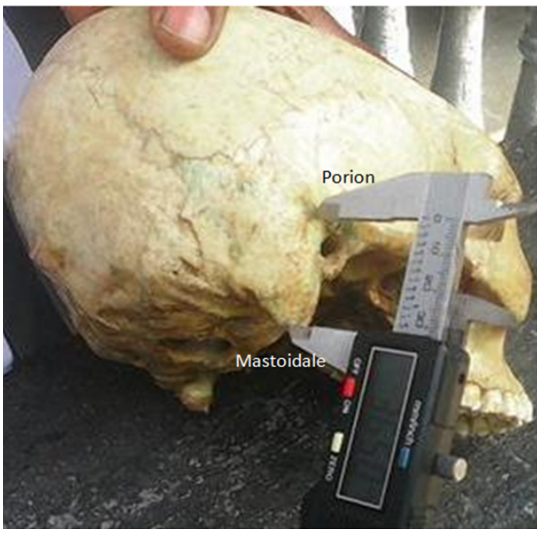

Figure 1 Mastoid length.

Graph Pad Prism 5.03 was used to analyse the data. The maximum, minimum, geometric mean, coefficient of variation, mean, standard deviation, standard error of mean correlation, linear regression, percentiles, sexual dimorphism ratio were analysed. Male to female and right to left measurements were compared using Student's T-test

Table 1 Effect of sex on mastoid length

Parameters	Sex	Mean± SEM	Coefficient of variation	Maximum	Minimum	Significant level
Right mastoid length	M	35.48±0.37	9.97%	41.54	24.38	p<0.05*
	F	31.25±0.36*	3.66%	32.50	29.40	
Left mastoid length	M	34.27±0.49	9.08%	40.42	27.02	p<0.05*
	F	30.4 ±0.32*	3.27%	31.84	29.29	

Table 2 Sexual dimorphism ratio

Parameters	Male(mean)	Female(mean)	Sexual dimorphism ratio (Mean M/Mean F)
Mastoid length	34.88	30.83	1.13

Table 3 Correlation of mastoid length of Nigerian male/female population

Male/Female craniometric parameter (x vs. y)	Regression (correlation, r)
Male Mastoid length left v right	Y=0.67x+12.62(0.59*)
Female Mastoid length left v right	Y=0.02x+30.65(0.017)

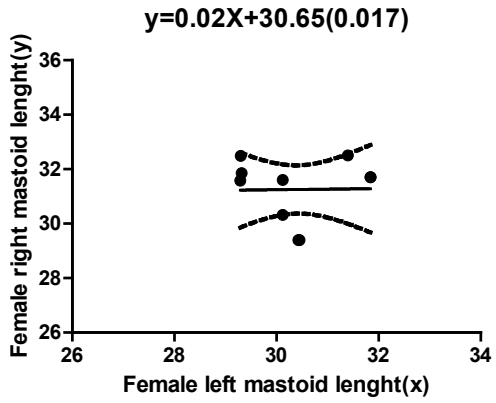

Figure 2 Linear regression graph of female left and right mastoid length.

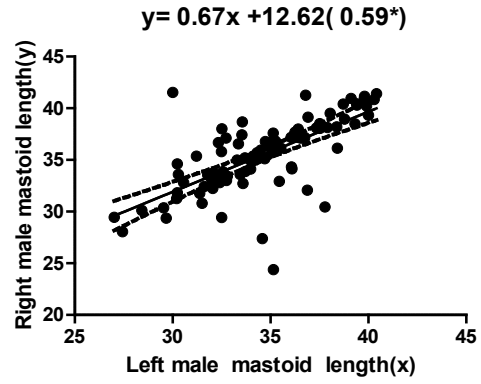

Figure 3 Linear regression graph of male left and right mastoid length.

Results

Table 1 shows effect of sex on mastoid length. It was seen that male cranial parameters were significantly higher than female parameter at p<0.05. Sexual dimorphism ratio of the various mastoid length parameters is shown in Table 2. The female /male ratios for the mean measurements were greater than one, indicating that the male crania were larger than the female crania. Table 3 shows correlation of craniometric parameters of Nigerian male/female population and there was positive correlation male mastoid length left v right, there was no correlation between left v right female mastoid lengths. Scatter plot of the linear relationship between left and right female mastoid length was shown in Figure 2. The fit line was straight indicating there was no correlation between the left and right. Scatter plot of the linear relationship between left and right male mastoid length is shown in Figure 3 and the fit line sloped upward which indicated positive statistical correlation between the left and right.

