

# A study of sexual dimorphism in permanent mandibular canines and its implications in forensic investigations

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## ABSTRACT

Teeth are well preserved after death and they exhibit remarkable sexual dimorphism. Hence, they provide excellent materials for forensic investigations intended for identification of sex. Present study was undertaken on permanent mandibular canines of 90 male and 90 female subjects of age group 17-23 years. The mesiodistal width for right and left mandibular canines and intercanine distance were measured. Subsequently, canine index was calculated for both sides. Significant sexual dimorphism was found in all parameters except intercanine distance. All the results were compared with previous studies and discussed in the light of genetic, evolutionary and metabolic reasons for sexual dimorphism.

**Keywords:** Sexual dimorphism, mandibular canine, mesiodistal width, intercanine distance, canine index.

## INTRODUCTION

Teeth are the hardest and chemically most stable tissues in the body and exhibit least turnover of natural structure. They are well preserved after death. Further, they show significant sexual dimorphism and are readily accessible for examination. Thus, they provide excellent materials for forensic studies involving identification of sex.<sup>1</sup>

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.<sup>2</sup> Various features like tooth morphology and crown size are characteristic of male and female.<sup>3</sup> In addition, tooth size is influenced by a galaxy of factors due to which its morphometric study is a subject of profound interest and gives significant results. Tooth size standards are frequently used in sex determination. Out of the two proportions - width and length, the former is considered to be more important.<sup>4</sup>

Mandibular canines are found to exhibit greatest sexual dimorphism. The mandibular canines have a mean age of eruption of 10.87 years and they are the last teeth to be extracted with respect to age. They are less affected by periodontal diseases and are most likely to survive severe trauma such as air disasters, hurricanes or conflagration. These findings indicate that mandibular canines can be considered as the 'key teeth' for personal identification.<sup>5</sup>

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 and canine index. It is an effort to corroborate the results with those

obtained in the similar studies and to establish the effectiveness of mandibular canine index in predicting sex, taking correct dental alignment into consideration.

Mesiodistal width of left and right mandibular canines were measured in the present study in a comparable cohort of male and female subjects keeping other parameters which influence tooth size same for both the groups. The measurements were then subjected to statistical comparisons and values of significance were calculated to know the importance of parameters in determination of sex.

## MATERIALS AND METHODS

This study was conducted on the undergraduate students of Gajra Raja Medical College, Gwalior, India. 180 subjects (90 males and 90 females) in the age group of 17-23 years were selected for the study.

Inclusion Criteria:

- Healthy state of gingiva and periodontium.
- Caries free teeth.
- Normal overjet and overbite.
- Absence of spacing in the anterior teeth.
- Normal molar and canine relationship.

Following parameters were determined in this study:

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

**Table-1:** Measurements of various parameters of permanent mandibular canine in males and females and their statistical significance.

| Parameter                                    | Sex    | Range (in cm*) | Mean (in cm*) | SD** (in cm*) | Variance | z Value   | Significance            |
|--|--------|----------------|---------------|---------------|----------|-----------|-------------------------|
| Mesiodistal Width of Right Mandibular Canine | Male   | 0.64-0.8       | 0.74          | 0.04246       | 0.0018   | 11.95     | Very Highly significant |
|  | Female | 0.5-0.77       | 0.65          | 0.04913       | 0.00241  |           |                         |
| Mesiodistal Width of Left Mandibular Canine  | Male   | 0.61-0.83      | 0.74          | 0.04418       | 0.00195  | 21.96     | Very Highly significant |
|  | Female | 0.58-0.78      | 0.67          | 0.05265       | 0.00277  |           |                         |
| Intercanine distance                         | Male   | 2.1-3.14       | 2.576         | 0.21541       | 0.0464   | 0.171105  | Not Significant         |
|  | Female | 2.1-3.55       | 2.5622        | 0.27415       | 0.07516  |           |                         |
| Right Mandibular Canine Index                | Male   | 0.2092-0.3505  | 0.2864        | 0.0289        | 0.0008   | 7.1548107 | Highly Significant      |
|  | Female | 0.1855-0.3097  | 0.2569        | 0.0271        | 0.0007   |           |                         |
| Left Mandibular Canine Index                 | Male   | 0.2179-0.3476  | 0.2888        | 0.0284        | 0.0008   | 5.8936237 | Highly Significant      |
|  | Female | 0.1681-0.3053  | 0.2645        | 0.027         | 0.0007   |           |                         |

\*cm = centimeter; \*\*SD = Standard Deviation.

