The role of maxillary canines in forensic odontology

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ABSTRACT

Background: This study aimed to determine the gender of a sample of Iraqi adults utilizing the mesio-distal width of maxillary canines, inter-canine width and standard maxillary canine index, and to determine the percentage of dimorphism as an aid in forensic odontology.

Materials and methods: The sample included 200 sets of study models belong to 200 subjects (100 males and 100 females) with an age ranged between 17-23 years. The mesio-distal crown dimension was measured manually, from the contact points for the maxillary canines (both sides), in addition to the inter-canine width using digital vernier. Descriptive statistics were obtained for the measurements for both genders; independent samples t-test was performed to evaluate the gender difference, percentage of dimorphism was obtained and discriminant function statistics were used for gender identification in addition to the percentages of gender identification accuracy.

Results: Generally, the mesio-distal width of the maxillary canine and the inter-canine width were larger in males than females with a high significant difference. The accuracy of genders determination using standard maxillary canine index was 44% for males, 74% for females and 59% for the combined sample, while it was 70% for males, 76% for females and 73% for the combined sample using discriminant function statistics depending upon the canines, inter-canine widths and maxillary canine index. The percentages of dimorphism were 6.13% for the canine mesio-distal width and 4.66% for the inter-canine width.

Conclusions: Maxillary canines can be used in genders identification as an aid for forensic odontology.

Keywords: Canine width, inter-canine width, canine index, forensic odontology. (J Bagh Coll Dentistry 2013; 25(4):109-113).

INTRODUCTION

Teeth are the hardest and chemically most stable tissues in the body and exhibit least turnover of natural structure. They are well preserved after death. Further, they show significant sexual dimorphism and are readily accessible for examination. Thus, they provide excellent materials for forensic studies involving identification of genders [(1)].

Many authors have done measurements of crowns in the teeth of both men and women and found certain variations. Bosset and Marks [(2)] and Krogh [(3)] stated that the study of the permanent mandibular and maxillary canine teeth offers certain advantages. These advantages emanate from the fact that they are the least frequently extracted teeth and being less affected by periodontal disease. The canines are commonly referred to as the 'cornerstones'of the dental arches as four canines are placed at the 'corners' of the oral cavity. The shape of the crowns, with their single pointed cusps, their locations in the mouth and the extra-anchorage furnished by the long, strongly developed roots make these canines resemble those of the carnivore. This resemblance to the prehensile teeth of the carnivore gives rise to the term 'canine'.

Many studies [(4-9)] used the maxillary canines in genders identification; some depended on the mesio-distal width or the inter-canine width and the other combined both measurements to develop the canine index and standard canine index.

In Iraq, many studies were carried out as an aid in forensic odontology. Al-Nakib and Al-Saadi [(10)] estimated the chronological age of an Iraqi sample by the application of Kvaal's technique on digital panoramic image and comparing between the real age and the estimated age. Rashid and Ali [(11)] used the linear measurements related to the mental and mandibular foramina vertical positions on digital panoramic images in genders determination. Ali and Al-Nakib [(12)] evaluated the accuracy of digital cephalometric system in genders determination in Iraqi samples with different age range using certain linear and angular craniofacial measurements. Taha and Al-Nakib [(13)] differentiated between Class I and Class II mal-relationship using helical computed tomography. Habeeb and Fattah [(14)] estimated the chronological age among Iraqi adult subjects based on various morphological variables of canine teeth using digital panoramic radiograph. These methods are X-ray dependant which is hazardous and not

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cheap. On the other hand, Al-Fahdawi [15] identified the genders of an Iraqi sample from Al-Anbar governorate using the mesio-distal crown diameter of the permanent teeth. He found that half of the teeth in the maxilla and more than half of the teeth in the mandible were significantly different with respect to genders, while Nahidh [16] determined the gender of a sample of Iraqi adults utilizing the mesio-distal width of maxillary central incisors and canines and determined the percentage of dimorphism as an aid in forensic dentistry.

The aim of this study was to determine the gender of a sample of Iraqi adults utilizing the mesio-distal width of maxillary canines, inter-canine width and standard maxillary canine index, and to determine the percentage of dimorphism as an aid in forensic odontology.

MATERIALS AND METHODS

Sample

The sample of this study consisted of 200 students with an age ranged between 17-23 years old (100 males and 100 females). Those were selected from the students of the College of Dentistry, University of Baghdad and some secondary schools. They had full complement of permanent teeth with normal occlusion and no spacing, crowding, attrition, caries, dental fillings or periodontal problems in the anterior teeth. All of them had no history of orthodontic treatment, orthognathic or cranio-facial surgery.

