

Significance of mandibular canine index in sexual dimorphism and aid in personal identification in forensic odontology

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Abstract

Background: Forensic odontology is basically the science dealing with establishing identity by teeth and has played an important, often crucial, role in the identification of victims of mass disasters. Among all teeth, the mandibular canines are found to exhibit greatest sexual dimorphism. Hence, this study was undertaken to evaluate the effectiveness of mandibular canine index (MCI) in the determination of sex. **Materials and Methods:** The study was conducted on 62 subjects (31 males, 31 females). Mesiodistal diameter of mandibular canines was measured with the help of digital Vernier calipers. Intercanine distance was measured with the help of a divider. The standard MCI value is used as a cut off point to differentiate males from females. Statistical analysis was done using *t*-test. **Results:** The width of mandibular canine was higher in males than in females, which was statistically significant. The left canine is found to exhibit greater sexual dimorphism, i.e., 7.62% as compared with right canine, i.e., 6.85%. The calculated standard MCI for both male and female was 0.247. With these calculations, the overall percentage of sex determination was 79.03%. **Conclusion:** The ability to determine gender using Standard MCI was estimated to be 73.33% in males and 80% in females. It was concluded that with standard MCI, it was possible to detect sex for forensic purposes.


Key words: Canine index, intercanine distance, mandibular canine, mesiodistal width, sexual dimorphism

Introduction

Teeth are an excellent material in living and nonliving populations for anthropological, genetic, odontologic, and forensic investigations. They serve as an invaluable tool for identification because of their durability in the face of fire and bacterial decomposition.^[1] Teeth are particularly

useful in gender determination by utilizing different odontometrical techniques of real interest when bodies are often damaged beyond recognition during major disasters.^[2]

Odontometry has been performed on various tooth groups with the objective of establishing measurements

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that can act as standards. This information would assist some procedures in dental surgery and could also serve as an important tool in forensic odontology.^[3] Tooth size is of immense importance, not only to indicate the various activities related to occlusion or to determine the occurrence of dento-osseous anomalies applied to orthodontic treatment but also to establish sexual dimorphism.^[4]

Sexual dimorphism refers to the differences in size, stature, and appearance between male and female. This can be applied to dental identification also because no two mouths are alike.^[5] Various features such as tooth morphology and crown size are characteristics of male and female.^[6] In addition, a variety of factors influence tooth size due to which its morphometric study is a subject of great interest and gives significant results. According to Black, tooth size standards based on odontometric investigations can be used in age and sex determination.^[7] Whenever, it is possible to predict the sex, identification is simplified as missing persons belonging to only one gender are considered. In this sense, identification of sex takes precedence over age.^[8]

Mandibular canines are found to exhibit the greatest sexual dimorphism.^[9] The mean age of eruption of mandibular canines is 10.87 years, and they are the last teeth to be extracted with respect to age; therefore, they can be considered as the key teeth for personal identification.^[10] Hence, the present study was conducted to measure the mesiodistal diameter of both mandibular canines so as to establish canine measurement variations in sex determination and to evaluate the effectiveness of mandibular canine index (MCI) in gender identification.

Materials and Methods

Ethical clearance and informed consent

The present study was conducted in a private dental college and hospital in India after obtaining ethical clearance from the institutional authorities. The subjects were fully informed about the study undertaken and written informed consent was obtained. They were also assured that their unwillingness to participate in the study would not affect their treatment.

Study population and study sample

The study population consisted of new patients who were visiting dental hospital for availing some kind of dental treatment or for a routine dental checkup. The study comprised 62 subjects in the 15–25 years age group, of which 31 were males and 31 females. The subjects were included in the study on the basis of following criteria-age group between 15 and 30 years, having all fully erupted teeth with no spacing, periodontally healthy teeth, noncarious and nonattrited teeth, diastema or crowding and subjects with no clinical evidence of any restoration, orthodontic treatment, and trauma.^[11] The significant exclusion criteria

for selection of the study sample were the presence of partially erupted/ectopically erupted teeth, patients with dental/occlusal abnormalities, teeth showing physiologic or pathologic wear and tear and patients with deleterious oral habits (like bruxism).

