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Gender and ethnic variations in the crown dimensions of maxillary canines and first molars in a population of Coorg, Karnataka

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Abstract

Objective: The purpose of this study was to examine and compare the mesiodistal and buccolingual crown dimensions of the maxillary canines and maxillary first molars in three ethnic groups of Coorg: 39 Malayalees [19 males and 20 females], 33 Coorgis [17 males and 16 females] and 33 Tibetans [17 males and 16 females]. It also investigates the presence of sexual dimorphism in the dimensions of these teeth in this population., Materials and methods: Buccolingual (BL) and mesiodistal (MD) dimensions of maxillary first molars and maxillary canines were measured on 105 dental casts with vernier calipers with a resolution of 0.02 mm. Data were analyzed using paired t-tests and ANOVA., Results: Male values exceeded female ones in all observed dimensions. The canines showed higher mean differences between sexes in BL and MD dimensions when compared to the first molars in all the three ethnic groups ($p<0.05$)., Significant differences between the three ethnic groups were evident in a few tooth dimensions, the difference in the BL dimensions of molars being the most pronounced., Conclusion: Sexual dimorphism exists in this population of Coorg, with the maxillary canines being more dimorphic than the maxillary first molars. Hence, odontometry of maxillary canine teeth can effectively be used as an adjunct in the determination of sex along with other odontometric and skeletal traits. However, the use of this method for determining ethnicity in this population is questionable.

Keywords: *F*orensic odontology, sex determination, ethnicity

Introduction

The dentition is often preserved, even when the bony structures of the body are destroyed because of its physical characteristics and the protection it gets from the bony jaws. It has the ability to resist, better than any other skeletal structure, the destructive action of the medium in which it is found [1]. Teeth are extremely durable even at high temperatures. They are invaluable as additional tools to determine sex on fragmentary adult skeletons [2].

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Sexual dimorphism refers to the systematic difference in form (shape, size or colour) between individuals of different sexes in the same species. Teeth of various species are known to exhibit sexual dimorphism [2]. The size of the teeth is of great importance not only to indicate the different activities related to the occlusion or determine the frequency of dental anomalies applied to the orthodontic treatment, but also to establish sexual dimorphism. The existence of this behaviour morphogenetically determined that the shape and dimensions of the tooth are fairly stable and has been seen as a determining factor in providing sexual dimorphism in skeletal remains, which is required for forensic identification purposes [1].

Teeth can provide evidence about the nature and extent of diversity between human populations and variations in dental crown size have been reported between different populations. Numerous factors can contribute to variation in tooth size and these may be described broadly as genetic, epigenetic and environmental influences [3]. Nevertheless, races with large teeth have been distinguished from races with small teeth [4].

Of all the teeth in the human dentition, the canines are the least frequently extracted teeth (possibly because of the relatively decreased incidence of caries and periodontal disease). Also, canines are reported to withstand extreme conditions and have been recovered from human remains even in air disasters and hurricanes [2]. While canines have, conventionally, shown the greatest degree of sexual dimorphism across populations, first molars have also been reported as the most or among the most sexually dimorphic teeth in some studies [5-7].

Aim

The aims of the present study were

1. To investigate the presence of sexual dimorphism in the buccolingual (BL) and mesiodistal (MD) crown dimensions of the maxillary canines and maxillary first molars in a population of Coorg and

2. To examine differences in crown size dimensions of these teeth, between three ethnic groups of Coorg namely Malayalees, Kodavas and Tibetans.

MATERIALS AND METHODS

A descriptive study was conducted through cross-sectional indirect anthropometry. 105 dental casts were obtained from subjects who were all residents of Coorg District. However, they belonged to three different ethnic groups of Coorg. Thus the study sample was composed of dental casts from 39 Malayalees (19 males and 20 females), 33 Kodavas (17 males and 16 females) and 33 Tibetans (17 males and 16 females). The study subjects were any one of the following:

i. Students and staff of Coorg Institute of Dental Sciences, ii. Patients and their bystanders who attended the outpatient department of Coorg institute of Dental Sciences and its nodal centers situated in different parts of Coorg.

