

Mandibular Canine Index as A Tool in Gender Identification - A Study in Malwa Population

Sandhya Jain¹, Merin Kuriakose²

¹Professor and Head of The Department, Department of Orthodontics and Dentofacial Orthopedics, Government College Of Dentistry, Indore, Madhya Pradesh, India, ²Postgraduate Student, Department of orthodontics and dentofacial orthopedics, Government college of dentistry, Indore, Madhya Pradesh, India

Abstract

Teeth are the hardest tissue in the body. Mandibular canines are important tooth in the human body which shows significant sexual dimorphism. Mandibular canine index can be used for gender identification during mass disasters and crime scenes. The purpose of this study was to investigate the accuracy with which gender can be differentiated in Malwa population by using the Mandibular Canine Index and sexual dimorphism.

Materials and Method: The study sample includes 300 Mandibular casts of people residing in Malwa. It included 137 males and 163 female participants. Mesio distal diameter of mandibular canines were measured from mesial contact point to distal contact point of right and left mandibular canines. Inter canine distance was measured between tips of both canines. These were used for deriving MCI and determining sexual dimorphism exhibited by mandibular canines.

Results: The mesiodistal width of mandibular canine were larger in males than in females. The mean difference of MCI between males and females were more on the left canine, thus making it highly significant (P Value<0.001). The standard mandibular canine index for Malwa population was obtained as 0.262. Sexual dimorphism of right mandibular canine was estimated as 4.30% and for left mandibular canine was 5.58%. Sexual dimorphism of mandibular canine is more on left side. The overall percentage accuracy of sex prediction using standard mandibular canine was found to be 65.52%. **Conclusion:** Tooth remains obtained from crime scenes or disasters can be used for gender identification as this method is very simple, accurate and useful.

Keywords: Canine, Mandibular Canine Index, Sexual Dimorphism, Gender Identification, Forensic odontology, sex prediction.

Introduction

Teeth are the hardest tissues in the body which can withstand most of the physical, chemical and thermal insults to a great extent. Forensic odontology or forensic dentistry is the application of dental knowledge to those criminal and civil laws that are enforced by police

agencies in a criminal justice system. Forensic dentistry is the proper handling, examination and evaluation of dental evidence, which will then presented in the interest of justice.

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 alike¹. Various features such as tooth morphology and tooth size are characteristics of male and female.

The human males have permanent canines that are more masculine in form². The mandibular canines usually exhibit greater sex difference in mesio distal crown size and canine separation or arch width. These

Corresponding Author:

Dr Merin Kuriakose

Postgraduate Student, Department of orthodontics and Dentofacial Orthopedics, Government college of dentistry, Indore, Madhya Pradesh, India

Phone no- +91 6263435301, +91 8939273396

EMAIL ID- orthopublications09@gmail.com

teeth erupt by the age of 12 years, mean age of eruption being 10.87 years³. Canines are less affected by periodontal diseases than other teeth and are usually the last teeth to be extracted with respect to age. Canines are also better likely to survive severe trauma, major disasters, natural calamities etc. These findings indicate that the mandibular canines may be considered as the 'key tooth' for the purposes of personal identification.

The purpose of this study was to investigate the accuracy with which gender can be differentiated in Malwa population by using the Mandibular Canine Index and sexual dimorphism.

Materials and Method

The study sample includes 300 Mandibular casts of patients visiting outpatient department of Government college of Dentistry Indore.

Inclusion criteria

- Age group between 15 and 35 years
- Having all fully erupted teeth
- Healthy periodontium
- No caries
- Non attrited teeth
- No restorations

Exclusion criteria

- Partially erupted and ectopically erupted teeth
- Teeth showing wear and tear (e.g. attrition, abrasion, abfraction, erosion)
- Patients with oral habits (e.g. bruxism)
- Trauma
- Carious teeth
- Restorated teeth

Measurement of the Mesiodistal Width- Mesio distal diameter of mandibular canines were measured from mesial contact point to distal contact point of right and left mandibular canines with the help of dividers. The divider was then held against the digital Vernier calipers

accurate to 0.01 mm and read. Each reading was taken 3 times, and the average of three values was obtained to minimize the intra observer error.

Intercanine distance measurement- Intercanine distance was measured between tips of both canines. The divider points were applied to the tips of the right and left mandibular canines. The divider was then held against the Vernier caliper, and read.

