Original article

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Mandibular and maxillary canine as a tool for sex determination

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Abstract

Introduction: Teeth measurement assist in the forensic and anthropological investigation to estimate age, confirm sex and race of a person. Maximum resistance to change in a natural disaster and also the most level of sexual dimorphism in canines makes them important in mentioned fields. **Materials and Methods:** During this study, an effort has been created to determine the sex of a person by using Canine Index (CI) which calculated for mandibular and maxillary canines. Mesio-distal (MD) breadth of canines and also the respective inter-canine distances (ICD) were tested using the independent samples t-test revealed significant sex dimorphism among the 100 individuals (50 males and 50 females) of Iranian population in the age group of 18-35 years. **Conclusion**: It is evident from our study that the maxillary canine index (MaxCI) is a valuable tool for determining sex.

Keywords: forensic anthropology, sex determination, mandibular and maxillary canines.

1 Introduction

Teeth are a distinguished material in living and non-living populations for forensic, genetic, odontology and anthropological investigations. Being the hardest and with chemicals, the foremost stable tissues within the body they're selectively protected and fossilized, by this means providing by far the best evidence for evolutionary change (LUND and MÖRNSTAD, 1999). Their persistence in the face of fire and bacterial decomposition makes them valuable for identification and sex determination. The actual fact that the majority teeth complete development before skeletal maturation makes the dentition a valuable sex indicator, particularly in young persons (LUND and MÖRNSTAD, 1999). Of all the teeth within the human dentition, the canines are the minimum often extracted teeth (probably due to the comparatively reduced incidence of dental caries and periodontal disease). canines are considered as the "key teeth" for personal identification and have the mean age of eruption of 10.87 years (KAUSHAL, PATNAIK, SOOD et al., 2004; LATIF, RASHID, KAUR et al., 2016). Among the teeth, canines have constantly shown the greatest sexual dimorphism. It was for these reasons that proposed the exclusive use of canines in sex identification (ACHARYA and MAINALI, 2007, 2009; İŞCAN and KEDICI, 2003; RAO, RAO, PAI et al., 1989). Although the degree of dimorphism varies within various populations, and sexual variation in the human skeleton and dentition is of great concern for anthropologic and forensic investigations (ATEŞ, KARAMAN, IŞCAN et al., 2006; KAPILA, NAGESH, IYENGAR et al., 2011). Sexual dimorphism represents a set of morphologic characteristics between individuals of different sexes in the same species (BOAZ and GUPTA, 2009). Males possess larger tooth crowns than females in contemporary human populations (ADEYEMI and ISIEKWE, 2003; MUGHAL and SAQIB, 2010; SCHWARTZ and DEAN, 2005). This may be due to a longer period of amelogenesis for both deciduous and permanent dentitions in males (MOSS and MOSS-SALENTIJN, 1977). This study aimed to evaluate the validity of the determination of gender from canine measurements in an adult Iranian population sample.

2 Materials and Methods

2.1 Sample

The present study consisted of 100 students comprising 50 males and 50 females in the age group of 18-35 years belonging to Iranian students in Mysore University of India. This age group was selected as all canines would have erupted by this age and attrition is expected to be minimal (KAUSHAL, PATNAIK, SOOD et al., 2004).

2.2 Exclusion criteria

Subjects with the subsequent situation of teeth were excluded from the study.

1. Abnormal teeth alignment;
2. Missing anterior teeth;
3. Excessive spacing within the teeth;
4. Abnormal over jet and overbite;
5. Decay teeth;
6. Subjects with orthodontic treatment;
7. Parents of non-Iranian origin.

2.3 Measurements

After choosing the subjects at random, aims of the study were explained to them and verbal consent was taken. The mandibular and maxillary canine impressions and inter-canine distance were taken intra orally on either side of the jaw employing a digital caliper with an accuracy of 0.01 mm with the preparation to fix it within the favorite position so as

to avoid any errors in recording the accurate measurements of canines and a divider with pointed tips. The following measurements were taken within the subjects.

Mesio-distal crown width of canines (AL-RIFAIY and ABDULLAH, 1997**):**

Using a divider, the greatest mesio-distal width of a canine tooth at a contact point with the adjacent teeth was taken and also the value was measured by putting the two pointed ends of the divider in between jaws of the digital caliper and measurements were noted.

Inter-canine distance:

The inter-canine distance was measured employing a digital caliper by putting the two pointed ends of its jaws over the canine tip and values were noted (direct method). Just In the case of attrition, wherever canine tips were effete, the labial ridge was taken as an indicator of the anatomical tip since, initially, it concerned with the canine tip.

