ORIGINAL ARTICLE

SEX DIFFERENCES IN OCCIPITAL CONDYLES IN MAIDUGURI, NORTHEASTERN NIGERIA USING COMPUTED TOMOGRAPHIC SCAN IMAGES

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ABSTRACT

Background: Measurements of the occipital condyle (OC) have been reported to be used in sex identification. Hence, the present study attempts to find out whether the OC is sexually dimorphic, and whether morphometric analysis of the same, using computed tomography (CT) scan images, could be a useful tool in sex determination in the sample population. **Method:** The sample population comprised of basicranial CT images of 110 patients (60 males and 50 females) aged 18–65 years obtained from the Federal Neuropsychiatric Hospital, Maiduguri, Borno State-Nigeria. The parameters measured were the right and left antero-posterior and mid-transverse distances of the OC. **Results:** Males have significantly higher mean values for all the OC parameters measured (p<0.001). The success rate for sex identification using Baudoin condylar index (BCI) was 52.92% for males and 46.67% for females. On deploying demarking points (DPs) for sex determination, however, only 13 (21.67%) out of the 60 males were identified using right antero-posterior distance of the OC and 7 (11.67%) using right mid-transverse distance. Using right mid-transverse distance, 8 (16%) of the 50 females were identified and 6 (12%) of the 50 females were identified using left mid-transverse distance. **Conclusion:** This study showed that the OC is sexually dimorphic and can be used in sex determination in the sample population. Although the occipital condyles can be used in sex estimation, they remain, however, inadequate for forensic application especially when demarking points and Baudoin condylar index are the methods to be deployed for this purpose.

Keywords: Condyles, Dimorphism, Index, Demarking

INTRODUCTION

The occipital condyles (OCs) are important structures of the skull base that form part of the cranio-vertebral junction. The OCs is a unique bony structure that connects the skull and the vertebral column[1]. The OCs is sexually dimorphic and has been used in metric and morphological evaluations.[2,3]In establishing personal identity for forensic purposes, sex identification is one of the most important and first procedures to be performed.[4]Using skeletal remains for sex identification of an individual is a very challenging task in forensic medicine,[5] because the skeleton is often subjected to different types of 'inhumation', or physical insults.[6]

In certain situations like mass disasters and criminal attacks in which the victim's body is disfigured beyond recognition, fragment of skeletal remains especially those of the skull could play significant role in sex identification.[7] The basicranium, where the OCs are located, is best suited for this task because it is thick and lies in protected anatomical position and is likely to survive damage resulting from fires, explosion and violence.[8]

Difference in skull size is the basis for sexing the crania.[5] Cranial size is influenced by genetic, social, and environmental factors.[9] For this, sex identification using the skull differs from population to population.[10] Therefore, the present study attempts to find out whether the OC is sexually dimorphic, and whether morphometric analysis of the same could be a useful tool in sex determination in the sample population.

MATERIALS AND METHOD

Materials: The sample population for this study comprised of basicranial CT images of 110 patients (60 males and 50 females) aged 18–65 years obtained by *purposive sampling technique* from the archive in the work station of the department of radiology, Federal Neuropsychiatric Hospital, Maiduguri, Borno State-Nigeria. Images of patients below 18 or above 65 years of age were not included in this study. Poorly produced CT images were also exempted from the study. The images used for this study, were made by 16-slice bright speed CT scanner.

Method: The parameters measured are the right and left antero-posterior and mid-transverse distances of the OCs, and the readings of the measurements were taken and recorded in millimetre (mm) to two decimal places. Measurements were conducted on the CT images according to the following protocols:

1. The antero-posterior distance (APD) of the OC was taken as the distance from the tip of the anterior end of the OC to the tip of the posterior end of the OC.
2. The mid-transverse diameter (MTD) of the OC was taken as the distance from the most lateral point on the lateral margin of the OC to the medial margin. The measurement was made transversely (and perpendicularly) across the OC.

Statistical Analysis

The data obtained was subjected to statistical analysis using Instat GraphPad (version 3.05). The level of significance for difference in the parameters tested was placed at $p<0.05$. Index for sexual dimorphism (ISD) was used to assess whether the parameters measured were sexually dimorphic. ISD was calculated thus:

$$ISD = \frac{\text{males' mean value}}{\text{Females' mean value}} \times 100$$

ISD is expressed as a percentage and a value greater than 100% indicates sexual dimorphism while value less than 100% is considered not sexually dimorphic[11].

Baudoin condylar index (BCI) and demarking points (DPs) were used for sex identification of the CT images used. For BCI, a value greater than 55 point was considered a female and a value below 50 point considered a male, while points from 50 to 55 remain inconclusive[2]. BCI (in percentage) was calculated according to the following formula:

$$BCI = \frac{MTD}{APD} \times 100$$

Where: BCI = Baudoin condylar index
MTD = Mid-transverse distance of the OC
APD = Antero-posterior distance of the OC

For DPs, a value greater than the upper limit of females' estimated range (ER) was considered a male, and a value less than the lower limit of males' ER was considered a female. ER was calculated according to the following formula:

$$ER = M \pm 3SD$$

Where: ER = Estimated range
M = Mean
SD = Standard deviation

RESULTS

The mean values of the OC measurements made are presented in table 1, and the mean values of all the parameters measured are higher in males. Index for sexual dimorphism (ISD), which is an indicator of sexual difference, was calculated for all the parameters and the results recorded in table 2. Success rate of sex identification using demarking points are also presented in table 2. Baudoin condylar index (also used for sex identification) was calculated and the results presented in table 3.