The Mandibular Canine Index (MCI)³ is derived as a ratio between canine crown width and canine arch width (measured in mm and is calculated as follows:

$$\text{MCI} = \frac{\text{Mesio distal crown width of mandibular canine}}{\text{Mandibular canine arch width}}$$

Mandibular canine arch width

The standard MCI value was used as a reference to differentiate males from females, which is obtained by applying following formula:

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

Calculation of sexual dimorphism can be done according to the formula given by Garn *et al*⁴.

$$\text{Sexual dimorphism in mesio distal width} = \left[\frac{X_m}{X_f} - 1 \right] \times 100$$

X_m = Mean value of canine width in males

X_f = Mean value of canine width in females.

Results

The present study involved 300 samples (mandibular casts) of people residing in Malwa. It included 137 males and 163 female participants.

The results are shown in Table 1 and table 2.

The result showed that the mean value of right mandibular canine width in males was 7.328±0.470mm and in females 7.02±0.444mm. The mean value of left mandibular canine width in males was 7.381±0.496mm and in females 6.990±.389mm. The mean inter canine width in males was 27.41±2.42mm and in females 26.69±1.90mm.

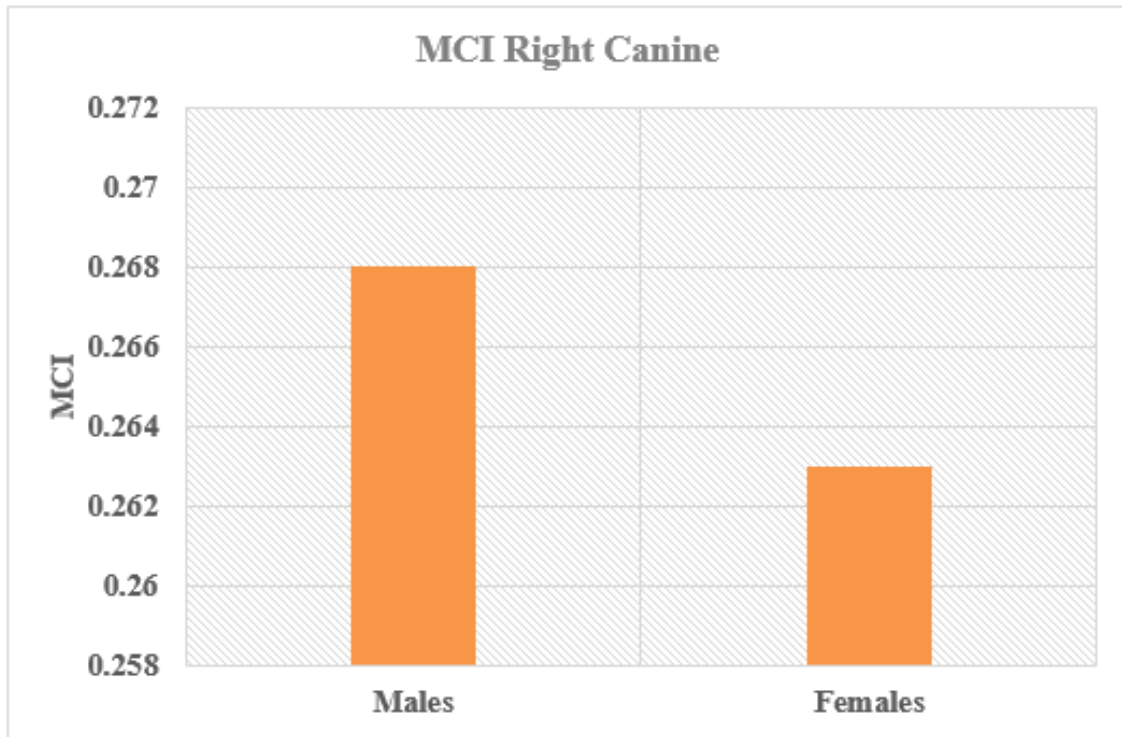


Chart 1. Mean Mandibular Canine Index values of right Canine among males and females

