

# Mandibular canine: A tool for sex identification in forensic odontology

Ramniwas M. Kumawat,  
Sarika L. Dindgire<sup>1</sup>,  
Mangesh Gadhari<sup>2</sup>,  
Pratima G. Khobragade<sup>1</sup>,  
Priyanka S. Kadoo<sup>3</sup>,  
Pradeep Yadav<sup>4</sup>

*Department of Oral Pathology and Microbiology, Center for Dental Education and Research-AIIMS, New Delhi, <sup>1</sup>Department of Oral Pathology and Microbiology, Government Dental College and Hospital, <sup>3</sup>Department of Oral Pathology and Microbiology, SDKS Dental College and Hospital, Nagpur, Maharashtra, <sup>4</sup>Department of Oral and Maxillofacial Surgery, Dr. Harvesh Singh Judge Institute of Dental Sciences, Chandigarh, India, <sup>2</sup>MD in Preventive and Social Medicine, UNICEF - Health Officer of North East Region of India*

#### Address for correspondence:

Dr. Ramniwas M. Kumawat,  
Department of Oral Pathology and Microbiology, Center for Dental Education and Research-AIIMS,  
New Delhi, India.  
E-mail: drramniwask@gmail.com

#### Abstract

**Aim:** The aim of this study was to investigate the accuracy of mandibular canine index (MCI) and mandibular mesiodistal odontometrics in sex identification in the age group of 17–25 years in central Indian population. **Materials and Methods:** The study sample comprised total 300 individuals (150 males and 150 females) of an age group ranging from 17 to 25 years of central Indian population. The maximum mesiodistal diameter of mandibular canines, the linear distance between the tips of mandibular canines, was measured using digital vernier caliper on the study models. **Results:** Overall sex could be predicted accurately in 79.66% (81.33% males and 78% females) of the population by MCI. Whereas, considering the mandibular canine width for sex identification, the overall accuracy was 75% for the right mandibular canine and 73% for the left mandibular canine observed. **Conclusion:** Sexual dimorphism of canine is population specific, and among the Indian population, MCI and mesiodistal dimension of mandibular canine can aid in sex determination.

**Key words:** Canine width, intercanine distance, mandibular canine, mandibular canine index

## Introduction

The sex identification is an essential step in the identification of criminals, in the identification of a criminal and victim in the court of law, and also in the identification of other persons and dead bodies.<sup>[1]</sup> Today's modern community faces sudden and unexpected death, fires, various railway, aircraft, and hurricane disasters where cranial bones are fragmented, body parts are decomposed


or mutilated, and identification of an individual becomes difficult. In these conditions, the tooth acts as a useful adjunct in identification because it is the most stable and hardest tissue in the body.<sup>[2]</sup> The mandibular canines are not only exposed to less plaque, calculus, abrasion from brushing, or heavy occlusal loading than other teeth, but they are also less severely affected by periodontal disease and so, usually, they are the last teeth to be extracted with respect

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**How to cite this article:** Kumawat RM, Dindgire SL, Gadhari M, Khobragade PG, Kadoo PS, Yadav P. Mandibular canine: A tool for sex identification in forensic odontology. J Forensic Dent Sci 2017;9:109.

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<b>Website:</b> www.jfds.org	<b>Quick Response Code</b> 
<b>DOI:</b> 10.4103/jfo.jfds_41_16	

to age, these findings indicate that mandibular canines are considered “key teeth” for personal identification.<sup>[3,4]</sup> Garn *et al.* studied the magnitude of sexual dimorphism in Caucasian population and concluded that the magnitude of canine tooth sexual dimorphism varied among different ethnic groups.<sup>[2]</sup> Rao *et al.* studied mesiodistal width and intercanine distance in South Indian population and concluded that 84.3% of the males and 87.5% of the females could be discriminated correctly with respect to sex.<sup>[5]</sup>

Mandibular canine index (MCI) was employed in various studies on large populations as it is simple, reliable, inexpensive, and easy to perform. Hence, this study was undertaken to assess the dimorphism of permanent mandibular canine by using the MCI and mandibular mesiodistal odontometrics in central Indian population and to correlate with other studies.