Table 1: Comparison of the mean values of right and left antero-posterior diameter and mid-transverse diameter between males and females

Parameters	Sex (n)	Mean±SD (mm)	MD (mm)	P value
RAPD	Males (60)	25.29±3.18	3.93	< 0.001
	Females (50)	21.36±2.34		
LAPD	Males (60)	24.30±3.23	3.25	< 0.001
	Females (50)	21.05±3.19		
RMTD	Males (60)	11.58±1.31	2.32	< 0.001
	Females (50)	9.26±1.34		
LMTD	Males (60)	11.42±1.23	2.23	< 0.001
	Females (50)	9.19±1.32		

RAPD = right antero-posterior distance, LAPD = left antero-posterior distance RMTD = right mid-transverse distance, LMTD = left mid-transvers distance, SD = standard deviation, MD = mean difference, mm = millimetre, n= sample size per sex

Table 2: Index for sexual dimorphism, range, estimated range, demarking points, and success rate of sex estimation using demarking points

Parameters	Sex (n)	Mean±SD (mm)	ISD (%)	Range (mm)	Estimated range (mm)	DPs (mm)	Success Rate
RAPD	Males (60)	25.29±3.18	118.40	20.5–32.9	15.75–34.83	>28.38	13(21.67%
	Females (50)	21.36±2.34		15.6–25.0	14.34–28.38	<15.75	2 (4.0%)
LAPD	Males (60)	24.30±3.23	115.44	17.4–29.7	14.61–33.99	>30.62	0 (0.0%)
	Females (50)	21.05±3.19		14.2–28.0	11.48–30.62	<14.61	2 (4.0%)
RMTD	Males (60)	11.58±1.31	125.05	9.2–14.7	7.65–15.51	>13.28	7 (11.67%)
	Females (50)	9.26±1.34		7.0–13.3	5.24–13.28	<7.65	8 (16.0%)
LMTD	Males (60)	11.42±1.23	124.27	9.1–14.3	7.73–15.11	>13.15	5 (8.33%)
	Females (50)	9.19±1.32		6.9–13.1	5.23–13.15	<7.73	6 (12.0%)

RAPD = right antero-posterior distance, LAPD = left antero-posterior distance, RMTD = right mid-transverse distance, LMTD = left mid-transvers distance, SD = standard deviation, mm = millimetre, ISD = index for sexual dimorphism, Dps = demarking points, n= sample size per sex

Table 3: Success rate of sex identification using Baudoin condylar index

Parameters	Identified as males (x<50)	Success rate	Identified as females (x>55)	Success rate	Inconclusive range (50<x<55)
Right Baudoin Index	91	51 (56%)	06	03 (50%)	13
Left Baudoin Index	88	44 (50%)	10	04 (40%)	12
Mean Baudoin index (both sides)	91	48 (52.75%)	06	03 (50%)	13
Mean of success rates		52.92%		46.67%	

DISCUSSION

From the results of the present study (table 1), males have significantly higher mean values for all the OC parameters measured (p<0.001). However, few of the females presented OC values higher than that of some males; this may be due to nutritional status of those females. A proof of males having higher mean values is the ISD calculated in which all the parameters presented ISD values greater than 100% (table 2). This result is also a proof that the OC is sexually dimorphic in the sample population and hence can be used for sex determination.

Other authors also reported higher mean values of OC measurements in males compared to females.[6,12-16]Reported RAPD mean value of 23.7 mm for males and 22.7 mm for females while the LAPD for males was 24.1 mm and 22.7 mm for females. They reported mean RMTD values of 12.9 mm for males and 12.7 mm for females. It was also found that 25.6 mm as the RAPD mean value for males and 23.1 mm for females. The LAPD mean values were 26.1 mm and 22.2 mm for males and females respectively.[6]Generally, morphological structures of bones tend to be larger and robust in males compared to females, and this may explain why males have higher mean values of all the OC parameters measured.Deploying demarking points for sex determination, only 13 (21.67%) out of the 60 males were identified using RAPD and 7 (11.67%) using RMTD. Using RMTD, only 8 (16%) of the 50 females were identified and 6 (12%) females were identified using LMTD.On deploying Baudoin index for sex estimation, success rates in the males are 51 (56%), 44 (50%) and 48 (52.75%) for right, left and mean Baudoin condylar indices respectively. In females the success rates are 3 (50%), 4 (40%) and 3 (50%) for right left and mean Baudoin condylar indices respectively.

Success rates using the mean value of the three indices (right, left and mean Baudoin condylar indices) in identification of samples as males and females are 52.92% and 46.67% respectively. However, the success rate was higher in females compared to males as reported by those who used human skulls. They reported that the success rate of the Baudoin index for sex determination was 44.83% to the skulls classified as males, and 51.93% to the supposed females.[4]

Although Baudoin condylar index can be used in sex estimation,[3]reported that the Baudoin condylar index has a low yield as a diagnostic test for sex estimation in the skulls studied.

CONCLUSION

This study showed that the OC is sexually dimorphic and can be used in sex determination in the sample population. Although the occipital condyles can be used in sex estimation, they remain, however, inadequate for forensic application especially when demarking points and Baudoin condylar index are the methods to be deployed for this purpose.A high awareness of malaria and the dynamics involved in its transmission and prevention as well as a high awareness of insecticide-treated nets (ITNs) were demonstrated in this study. However, there was a low level of utilisation of ITNs in this rural community, where location and ecological factors obviously favour the endemicity of malaria.[18] It is therefore, recommended that government agencies and all stakeholders involved intensify efforts at identifying and addressing issues hindering the utilisation of nets and other strategies in the prevention and control of malaria. This should be implemented with adequate priority given to groups more vulnerable to malaria. The promotion of such interventions when implemented consistently and intensively is likely to contribute immensely to improving malaria control and elimination efforts in the country, towards the possibilities of malaria vaccines and ultimate eradication.

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