Mesiodistal width measurement

The subjects were seated on a dental chair, and mandibular impressions with Alginate impression material (Cavex CA 37 Alginate, Holland) were made. Thereafter, impressions were poured with dental stone and study models were fabricated. The mean values of the mesiodistal width of the left and the right mandibular canines in males and females were obtained by measurement on stone models. Mesiodistal diameter of mandibular canines was measured with the help of digital Vernier calipers (Mitutoyo, Japan) accurate to 0.01 mm at the maximum mesiodistal width between the contact points of teeth on either side of cast. The mesial and distal surfaces of the teeth were identified, and the distance between the crest of curvature on the mesial surface and crest of curvature on the distal surface was recorded by the divider points (in case of difficulty in placing digital Vernier caliper). The divider was then held against the Vernier caliper and reading was noted [Figure 1]. Each reading was taken 3 times, and the average of three values was obtained to minimize the intraobserver error.

Intercanine distance measurement

Intercanine distance was measured between tips of both canines. The divider points were applied to the tips of the mandibular canines. The divider was then held against the Vernier caliper, and the reading was noted [Figure 2].

The observed MCI (MCI_o) – it was calculated by dividing the mesiodistal width of the canine by the intercanine distance.

MCI_o = Mesiodistal width of the canine/intercanine distance



Figure 1: Measurement of canine width on the study model with divider

The observed mandibular canine width and intercanine distance were subjected to statistical analysis to assess sex difference. The standard MCI value was used as a cut off point to differentiate males from females, which is obtained by applying following formula:

$$\text{Standard MCI (MCI}_s) = (\text{mean male MCI} - \text{SD}) + (\text{mean female MCI} + \text{SD})/2$$

Calculation of sexual dimorphism was done according to the formula given by Garn *et al.*^[12]

$$\text{Sexual dimorphism in mesiodistal width} = X_m/X_f \times 100$$

X_m = Mean value of canine width in males

X_f = Mean value of canine width in females.

Statistical analysis

The recorded data were transferred to a personal computer, and statistical analysis was carried out using Statistical Package for Social Sciences, version 15.0 for Windows (SPSS Inc., Chicago, IL, USA). The mean value of the mandibular canine width in males and females on the right and left sides were compared using *t*-test. Standard deviation, variance, and *t* values were calculated for each parameter.

Results

Table 1 shows sex-related differences among various parameters. When the mean value of intercanine distance of 62 subjects (31 males and 31 females) was compared, males showed higher values than females and the difference was statistically significant. The width of mandibular canine was higher in males than in females, which was statistically significant. Left canine is found to exhibit greater sexual dimorphism, i.e., 7.62% as compared with right canine, i.e., 6.85% [Table 2].

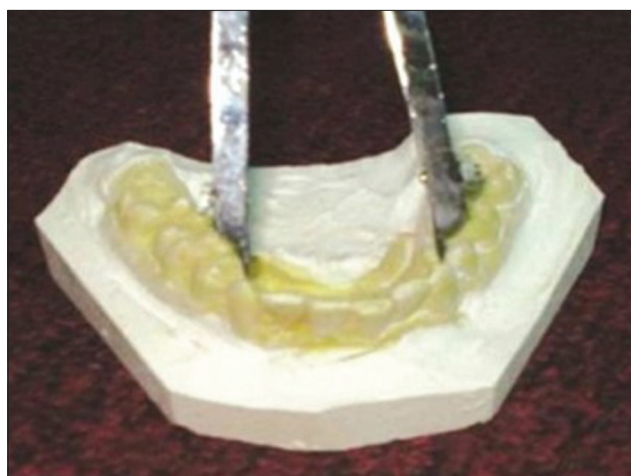


Figure 2: Measurement of intercanine distance on the study model with divider

The ability to determine gender using Standard MCI was estimated to be 73.33% in males and 80% in females. The accuracy of the method, when applied to the combined data, was 76.66%.

The calculated standard MCI for both male and female was 0.247. With these calculations, the overall percentage of sex determination was 79.03%. On comparing the MCI values of this study to the standard MCI values of Rao *et al.*^[13] (0.274) and Muller *et al.*^[2] (0.269), the percentage of success of sex prediction was increased [Table 3].

