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Evaluation of Sexual Dimorphism using Mesiodistal Dimensions of Permanent Maxillary Central Incisors, Canines and Maxillary Intermolar Width in Davanagere Children - An Odontometric Study

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Abstract

Background: Teeth have been used as the means for sex determination and for individual identification as they are resistant to various insults. **Aims and Objectives:** To determine the sexual dimorphism based on the linear measurements of mesiodistal dimensions of permanent maxillary central incisors and canines and maxillary inter-molar width. **Setting and Design:** Descriptive study. **Materials and Methods:** A total of 130 children, 65 boys and 65 girls of age between 11-14 years were included in the study. Impressions of the maxillary arch were taken with alginate, poured in dental stone and were allowed to set and then the cast bases were made with dental plaster. A digital vernier calliper was used for measuring the parameters. Mesiodistal width and maxillary inter-molar width were measured in millimetres. The data was statistically analysed with SPSS version 22.0 software using unpaired "t" test. **Results:** Mesiodistal width of the maxillary central incisors and canines were higher in boys than girls and inter-molar width was also higher in boys than girls. Percent sexual dimorphism was highest with maxillary right central incisor and least with maxillary inter-molar width. **Conclusion:** Mesiodistal dimensions and maxillary inter-molar width can be used as an aid for sex determination as an inexpensive and alternative method.

Keywords: Forensic Odontology, Intermolar Width, Mesiodistal Width, Sexual Dimorphism, Unpaired T-Test

Introduction

"Forensic Odontology" is a branch of dentistry responsible for the proper management and evaluation of dental evidence and for the proper evaluation and presentation of dental findings for the benefit of justice. The basic utility of forensic odontology is the identification of individual traits from dental remains of different individuals[1]. Teeth may be used to classify sex by measuring their buccolingual and mesiodistal dimensions[2]. This is especially important for young people when the secondary sexual characters of the skeletal structure have not yet developed. Studies show significant differences between the permanent and primary tooth dimensions of males and females[3]. The Study of permanent mandibular and maxillary canine teeth offer some advantages in that the teeth are less affected by periodontal and the last teeth to be extracted according to the age, as described by Bossert and Marks[4]. The diameter of the mandibular inter-canine arch and the extent of the Maxillary inter-molar are highly dependent on sexual dimorphism[5]. The present study was carried out, with the following aims and objectives.

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- To evaluate the mesiodistal width of permanent maxillary central incisors and canines.
- To evaluate the intermolar width in maxillary arch.
- To evaluate the sexual dimorphism in permanent maxillary central incisors, canines and maxillary inter-molar width.

Methodology

A total of 130 children, comprising of 65 boys and 65girls aged between 11-14 years irrespective of the race and socioeconomic status were randomly selected from the out-patient clinic of the Department of Paediatric and Preventive Dentistry at College of Dental Sciences, Davangere, Karnataka, India. Ethical clearance to conduct the study was obtained from the Institutional ethical review board (Ref. No CODS/ 3226 2019-2020).

Inclusion Criteria

- Clinically healthy periodontium
- Fully erupted permanent incisors, canines and molar teeth

Exclusion Criteria

- Developmental abnormalities of teeth
- Physical or chemical injuries to the teeth
- Teeth with proximal restoration /crowns, crowding, attrition, caries, orthodontic treatment.

After obtaining consent from the parent/guardian of the child, impression of the maxillary arch will be made using alginate material. The impression will be disinfected with 0.5% sodium hypochlorite. The impression will be poured in dental stone and will be allowed to set and then the cast base will be made with dental plaster. The mesiodistal diameter (width of crown) of the permanent maxillary central incisors, canines, and intermolar width in maxillary arch will be measured using digital Verniercalliper. The mesiodistal width (defined as the maximum distance between the most mesial and the most distal point of the crown) will be measured with the calliper beaks placed incisally along the long axis of the tooth at incisal third of the tooth. Maxillary intermolar width (distance between the central fossae of the right and left first maxillary molars) is measured using calliper beaks placed on from central fossae of 1st molar on one side to that on other side. All measurements were done on the casts for easy reproducibility using digital verniercallipers with resolution of 0.01mm by a single observer. After collecting all the casts for study, they were numbered and randomly selected for the study. To assess the intra-observer error, 1/4th of the total casts were randomly selected and measured again.

Statistical Analysis

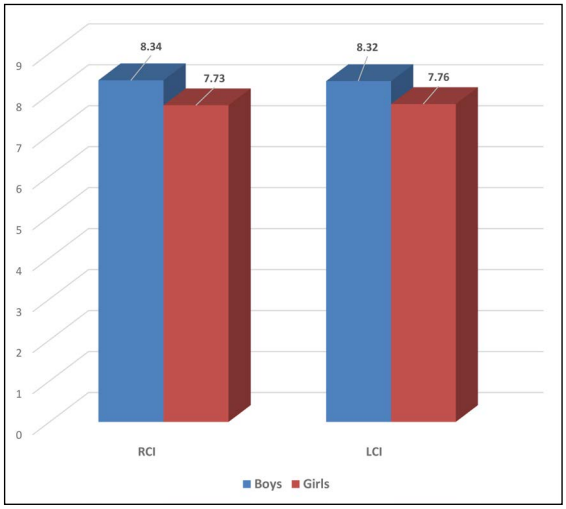
The data collected will be subjected to statistical analysis using SPSS version 22.0. The mean, range and standard deviation will be calculated for the size of the teeth. A two-sample t-test will be used to test statistical difference between means.