Methods

Each subject was examined clinically to fulfill the inclusion criteria. Then upper and lower impressions with alginate impression material were taken to construct the study models.

The mesio-distal crown dimensions of the maxillary right and left canines were measured from the anatomical contact points [17] using digital sliding caliper gauge with the pointed beaks inserted in a plane parallel to the long axis of the tooth. The measurements were made to the nearest 0.01 mm.

The inter-canine width or distance was measured from the canine tip to the canine tip on the other side with same caliper gauge [4-6].

Maxillary Canine Index (MCI) was used for the first time for maxillary canines by Sherfudhin *et al.* [4] when depended upon the method of Rao *et al.* [18] who applied it on the mandibular canines. MCI was calculated by dividing the mesio-distal width of the maxillary canine by the inter-canine distance [4,6].

Based on these values, the standard MCI was derived as follows [4,6]: Standard MCI =

$$\frac{(\text{Mean males MCI} - \text{SD}) + (\text{Mean females MCI} + \text{SD})}{2}$$

Statistical analyses

All the data of the sample were subjected to a computerized analysis using SPSS program version 19. The statistical analyses included:

- Descriptive statistics: means, standard deviations, frequency, percentages and statistical tables.
- Inferential statistics: Independent sample t-test to evaluate the genders difference. Percentage of dimorphism which is the percentage by which the tooth size of males exceeds that of females {it equals to = [(Xm/Xf)-1x100] where Xm is the mean tooth dimension of males and Xf is the mean tooth dimension of females} [19]. Discriminant function statistics were used in gender identification in addition to the percentage of gender identification accuracy.

In the statistical evaluation, the following levels of significance were used:

P > 0.05	**NS**	**Non-significant**
0.05 ≥ P > 0.01	**S**	**Significant**
P ≤ 0.01	**HS**	**Highly significant**

RESULTS AND DISCUSSION

In this study, maxillary canines were chosen because Hashim and Murshid [20] found that the canines were the only teeth that exhibit dimorphism. Subjects with age ranged from 17 to 23 years were selected since attrition is minimal in this age group and the eruption of canines and growth in width of both the jaws, including the width of the dental arches, are completed [21].

Sillman [22] stated that after 2 years of age, the inter-canine width continued to increase in the maxilla until 13 years of age, after this time, canine width remained stable.

The results in Table 1 indicated that the mesio-distal width of maxillary canines were higher in males than females with a highly significant difference; this comes in agreement with Sherfudhin *et al.* [4], Kalia [6], Parekh *et al.* [8] and Bakkannavar *et al.* [9], while Al-Rifaiy *et al.* [5] and Boaz and Guota [7] found non-significant genders difference.

It is suggested that the way of influence of the Y chromosome on the amelogenesis is regulatory, and that the difference in tooth size between males and females is explained by a differential growth-promoting effect of the Y chromosome compared to the X chromosome. The general

finding that tooth crown sizes in males exceeded, on average, those in females resulted from a greater thickness of dentin in male teeth. The difference is explained by the promoting effect of the Y chromosome on dentin growth, probably through cell proliferation. It is conceivable that due to the Y chromosome, mitotic potential is increased, which at different stages of development leads to the increase in cell division and may also account for other differences in the dentition [23,24]. Other cause for the difference in tooth size between males and females is the greater thickness of enamel in males due to the long period of amelogenesis compared to females [25].

The mean value of inter-canine width was higher in males than females with a highly significant difference (Table 1). This agrees with Sherfudhin *et al.* [4], Al-Rifaiy *et al.* [5] and Parekh *et al.* [8]. Kalia [6] found non-significant genders difference.

The differences between the results of the present study and other studies may be attributable to the sample size, different ethnic groups or the accuracy of the instruments used in the tooth and inter-canine width measurement.

The maxillary canine index was nearly similar in both genders depending on the mean canine width as there was no significant side difference in both genders. Kalia [6] found highly significant genders difference with higher mean in males.

The percentage of dimorphism was 6.13% for the mean canines' widths, 4.66% for the inter-canine width and 1.38% for the maxillary canine index (Table 1). This finding is nearly equal to that of Gran *et al.* [26] which was 5.9% and greater than Bakkannavar *et al.* [9] which were 3.31% for right canine and 3.29% for left canine but less than Parekh *et al.* [8] which were above 7% for the canines and 5.15% for the inter-canine width.

