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# Sex determination using mandibular canine index in optimal-fluoride and high-fluoride areas

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## Abstract

**Objectives:** The objective of this study was to find out if exposure since birth to a naturally fluoridated drinking water supply has any impact on sexual dimorphism as assessed by measurement of the mandibular canine index. **Materials and Methods:** Children from two areas were selected for the study: Aaspur (Dungarpur) and Chikhalwas (Udaipur), which are high-fluoride (4.0 ppm) and optimal-fluoride (1.1 ppm) areas, respectively. Data were obtained from 145 school children in the 14–15 year age-group. Of these, 75 were from the high-fluoride area and 70 were from the optimal-fluoride area. Alginate impressions of the mandibular arch were made for all subjects and these were poured immediately in type IV dental stone to minimize dimensional shrinkage. The parameters considered were canine width, intercanine distance, and mandibular canine index. All the measurements were recorded using a modified vernier calipers and divider. Data were statistically analyzed using SPSS/PC+ (SPSS Inc., Illinois, USA). **Results:** Significant differences were found between optimum-fluoride and high-fluoride areas in all the considered parameters except for the right canine width and the intercanine distance. Standard mandibular canine index is a quick and easy method for determining sex. **Conclusion:** Fluoride level does not have any particular impact on assessment of sexual dimorphism using the mandibular canine index.

**Key words:** Mandibular canine width, mandibular canine index, intercanine distance, fluorides, sex determination

## Introduction

The teeth are small whitish structures that guard the main entrance into the body. The teeth are the hardest tissue in the body and exhibit the least turnover of natural structure; because of its resistance to destruction, the teeth are a durable record of valuable information and therefore have immense importance in many investigations. They are excellent material for anthropological, genetic, and odontologic investigations in both living and dead population and are therefore of paramount importance in forensic practice.[1] Their ability to survive fire and bacterial decomposition makes them valuable in forensic identification.[2]

Odontometry has been performed on various tooth groups with the objective of establishing measurements that can act as standards. This information would facilitate some procedures in dental surgery and also be extremely useful in forensic odontology.[3] In addition to determination of age, sex can also be determined from the teeth.[4]

The size of the teeth is of great importance, not only to indicate the different activities related to occlusion or to determine the frequency of dento-osseous anomalies applied to orthodontic treatment, but also to establish sexual dimorphism. Out of the two proportions, width and length, the former is considered to be more important.[5]

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.[6] Various features like tooth morphology

and crown size are characteristic for males and females.[7] However, tooth morphology is also known to be influenced by cultural, environmental, and racial factors.[8] Variation in tooth form can be studied by measurement of enamel height, dentine height, pulp height and pulp width which exhibit sexual dimorphism.

Determination of sex using skeletal remains presents a challenge for forensic experts, especially when only fragments of the body are recovered. Forensic odontology plays an important role in establishing the sex of victims when bodies are mutilated beyond recognition following major mass disasters.[9] In such situations, forensic dentists assist other experts, using skull fragments and teeth to identify the sex of the remains; this can be of great help for the authorities trying to identify missing persons as, once the sex has been determined, only missing persons of that sex need to be considered. In this sense, identification of sex takes precedence over determination of age.[10] New techniques like PCR (polymerase chain reaction) are now available that can accurately determine the sex of the remains.[11]

It has been reported that the dental dimensions of males are larger than that of females.[12] The mandibular canines are considered to be the 'key teeth' for sexual dimorphism.[13] For example, Garn *et al*. and Nair *et al*. have found the mandibular canines to exhibit the greatest sexual dimorphism amongst all teeth.[14,15]

The mandibular canines erupt at a mean age of 10.8 years. They are the last tooth to be extracted and are the least affected by periodontal diseases. Moreover, they are also very likely to survive severe trauma, air crash, cataclysm, hurricane, conflagration, etc.

## Materials and Methods

The present study was conducted in Aaspur in Dungarpur district and Chikhalwas in Udaipur district, both of which are situated in southern Rajasthan in north-west India. Aaspur is a high-fluoride (4.0 ppm) area and Chikhalwas is an optimal-fluoride (1.1 ppm) area. The study was conducted during the first and second week of the month of January 2009. Prior permission was taken from the concerned school authorities. Ethical clearance was obtained from the Ethical Committee of Research, Darshan Dental College and Hospital, Udaipur.

The study subjects were 14- to 15–year-old school children residing in high-fluoride (Aaspur) and optimal-fluoride (Chikhalwas) areas. This age-group was selected because there is relatively little attrition of the teeth at this age.