Results

The present descriptive study was carried out to assess the mesiodistal width of the permanent maxillary central incisors, canines and intermolar width in maxillary arch, and to evaluate the extent of sexual dimorphism using dental dimension. Total of 65 boys and 65 girls of age group 11-14 years were included. The obtained data from the available sample were subjected to statistical analysis using SPSS 22.0 software. The statistical test carried out was unpaired t test and logistic regression analysis. Result obtained along with statistical analysis has been explained under the section of tables. Detailed explanation of each table is described below.

Table 1 shows average mean and standard deviation of mesiodistal dimensions of right and left permanent maxillary central incisors between males and females. The mean of permanent maxillary central incisor of right side in boys is 8.34 (± 0.36 SD) and girls showed a mean of 7.73 (± 0.48 SD). Whereas the mean of permanent maxillary central incisor of left side in boys is 8.32 (±0.38 SD) and in girls is 7.76 (±0.47 SD). Boys in the present study had statistically significant higher mean in both right and left central incisor dimensions ($p<0.05$) than girls. It is represented graphically in Graph 1.

Table 2 shows average mean and standard deviation of mesiodistal dimensions of right and left permanent maxillary canines between males and females. The mean of permanent maxillary canine of right side in boys is 7.34 (±0.30 SD) and in girls showed a mean of 6.90 (±0.44



Graph 1. Shows comparison of mean value of mesiodistal dimensions with respect to permanent maxillary right and left central incisors between groups.

Table 1. Intergroup comparison in maxillary central incisors using un-paired t-test

MEASURE	GENDER				Mean Difference	Unpaired t-test t- value	P-value
	Boys (n=65)		Girls (n=65)				
	Mean	SD	Mean	SD			
RCI	8.34	0.36	7.73	0.48	0.61	8.196	0.001*
LCI	8.32	0.38	7.76	0.47	0.57	7.559	0.001*

Table 2. Intergroup comparison in maxillary canines using un-paired t-test

MEASURE	GENDER				Mean Difference	Unpaired t-test t- value	P-value
	Boys (n=65)		Girls (n=65)				
	Mean	SD	Mean	SD			
RC	7.34	0.30	6.90	0.44	0.44	6.782	0.001*
LC	7.36	0.28	6.88	0.53	0.48	6.475	0.001*

Table 3. Intergroup comparison in molars using un-paired t-test

MEASURE	GENDER				Mean Difference	Unpaired t-test t- value	P-value
	Boys (n=65)		Girls (n=65)				
	Mean	SD	Mean	SD			
IMW	45.50	0.85	43.35	1.45	2.15	10.306	0.001*

Table 4. Sexual dimorphism ratio for each independent variable

MEASURE	Sexual Dimorphism Ratio (SDR)	(SDR)* 100	Percent sexual dimorphism
RCI	1.079	107.89	7.89%
LCI	1.072	107.22	7.22%
RC	1.064	106.38	6.38%
LC	1.070	106.98	6.98%
IMW	1.050	104.96	4.96%

SD). Whereas in permanent maxillary canine of left side in boys is 7.36 (±0.28 SD) and in girls is 6.88 (±0.53 SD). Boys in the present study had statistically significantly higher mean in both right and left canine dimensions ($p<0.05$) than girls which is represented graphically in Graph 2.

In Table 3, the mean of intermolar width in the maxillary arch was mentioned along with the standard deviation. The mean of the IMW of maxillary arch in boys is 45.50 (±0.85 SD) and in girls is 43.15 (±0.85 SD). Boys in the present study had statistically significantly higher mean inter-molar width ($p<0.05$) than girls.

Figure 1. Measuring of mesiodistal dimension of permanent maxillary central incisor.

Figure 2. Measuring of mesiodistal dimension of permanent maxillary Canine.