Characteristics of the participants

Only young adults in the age-group of 1934 years were included in the study. Majority of the subjects (91.4%) in all the three groups [39 Malayalees, 30 Kodavas and 27 Tibetans] were in the age range of 22-27 years.

The objective of limiting the sample to young adults was to ensure that dentitions were relatively intact, free of pathology and wear, thereby maximizing odontometric information.

Exclusion criteria

For study subjects

Individuals undergoing orthodontic treatment or any other surgical procedure during the study period, those with partially erupted teeth, facial/dental/occlusal abnormalities (crowding, rotation, presence of supernumerary teeth), or any one or more teeth missing (except third molars) in the maxillary arch or any other

condition which would hinder impression making procedure and/or the accurate measurement of teeth on the casts and those who did not give consent to participate in the study were excluded from the study.

For teeth

Maxillary canines and maxillary first molars exhibiting dental caries, restorations, fractures, physiologic or pathologic tooth wear or any other morphological abnormalities were excluded.

Ethical approval was obtained from the Ethical Review Board of the Coorg Institute of Dental Sciences. The study was carried out from May 2010 to August 2010. After obtaining informed consent from the selected individuals, alginate impressions (Tropica Algin, Zhermack Ltd) of the maxillary arch were made in perforated trays. The casting was done in a standard way used by dentists. Casts were immediately poured in dental stone type IV (Gold stone, Asian chemicals). Procedures were performed in accordance with the manufacturer's instructions. The models were assigned codes according to the ethnic group and sex, which were blinded to the examiner.

Tooth measurements

The mesiodistal (MD) and buccolingual (BL) dimensions of the left and right maxillary canines and maxillary first molar teeth were measured on the casts using a vernier caliper calibrated to 0.02 mm.

The MD dimension was defined as the greatest distance between contact points on the approximate surfaces of the tooth crown and was measured with the caliper beaks placed occlusally along the long axis of the tooth. The BL measurement was defined as the greatest distance between the labial/buccal surface and the lingual surface of the tooth crown, measured with the caliper beaks held at right angles to the MD dimension [7].

To estimate intra-observer error, all four measurements (BL and MD dimensions of canines and first molars) were repeated on 20 randomly selected casts after 2 days.

Statistical analysis

The significance level was set at 95 %. The collected data was classified and measurements were recorded on a MS-Excel spread sheet and subjected to paired t-tests, independent samples t-test and ANOVA using SPSS-17.

RESULTS

Background characteristics of the study subjects

Table 1 shows the background characteristics of the samples investigated. The mean age of the subjects in each group ranged from 22- 27 years.

Intra-observer variations

Intra-observer variation was checked with a paired t-test. No significant variations were observed in any of the tooth dimensions measured ($p>0.05$). The maximum difference obtained was not more than 0.30 mm.

Dental asymmetry

The possibility of bilateral dental asymmetry was evaluated and a paired t-test was performed to compare between corresponding teeth on each side of the arch. Table 2 depicts the paired t-test used to check differences between the right and left side teeth. The values showed no significant differences between the right and left side teeth dimensions of either the canine or the first molars in the whole population ($p>0.05$).

Since no differences were found, it followed that either the right or the left side could be taken to represent the observed tooth dimension. Hence, for further analysis only the right side canines and right side first molars of the samples were considered.

Descriptive statistics

Figures 1 and 2 show the mean values of the canine and molar dimensions respectively in males and females of the three ethnic groups examined. It

can be noticed that both the BL and MD dimensions of canines and molars were more in the males than in the females in all the three ethnic groups.

The mean observed tooth dimensions in the males were greater than the females in all the ethnic groups. However, statistically significant differences between males and females in all the three populations were observed only in the canine dimensions, both BL and MD ($p<0.05$). With respect to the molar dimensions, significant differences between the sexes existed only in the Malayalees and this difference was seen in both the BL and MD dimensions ($p<0.05$) as can been seen understood from table 3.

