

DIMORPHISM OF MANDIBULAR AND MAXILLARY CANINE TEETH IN ESTABLISHING SEX IDENTITY

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هدفت الدراسة لتقصي إزدواجية الشكل للأنياب العلوية والسفلية الدائمة وعرض الأقواس النابية لتحديد الجنس. شملت الدراسة (٥٠٣) طفلاً من مدارس الرياض - المملكة العربية السعودية. ٢٥١ ذكراً و ٢٥٢ أنثى، بعمر يتراوح بين ١٥ - ١٨ سنة. تم قياس أكبر عرض أنسي وحتي بين نقاط تماس الأنياب والمسافة بين ذرى حدية أنياب القوسين وذلك باستعمال مقياس السماكة بتقريب ٠,١ مم. تم إستعمال تحليل التمييز متعدد القيم لتأسيس تحديد الجنس. تبين أن عرض الأنياب العلوية والسفلية، اليمنى واليسرى متماثلاً في كلا الجنين في الذكور والإناث معدل قيمة عرض الأنياب العلوية والسفلية، اليمنى واليسرى كان أقل في الإناث منه في الذكور، لكن إحصائياً، ليس لهذا الاختلاف أية دلالة. معدل قيمة عرض القوس النابية كان أقل في الإناث منه في الذكور بدلالة إحصائية (٠,٠٥) و (٠,٠٠١) على التوالي. أظهر تحليل التمييز متعدد القيم لعرض الأنياب والأقواس النابية العلوية والسفلية بأن نسبة صحة تصنيف الجنس كانت ٥٧,٠٧% و ٤٨,٦٥% على التوالي.

Abstract

The purpose of this study was to investigate whether dimorphism of permanent mandibular and maxillary canine teeth as well as intercanine distance play a role in establishing sex identity. Five hundred three school students from Riyadh, Saudi Arabia comprising of 251 males and 252 females, with age ranging from 15 to 18 years were selected. The greatest mesiodistal width of the canine teeth and the distance between the tips of canines of both arches were measured using vernier caliper with 0.1mm resolution. The procedure of multivariate discriminant analysis was used for establishing the sex identity. The width of the mandibular and maxillary right and left canine teeth were almost bilaterally symmetrical in females and males. The mean values for left and right mandibular and maxillary canine widths were less for females than for males and the differences were not statistically significant. The mean value for mandibular and maxillary intercanine distances for females were less than for males and the differences were statistically significant, ($P < 0.05$ and $P < 0.0001$, respectively). The multivariate discriminant analysis using the canine width and intercanine distance of the mandible and maxilla showed that the rate of correct classification of sex was 55.07% and 65.48%, respectively.

Introduction

To establish the sex of a victim is an essential stage in identification. In major air, train and hurricane disasters where postcranial bones are fragmented, measurement of mesiodistal width of the mandibular and maxillary canine teeth and intercanine distance provides evidence of sex identification due to dimorphism.^{1,2}

Bosset and Marks³ and Krogh⁴ 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. Canine teeth have also been reported to survive in air and hurricane disasters⁵

Rao et al⁸ studied mesiodistal width and intercanine distance of 384 females and 382 males of South Indian population with an age-group of 15-21 years. The mesiodistal width was measured using a vernier caliper with a resolution of 0.1mm. The greatest mesiodistal width was measured between the contact points and they reported that the mesiodistal width of mandibular canine was significantly greater in males than in females. They concluded that 84.3% males and 87.5% females could be discriminated correctly with respect to sex.

A study of Anderson and Thompson¹ consisted of measuring the mesiodistal width of mandibular canines, lateral incisors and intercanine distance of 83 males and 88 females of a Toronto population, aged 14-17 years. Their study showed that mandibular canine width and intercanine distance was greater in males than in females and permitted 74.3% correct classification of sex.

Garn et al² studied the magnitude of sexual dimorphism by measuring the mesiodistal width of the canine teeth of an Ohio Caucasian population and concluded that the magnitude of canine tooth sexual dimorphism varied among different ethnic groups. Furthermore, they stated that "the mandibular

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canine showed a greater degree of sexual dimorphism than the maxillary canine.⁸ However, other investigators^{7,9} reported that maxillary canine showed a higher degree of sexual dimorphism compared to the mandibular canine in a Japanese population. Thus, controversy exists regarding the degree of sexual dimorphism between mandibular and maxillary canine teeth in different ethnic groups. The role of the maxillary intercanine distance to establish sex identity has not been reported. Furthermore, sexual dimorphism of the mandibular and maxillary canine and inter-canine distance of Saudi population has not been reported in the literature.

The purpose of this study was to investigate the sexual dimorphism of the permanent mandibular and maxillary canine width and intercanine distance of high school students in Riyadh, Saudi Arabia.