**MEASUREMENT PROCEDURE**

All the measurements were taken intra-orally in clean and well-illuminated room, keeping all the aseptic precautions.

Measurement of the Mesiodistal Width (Fig. 1) – The procedure for measuring the mesiodistal tooth width was performed as described by Hunter and Priest.<sup>6</sup> 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. The divider was then held against the Vernier caliper and read.

Measurement of the Inter-canine Distance (Fig. 2) – The inter-canine distance was measured between the tips of the mandibular 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.

Mandibular Canine Index – It was calculated by dividing the mesiodistal width of the canine by the intercanine distance.

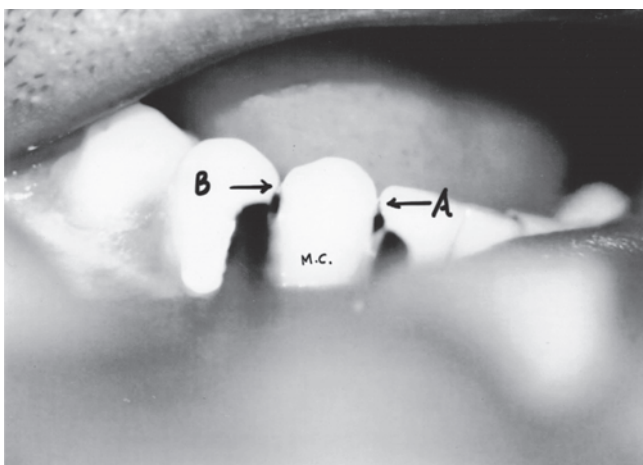
All measurements were recorded in a tabulated manner and statistically analyzed. Standard deviation, variance and z values were calculated for each parameter.

Sexual dimorphism was calculated according to the formula given by Garn et al (1967) as follows:

Sexual Dimorphism in mesiodistal width =  $\left\{ \frac{X_m}{X_f} \right\} - 1 \times 100$ ; where  $X_m$  is mean mesiodistal width in males and  $X_f$  is mean mesiodistal width in females.<sup>7</sup>

**RESULTS**

Results of present study are depicted in Table-1 and 2. In Table-1 the parameters of mandibular canines of male



**Fig. 1.** Measurement of Mesiodistal width of right mandibular canine

M.C. = Mandibular canine; A = Crest on mesial surface; B = Crest on distal surface



**Fig. 2.** Measurement of intercanine distance. Arrows indicate tips of mandibular canines.

and female and their statistical significance have been shown.

The mean mesiodistal width of right and left mandibular canines are significantly different in male and female. The z value for mesiodistal width of left mandibular canine is more than the right mandibular canine.

Intercanine distance was also statistically analyzed. The difference of means of intercanine distance of male and female was not statistically significant.

Mandibular canine indices for right and left canines were also found to be significantly different in male and female.

Sexual dimorphism was calculated and right mandibular canine was found to be more dimorphic than left mandibular canine.

## DISCUSSION

Lund and Mornstad studied 58 dental casts of Swedish subjects and found the canines to be most dimorphic of all the teeth.<sup>8</sup> Lysell and Myrberg in an extensive study of more than 1000 subjects concluded that the mandibular canine demonstrated the greatest sexual dimorphism (5.7%) amongst all teeth.<sup>9</sup> Hashim and Murshid conducted a study on pretreatment orthodontic casts of 720 Saudi male and female subjects in the age group of 13-20 years and found that the mandibular canines were only teeth to exhibit sexual dimorphism.<sup>10</sup> Hence the present study was conducted on mandibular canines to find out sexual dimorphism.