Readings obtained were subjected for analysis to derive conclusions. Further, the canine index and standard canine index were calculated for all the four canines exploitation the formula cited by Muller et.al (MULLER, LUPI-PEGURIER, QUATREHOMME et al., 2001).

$$\textbf{Canine index} = \frac{\text{Mesiodistal crown width of canine}}{\text{Inter canine distance}} \quad (1)$$

$$\textbf{Standard canine index} = \frac{(\text{mean male CI} - \text{SD}) + (\text{mean female CI} + \text{SD})}{2} \quad (2)$$

Data obtained were quantified and analyzed statistically utilization SPSS (Statistical Package for the Social Sciences, Version 11.5) to see the significance of variations between the sex. This was done through the utilization of various descriptive statistics and comparison of group means. Potential sex variations within the MD dimension of right and left canines and also inter-canine arch width were tested using the independent samples t-test. The CI was calculated for every sample as the ratio of the maximum MD canine dimension and the inter-canine arch width. Descriptive statistics for the CI were obtained and potential sex differences in it also examined using the independent samples t-test. Sex was expected based on the observed canine index and standard canine index for the population. If the observed canine index was more than the standard canine index, then the individual was considered to be male and if the observed canine index was less than the standard canine index, then the individual was considered to be female. Percentage accuracy of reporting sex identity by this technique was then checked as the true sex of every participant was known.

3 Results

It was observed that the mean value of the mesio-distal crown width of right and left maxillary canines in males was more than their counterparts as depicted in (Table 1). This value was statistically significant ($p \leq 0.05$). Similarly, results were noticed for the mesio-distal crown width of right and left mandibular canines with statistically significant values as shown in the same table. The mandibular and maxillary inter-canine distances were statistically larger in males ($p < 0.05$) as shown in (Table 2).

The right maxillary canine index in males ranged from 0.1804 to 0.2801 with a mean of 0.2343 ± 0.0034, while it ranged from 0.1977 to 0.2500 with a mean of 0.2243 ± 0.0019 in females as depicted in (Figure 1). This was statistically significant ($p= 0.014$).The left maxillary canine index in males ranged from 0.1891 to 0.3113 with the mean of 0.2357 ± 0.0039 and in females, it ranged from 0.1917 to 0.2647 with a mean of 0.2184 ± 0.0026 as depicted in (Figure 2). This was statistically significant ($p= 0.001$).

The right mandibular canine index in males ranged from 0.2236 to 0.3530 with a mean of 0.2677 ± 0.0042, while it ranged from 0.2040 to 0.3478 with a mean of 0.2545 ± 0.0043 in females as depicted in (Figure 3). This was statistically significant ($p= 0.033$). The left mandibular canine index value in males ranged from 0.2249 to 0.3530 with a mean of 0.2704 ± 0.0038, and in females, it was 0.2097 to 0.3478 with a mean of 0.2567 ± 0.0037 as depicted in (Figure 4). This was also statistically significant ($p= 0.012$).

The standard canine index for the right and left maxillary canines were 0.2240 and 0.2224, respectively and for the right and left mandibular canines were 0.2612 and 0.2631, respectively as shown in (Table 3). Sex predictability using the standard canine index and mandibular canine index (MnCI) showed low accuracy in sexing as shown in (Table 4) whereas the maxillary canine index (MxCI) showed slightly higher sex predictability as shown in (Table 5).

Table 1. Descriptive statistics and t-values for mesio-distal crown widths of canines.

	Sex	Maxillary canine			Mandibular canine		
		Mean	±S.D.	t-Value•	Mean	±S.D.	t-Value•
Right	Male	8.25	0.75	-4.69	7.48	0.69	-6.08
	Female	7.67	0.43		6.68	0.62	
Left	Male	8.30	0.90	-5.41	7.56	0.61	-7.29
	Female	7.46	0.61		6.74	0.49	

•Significantly larger in males at $p \leq 0.05$ level.

Table 2. Sex distribution of inter-canine distances (ICD).

	ICD (mm)	Range	Mean	±SD	t-Value
Maxilla	Male	32.00-39.20	35.27	1.56	-3.95
	Female	32.00-36.50	34.20	1.08	
Mandible	Male	24.12-31.70	28.4	1.73	-5.23
	Female	23.00-29.40	26.34	1.49	

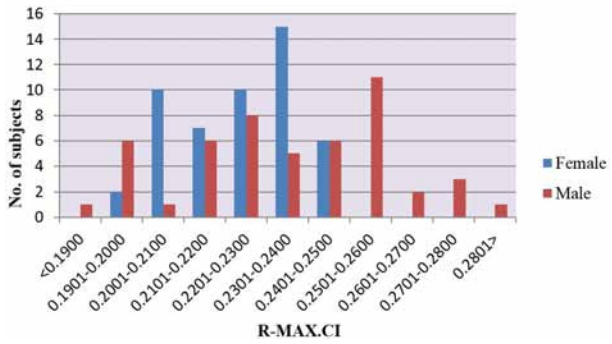

Figure 1. Sex distribution of right maxillary canine index.

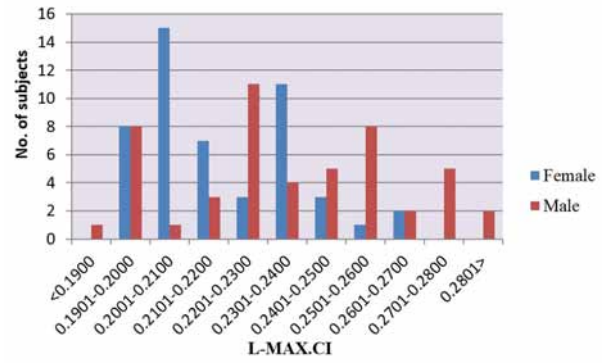

Figure 2. Sex distribution of left maxillary canine index.