## Materials and Methods

### Patient selection

This study protocol was approved by MUHS, Nashik, and clearance was taken from the Institutional Ethical Committee, this prospective study population consisted of 300 individuals (150 males and 150 females) with age ranging from 17 years to 25 years; by this age, attrition is expected to be minimal. All the patients attending the outpatient department from 2010 to 2012 were randomly selected and explained the aim of the study, and detailed history and informed consent were obtained from every patient by one observer who is recruited in this study.

Patients were selected based on the following inclusion criteria:

1. Normal overjet and overbite (2–3 mm)
2. Healthy condition of gingiva and periodontium
3. Normal molar and canine relationship (Class 1)
4. Caries-free anterior teeth
5. Absence of spacing or crowding.

Exclusion criteria: Patients with the following conditions were excluded from the study:

1. Caries teeth
2. Maligned teeth
3. Missing anterior teeth
4. Any trauma to canine teeth
5. History of orthodontic treatment
6. Abnormal overjet and overbite
7. Patients having bony pathology.

After clinical examination, alginate hydrocolloid impression of the lower teeth was made using perforated metal trays, and the study models were made using dental stone.

### Method for analysis

To avoid any bias, gender of every patient was unknown

to the investigator during evaluation of the casts. The following measurements were taken from the casts of every individual selected for the study

1. Mesiodistal width of mandibular canine - Mesiodistal width of the mandibular canine is taken on either side of jaw (right and left sides) [Figure 1]
2. Intercanine width - Intercanine distance measured between the tips of the right and left canines in the lower jaw [Figure 2].

The measurements were taken in millimeters using digital vernier caliper (Forbes Gokak Ltd., Model no. 111–322). The vernier caliper has measurements from 0 to 150 mm (0–6 inches), with a resolution of 0.01 mm and accuracy of  $\pm 0.02$  mm [Figures 1 and 2].

To study the canine dimorphism, MCI was calculated based on formula used by Rao *et al.*<sup>[5]</sup>

Mandibular canine index =

$$\frac{\text{Mesiodistal crown width of mandibular canine}}{\text{Intercanine width}}$$

Thus, the following parameters were determined in every individual:

1. Mesiodistal width of the right mandibular canine
2. Mesiodistal width of the left mandibular canine
3. Intercanine width
4. Right MCI
5. Left MCI.

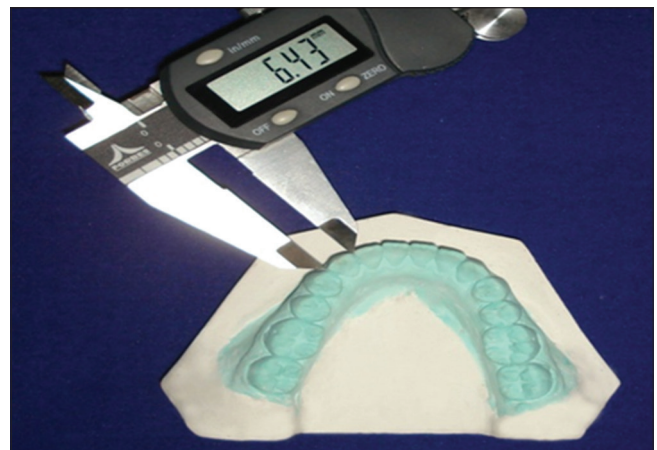
Based on these values, the standard MCI was derived as follows:

Standard MCI =

$$\frac{(\text{Mean male MCI} - \text{SD}) + (\text{Mean female MCI} + \text{SD})}{2}$$

Where, SD is the standard deviation.

As MCI was used for sex predilection according to the method suggested by Rao *et al.*, the percentage accuracy of



**Figure 1:** Measurement of mesiodistal width of the mandibular canine taken on either side of jaw (right and left sides)