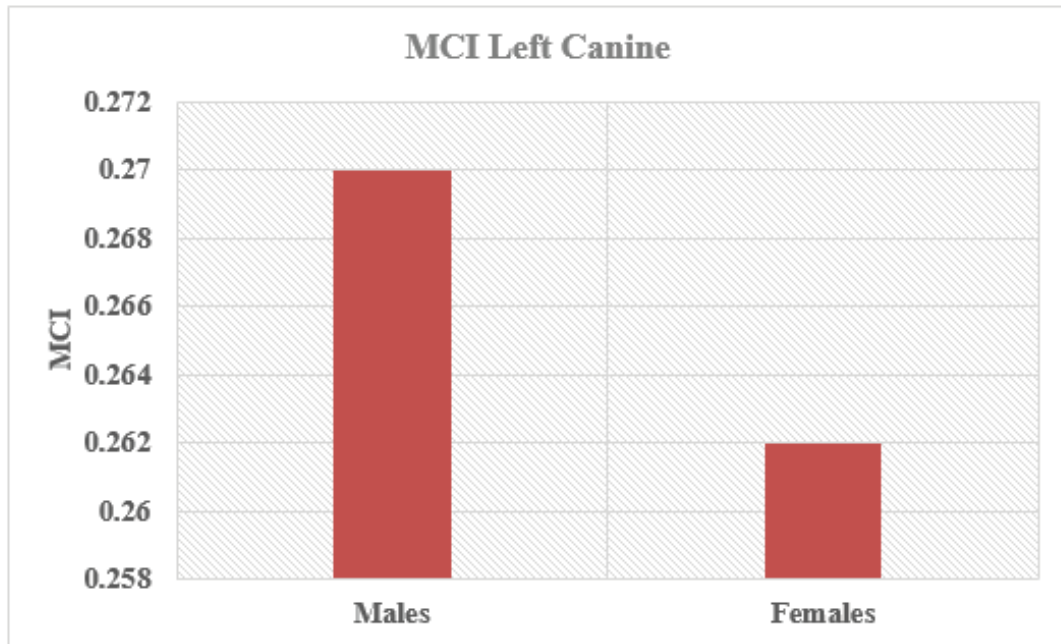


Chart 2. Mean Mandibular Canine Index values of Left canine among males and females

The mean value of right mandibular canine index in males was 0.268 ± 0.0227 and in females 0.263 ± 0.017 (chart 1). The mean value of left mandibular canine index in males was 0.270 ± 0.025 and in females 0.262 ± 0.017 (chart 2). The mean difference between males and females were more on the left canine, thus making it highly significant ($P \text{ Value} < 0.001$).

Table 1. Descriptive statistics of the study variables

Variable	Males (Mean±SD)	Females (Mean±SD)
Mesiodistal Width Right (In mm)	7.328±0.470	7.02±0.444
Mesiodistal width Left (In mm)	7.381±0.496	6.990±.389
Inter-Canine width(In mm)	27.41±2.42	26.69±1.90
MCI Right Canine	0.268±0.0227	0.263±0.017
MCI Left Canine	0.270±0.025	0.262±0.017

Table.2 Independent samples t test to test the significance between mean M <CI values between gender groups.

Variable	Males	Females	Mean Difference	t statistic	P Value	Confidence Interval
	Mean±SD	Mean±SD				
MCI Right Canine	0.268±0.0227	0.263±0.0179	0.00491	2.049	0.042	0.000191-0.00964
MCI Left Canine	0.270±0.025	0.262±0.017	0.00813	3.332	0.001	0.00317-0.01310

The independent samples ‘t’ test (Student’s t) reveals that the mean values of MCI on the left and right canine were significantly different between males and females (slightly higher in males compared to females). The mean difference between males and females were more on the left canine, thus making it highly significant (P Value<0.001).

Table. 3 Summary of Canonical Discriminant function coefficient for the dimensions

Parameters	Standard coefficient	Structure matrix	Centroid - Male	Centroid - Female	Prediction accuracy for males	Prediction accuracy for females	Overall Accuracy (%)
MCI	1	1	0.177	-0.149	66%	51.8%	65.52%

Parameters	Constant-a (Canonical Discriminant constant)	Constant-b (Unstandardized coefficient)
MCI	-13.284	49.950