For inclusion in the study the child had to fulfill the following criteria:

1. Age-group of 14–15 years
2. Healthy state of gingiva and periodontium
3. Caries-free teeth
4. Normal overjet and overbite
5. Normal molar and canine relationship

Moreover, only children who gave written consent for participation in the study and were present on the days of the survey were eligible for inclusion. Selected children who, for any reason, were absent on the days of the survey were excluded from the study.

Before the survey, both the examiners (HT and KP) were calibrated for inter-examiner variability in selection of subjects. Training was given to the examiners for impression making and they also practiced casts pouring.

Of the 145 subjects, 70 were from the optimal-fluoride area and 75 from the high-fluoride area. For all subjects, alginate impressions were made for the mandibular arch. The impressions were cast immediately in type IV dental stone to minimize the dimensional shrinkage. Investigator-blind odontometric analysis was carried out on the casts obtained. Casts with grossly decayed, fractured, or missing teeth were excluded from the study.

The width of mandibular canines was taken as the greatest mesiodistal width between the contact points of the teeth on either side of the jaw. The dimensions were measured with the help of modified vernier calipers.[16] For measuring the mesiodistal width, the calipers[16] were held at right angles to the plane of the occlusal surface and approximately parallel to the buccal surface. The greatest distance was then obtained between contact points or where contact with neighboring teeth normally occurs [Figure 1].

The following measurements were taken in all casts:

1. The greatest mesiodistal width of the mandibular canine (both on the right and left sides)
2. The intercanine distance (i.e., the distance between the tips of both canines in the lower jaw) [Figure 2]

The following parameters were determined on study casts in males and females:

1. Intercanine distance
2. Right mandibular canine width
3. Left mandibular canine width
4. Right mandibular canine index
5. Left mandibular canine index

Sexual dimorphism in right and left mandibular canines was calculated using formula given by Garn *et al*[15] which is as follows:

$$\text{Sexual dimorphism} = X_m / X_f$$

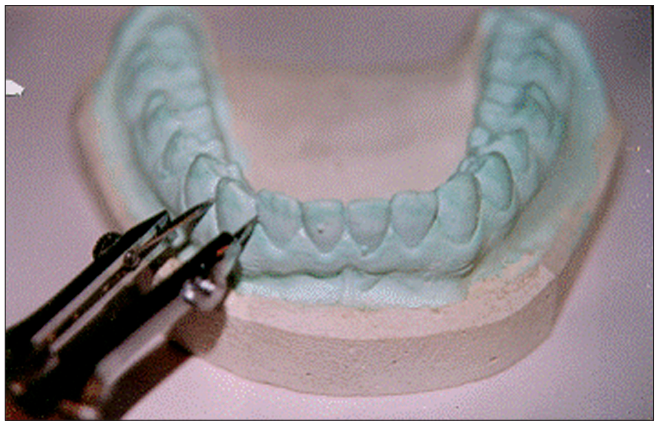

**Figure 1:** Measurement of canine width (casts)

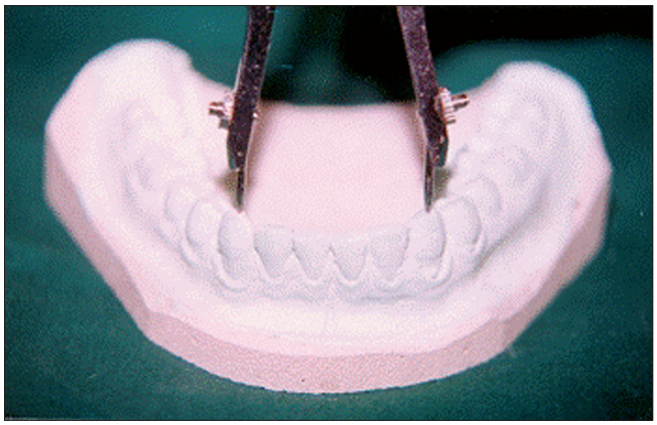

**Figure 2:** Measurement of inter-canine distance (casts)

**Table 1: Differences in parameters in males *vs* females**

| Parameter | Group | Sex | Number | Mean | SD | 't' | *P*-value |
|---|---|---|---|---|---|---|---|
| Right canine width | Optimal-fluoride | Male | 32 | 7.05 | 0.27 | 12.61 | 0.00 |
| | | Female | 38 | 6.22 | 0.28 | | |
| | High-fluoride | Male | 32 | 6.63 | 0.57 | 0.33 | 0.74 |
| | | Female | 38 | 6.67 | 0.43 | | |
| Left canine width | Optimal-fluoride | Male | 32 | 7.25 | 0.38 | 9.00 | 0.00 |
| | | Female | 38 | 6.44 | 0.36 | | |
| | High-fluoride | Male | 32 | 7.11 | 0.52 | 4.07 | 0.00 |
| | | Female | 38 | 6.67 | 0.42 | | |
| Inter-canine distance | Optimal-fluoride | Male | 32 | 34.63 | 2.42 | 2.12 | 0.37 |
| | | Female | 38 | 33.71 | 1.01 | | |
| | High-fluoride | Male | 32 | 35.41 | 1.31 | 3.61 | 0.00 |
| | | Female | 38 | 34.49 | 0.90 | | |
| Right mandibular canine index | Optimal-fluoride | Male | 32 | 20.46 | 1.86 | 5.98 | 0.00 |
| | | Female | 38 | 18.46 | 0.80 | | |
| | High-fluoride | Male | 32 | 18.73 | 1.51 | 1.94 | 0.05 |
| | | Female | 38 | 19.34 | 1.21 | | |
| Left mandibular canine index | Optimal-fluoride | Male | 32 | 21.07 | 2.19 | 4.76 | 0.00 |
| | | Female | 38 | 19.14 | 1.11 | | |
| | High-fluoride | Male | 32 | 20.10 | 1.40 | 2.52 | 0.01 |
| | | Female | 38 | 19.34 | 1.21 | | |

where, $X_m$ = mean values for males and $X_f$ = mean values for females.

The unpaired 't' test was used to compare the measurements for males and females.

## Results

The various measurements and indices among males and females in both high-fluoride and optimal-fluoride areas are tabulated in Table 1.

With regard to the right canine width, we found statistically significant difference between males and females in the optimal-fluoride area, while the difference was nonsignificant in the high-fluoride area. However, in the left canine width, there was statistically significant difference between males and females both in high-fluoride and optimal-fluoride areas.

We also found a statistically significant difference in the intercanine distance between males and females from the high-fluoride area, but the difference was nonsignificant in subjects from the optimal-fluoride area.

With regard to the right and left mandibular canine index, there was statistically significant difference between males and females in both the high-fluoride and the optimal-fluoride areas.

## Discussion

Sex can be easily determined in mature individuals if the postcranial skeleton is intact. But in the young child and infant, determination of sex from the skeleton is difficult.[17] Teeth provide excellent models for the study of relationship between ontogeny and phylogeny. It has already been stressed that any measurement of teeth that is unaccompanied by details of age, race, and sex must be treated within great reserve.[18] Intact dentition establishes the intercanine distance, molar arch width and premolar arch width, which are useful parameters in differentiating the sexes.

The mandibular canines are considered to demonstrate the greatest percentage of sexual dimorphism amongst all teeth in their mesiodistal width.[19–22]

It has been postulated[23] that during the evolution of primates the canines were functionally not masticatory but served the purpose of conveying threat of violence and actually inflicting violence. A gradual relocation of this aggressive function from the teeth to the fingers took place, but until this transfer was complete, survival was dependent on canines, especially in males. Thus, in the present day human, sexual dimorphism in the mandibular canine index is not merely a coincidence but is the remnant of past functional activity.

It must be noted that such a method of sex determination has its limitations; the sex of the subject to whom the fragment of the mandible belongs can be determined satisfactorily only when the fragment is found in the geographical area where the subject was born.

In the present study, we examined certain parameters for males and females in high-fluoride and optimal-fluoride area. Briefly, for the right canine width, we found a statistically significant difference between males and females from the optimal-fluoride area, though the difference was nonsignificant among the subjects from the high-fluoride area. For intercanine distance, we found a statistically significant difference between males and females from the high-fluoride area, whereas the difference was nonsignificant in those from the optimal-fluoride area. Finally, for the left canine width and the right and left mandibular canine indices, we found statistically significant differences between males and females in both the optimal-fluoride and the high-fluoride areas.

Thus, it can be seen that fluoride intake does not have any particular impact on sexual dimorphism as assessed by measurement of the mandibular canine index.

The mesiodistal width of mandibular canines is considered to demonstrate highest sexual dimorphism. However, impacted canines and maxillary first molar (B-L diameter) especially on the right side exhibit a higher sexual dimorphism (8.49% casts, 8.27% intraorally) as compared to the left side.[15]

## Conclusion

The present study establishes the existence of a definite, statistically significant, sexual dimorphism in mandibular canines. We conclude that the standard mandibular canine index is a quick and easy method for determining sex in identification. The results of the present study indicate that there is a statistically significance difference between males and females in both high-fluoride and optimal-fluoride areas. However, the fluoride level does not seem to have any particular impact on dimorphism as assessed by the mandibular canine index.

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