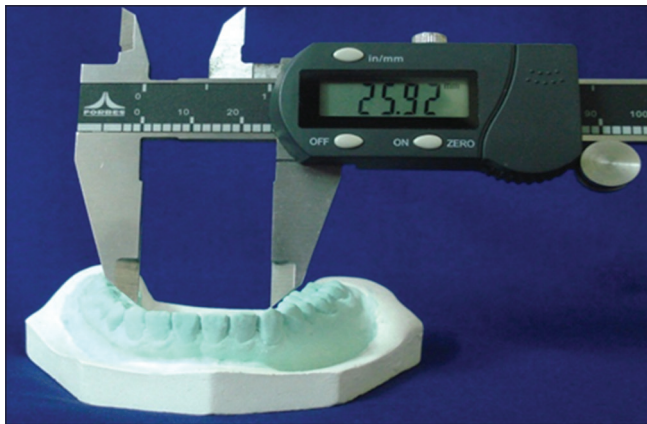
reporting sex was checked as the true sex of each patient was known.<sup>[5]</sup>

### Statistical analysis

Statistical analysis was done using statistical software SPSS 14.0® (Statistical Package for Social Science- IBM Corp. in Armonk, NY). The categorical data were reported in numbers and percentage and continuous data in mean  $\pm$  SD. To make the comparison between male/female on the basis of various numerical parameters, unpaired *t*-test was applied. For all the tests, confidence interval and *P* value were set at 95% and  $\leq 0.05$ , respectively.

### Results

The mesiodistal width of the mandibular canine on the right and left sides was measured separately in males as well as in females. In males, the mean mesiodistal width of the right mandibular canine was  $6.66 \pm 0.40$  mm (range: 5.61–7.87 mm) and the left mandibular canine was  $6.72 \pm 0.40$  mm (range: 5.81–7.92 mm). In females, the mean mesiodistal width of the right mandibular canine was  $6.37 \text{ mm} \pm 0.34$  mm (range: 5.55–7.35 mm) and the left side mandibular canine was  $6.44 \pm 0.33$  mm (range: 5.60–7.42 mm). The mean mesiodistal width of the right as well as left mandibular canines was



**Figure 2:** Measurement of intercanine distance between the tips of the right and left canines in the lower jaw

larger in males as compared to females. When the mean mesiodistal width of the right and left mandibular canines was compared among males or females (individual sex), statistically nonsignificant difference was observed ( $df = 298$ ;  $P > 0.05$ ). Whereas, in the comparison of mesiodistal width of mandibular canine between males and females, the statistically significant difference was seen on both sides ( $df = 298$ ;  $P < 0.05$ ) [Table 1].

### Calculation of sexual dimorphism in mesiodistal width of mandibular canine

Sexual dimorphism is the percent to which the tooth size of males is greater than females and is calculated using formula given by Garn *et al.* in 1967.<sup>[2]</sup>

$$\text{Sexual dimorphism} = (X_m/X_f - 1) \times 100$$

Where,  $X_m$  - mean values of mesiodistal width of mandibular canines in males

$X_f$  - mean values of mesiodistal width of mandibular canines in females.

In our study, the sexual dimorphism was calculated for the mandibular canine of both the sides (right as well as left).

The sexual dimorphism in the right and left mandibular canines was 5.53% and 5.42%, respectively.

The intercanine width in males was significantly greater than females, and there was statistically significant difference in the mean values of intercanine width between males and females ( $df = 298$ ;  $P < 0.05$ ) [Table 1].

In males, the mean MCI on the right side ranged from 0.21 to 0.30 with a mean of  $0.25 \pm 0.002$ , and on the left side, it ranged from 0.22 to 0.29 with a mean of  $0.25 \pm 0.001$ . In females, the mean MCI on the right side ranged from 0.21 to 0.28 with a mean of  $0.24 \pm 0.011$ , and for the left side, it ranged from 0.22 to 0.27 with a mean of  $0.24 \pm 0.001$ . Based on these values, standard MCI was calculated for the study population. The MCI of the right and left sides in males was

**Table 1: Comparison of different parameters between males and females**

Parameters	Sex	Range	Mean $\pm$ SD	t-statistical	P, df	Significance
Inter-canine width	Male	23.08-30.28	$26.92 \pm 1.37$	5.27	0.001, 298	Highly significant
	Female	22.59-29.61	$26.10 \pm 1.07$			
Right canine width	Male	5.61-7.87	$6.66 \pm 0.40$	5.341	0.002, 298	Highly significant
	Female	5.55-7.35	$6.37 \pm 0.34$			
Left canine width	Male	5.81-7.92	$6.72 \pm 0.40$	5.522	0.001, 298	Highly significant
	Female	5.60-7.42	$6.44 \pm 0.33$			
Right MCI	Male	0.21-0.30	$0.25 \pm 0.002$	4.235	0.014, 298	Significant
	Female	0.21-0.28	$0.24 \pm 0.011$			
Left MCI	Male	0.22-0.29	$0.25 \pm 0.001$	4.324	0.012, 298	Significant
	Female	0.22-0.27	$0.24 \pm 0.001$			