Materials and Methods

Five hundred and three school students from Riyadh, Saudi Arabia, comprising of 251 males and 252 females, with age ranging from 15 to 18 years were selected. Subjects who had fully erupted maxillary and mandibular canine teeth without attrition, and who did not have orthodontic treatment, or crown restorations of the anterior teeth were included in this study. The greatest mesiodistal width of the mandibular and maxillary right and left canine teeth were measured using a vernier caliper with 0.1mm resolution. The mesiodistal width of a canine was measured between its contact points. In the absence of contact points, the greatest-mesiodistal width of the canine was measured and recorded.

The other measurement consisted of the distance between the tips of the two mandibular and two maxillary canines in a straight line (intercanine distance). Each parameter was measured three times and the average value was computed and recorded separately by two investigators. Percent agreement, analysis of variance (ANOVA) and Pearson correlation were used to determine the concordance level of the two investigators.

The main frame computer system of King Saud University was employed for analyzing the data. Multivariate quadratic discriminant analysis was used for sex classification. Discriminant analysis¹⁰ (PROC-DISCRIM) of the statistical analysis system¹¹ was used for computation.

Results

The percent agreement showed that at least 80% of the time the two investigators agreed ($\pm 2\%$) in measuring the variables. The P-values of ANOVA showed that on the average the measurements were not significantly different. The coefficient of Pearson correlation indicated that the measurements of these variables were highly correlated (Table 1).

The width of the mandibular canine was almost bilaterally symmetrical in both the males and females (Table 2). When the mean width values for left and right mandibular canine of the 503 subjects were compared between males and females, the females showed less value but the difference was not statistically significant ($P=0.062$). Furthermore, variation in width of the mandibular right and left canines was more in the females than in the

Table 1. Concordance level of measurement between two investigators.

	Percent Agreement	ANOVA P=Value	Pearson Correlation r-value
Mandibular mesiodistal width (right)	95.0	0.8037	0.9873
Mandibular intercanine distance	100.0	0.1263	0.9989
Maxillary mesiodistal width (right)	80.0	0.1992	0.9362
Maxillary intercanine distance	95.0	0.3002	0.9717

Table 2. Mean, standard deviation, test of equality of variance and means for male and female mandibular canine width and intercanine distance.

	MALES		FEMALES		Test of equal variance (P)	Test of equal means (P)
	N _m	\pm SD (mm)	N _f	\pm SD (mm)		
Right mandibular canine width	251	6.9357 \pm 0.6615	252	6.8016 \pm 0.9259	<.0001	0.0620
Left mandibular canine width	251	6.9124 \pm 0.6507	252	6.8310 \pm 0.9345	<.0001	0.2574
mandibular intercanine distance	251	27.0171 \pm 2.3168	252	26.4615 \pm 2.7761	.0043	0.0151

* SAS Users Guide: Statistics, SAS Institute Inc., Box 8000, Cary, NC 27511-8000, U.S.A.

males. The observed difference in variation of the right and left canine width between males and females was statistically significant ($P < 0.0001$). The mean value (Table 2) of intercanine distance for females was less than that for the males and the difference was statistically significant ($P < 0.05$). However, the variance value for the females was more than that for the males and the difference was statistically significant ($P < 0.005$),

In Table 3, the right and left maxillary canines width were also bilaterally symmetrical in both males and females. However, the values for females were more scattered compared to the males and the differences in variance were significant (right canine $P < 0.005$ and left canine $P < 0.05$). The

mean intercanine distance for females was less than that for males and the difference was significant ($P < 0.0001$) but the variation was not significant.

The multivariate discriminant analysis (Table 4) using mandibular sex-specific data showed that 43.25% females were misclassified into males while 46.61% males were wrongly classified into females. An average of 44.93% were misclassified, and permitted 55% correct classification of sex.

Multivariate discriminant analysis for maxillary arch (Table 5) using sex-specific data indicated that 35.71% of females were misclassified into males while 33.33% of males into females. An average of 34.52% were misclassified, and permitted 65.5% correct discrimination of sex.

Table 3. Mean, standard deviation, test of equality of variances and means for male and female maxillary canine width and intercanine distance.

	MALES		FEMALES		Test of equal variance (P)	Test of equal means (P)
	N _m	± SD (mm)	N _f	± SD (mm)		
Right mandibular canine width	251	7.5433 ± 0.6868	252	6.8016 ± 0.9259	.0026	0.8426
Left mandibular canine width	251	7.5405 ± 0.6755	252	6.8310 ± 0.9345	.0128	0.3360
mandibular intercanine distance	252	34.7623 ± 2.8616	252	26.4615 ± 2.7761	.6927	0.0001

Table 4. Discriminant analysis using mesiodistal canine width and intercanine distance of the mandible in mm.

from sex	Number of Observations and percent classified into sex			Misclassification Rate (%)
	female	Male	Total	
Females	143 (56.75)	109 (43.25)	252 (100.0)	43.25
Males	117 (46.61)	134 (53.39)	251 (100.0)	46.61
Total	260 (51.69)	243 (48.31)	503 (100.0)	44.93