When inter-group comparisons were made, only a few tooth variables were found to be significantly different between the groups. Male teeth dimensions exhibited statistically significant differences in the BL width of canine between the Kodavas and Tibetans. The BL dimension of molars in Kodava males differed significantly from those of Malayalee as well as Tibetan males ($p<0.05$).

The Tibetans differed from other two groups with respect to BL dimensions of canines. Also, significant differences were evident in MD dimensions of first molars between Tibetans and Kodavas ($p<0.05$). These differences however did not follow any consistent or distinct pattern of variation. Intra and intergroup differences are summarized in table 3.

DISCUSSION

The emerging field of forensic odontology in India relies a lot on inexpensive and easy means of identification of persons from fragmented jaws and dental remains [2].

The dentition takes precedence particularly when preferred parameters such as the pelvis are unavailable and cranial and long bones fragmentary [8].

Ditch and Rose (1972) were the first to prove that teeth diameters can be successfully used in determining sex in poorly preserved and fragmentary skeletal remains in archaeology [9].

Intra-observer variation

Significant intra-observer variations have been observed in other studies and the authors attributed these to the difficulty in measuring MD dimensions in cases of crowding of teeth. Also, the accentuated rhomboidal outline of maxillary first molars undermines easy BL measurement in this tooth. They also suggested the possibility of systematic errors in certain tooth dimensions [7].

To rule out such errors, in the present study, intra-observer variability was checked for. No significant differences were observed between the base and repeat odontometric measurements. It should be noticed that dentitions with crowding and teeth, with abnormal tooth morphology were excluded in this study which may have partly contributed to more precise measurements.

Dental asymmetry

Laterality is recognized as an intrinsic characteristic of living organisms [10].

Hence, in the present study, possible differences between tooth dimensions on the two sides of the maxillary arch were evaluated and no significant differences were found. Tooth size studies on modern populations generally have shown non-significant or only small asymmetries [10] which are similar to the findings of this study

Sexual dimorphism

Similar studies on sexual dimorphism have shown male teeth to be larger than female teeth, [1-2, 7, 9] though exceptional cases of lack of dimorphism and reverse dimorphism (where female teeth were larger than males) have been reported in literature [6, 11].

In this study, the maxillary canines showed significant sexual dimorphism in all the three ethnic groups and the differences were evident in both MD and BL dimensions.

Moorrees C.F.A et.al as early as 1957 identified that tooth crowns of males were invariably broader than those of females in North American children [12].

In a study by Acharya A.B & Manali S (2007) on Nepalese dentition, all the variables measured (BL & MD widths of all teeth) exhibited sexual dimorphism, barring the MD dimension of mandibular second premolars which showed reverse dimorphism. In the same study, the canines showed the greatest dimorphism in either arch [6].

Galdames I.S et.al (2008) identified the presence of larger teeth in males when compared to females in a Chilean population and the difference was more pronounced in the BL dimensions [1]. A study by Rani P. et.al (2009) on a South Indian population showed that males had greater BL dimensions of teeth than females [13].

In most of these studies, the magnitude of difference comes from the canines as was seen in the present study.

Canines differ from other teeth with respect to survival and sex dichotomy. These differences probably are related to their function. In the evolution of primates, the function of canines was not masticatory; it was related to threat of aggression and actual aggression. A transfer of this aggressive function occurred from the canines in apes to the fingers in man, and that until this transfer was complete, survival was dependent on the canines, especially those of the males [14]. Hence, dimorphism in canines as revealed by this study may not be a result of mere coincidence but can be expected to be based on functional activity.

According to Moss, greater diameter of the crown of canines in males is a result of difference in enamel thickness due to the long period of amelogenesis in males. However, in females the completion of calcification of crown occurs earlier in both deciduous and permanent dentition as quoted by de Vito [13].

Although human sexes differ from each other considerably, there is population specific anatomic variation [9].