Table 1. Descriptive statistics, genders' differences and percentage of dimorphism for the measured variables (mm.)

Variables	Genders	Descriptive statistics		Genders difference		Percentage of dimorphism
		Mean	S.D.	t-test	p-value	
Right Canine (RC)	Males	7.99	0.43	7.683	0.000 (HS)	6.11
	Females	7.53	0.44			
Left Canine (LC)	Males	7.94	0.49	6.938	0.000 (HS)	6.01
	Females	7.49	0.40			
Mean of Both Canines	Males	7.97	0.44	7.690	0.000 (HS)	6.13
	Females	7.51	0.39			
Inter-canine Width (ICW)	Males	36.38	2.84	4.501	0.000 (HS)	4.66
	Females	34.76	2.21			
Maxillary Canine Index (MCI)	Males	0.220	0.02	1.433	0.150 (NS)	1.38
	Females	0.217	0.01			

The frequencies and percentages of correctly classified and misclassified cases using the standard maxillary canine index were presented in table 2. The value of this index was 0.22 which was nearly equal to that of Kalia [6]. Value of maxillary canine index above 0.22 was classified as male and equal to and less than 0.22 was classified as female.

In this study, the percentages of gender identification accuracy using standard maxillary canine index were 44% for males, 74% for females and 59% for the combined sample. Kalia [6] found them 77.38 % in males, 74.21 % in females and 75.79 % in combined sample which were higher than the present study. This may be attributed to the larger sample size utilized in Kalia's [6] study which was (252 males and 252 females).

Table 2. Frequencies and percentages of correctly and misclassified cases using standard maxillary canine index

Genders	Frequencies and percentages of correctly classified cases	Frequencies and percentages of misclassified cases
Males	44 (44%)	56 (56%)
Females	74 (74%)	26 (26%)
Total	118 (59%)	82 (41%)

Discriminant analysis involves the determination of a linear equation like regression that will predict which group the case belongs to. The aim of the statistical analysis in discriminate analysis is to combine (weight) the variable scores in some way so that a single new composite variable, the discriminant score, is produced.

Discriminant analysis creates an equation which will minimize the possibility of misclassifying cases into their respective groups or categories. The form of the equation or function is: **D = a + b1x1 + b2x2 +…+ bnxn**

D is predicted score (discriminant score: this is a weighted linear combination (sum) of the discriminating variables.)

a is constant

x is predictor and

b is discriminant coefficient.

In this study, the formula was: **D= -29.512 + 0.930 (RC) – 0.014 (LC) + 0.380 (ICW) + 40.643 (MCI).**

where:

RC= Right Canine

LC= Left Canine

ICW= Inter-Canine Width

MCI= Maxillary Canine Index

A further way of interpreting discriminant analysis results is to describe each group in terms of its profile, using the group means of the predictor variables. These group means are called centroids. In this study, males had a mean of 0.595 while females produce a mean of –0.595. The cut-off point for discrimination between the gender is ½ (0.595 + (-0.595)) = 0. if the calculated discriminant score is less than zero the case is classified as "Female" and if the score is greater than or equal zero, the case is classified as "Male"

The frequencies and percentages of correctly classified and misclassified cases were shown in table 3. The percentage of correctly classified male cases was 70% and of females was 76% while of the total sample it was 73%. These percentages were higher than that of Al-Rifaiy *et al.* [5] which were 66.67% for males, 64.29% for females and 65.48% for the total sample although the standard MCI was not used in that study. On the other hand, the percentages of accuracy in the present study were less than that of Sherfudhin *et al.* [4] which were 88% for males, 86.8% for females and 87.38% for the total sample. This difference may be attributed to the larger sample size of Sherfudhin *et al.* [4] which was 150 males and 151 females in addition to the difference in the mesio-distal width of the maxillary canines, i.e. 8.2 mm. for males and 6.7 mm. for females in comparison with the present study.

Table 3. Frequencies and percentages of correctly and misclassified cases using discriminate analysis

Genders	Frequencies and percentages of correctly classified cases	Frequencies and percentages of misclassified cases
Males	70 (70%)	30 (30%)
Females	76 (76%)	24 (24%)
Total	146 (73%)	54 (27%)

In conclusion; this is the third study that takes the standard maxillary canine index in gender determination after Sherfudhin *et al.* [4] and Kalia [6]. Maxillary canines can be used in genders identification as an aid for forensic odontology and the discriminant function analysis gives a good prediction than standard MCI when maxillary canine width, inter-canine width and maxillary canine index taken in consideration.

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