Table 5. Discriminant analysis using mesiodistal canine width and intercanine distance of the maxilla in mm.

from sex	Number of Observations and percent classified into sex			Misclassification Rate (%)
	female	Male	Total	
Females	162 (64.29)	90 (35.71)	252 (100.0)	35.71
Males	84 (33.33)	168 (66.67)	252 (100.0)	33.33
Total	246 (48.81)	258 (51.19)	504 (100.0)	34.52

(.) are in percentages

Discussion

The dimensions of canine teeth were studied by several methods which include Moire's topography and Fourier's analysis and measurement of linear dimensions, such as mesiodistal width, buccolingual width and incisocervical height.^{1,2,6,7,8} The use of Moire's topography and Fourier's analysis were limited to small samples whereas measurements of linear dimensions of canine teeth was employed in a large population because it is simple, reliable, inexpensive and easy to perform.

Subjects, with age ranging from 15 to 18 years, were selected because eruption of canines and growth in width of both the jaws, including the width of the dental arches, are completed before the adolescent growth changes. The intercanine distance do not increase after 12 years of age.¹²

In this study, the width of the right and left mandibular and maxillary canines were bilaterally symmetrical, both in males and females. The findings of this study agree with the reports of other investigators.¹⁷ Schield et al¹³ showed sexual difference in tooth size among American black, European and Mongoloid populations. The degree of sexual dimorphism of the mandibular canine width is more in Ohio Caucasians and Australian aborigines than in the Pima, Indians and Tristanite population.²

This study also indicated that the mesiodistal width of the mandibular and maxillary canine teeth was larger in males than in females, but the differences was not statistically significant. This finding is in agreement with a study of human fossil excavated at Ra's Al-Hamra, Eastern Arabian Coast which showed a general low degree of sexual dimorphism of mandibular canine teeth.¹⁴ The canine arch width of the mandible and maxilla was more in males than in females and the difference was statistically significant ($P < 0.00001$). The result of this study is in agreement with that of Anderson and Thompson 1 and Roa et al⁷. Although sexual dimorphism of the mandibular and maxillary canines existed, the intercanine distance on both jaws was significantly different. It permitted only 55% and 65.5% correct classification of females and males, respectively.

In this study the magnitude of sexual dimorphism of the mandibular and maxillary canine teeth was observed to be low. However, further investigation is desirable to substantiate these findings.

Conclusions

The mesiodistal width of the mandibular and maxillary canine teeth was larger in males than in females but the

difference was not statistically significant. The intercanine distance of the mandible and maxilla was greater in males than in females and the difference was statistically significant ($P < 0.00001$). The canine mesiodistal width and intercanine distance in both jaws permitted 55% and 65.5% correct classification of females and males, respectively.

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References

1. Anderson DL, Thompson GW. Interrelationship and sex differences of dental and skeletal measurements. *J Dent Res* 1973;52:431-38.
2. Garn SN, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. *J Dent Res* 1967;46:963-72.
3. Bosset WA, Marks HH. Prevalence and characteristics of periodontal disease in 12,800 persons under periodic dental observation. *J Am Dent Assoc* 1956;52:442-49.
4. Krogh HW. Permanent tooth mortality: A clinical study of causes of loss. *J Am Dent Assoc* 1968;57:570-675.
5. Patterson KB, Kogan SL. Dental identification in woodbridge disaster. *J Canad Dent Assoc* 1985;37:301-06.
6. Suzuki T, Yokosawa S, Ueno M et al. A study on sex determination based on mandibular canines. *Nihon Univ Dent J* 1984;26:246-55.
7. Minzuno O. Sex determination from maxillary canine by Fourier analysis. *Nihon Univ Dent J* 1990;2:139-42.
8. Rao NS, Rao NN, Pai ML, Kotain MS. Mandibular canine index - a clue for establishing sex identity. *Forensic Sci Int* 1989;42:249-54.
9. Kuwana T. On sex difference of maxillary canines observed in the Moire stripes. *Nihon Univ Dent J* 1983;57:88-97.
10. Anderson TW. An introduction to multivariate statistical analysis. New York:John Wiley & Sons Inc, 1986:207.
11. Eimert S, De Vore I. The primates. New York:Times Inc, 1965:148.
12. Proffit MR, Field HW Jr, Ackerman JL, Thompson PM, Tullock SAC. Contemporary orthodontics. St. Louis:CV MosbyCo, 1986:84.
13. Schield ED, Altschuller A, Choi EY, Michaud M. Odontometric variation among American black, European and mongoloid population. *J Craniofac Genet Biol* 1990; 10:7-18.
14. Macchiarelli R. Pre-historic "fish eaters" along the eastern Arabian coast: Dental variation, morphology and oral health in the Ra's Al-Hamra community (Qurum, Sultanate of Oman, 5th-4th millennia BC). *Am J Phys Anthropol* 1989;78:575-94.