

Research Article

A Comparative Study of the Canine Tooth as a Tool in Gender Determination in Nigerian Population

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Abstract

Dental evidence has been demonstrated as a major forensic tool for the identification of individuals and sex determination.

The objective of the research was to determine sex in Delta Ibo ethnic group of Nigeria using the mandibular and maxillary canine teeth.

Materials and methods. The study comprised 201 (100 males and 101 females) subjects of Delta Ibo ethnicity at the age of 17 – 25 years. The mesiodistal crown width and intercanine distance of both the maxillary and mandibular canines were measured intraorally using a pair of dividers and a ruler. Unpaired T-test at a probability value of $p < 0.05$ was used to ascertain the mean significant differences between the male and female canine indices.

Results. Study results showed a statistically significant difference between male and female mandibular and maxillary canine mesiodistal width. This implied a sexual and reversed sexual dimorphism in the studied population.

Conclusions. The study confirmed that the canines of Delta Ibos exhibit sexual dimorphism like other populations and the maxillary canine indices give the most accurate prediction in sex determination.

Keywords

maxillary canine index; mandibular canine index; Delta Ibo; sex determination

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Problem statement and analysis of the latest research

Sex determination of skeletal remains has remained highly imperative in archaeology and medico-legal examinations particularly when the bodies are damaged or mutilated [1]. In such situations, forensic experts have reported dilemma in gender determination using skeletal remains for human identification [2]. Some of the major challenges faced by forensic experts when using DNA analysis for the determination of gender in developing countries such as Nigeria are lack of facilities and financing cost. Thus,

this has made the morphometric analysis as one of the most established technique in odontometry [1, 2].

Teeth are the hardest and the most chemically stable tissues in the body being resilient in case of fire, bacterial decomposition, hurricane and air disasters [3]. Among all human teeth, the canines were reported to be the least frequently extracted teeth due to relatively decreased incidence of caries and periodontal disease. Even though in 2013, Ash and Stanley stated that the mandibular and maxillary canines are also referred to as the corner stones of the

mouth, as they are all located three teeth away from the midline and separate the premolars from the incisors; this position reflected their dual function in mastication [4].

Although the canines have also been demonstrated to differ from other teeth with respect to survival and sex dichotomy, a study reported that these differences have been linked to their functions [5]. However, sex determination using dental features is based primarily on the comparison of tooth dimension in males and females [6]. Mohammed et al. (1997), reported sexual dimorphism in humans using the mesiodistal diameter which is also known as the width of the canine [7].

A study conducted on 120 individuals of Niger-Delta origin of Nigeria at the age of 17-25 years revealed that the mandibular canine index exhibited significant sexual dimorphism. It also showed a significant correlation between mandibular canine width and stature [8].

Another study carried out on 100 dental students from DJ College of Dental Science and Research, Modinagar in North India at the age of 20-30 years revealed sex determination using the right and left maxillary canines with 64% accuracy in females and 58% in males [9]. They concluded that the maxillary canines showed significant sexual dimorphism and, therefore, they can be used as an adjunct along with other accepted anthropometrical procedures for sex determination when fragmented remains are encountered in mass disasters [9].

A contrary observation was noted by Harshim and Musrhid in 1993 [10]. They reported no significant difference in the canine dimensions studied and statistically significant sexual dimorphism between male and female canines in the Indian population [10].

In human populations, males have been demonstrated to possess a larger tooth crown than females [11]. These mean differences observed in male and female tooth crowns were attributed to the longer period of amelogenesis for both deciduous and permanent dentitions [11]. Several studies have been conducted to determine baseline data in the assessment of the mandibular and maxillary canines in the inhabitants of the Niger Delta, India [8, 9, 10, 11].

A study by Bansal et al. (2008), considered the mandibular canines as the key teeth for personal identification [12]. Furthermore, Garn et al. (1967) and Nair et al. (1999), discovered that the the mandibular canines exhibit the highest sexual dimorphism among all the teeth [13, 14].

Due to the non-availability of a comprehensive anthropometric database and no population-specific standards for estimating sex using the canine tooth among the Delta Ibos in Delta State, Nigeria, **the objective of the research** was to determine sexual dimorphism in Delta Ibos using morphometric analysis of the mandibular and maxillary canine teeth.

1. Materials and Methods

The study comprised 201 (100 males and 101 females) subjects of Delta Ibo ethnic group studying at the Delta State University, Abraka, Nigeria at the age of 17-25 years. This age group was considered suitable for this study since: firstly, at this age, attrition rate is minimal; secondly, the canine teeth has erupted and the inter-canine distance had already fixed at the age of 12 years [15].