Discussion

Craniometry which is defined as measurement of skull is an invaluable tool to forensic science with respect to sex determination and craniometrics prediction. The comparison of the mean values of mastoid length of Nigerian population with Caucasians showed some variations which can be as a result of interaction between environmental factors and genetic, as well as racial variations.[2]

The present study showed an average mastoid length of male to be 34.86±0.04mm and female 30.83±0.34mm and the difference showed statistically significant at p<0.05 which is in accordance to study done by Maryna & Iscan[8] In their work they used 43 males and 46 females and they found that the difference between mastoid lengths in males and females 34.0±3.39 and 30.9±3.92 mm respectively were statistically significant at p<0.05. The mastoid length from this study is however higher than previous results of[2–7] Deshmukh & Devershi[2] Using 74 adult crania of known sex (40 males & 34 females) reported mastoid lengths 29±3.16 and 27±4.02mm in males and females respectively which was significantly p<0.05 different by univariate analysis.[9]

Elena et al.[6] found mastoid length for male (31.69±3.71 and female (28.56±3.50mm) and was statistically significant at p<0.05. Keen[3] observed that mean mastoid length was higher in skulls of male individuals (29.3mm) as compared to skulls of female individuals (26.5mm). Giles & Elliot[4] also observed that mean mastoid length was higher in male as compared to female.

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Sumati & Phatak[5] using 60 adult human skulls of South Indians mastoid process in sex determination, found that the mean values of mastoid length were higher in males and was significant for sex determination. Das Gupta et al.[7] worked on North Indian skulls using 70 (35males and 35females). Their findings showed the mean mastoid lengths to be 29.3 and 22.44mm. Vidya et al.[10] in their work t of sexual dimorphism of skulls of South Indian found the right mastoid length to be 3.53±0.42 and 3.42±0.30cm, left 3.54±0.42cm and 3.3±0.34 for male and female respectively. These results are in line with present study which showed the left mastoid length of male and female were 34.27±0.49 and 30.41±0.32mm respectively. Similarly, the right mastoid length of male and female from our study were 35.48±0.37 and 31.25±0.36mm respectively significant at $p<0.05$. Franklin et al.[11] in their study on sexual dimorphism and discriminate function sexing in indigenous South African crania in three indigenous South African subgroups (Natal Nguni, Cape Nguni and Sotho) reported higher values of male mastoid lengths than females. The mean mastoid process length among males at left was 30.70±3.09mm and on right were 30.20±2.64mm and 26.20±3.49mm on left and 26.20±2.57mm on right in females respectively. The difference was shown to be statistically significant ($p<0.001$). Passey et al.[12] reported that male parameter was also significantly higher in male than female (29.7±3.67 and 24.5mm±3.57) respectively as in present study although the values lower which can be attributed to racial differences.

The right mastoid length was found to be right 34.90±2.7 and 34.13±3.10mm, left 32.59±2.52 and 31.21±2.78 for male and female respectively a study done in India which is in consistence with the present study.[13]

The present study reported that sexual dimorphism ratio for the mean measurements greater than unity. This is in accordance with Ahmed et al.[14] Reported that sexual dimorphism ratio (male/female ratios) for the mean measurements were greater than unity too indicating that the male crania were larger in all linear dimensions than female crania.

This study has employed linear regression and correlation tools as aforementioned using the equation $y = ax + b$. in order to model the relationship between two anthropometric parameters. With this equation the value y can be predicted when x is known.

The algorithms for males and females were derived to be

$Y=0.67x +12.62(0.59)$ male

$Y=0.022x + 30.65(0.17)$ female

However there is dearth of information on the mathematical models of this craniometric parameters.[15] There was no correlation between left versus right female mastoid length and the fit line was straight while positive regression coefficient indicates a positive relationship between two variables and from the graph the fit line sloped upward as in male mastoid length left versus right.

Conclusion

Mastoid process length could be used to determine sex from the cranium. Knowledge of anthropometric dimensions of mastoid length can therefore be an invaluable tool to the forensic scientist with respect to identifying the sex of unknown individuals, craniometric prediction, and also relevant tool to craniofacial surgeons.

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Conflicts of interest

The authors declare there are no conflicts of interest.

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