Kaushal *et al* found left mandibular canine (9.796% in casts and 8.891% intraoral) to be more dimorphic than the right mandibular canine (7.96% in casts and 7.954% intraoral).<sup>2</sup> Nair *et al* concluded that the left mandibular canine revealed maximum sexual dimorphism (7.7%) followed by the right mandibular canine (6.2%).<sup>11</sup> However in the present study, the right mandibular canine (12.51%) was found to be more dimorphic than left mandibular canine (10.15%). This difference can be attributed to several factors namely, racial, environmental and nutritional factors.

The mean mesiodistal width of right and left mandibular canine as found in the present study are similar to those found by Kaushal *et al*, Garn *et al* and Legovic *et al*.<sup>2,12,13</sup>

**Table-2:** Sexual Dimorphism in Mesiodistal Width of Mandibular Canines, calculated as per the formula of Garn and Lewis

| Parameter         | Right Mandibular Canine | Left Mandibular Canine |
|-------------------|-------------------------|------------------------|
| Sexual Dimorphism | 12.51%                  | 10.15%                 |

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 identify male and female mandibular canines.

The value of mean intercanine distance was found to be similar to those found by Kaushal *et al* and Quimby *et al*.<sup>2,14</sup> Cassidy *et al* analyzed the size and shape of the mandibular dental arches of 320 adolescents. They concluded that arch dimensions were significantly larger in boys than in girls, mesiolaterally as well as anteroposteriorly - a sex difference largely established prior to the onset of the adolescent growth spurt.<sup>15</sup>

Rao *et al* have demonstrated that intercanine distance and mandibular canine indices are useful parameters in differentiating the sexes.<sup>16</sup> In the present study, right and left mandibular canine indices were found to be significantly different in males and females. This is in conformity with the findings observed by Kaushal *et al*.<sup>2</sup>

The sexual dimorphism is calculated as per the formula given by Garn *et al* using mesiodistal width of the teeth.<sup>7</sup> In the present study, the right mandibular canine (12.51%) is found to be more dimorphic than left mandibular canine (10.15%).

The mandibular intercanine distance was not statistically significant. So the intercanine distance is an equivocal parameter to identify sex from mandibular canines. Acharya and Mainali obtained similar results in their study of 63 males and 54 females of 19-28 years age group in Nepal.<sup>17</sup>

Sexual dimorphism in canine size is influenced markedly by genetic factors. Both X and Y chromosomal involvement have been found by various workers.<sup>18,19,20</sup>

Teeth are excellent models for the study of relationship between ontogeny and phylogeny. Eimerl and DeVore postulated that in the evolution of primates, the canines are functionally not masticatory but are related to threat of aggression and actual aggression. A transfer of this aggressive function occurred from the teeth to the fingers in humans and until this transfer was complete, survival was dependent on canines, especially in males.<sup>2</sup> Thus in the present day humans; sexual dimorphism in mandibular canines is not merely a coincidence but can be expected to be based on functional activity.

Various other factors have also been found to have some bearing on tooth size giving rise to morphometric differences between male and female teeth, namely environmental factors and eating habits.<sup>21,22,23</sup>

Garn *et al* in their large study at Fels Institute had correlated sexual dimorphism in canines with number of variables, namely stature, weight, subcutaneous fat thickness, bone age, menarche in girls and the time of epiphyseal union. These correlations suggested direct influence of steroidal hormones on tooth development and maturation. They found that tooth eruption is accelerated in early maturing girls; indicating that to some extent steroid hormones of gonadal and adrenal origin may be involved in the relationship between sexual maturation and dental development.<sup>12</sup>

Harris *et al* found the contribution of various tissues in sexual dimorphism of tooth size. They found that males typically have significantly larger dentine and pulp dimensions than females; while marginal enamel thickness is similar in both sexes.<sup>24</sup> Moss *et al* suggested that dimorphism is related to an absolutely longer period of amelogenesis for both deciduous and permanent dentitions.<sup>25</sup>

It is concluded that the mesiodistal widths of mandibular canines are significantly different in males and females, as are the mandibular canine indices. The mandibular intercanine distance was not significantly different. The right mandibular canine was found to be more dimorphic than left mandibular canine. The parameters measured in the present study will be of immense help in identification of sex in forensic investigations.

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