1.1 Selection criteria

Subjects with absence of anterior spacing, healthy state of gingiva and periodontium and carries-free teeth were considered suitable for this study, while subjects having partially erupted teeth, dental abnormalities and teeth with pathological conditions were excluded from this study.

1.2 Ethical consideration

The approval for this study was obtained from the research and ethics committee of the Department of Human Anatomy and Cell Biology, Delta State University, Abraka, Nigeria (DELSU/CHS/ANA/18/124). In addition, the aims and objectives of the study were explained to the subjects and written informed consent was obtained in the prescribed form.

1.3 Methodology

The measurements were taken intraorally on either side of the jaw using a pair of dividers spread between the focal points to avoid recording errors in

the measurement of the canines. The following measurements were taken in the subjects with the mouth widely open.

- Maxillary Canine Width: it was taken as the maximum mesiodistal width;
- Maxillary Intercanine Distance: it was measured as the linear distance between the canine tooth from right to left in the upper jaw;
- Mandibular Canine Width: it was taken as the greatest mesiodistal width between the sides of the canine tooth in the lower jaw;
- Mandibular Intercanine Distance: it was measured as the linear distance between the right and the left canine tooth in the lower jaw.

1.4 Canine indices

They were calculated using the following indices adopted from a previous study [15].

Mandibular canine index (MCI) =

$$\frac{\text{Mesiodistal crown width of mandibular canine}}{\text{Intercanine distance}}$$

Standard mandibular canine index (SMCI) =

$$\frac{(\text{Mean male MSCI}-SD) + (\text{Mean female MCI}+SD)}{2}$$

Maxillary canine index (MxCI) =

$$\frac{\text{Mesiodistal crown width of maxillary canine}}{\text{Intercanine distance}}$$

Standard maxillary canine index (SMxCI) =

$$\frac{(\text{Mean male MxCI}-SD) + (\text{Mean female MxCI}+SD)}{2}$$

1.5 Data analysis

The data obtained were analysed using statistical package for social sciences (SPSS). Unpaired T-test and a probability value of $p < 0.05$ were used to ascertain the mean significant differences between the

male and female canine indices. Sex was predicted based on the observed canine index and the standard canine index.

2. Results

Table 1 showed the maxillary parameters of male and female delta Ibos. The right and left MxCI were statistically significant ($p < 0.05$); when comparing between males and females, the intercanine distance was greater in females (4.177 mm) than males (4.306 mm); the left maxillary mesiodistal crown width was greater in females (0.894 mm) than males (0.839 mm); the right maxillary mesiodistal crown width was greater in males (0.890 mm) as compared to females (0.851 mm); the differences were statistically significant.

In all the parameters measured in Table 2, males were shown to have a significantly greater mean as compared to females. The highest mean difference was demonstrated in the right mesiodistal crown.

Table 3 showed that the highest recorded sexual dimorphism was seen in the left mandible canine (7.72) and the right mandible canine (6.80); the least sexual dimorphism between male and female canines was recorded in the left maxillary canine (3.85).

According to Table 4, the level of accuracy for sex determination in males using the right side of the mandibular canine was 99% correctly classified, while the left side of the mandibular canine showed a very low percentage. The right male maxillary canine also showed a 100% level of accuracy for sex determination.

In females, the mandibular canine in both the left and right side showed a very low level of accuracy with a high percentage level of accuracy in both the right and left maxillary canine with a percentage of 100% highly classified.

3. Discussion

Sexual dimorphism has been described as several variations in the physical appearance between male and female that is imperative in dental identification [16]. In human identification by means of the teeth, gender assessment has been reported as the

Table 1. Maxillary parameters between male and female Delta Ibos.

Parameters	Sex	Mean (mm)	SD	Coefficient of variation	T-stat	“p” value
Left mesiodistal crown width	Male	0.839	0.059	7.03	28.368	0.02*
	Female	0.894	0.057	6.38		
Right mesiodistal crown width	Male	0.89	0.104	11.69	158.2	0.00*
	Female	0.851	0.055	6.46		
Inter canine distance	Male	4.306	0.212	4.92	65.569	0.01*
	Female	4.177	0.206	4.93		
Left MxCI	Male	0.208	0.014	6.73	54.429	0.01*
	Female	0.201	0.014	6.97		
Right MxCI	Male	0.208	0.014	6.73	193	0.01*
	Female	0.204	0.012	5.88		

Note: * $p \leq 0.05$ is significant.

Table 2. Mandibular canine parameters between males and females.