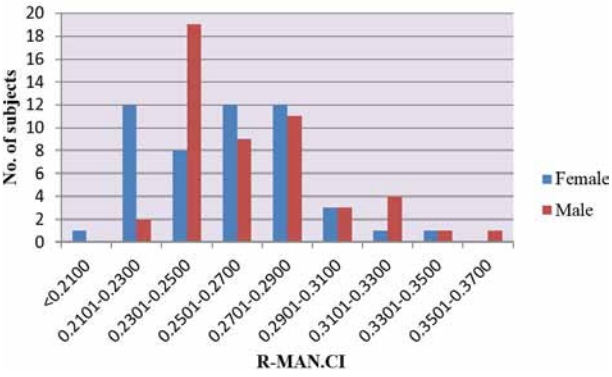

Figure 3. Sex distribution of right mandibular canine index.

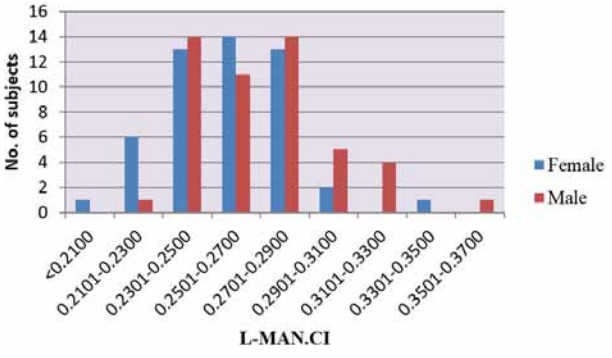

Figure 4. Sex distribution of left mandibular canine index.

Table 3. Standard canine indices.

Standard CI	Value
Right Max CI	0.2240
Left Max CI	0.2224
Right Max CI	0.2612
Left Max CI	0.2631

Table 4. Accuracy of sexing using mandibular canine index.

ManCI	Sex	Case	Percentage
Right ManCI	Male	22/50	44%
	Female	31/50	62%
Total		53/100	53%
Left ManCI	Male	27/50	54%
	Female	32/50	64%
Total		59/100	59%

Table 5. Accuracy of sexing using maxillary canine index.

MaxCI	Sex	Case	Percentage
Right MaxCI	Male	34/50	68%
	Female	26/50	52%
Total		60/100	60%
Left MaxCI	Male	36/50	72%
	Female	32/50	64%
Total		68/100	68%

4 Discussion

Teeth facilitate in forensic and anthropology investigation to estimate age, confirm sex and race of a person even in decomposed and burnt bodies. Studies on sexual dimorphism give information concerning the evolution of a population and for that matter, an individual too (CAMPS, 1976). During this study, an effort has been created to ascertain the sex of a person by using the mesio-distal breadth of canine teeth and also the respective inter-canine distances within the Iranian population.

In our study, prediction of sex accurately using the right mandibular canine index was 44% for males and 62% for females with an overall accuracy of 53%, and the left mandibular canine index was 54% for males and 64% for females with an overall accuracy of 59%. The overall sex predictability using mandibular canine index was 56% partially similar sex prediction has been reported for studies conducted by Muller, Upi-Pegurier, Quatrehomme et al. (2001) on the French population (59.57%), and was higher than sex prediction has been reported for Nepalese 51.28% (ACHARYA and MAINALI, 2009), whereas the overall accuracy of several other populations belonging to South and North Indians has been reported (75-85.9%) (BAKKANNAVAR, MANJUNATH, NAYAK et al., 2015; KAUSHAL, PATNAIK, SOOD et al., 2004; MUGHAL and SAQIB, 2010; RAO, RAO, PAI et al., 1989).

Accuracy of prediction of sex using the right maxillary canine index in our study was 68% for males and 52% for females with an overall accuracy of 60%, but respectively 63.2% for males and 33.6% for females with an overall accuracy of 48.4% that has been reported for South Indian population (BAKKANNAVAR, MANJUNATH, NAYAK et al., 2015). Using the left maxillary canine index, 72% of males and 64% females were accurately predicted for sex with an overall accuracy of 68%, whereas the left

maxillary canine index was 64% for males and 33.6% for females with an overall accuracy of 48.8% for South Indian population (BAKKANNAVAR, MANJUNATH, NAYAK et al., 2015).

The sex discrimination using maxillary canine index displayed higher statistical significance against the mandibular canine index which is a contrast to previous studies.

5 Conclusion

It is evident from our study that the maxillary canine index is a useful tool for determining sex. Along with other parameters, it increases the percentage accuracy of sex identity and is a quick and easy method. It is particularly significant when more advanced methods for sex determination are not readily available. However, it can only be used as a supplemental tool. Although canines reveal the greatest and most consistent sex dimorphism in the dentition but forasmuch as the method is essentially dependent on one type of tooth, sex assessment is best accomplished using measurements of as many teeth as are available rather than indices or individual teeth.

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