Discussion

It is a known fact that teeth provide excellent models for the study of the relationship between ontogeny and phylogeny. Individual identification is eased if sex is determined and it is of immense forensic importance.^[14] The present study is a sincere attempt to delineate the sexual variation in the morphology of permanent mandibular canines. It involved measurement of mesiodistal width, intercanine distance,

Table 1: Difference between various parameters in males and females

Group	n	Mean±SD	P
Right canine width (mm)			
Male	31	6.95226±0.559873	0.001 (S)
Female	31	6.50645±0.488327	
Left canine width (mm)			
Male	31	6.96065±0.557243	0.000 (S)
Female	31	6.46774±0.483478	
Mean canine width (mm)			
Male	31	6.95645±0.558424	0.001 (S)
Female	31	6.48710±0.480022	
Inter canine distance (mm)			
Male	31	28.14581±2.349878	0.000 (S)
Female	31	25.94516±1.514569	
MCI _o			
Male	31	0.24808±0.021182	0.643 (NS)
Female	31	0.25036±0.017039	

S: Significant, NS: Not significant, MCI_o: Observed mandibular canine index, SD: Standard deviation

Table 2: Sexual dimorphism in mandibular canine

Sexual dimorphism in mandibular canine	Percentage (%)
Right canine	6.85
Left canine	7.62

Table 3: Probability of sex determination

Gender	Number of cases studied	Number of cases with correct gender prediction by using standard MCI	Percentage accuracy
Males	31	23	74.19
Females	31	26	83.8
Total	62	49	79.03

Standard MCI - 0.247. MCI: Mandibular canine index

and canine index. The study sample comprised patients attending a dental teaching hospital as individuals of different age groups are available at the same place and time.

The present study measured the mesiodistal width of the left and right mandibular canines in a comparable cohort of male and female subjects keeping other parameters which influence tooth size similar for both groups. The method analyzed in the present study is based on the measurement of the mandibular canines. The pattern of dimorphism of mandibular canines may have existed for millions of years but only during recent few decades, this pattern has been under close observation.^[2]

The mesiodistal dimensions of mandibular canines were comparable to those already reported in literature taking both genders together, the average being 6.9 mm in males and 6.5 mm in females.^[2,3,8,15,16] The mesiodistal dimensions also varied according to sex such that men's teeth were larger than those of women. These findings were in accordance with studies carried out by other authors.^[2,3,5,16,17]

We found left mandibular canine (7.62%) to be more dimorphic as compared to the right canine (6.85%). These findings were in accordance with the findings of Kaushal *et al.*^[5] and Nair *et al.*^[18] The sexual dimorphism is genetically controlled. "Y" chromosome which controls the thickness of dentine, intervenes most in the size of teeth as compared to "X" chromosome which has a greater influence on the thickness of enamel.^[2,19] The difference of mean mesiodistal width of mandibular canine of male and female was found to be statistically more significant for left mandibular canine than right mandibular canine. This indicates that mesiodistal width of left mandibular canine is a better parameter to differentiate male and female mandibular canines.^[11]

The mean intercanine distance was found to be similar to those found by Kaushal *et al.*^[5] Cassidy *et al.* analyzed the size and shape of the mandibular dental arches of 320 adolescents. They concluded that boys demonstrated larger arch dimensions as compared to girls, - a sex difference largely established before the onset of the adolescent growth spurt.^[20] Rao *et al.* demonstrated that intercanine distance and mandibular canine indices are useful parameters in differentiating the both the sexes. In the present study, right and left mandibular canine indices were found to be significantly different in males and females.^[13] This is in congruence with the findings observed by Kaushal *et al.*^[5]

On comparing the MCI values of this study to the standard MCIs values of Rao *et al.*^[13] (0.274) and Muller *et al.*^[2] (0.269), the overall percentage of sex determination was higher (79.03%). Any measurement of teeth unaccompanied by information about age, race, and sex must be interpreted with

great caution. In the present study, sex could be predicted to the extent of about 79% under certain limitations due to variations of this parameter with geographic distribution. This implies the need for further studies to be performed with random and larger sample of the population from a particular geographical area to calculate standard MCI.

Conclusion

MCI is a quick and reliable method for sex identification when a standard for the population is available. The ability to determine gender using standard MCI was estimated to be 73.33% in males and 80% in females. Sex determination using the pelvis and skull bones shows the accuracy of 95% and above. As the accuracy of MCI in gender identification has never exceeded 87.5% in literature, it can only be used as a supplemental tool.

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Conflicts of interest

There are no conflicts of interest.

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