Original article

A dimorphic study of maxillary first molar crown dimensions of Urhobos in Abraka, South-Southern Nigeria

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Abstract

Introduction: Human identification, an aspect of forensic anthropology, is the recognition of an individual based on the physical characteristics unique to the individual. Among the four main attributes of biological identity, sex determination is usually the first step in the human identification process. The objective of this study was to assess the dimorphic status of mesio-distal and bucco-lingual widths of maxillary first permanent molars of the Urhobos in South-Southern Nigeria. **Material and methods**: The study subjects were 100 male and 100 female Urhobos, aged 17-26 years. The descriptive study adopted the purposive sampling technique. Intra-oral measurements of mesio-distal and bucco-lingual dimensions of the first maxillary molars were taken using digital vernier caliper after informed consent was obtained. The data obtained were subjected to statistical analysis using descriptive statistics and t-test to compare dimensions between males and females. P-value ≤ 0.05 was considered statistically significant. **Results**: The mean mesio-distal width was 9.69 mm (right) and 9.62 mm (left) in males; 9.40 mm (right) and 9.56 mm (left) in females. The mean bucco-lingual width was 10.45 mm (right) and 10.49 mm (left) in males and 10.21 mm (right) and 10.23 mm (left) in females. The differences between males and females in all dimensions measured except left maxillary mesio-distal width were statistically significant (P-value < 0.05). All the dimensions exhibited sexual dimorphism of 3.0% except left maxillary mesio-distal width which showed 1.0%. **Conclusion**: The mesio-distal and bucco-lingual dimensions of the maxillary first molars may be used as an aid in sex discrimination.

Keywords: anthropology, gender dimorphism, maxillary molar, Nigeria.

1 Introduction

Forensic anthropology is a branch of physical anthropology that involves the examination of skeletal remains for medico-legal reasons (DAYAL, STEYN and KUYKEENDALL, 2008). The forensic anthropologist is usually asked to provide information that may be useful to confirm, or assist in determining the identity of an individual from their skeletal remains. This may be at the scene of an unexplained or natural death, homicide, suicide or mass disaster (SCHEUER, 2002).

Human identification is the recognition of an individual based on the physical characteristics unique to the individual. The four main attributes of biological identity that the forensic anthropologists may wish to determine are the gender, age, stature, and ethnic or racial background of the individual (SCHEUER, 2002). In forensic human identification, gender determination is usually the first step in the identification process. This is because, not only does an accurate gender diagnosis effectively cut the number of possible matches to half (MACALUSO JUNIOR, 2010), but also subsequent methods for age and stature estimation are often gender dependent (SCHEUER, 2002; MACALUSO JUNIOR, 2010).

The variations in tooth size are influenced by genetic and environmental factors. Whenever it is possible to predict the gender, identification is simplified because then only missing persons of one gender need to be considered. In this sense identification of gender takes precedence over the other attributes (CAMPS, 1976; AGNIHOTRI and SIKRI, 2010). Various features like tooth morphology and crown size are characteristic for males and females (DAYAL, SRINIVASAN and PARAVATTY, 1998).

In exhibiting gender dimorphism, the bony pelvis and skull give the most reliable results from morphological and metric analysis (MACALUSO JUNIOR, 2010; KRONGMAN, 1962; ADEBISI, 2003). Other bones such as the femur, humerus, radius, ulna, clavicle and calcaneus may also be found useful in accurate gender determination (MACALUSO JUNIOR, 2010; ADEBISI, 2003; STEWART; 1947; FRANCE, 1998).

Occasionally, the only evidence available to the forensic anthropologist for gender determination may be teeth (dentition), as they are more resistant to taphonomic degradation than bones (KIESER, 1990); and the degree to which they resist damage from bacterial decomposition, fire and fracture makes them very important in forensic investigation and research (PRATHIBHA, MAHIMA and PATIL, 2009).

Gender dimorphism in tooth size has been carried out by anthropologists and odontologists focusing on: Bucco-lingual and Mesio-distal dimensions of teeth (linear dimensions) (LUND and MONSTAD, 1999; ISCAN and KEDICI, 2003; ACHARYA and MAINALI, 2007; OTUYEMI and NOAR, 1966); diagonal measurements of tooth crowns (KARAMAN, 2006; RAI and ANNAND, 2007); dental indices have also been employed (EBOH and IGBIGBI, 2011; EBOH and ETETAFIA, 2010; AITCHISON, 1964; RAO, PAI, RAO et al, 1988; RAO, RAO, PAI et al., 1989; ACHARYA and MAINALI, 2008). It is known that gender dimorphic dimensions are only useful if relative to a population. Gender

determination using linear dimensions of maxillary molar teeth among the Urhobo people is lacking in the literature. This gap in literature is what this study intends to fill. This study was delimited to the Urhobos resident in Abraka, within the age group 17-24 years. The focus of this study is to measure the mesio-distal and bucco-lingual dimensions of the maxillary first permanent molar to find out their dimorphic nature.