Parameters	Sex	Mean(mm)	SD	Coefficient of variation	T-stat	“p” value
Left mesiodistal crown width	Male	0.837	0.054	6.45	14.505	0.04*
	Female	0.777	0.095	12.23		
Right mesiodistal crown width	Male	0.848	0.055	6.49	15.521	0.04*
	Female	0.794	0.097	12.22		
Inter canine distance	Male	3.5	0.2	5.71	71.527	0.01*
	Female	3.403	0.194	5.7		
Left MCI	Male	0.239	0.015	6.28	39.727	0.05*
	Female	0.231	0.018	7.79		
Right MCI	Male	0.243	0.017	6.99	63.571	0.01*
	Female	0.236	0.017	7.2		

Note: * $p \leq 0.05$ is significant.

Table 3. Sexual dimorphism in the mandibular and maxillary canines of Delta-Ibos.

Parameters (%)	Tooth	Sexual dimorphism
Mandible	Right Canine	6.80
	Left Canine	7.72
Maxilla	Right Canine	4.58
	Left Canine	3.85

first priority. This is due to the tooth is considered to be very crucial in identification during investigative procedures especially when there is a lack of evidence.

The present study analysed the use of morphometrical analysis of the canine in sex determination among males and females in the studied population. It revealed a significant sexual dimorphic difference between males and females of Delta Ibo ethnic group in Nigeria.

Although, this study clearly demonstrated males to have a higher mean significance in all the mea-

Table 4. Percentage of correctly predicted cases using canine indices.

Parameters	Sex	Number	Percentage (%)
Right side of the mandible	Males	99	99
	Females	2	1.98
	Total		50.49
Left side of the mandible	Males	1	1
	Females	7	6.93
	Total		3.97
Right side of the maxilla	Males	100	100
	Females	101	100
	Total		100
Left side of the maxilla	Males	22	22
	Females	101	100
	Total		61

$SMCI (right) = 0.204$, $SMCI (left) = 0.205$,
 $SxMCI (right) = 0.235$, $SxMCI (left) = 0.239$

sured maxillary canine parameters, females had a higher significant mean difference in the left maxillary mesiodistal crown width. This result pattern indicated a significant sexual dimorphism and a reversed sexual dimorphism in the left maxillary canine of Delta Ibos. Similar observations have been reported by studies carried out by Archaya and Mainali (2007) and Karen and Chavi (2009), who reported a larger mean of canine mesiodistal crown width in females than in males in Nepalese population and thus attributed this finding to evolutionary processes that may have resulted in a reduction in sexual dimorphism in these populations [6, 17]. However, the significant sexual dimorphism in the maxillary canine, is consistent with the results obtained by Muller et al. (2001), who carried out similar study on students (randomly selected 210 females and 214 males) of the University of Nice Sophia Antipolis and the results were statistically significant [18].

The present study recorded a significant difference in the left and right mesiodistal crown width, intercanine distance and left and right canine distance in the mandibular canine as well. This observation indicated a significant sexual dimorphism. This finding is consistent with other studies that suggested that the presence of more dentine in males as compared to females may have resulted in sexual dimorphism [19, 20]. In 2010, Agnihotri and Sikri reported the observation similar to the current study and attributed the reasons for their findings to be based on genetics; Y chromosomes control the size of the teeth, while enamel thickness is controlled by X chromosomes [21].

The results of the study revealed that sexual dimorphism in the mandible is greater in the left canine (7.72%) than in the right canine (6.80%). The reasons for this finding may be attributed to the fact that sexual dimorphisms in tooth size are population-specific and may vary among different ethnic groups as has been previously reported [13]. This was in agreement with the results obtained by Kaushal et al. (2003) who conducted a study on 60 subjects of the North Indian population; according to this study, greater dimorphism was observed in the left mandibular canine (8.8%) as compared to

the right one (7.9%); the authors concluded that if the width of the canine is greater than 7 mm, the probability of the individual being a male is 100% [15]. In addition, the results of sexual dimorphism of the maxillary canine showed a greater dimorphism in the right canine (4.58%) than in the left (3.85%) one.

The study demonstrated that sex could be predicted up to 99% and 100% in males using the right mandibular and maxillary canines, while in females, it can be predicted 100% accurately using the left and right maxillary canine teeth. Thus, this study has established that sexual dimorphism exists in the right maxillary and mandibular canine in males and in the maxillary canine teeth in the females.

4. Conclusions

The study revealed a significant sexual dimorphism in the mesiodistal crown width of the mandibular and maxillary canines; males had larger tooth widths than females apart from the left mesiodistal crown width that demonstrated a reversed sexual dimorphism. The left mandibular canine and the right maxillary canine were found to be more dimorphic. Finally, the maxillary canine indices showed greater degree of precision in sex determination amongst Delta Ibos than the mandibular canine indices.

Informed Consent

A written informed consent was obtained from all the subjects who participated in this study.

Conflict of Interest

The authors stated no conflict of interest.

Financial Disclosure

The authors declared no financial support.

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