The above mentioned formulae is in the format of the discriminant formula

$$[y = a + b (p)] \text{ Where, Gender}(y) = a + b*(\text{Parameter})$$

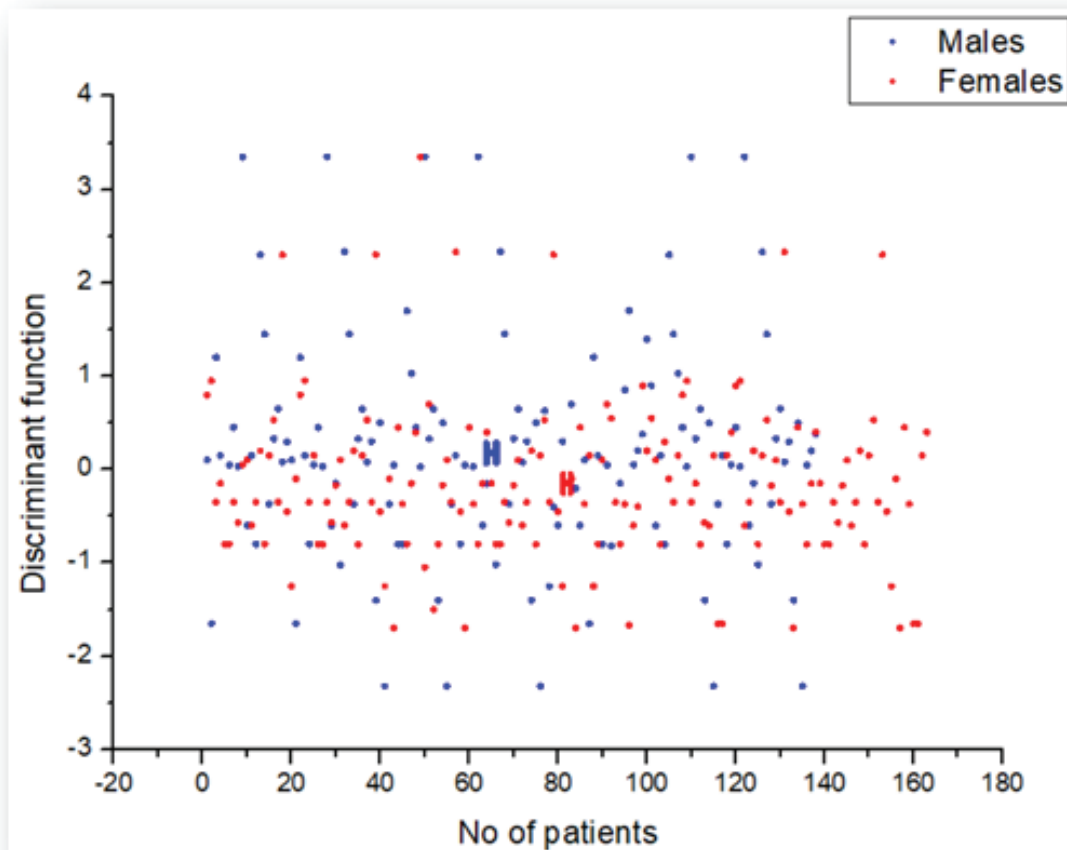
For MD dimension assessed, several stepwise univariate discriminant function statistics were used to develop a formula to determine sex [Table 3]. Coefficients and sectioning points were calculated for each dimension. The group centroids indicated the average discriminant scores for each sex. Sectioning point is the mean of male and female group centroids.

Unstandardized coefficients(b) are the discriminant function coefficients used to calculate the discriminant

score. To assess the sex, tooth dimensions are multiplied with the respective raw or unstandardized coefficients (b) and added to the constant (a). If the values (y) thus obtained were greater than the sectioning point the individual was considered a male and if less than the sectioning point the individual was considered female.

$$\text{i.e. } y = a + b(x)$$

where x is dimension of the tooth in millimeters.



Graph 1. Shows the discriminant function values for 300 samples of MCI. The accuracy of predicting males using MCI is 66% and females is 51.8%.

The prediction accuracy for males was found to be 66% and for females it is 51.8% using discriminant analysis.

The overall percentage accuracy of sex prediction using standard mandibular canine was found to be 65.52%. The standard canine index for Malwa population was obtained as 0.262. Sexual dimorphism of right mandibular canine was estimated as 4.30% and for left mandibular canine was 5.58%. Sexual dimorphism of

mandibular canine is more on left side.