There is lack of normative data on the Bucco-lingual and Mesio-distal dimensions of the molar teeth, especially the maxillary first permanent molars of the Urhobos in Southern Nigeria. Data on sexual dimorphism using maxillary first permanent molars is also absent in this population. This will militate against forensic human identification of sex using first molar teeth. Arising from the above, therefore, the major problem this study intends to examine is: Is there significant difference between males and females in the mesio-distal and bucco-lingual dimensions of the maxillary first permanent molar teeth?

This study will serve as reference data in forensic and physical anthropology as well as guide to dental practitioners in providing clinical information and education in this part of the world.

The purpose of this study is determine the mesio-distal and bucco-lingual dimensions of the maxillary first permanent molar in both males and females and to test the hypothesis that the linear dimensions of this tooth is not significantly higher in males than in females among the Urhobos, in Southern Nigeria.

2 Material and methods

Two hundred subjects (100 males and 100 females) aged 17-26 years and who are Urhobos by tribe were sampled and used for the study. This age range was chosen as clinical experience has shown that tooth surface wear is minimal at this age. The descriptive survey of the quantitative design was adopted and the purposive sampling technique was employed. Only individuals whose upper and lower dental arches fulfilled the following criteria were included:

- Healthy state of gingivae and periodontium;
- Cavities free teeth;
- Normal overjet and overbite; and
- Normal molar and canine relationship.

The subjects were told the nature and purpose of the study and only those who gave their voluntary consent participated, in accordance with International Ethical Guidelines for Biomedical Research involving Human Subjects (Helsinki Declaration of 1975, as revised in 2000). Accordingly, the research and ethics committee of the College of Health Sciences, Delta State University, approved the procedure employed in the study.

Measurements were taken intra-orally with a digital vernier caliper (Mitutoyo, Japan) with resolution of 0.01 mm, with the subject sitting in the dental chair. The following parameters were measured:

- Mesio-distal width (MDW) of the crown of the maxillary first permanent molar: This is measured as the maximum distance (in mm) between the contact points with the second premolar and second molar teeth (Figure 1); and
- Bucco-lingual width (BLW) of the crown of the maxillary first permanent molar: This is measured as the greatest distance (in mm) between facial and lingual surface of the crown parallel to the long axis of tooth (Figure 2).

In order to assess the degree of error of the measurements in this study, 20 subjects who were not part of the study population were randomly sampled and measurements of mesiodistal and bucco-lingual crown dimensions of the maxillary first permanent molar taken twice at interval of five days. Intra-observer error was calculated in accordance with Dahlberg (1940). The mean error as calculated was 0.080 mm for mesio-distal width and 0.30 mm for bucco-lingual width. Pearson correlation between respective first and second measurements was highly significant at the 0.01 level ($p = 0.000$); Pearson r is 0.931 for mesio-distal width and 0.982 for bucco-lingual width. The findings indicate that the errors were minimal and are unlikely to bias the results.

Gender dimorphism was calculated in accordance with previous studies (PRATHIBHA, MAHIMA and PATIL, 2009; GARN, LEWIS and SWINDLER, 1967). Gender dimorphism = [(mean male tooth dimension/ mean female tooth dimension) – 1] × 100.

In order to obtain a reference point to differentiate males from females, this study adapted the procedure used by Rao, Rao, Pai et al., (1989). If the linear values of the

Figure 1. Showing measurement of mesio-distal width of maxillary first permanent molar.

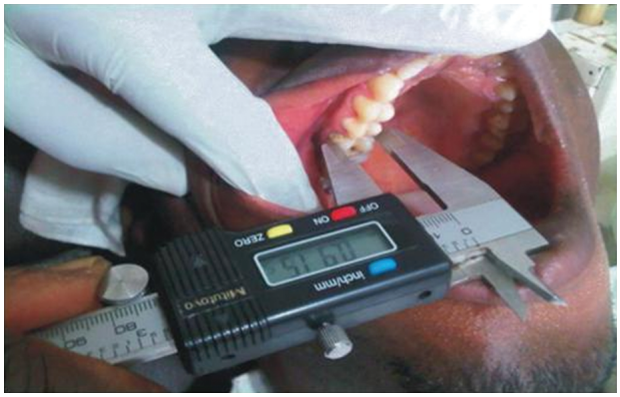

Figure 2. Showing measurement of disto-buccal width of maxillary first permanent molar.