It should be noted that, in the present study, though the first molars also presented sexual dimorphism across all the ethnic groups studied, statistically significant sex differences in the BL and MD dimensions were observed only in the Malayalees. The differences between the sexes in molar dimensions were not significant in the Kodavas and Tibetans. Thus, it confirms the observation that sexual dimorphism is a population specific phenomenon [9].

This absence of molar dimorphism in two of the ethnic groups can be explained by the theory that sexual dimorphism, in general, has systematically reduced over the course of human evolution [6].

The present study measured only linear dimensions (BL and MD) because of its simplicity, speed, and low cost. However, the greatest disadvantage of this method is the possibility of mistakes in cases where the normal dimensions of teeth are altered. Also, teeth may require careful cleaning to rid the cervical areas of calculus and other deposits [7]. At times, crown dimensions can be useless for sex determination due to pathological conditions like caries [11].

Ethnic variations

When differences among the three ethnic groups were investigated, significant differences existed only for a few tooth dimensions, majority of which were between the Kodavas and the Tibetans. Nevertheless, these differences did not follow any consistent pattern so much as to give conclusive evidence for ethnic variation.

A synthesis of data on dental dimensions from different populations worldwide has indicated that western Eurasian populations tend to have the smallest teeth, with indigenous Australians, Melanesians, Micronesians, Sub-Saharan Africans and Native Americans tending to have larger teeth. East and South-east Asian populations were found to be intermediate in tooth size between these groups [3].

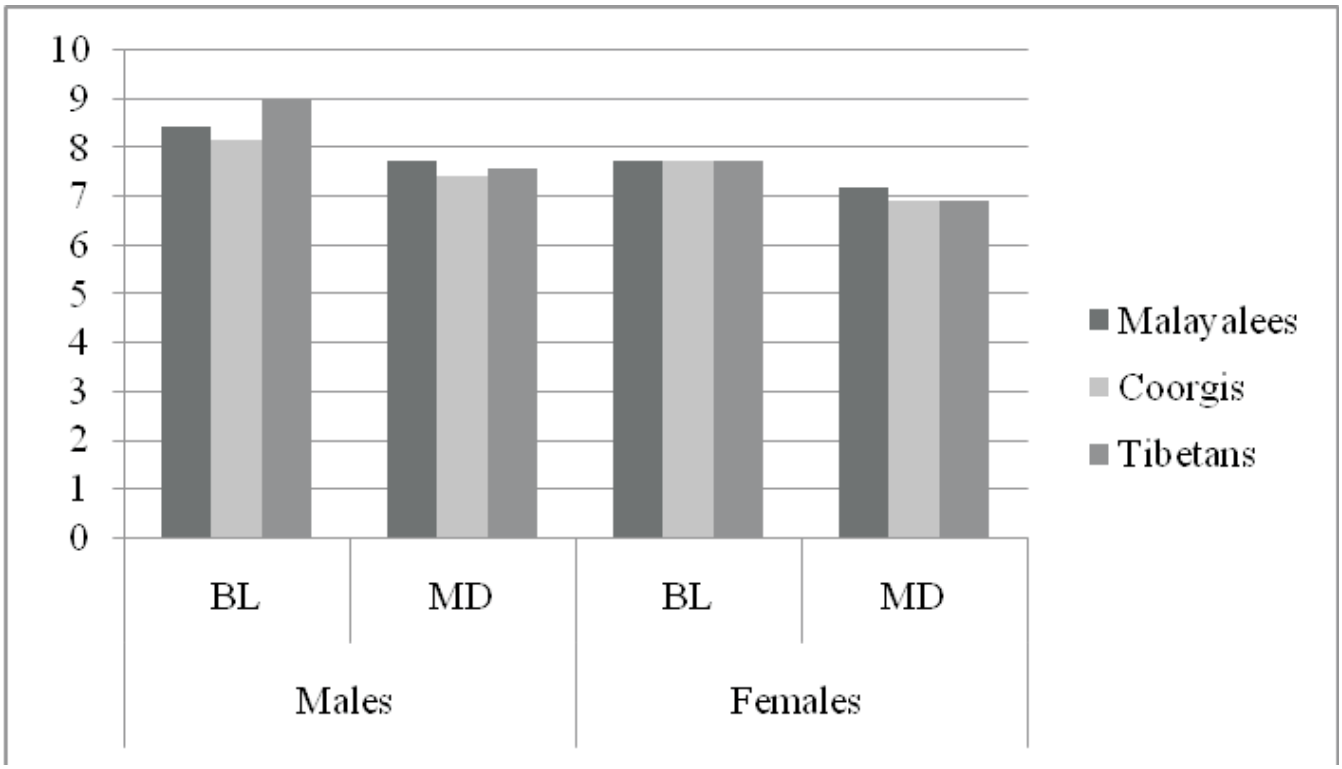
The three ethnic groups; Malayalees, Kodavas and Tibetans primarily belong to the South-east Asian population, which is probably why differences between the groups were not coherent and uniform.