Discussion

In this present study, the values obtained for mesiodistal width of right and left canine, intercanine width, right and left mandibular canine index was found to be significantly higher in males than in females. This is consistent with results of similar previous studies^{3,4,5}. The mesiodistal width of right and left canines were

larger in males than in females similar to other previous studies^{7,8}.

In this study, the mean right mandibular canine index for males was obtained as 0.268 ± 0.0227 . The mean right mandibular canine index for females was obtained as 0.263 ± 0.0179 . The mean left mandibular canine index for males was obtained as 0.270 ± 0.025 . The mean left mandibular canine index for females was obtained as 0.262 ± 0.017 . The independent samples 't' test (Student's t) reveals that the mean values of MCI on the left and right canine were significantly different between males and females (slightly higher in males compared to females). The mean difference between males and females were more on the left canine, thus making it highly significant (P Value < 0.001). This

finding is in agreement with previous studies done by Rao *et al*³, Reddy *et al*¹², Yadav *et al*¹³, Kaushal *et al*⁵.

The studies conducted in other countries by Sherfudhin *et al*⁹ and Al Rafaiy *et al*¹¹ on Saudi Arabian population and by Bishara *et al*¹⁰ on the population of the United States Egypt, and Mexico showed that the mesiodistal width of the mandibular canines is more in males than females, and the difference is statistically significant. Similar results were obtained by Ibeachu *et al*¹⁴ in Nigerian population, Alia O *et al*¹⁵ in Egyptian population and Lew and Keng¹⁶ in Chinese population.

Standard MCI value obtained in the present study was 0.262. Standard MCI value among North Indian population by Latif *et al*¹⁷ was 0.257.

Table 4. Shows the standard MCI values obtained in various studies in Indian populations.

Study	Standard MCI value
Rao <i>et al</i> ³ (South Indian population Karnataka)	0.274
Yadav <i>et al</i> ¹³ (South Indian population Karnataka)	0.298
Kaushal <i>et al</i> ⁵ (North Indian population Patiala)	0.256
Latif <i>et al</i> ¹⁷ (North Indian population)	0.257
Srivastava <i>et al</i> ¹⁸ (North Indian population Uttar pradesh)	0.257
Agarwal <i>et al</i> ⁸ (North Indian population)	0.274
Patel <i>et al</i> ¹⁹ (North Indian population Gandhinagar)	0.254
Present study (North Indian population Malwa Madhya Pradesh)	0.262

In the present study, sexual dimorphism of right mandibular canine was estimated as 4.30% and for left mandibular canine was 5.58. Left mandibular canine shows more sexual dimorphism.

Garn *et al.*, in their study in Caucasians in 1967, had found that the left mandibular canine showed the maximum sexual dimorphism at 6.4%⁴ and right mandibular canine showed sexual dimorphism of 5.7%. Study by Patel *et al*¹⁹ exhibited 8.42% sexual dimorphism for right mandibular canine while the left

canine exhibited 8.40%. Study by Kaushal and Patnaik (2004) who reported 9.058 and 8.891%, on the right and left sides, respectively. Study by Nair *et al*⁷ on South Indian population reported that the left mandibular canine exhibited a sexual dimorphism of 7.7% and the right mandibular canine exhibited 6.2%. Study by Ibeachu *et al*¹⁴ on Nigerian population exhibited left mandibular canine sexual dimorphism of 16.74% while the right mandibular canine was 15.23%. In all studies left mandibular canine showed maximum sexual dimorphism. So left mandibular canine can be a useful

tool for gender identification in forensic odontology.

In this study the overall accuracy in predicting gender using mandibular canine index was found to be 65.52%. The percentage accuracy of gender determination in males was found to be 66% and for females 51.8%. Discriminant analysis is used for calculating accuracy of gender prediction.

Conclusion

The mesiodistal width of mandibular canine were larger in males than in females. The right and left mean mandibular canine index in males and females showed statistically significant difference. Left mandibular canine showed more sexual dimorphism. The predictability of gender using standard mandibular canine index is also reasonably accurate ie,65%.

Tooth remains obtained from crime scenes or disasters can be used for gender identification as this method is very simple, accurate and useful in forensic odontology.

Conflict of Interest – Nil

Source of Funding- Nil

Ethical Clearance – Not applicable

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