Bucco-lingual and Mesio-distal dimensions are higher than their respective reference points the individual is considered to be a male otherwise the individual is a female. Reference point = [(mean male dimension – SD) + (mean female dimension + SD)]/2.

The data obtained were subjected to statistical analysis with the Microsoft Excel, using descriptive statistics; unpaired t-tests were used to compare the dimensions measured for males and females. P-value ≤ 0.05 was considered statistically significant.

3 Results and discussion

Table 1 shows descriptive statistics for mesio-distal and bucco-lingual widths of maxillary first molar of both sides in both genders. The mean MDW was 9.69 mm (right side) and 9.62 mm (left side) in males, while it was 9.40 mm (right side) and 9.56 mm (left side) in females. The mean BLW was 10.45 mm (right) and 10.49 mm (left) in male; in females it was 10.21 mm (right) and 10.23 mm (left).These values were observed to be higher in males compared with females.

These findings corroborate other studies which reported that males have larger teeth than females (GARN, and LEWIS, 1967; ALVESALO, TAMMISALO and TOWNSEND, 1990; SCHWARTZ and DEAN, 2005; SAUNDERS, CHAN, KAHLON et al., 2007). The mean values in this study were noted to be lower than a South African study (MACALUSO JUNIOR, 2010), which observed the mean mesio-distal width for males (11.09) and females (10.63 mm); and the mean bucco-lingual width for males (11.50 mm) and females (10.89 mm). They were also noted to be lower than an Indian study (AGNIHOTRI and SIKRI, 2010), which reported the mean mesio-distal width for males (11.33 mm right), 11.39 mm (left) and females (10.88 mm right), 10.87 mm (left); and the mean bucco-lingual width for males (12.53 mm right), 12.60 mm (left) and females (11.97 mm right), 11.98 mm (left). The variations among the different populations can be attributed to genetic, environmental, geographical and nutrition or dietary factors as they are known to affect tooth size (DAYAL, SRINIVASAN and PARAVATTY, 1998).

Table 2 shows the tests of significant difference between the genders for maxillary crown dimension. The right maxillary mesio-distal width (RMMDW), right maxillary bucco-lingual width (RMBLW), and left maxillary bucco-lingual width (LMBLW) were significant ($p < 0.05$), except maxillary mesio-distal width (LMMDW)($p > 0.05$).

This finding is consistent with previous studies which reported that mesio-distal width and bucco-lingual width measured are higher in males than females and the difference are statistically significant (MACALUSO JUNIOR, 2010; AGNIHOTRI and SIKRI, 2010; DAYAL, SRINIVASAN and PARAVATTY, 1998).

Table 3 shows sexual dimorphism for MDW and BLW of Maxillary First Molar. Sexual dimorphism was 3.0% in all parameters except left maxillary mesio-distal width (1.0%).

These values when compared with previous studies are lower. Agnihotri and Sikri (2010) reported mesio-distal with of 4.14% (right), 4.78% (left) and bucco-lingual width of 4.68% (right), 5.18% (left). Macaluso Junior (2010) reported mesio-distal width of 4.33% and bucco-lingual width of 5.60%. Rai, Jain, Duban et al. (2007) using both intra-oral and cast measurements of bucco-lingual width noted gender dimorphism to be 8.95% (right) and 8.4% (left) intra-orally; 8.8% (right) and 8.3% (left) using casts.

Table 1. Descriptive statistics for mdcw and blcw 0f maxillary first molar (n: Male = 100; Female = 100).

Parameter	Gender	Side	Mean (mm)	Range	SD
Mesio-distal	M	R	9.69	8.43-11.04	0.55
		L	9.62	8.71-10.86	0.53
	F	R	9.40	8.20-10.68	0.60
		L	9.56	8.60-10.76	0.56
Bucco-lingual	M	R	10.45	9.05-11.63	0.56
		L	10.49	9.68-11.79	0.47
	F	R	10.21	8.99-11.42	0.62
		L	10.23	6.81-11.58	0.79

M = male, F = female, R = right, L = left.

Table 2. T-test for maxillary crown dimension (n: Males = 100; Females = 100).