SD: Standard deviation, MCI: Mandibular canine index

significantly greater than the females. There was statistically significant difference in MCI of the right and left sides between males and females ( $df = 298$ ;  $P < 0.05$ ) [Table 1].

### Calculation of standard mandibular canine index

Standard MCI was drawn using formula given by Rao *et al.* in 1989.<sup>[5]</sup>

Standard MCI of the right side:

$$\text{Standard MCI} = \frac{(0.24 - 0.01) + (0.24 + 0.01)}{2} = 0.240$$

Standard MCI of the left side:

$$\text{Standard MCI} = \frac{(0.24 - 0.01) + (0.24 + 0.01)}{2} = 0.240$$

According to Rao *et al.*, if patients observed canine index was more than the standard MCI, the individual was considered to be male and if the observed MCI was less than the standard canine index, the individual was considered to be female.<sup>[5]</sup> In our study population, the standard MCI was 0.240. Thus, the patients with MCI up to 0.240 were females and above 0.240 were males. Hence, the standard MCI for the study population was 0.240 for both right as well as left sides.

### Calculation of percentage accuracy of sex identification

Percentage accuracy of sex identification was calculated with respect to an individual's sex. Considering the accuracy of individual sex, the overall correctly predicted sex using MCI was 79.66% [Table 2]. With respect to maximum mesiodistal mandibular canine width, the accuracy of sex determination was deliberated with an overall accuracy ranging from 75% for mesiodistal dimension of the right canine to 73% for mesiodistal dimension of the left canine [Table 3].

## Discussion

Identification of individual, living or dead, is based on the theory that all individuals are unique. Gender identification involves the use of skeletal that is remains, teeth, and DNA technique. Gender identification by skeletal varies and depends on the available bones and condition of bones. Although the DNA profile gives accurate results, it is expensive, technique sensitive, unreliable, and not possible in large population.<sup>[6]</sup>

Moreover, the structure which outlasts even after all the other body parts are destroyed is the "tooth." The sex identification using dental features is primarily based on the nonmetric and metric dental traits. The metric traits are nothing but the tooth dimensions, i.e., odontometrics.<sup>[7]</sup> Odontometric parameters can be used for the determination of sex in a large population because they are simple, reliable, inexpensive, and easy to measure.<sup>[8]</sup> Among all teeth, canines have been shown to be the teeth with maximum

**Table 2: Percentage of cases with correctly predicted sex using mandibular canine index**

Sex	Total (%)
Male	122/150=81.33
Female	117/150=78
Overall	239/300=79.66

Standard MCI=0.240. MCI: Mandibular canine index

**Table 3: Accuracy of sex determination by using mandibular canine width**

Variable	Sex	n (%)			Overall accuracy (%)
		Total	Male	Female	
Right mandibular canine width	Male	150 (100)	120 (80)	30 (20)	75
	Female	150 (100)	45 (30)	105 (70)	
Left mandibular canine width	Male	150 (100)	111 (74)	39 (26)	73
	Female	150 (100)	42 (28)	108 (72)	

sexual dimorphism. Sexual dimorphism is the systemic difference in the form between individuals of different sexes of same species.<sup>[4,9]</sup>

The calculated values were used to draw MCI. The mean values and SDs were used to draw standard MCI.<sup>[5]</sup>

The mesiodistal width of mandibular canine was measured from both the right as well as left sides from all patients in the study population. The mean values of mesiodistal width of mandibular canine are in accordance with the mean values of Ghose and Baghdady 1979,<sup>[10]</sup> Garn *et al.* 1967,<sup>[2]</sup> and Nair *et al.* 1999.<sup>[11]</sup>

Although the mean values in the study were lower than the mean values from the study done by Kaushal *et al.* 2003<sup>[12]</sup> in North Indian population and Yadav *et al.* 2002<sup>[13]</sup> in South Indian population, these differences are attributable to the regional differences in the tooth size.