The few differences seen in some of the teeth dimensions among the populations could be

Table 3. Differences within and between groups in the observed tooth dimensions. (Values in mm)

Tooth variables	Malayalees(a)	Kodavas(b)	Tibetans(c)
Males			
Canine/BL	8.44(±0.61)*	8.16(±0.49)*[c]	8.99(±0.70)*[b]
Canine/MD	7.65(±0.57)*	7.33(±0.42)*	7.49(±0.34)*
Molar/BL	11.95(±0.56)*[b]	11.34(±0.64)[a,c]	11.93(±0.55)[b]
Molar/MD	10.59(±0.84)*	10.09(±0.58)	10.85(±0.63)
Females			
Canine/BL	7.73(±0.40)*[c]	7.74(±0.47)*[c]	8.15(±0.58)*[a,b]
Canine/MD	7.17(±0.43)*	6.91(±0.49)*	7.25(±0.40)*
Molar/BL	11.45(0.42)*	11.24(±0.54)	11.68(±0.50)
Molar/MD	9.71(0.52)*	9.89(±0.63)[c]	10.62(±0.58)[b]

Intragroup comparison (between sexes) *statistical significant difference between sexes within the same group. $p<0.05$, **Intergroup comparison (between ethnic groups** [a] significant difference from group 'a', [b] significant difference from group 'b' [c] significant difference from group 'c' $p<0.05$, **Fig.1 Mean values (in mm) of canine dimensions in the three ethnic groups**



related, in part, to the degree of ethnic mixing. O'Rourke and Crawford concluded that the extent and direction of the micro- differentiation are reflections of differential amounts of mixing. There is actually a decrease in "racial" differences inherent to the increase of "racial" mixture [10].

It should be accepted that standards for skeletal identification varies among different populations, and that standards for one population may not be used for another population [10].

CONCLUSION

The conclusions that can be drawn from the present study are

1. Sexual dimorphism exists in this population of Coorg, with the maxillary canines being more dimorphic than the maxillary first molars.

Hence, odontometry of maxillary canine teeth can effectively be used as an adjunct in the determination of sex along with other odontometric and skeletal traits.

2. However, the use of this method for determining ethnicity in this population is questionable.

It may be necessary to measure teeth in more than one sample of a population before making conclusive statements concerning the odontometric findings and the ethnic origin of a population.