Parameter	Gender	Mean (mm)	Variance	T Critical two tail	"t" stat	P = value	Significance
LMMDW	M	9.62	0.28	1.97	0.84	0.40	Not Significant
	F	9.56	0.31				
RMMDW	M	9.69	0.30	1.97	3.53	0.0005	Significant
	F	9.40	0.37				
RMBLW	M	10.45	0.32	1.97	2.87	0.004	Significant
	F	10.21	0.38				
LMBLW	M	10.49	0.22	1.97	2.83	0.005	Significant
	F	10.23	0.63				

LMMDW = left maxillary mesio-distal width. RMMDW = right maxillary mesio-distal width. RMBLW = right maxillary bucco-lingual width. LMBLW = left maxillary bucco-lingual width. M = male, F = female.

Table 3. Sexual dimorphism for MDW and BLW of maxillary first molar.

Parameter	Right maxillary first molar	Left maxillary first molar
Mesio-distal width	3.0%	1.0%
Bucco-ligual width	3.0%	3.0%

Table 4. Accuracy of sexual dimorphism.

Parameter	Side	Gender	Accuracy (%)
Mesio-distal width	Right	Male	68
	Right	Female	62
	Left	Male	50
	Left	Female	59
Bucco-lingual width	Right	Male	55
	Right	Female	60
	Left	Male	48
	Left	Female	62

Genetic, environmental and geographic factors which affect population differences may be the reasons for the variation. It has been reported that teeth have behaved in many ways in the course of evolution, ranging from reduction of the entire dentition to reduction in a group of teeth in relation to another (ACHARYA and MAINALI, 2007, 2008). Such behavior influenced by genetic, environmental and geographic factors could have caused the reduction in the magnitude of dimorphism in Urhobos.

Table 4 shows accuracy of sexual dimorphism using mesio-distal and bucco-lingual widths of maxillary first molar of both sides. The percentage of cases correctly predicted using right mesio-distal width was 68% for male and 62% for females; while it was 50% for males and 59% for females in the case of left mesio-distal width. It was observed in this study that whenever the value of the right mesio-distal width is greater than 9.57 mm the individual is likely to be a male; and when the left mesio-distal width is greater than 9.61 mm the individual is likely to be a male. The percentage of cases correctly predicted using right bucco-lingual width was 55% for male and 60% for females; while it was 48% for males and 62% for females in the case of left bucco-lingual width. It was observed that whenever the value of the right bucco-lingual width is greater than 10.36 mm the individual is likely to be a male; and when the left bucco-lingual width is greater than 10.51 mm the individual is likely to be a male.

In a related study, Macaluso Junior (2010) reported accuracy of gender prediction to be 60.0% in males and 67.6% in females in the case of mesio-distal width; while accuracy of gender prediction is 76.2% in males and 70.5% in females. In a related study, Rai, Jain, Duban et al. (2007) reported that whenever the bucco-lingual width was greater than 10.7 mm, the probability of gender being male is 100%.

Comparing the properties of mesio-distal dimension with bucco-lingual dimension, it was observed in this study that the mean bucco-lingual dimension on the right and left sides in both genders were larger than the mesio-distal dimension on the corresponding sides. Furthermore, the percentage sexual dimorphism was noted to be higher in the case of bucco-lingual dimensions compared with corresponding mesio-distal dimensions. These observations are in consonance with other studies which noted higher mean bucco-lingual width and percentage sexual dimorphism than mesio-distal width (MACALUSO JUNIOR, 2010; AGNIHOTRI and SIKRI, 2010; GARN and LEWIS, 1967).

It is the combination of environmental factors and genetic that controls the mesiodistal and buccolingual dimensions, as the dimensions obtained for the male teeth are certainly higher compared to those for females (DEMPSEY and TOWNSEND, 2001; AGNIHOTRI and SIKRI, 2010). This has been attributed to the shape of the first molar tooth, which is controlled by the genetic constitution of the individual. Thus, the male teeth are usually larger in size as compared to the female teeth (AGNIHOTRI and SIKRI, 2010; ISCAN and KEDICI, 2003; ALVESALO, TAMMISALO and TOWNSEND, 1990). The Y chromosome is now known to contribute most in the size of teeth by controlling the thickness of dentine, whereas the X chromosome seems to be responsible for modulating thickness of the enamel. The sexual dimorphism in tooth morphology is attributable to the presence of relatively more dentine in the crowns of male teeth (AGNIHOTRI and SIKRI, 2010; ISCAN and KEDICI, 2003; ALVESALO, TAMMISALO and TOWNSEND, 1990).

4 Conclusion

This pioneer study provides normative morphometric data and establishes the existence of statistically gender dimorphism ($P < 0.05$) for the maxillary first molars among the Urhobos. It will be useful in anthropological, odontologic, genetic and forensic investigations, as ethnicity/race, culture and environment are known to affect tooth morphology.

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