According to the available literature, there are minor differences in the data of mesiodistal width of mandibular canine; these minor differences probably accounted for the racial variations in tooth size and these findings are in accordance with the studies by Garn *et al.* 1967.<sup>[2]</sup>

This sexual dimorphism in dental hard tissue is related to the differential growth influences of X and Y chromosomes. Alvesalo *et al.* have studied the enamel and dentin thickness in individuals with sex chromosome anomalies and observed that sexual dimorphism in average tooth size is caused by a intervening effect of the Y chromosomes on dentinal growth, whereas the X chromosomes come into play only considering the thickness of enamel.<sup>[14]</sup>

The percentage of sexual dimorphism is calculated using formula given by Garn *et al.* in 1967.<sup>[2]</sup> This percentage of sexual dimorphism was 5.53% for the right side and 5.42% for the left side. These values are comparable with the values

of Garn *et al.*, 1967,<sup>[2]</sup> Perzigian, 1976,<sup>[15]</sup> and Kaushal *et al.*, 2003.<sup>[12]</sup> This percentage difference indicates that the mean mesiodistal width of mandibular canine in males exceeds the mesiodistal width of mandibular canine in females by 5.53% for the right canine and 5.42% for the left canine.

Comparison of mesiodistal widths of mandibular canine between males and females was statistically significant ( $P < 0.05$ ) as shown in Table 1. This was in accordance with the previous studies by Garn *et al.*, 1967,<sup>[2]</sup> Ghose and Baghdady, 1979,<sup>[10]</sup> Nair *et al.*, 1999,<sup>[11]</sup> Yadav *et al.*, 2002,<sup>[13]</sup> and Hemani *et al.*, 2008.<sup>[16]</sup>

The intercanine width in females was less as compared to that in males, and the difference was statistically significant ( $P < 0.05$ ) as shown in Table 1. These findings are in accordance with Muller *et al.*, 2001,<sup>[17]</sup> Yadav *et al.*, 2002,<sup>[13]</sup> Anderson and Thompson, 1973,<sup>[4]</sup> and Kaushal *et al.*, 2003.<sup>[12]</sup> These differences in intercanine width between males and females may be because of late cessation of growth in males as compared to females.

Using these two sexual dimorphic characteristics of mandibular canine such as mesiodistal width and intercanine distance, Rao *et al.* had drawn the MCI for each individual and the standard MCI for the entire study population.<sup>[5]</sup>

The MCI was less in females as compared to males for both the right and left sides, and the difference was statistically significant ( $P < 0.05$ ). This was in accordance with Muller *et al.*, 2001,<sup>[17]</sup> Yadav *et al.*, 2002,<sup>[13]</sup> and Kaushal *et al.*, 2003.<sup>[12]</sup>

Using the mean values of MCI and SDs, the standard MCI was calculated, which was 0.240 for the study population. Thus, according to Rao *et al.*, the individuals with MCI up to the limit of 0.240 are females and individuals with MCI above 0.240 are males.<sup>[5]</sup>

In the present study, the mesiodistal width of mandibular canine of the right and left sides showed an accuracy of 75% and 73%, respectively, in the determination of sex correctly. The overall accuracy of sex determination by MCI and mandibular canine odontometrics ranged from 79.66% to 73% in the current study [Tables 2 and 3], which is in accordance with the study conducted by Iscan and Kedici,<sup>[18]</sup> where the canine measurement could correctly classify the sex by 77%.

Hence, this wide range of accuracy suggests that mandibular canine odontometrics should be used as a supplementary method along with the other methods to increase the accuracy of sex identification in unknown body remains.

## Conclusion

Using permanent MCI and mandibular mesiodistal

dimension is a quick and easy method for determining sex in identification. Since the accuracy of prediction using this method has never exceeded 84%–87.5% in any of the studies, identification using the pelvis and skull bones shows accuracy of 95% and above. Hence, the MCI may be used as an adjunct to enhance accuracy.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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