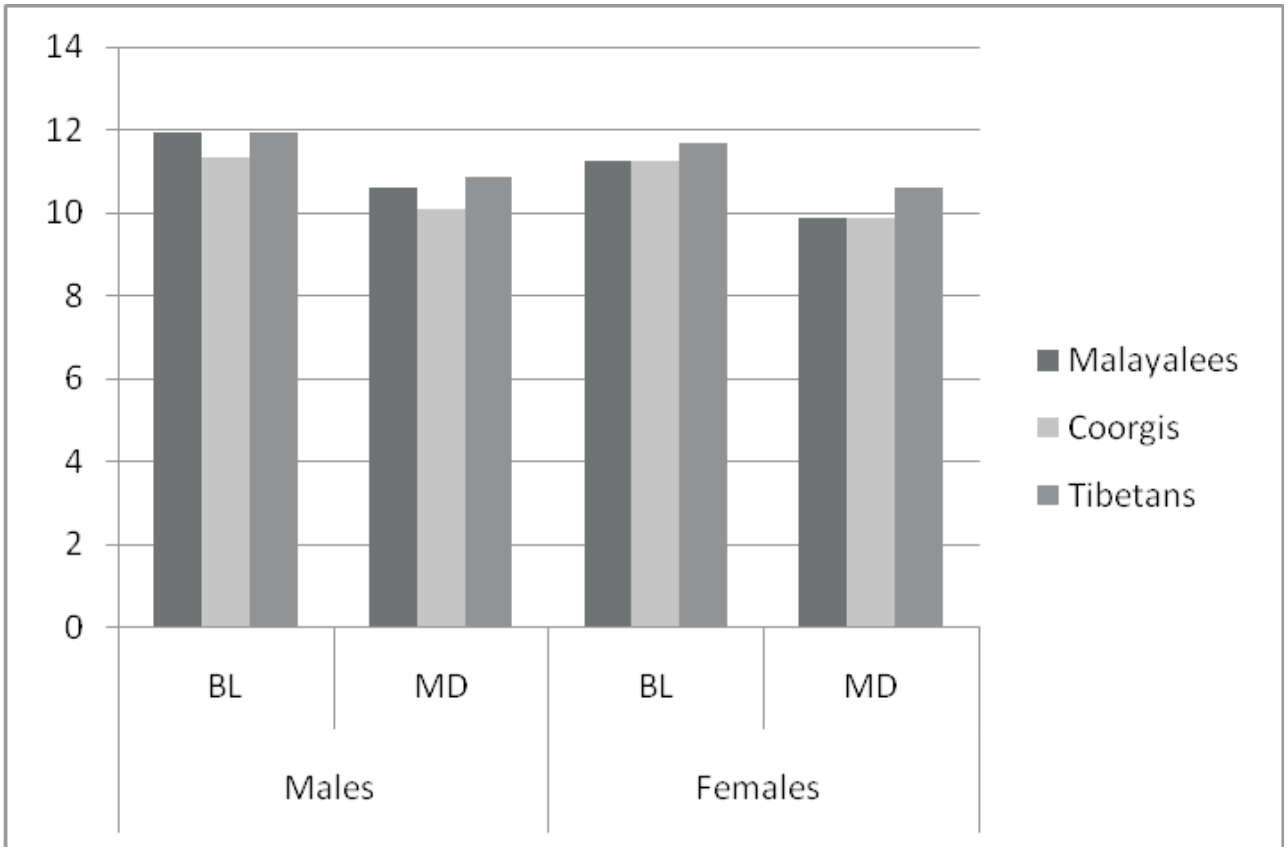
Table 1: Number (Mean age in years) of study subjects in each ethnic group

Gender	Ethnic group		
	39 Malayalees (22.8)	**33 Kodavas** (24.5)	**33 Tibetans** (26.1)
Males	19 (23.1)	17 (25.4)	17 (25.5)
Females	20 (22.6)	16 (23.6)	16 (26.7)

Table 2: Paired t-test to compare left and right side teeth dimensions

Tooth dimension	Right side Mean in mm (±SD)	Left side Mean in mm (±SD)	Degrees of freedom	t-value	p-value
Canine (BL)	8.20(±0.73)	8.21(±0.75)	104	-.088	.930
Canine (MD)	7.37(±0.52)	7.32(±0.52)	104	-1.669	.098
Molar (BL)	11.59(±0.63)	11.62(±0.63)	104	1.593	.114
Molar (MD)	10.29(±0.78)	10.33(±0.79)	104	1.339	.183

Fig 2. Mean values of (in mm) molar dimensions in the three ethnic groups



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