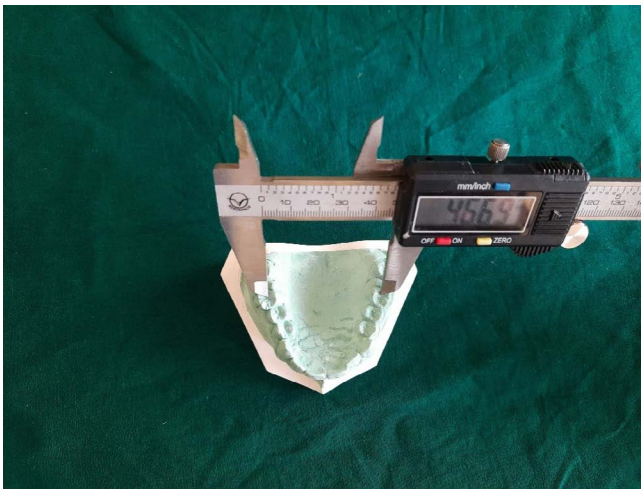
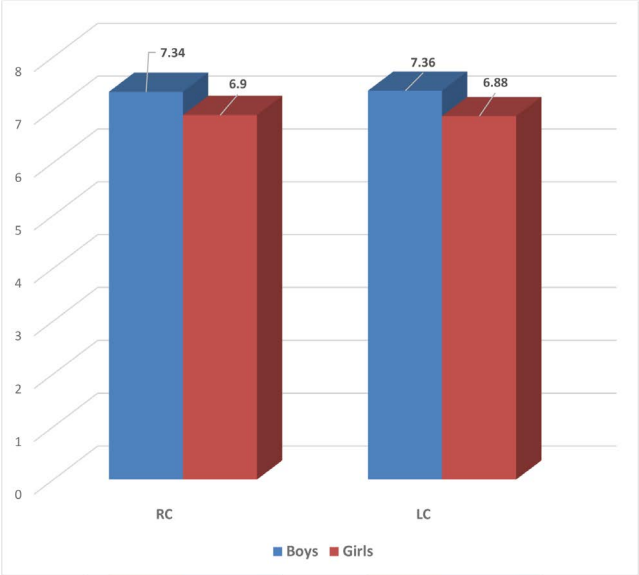


Figure 3. Measurement of permanent maxillary intermolar width.



Graph 2. Shows comparison of mean value of mesiodistal dimensions of permanent maxillary left and right canines between groups.

In Table 4, the sexual dimorphism of permanent maxillary central incisor on right side was found to be 7.89% and on left side is 7.22%. The sexual dimorphism of permanent maxillary canine on right side was found is 6.38% and on left side is 6.98%. The IMW in the maxillary arch was found to be 4.96%. Among the maxillary central incisors, right central incisor showed more sexual dimorphism, in maxillary canines, left maxillary canine showed more sexual dimorphism. The right maxillary central incisor showed the maximum sexual dimorphism and IMW showed the least sexual dimorphism.

Discussion

Forensic odontology is the subdivision of forensic medicine related to the proper examination, management and presentation of dental evidence in the court of law for justice. One of the challenges forensic experts may face is the establishment of a personal identity. The concept of identity includes a set of characteristics that define an individual. It is one of the least explored and fascinating branches of forensic science. It plays an important role in the identification of man-made or natural disasters and

many other events that lead to many institutions that may not be able to identify common causes. The theory of forensic dentistry states that "no two mouth are alike." The range of forensic dentistry is wide and always challenging. Each case is difficult. A major area of forensic odontology is to identify people, whether dead or alive[6].

Sexual dimorphism represents a group of morphological features that distinguish between male and female. Among these dimorphic features, the tooth has been tested in various societies for its effectiveness in anthropometric and forensic investigations. Gender determination plays an important role in resolving medical and legal cases as well as in anthropological studies. Sex can be determined from various parts of the body, such as the remains of the skull, bones etc[7].

Teeth are considered to be the strongest structures as they are resistant to mechanical, chemical, thermal effects, microbial degradation and other post mortem insults. Gender determination based on dental characteristics is primarily based on comparisons of tooth size in male, or female by comparing Non-Metric Dental Traits (NMDT). Morphometrics play an important role in determining gender in high-risk situations where the bodies are often unseen. Dental size measurements based on odontometric investigations can be applied to age and gender determination as human teeth indicate sexual dimorphism[7–9].

Although sex determination with the help of teeth is not effective if there is no other evidence, dentists can provide clues about a person's sex. Odontometrics, is a dental measurement technique used by scientists in determining gender. Determination of sex using this procedure is based on the gender dimorphism of tooth size. Linear measurements such as mesiodistal and buccolingual tooth size are widely used in determining sex. Diagonal measurements help to measure rotated, crowded and proximally restored teeth[10].

The most recent method of determining the sex of the teeth is the presence of sexual chromatin or Barr bodies in the dental pulp, according to a method designed by Barr & Bertram. Research has also been done to extract DNA from the pulp tissue and dentin and its use in determining sex using Polymerase Chain Reaction (PCR). Enamel protein due to its different patterns in men and women has also been used for sex determination using DNA techniques. Amelogenin or AMEI is a major protein found in the enamel. Amelogenin has different nucleotide sequence patterns in both male and female proteins[11].

Considering the fact that there are differences in odontometric traits in certain individuals, even within the same number of people in the context of history and evolution, it is necessary to determine certain demographics in order to make the diagnosis possible on the basis of dental measurements. Therefore, the current study examined the mesiodistal dimension of the PMCI, Canine and IMW in maxillary arch for boys and girls in Davanagere population[12].

Doris et al.,[13] has shown that the early permanent teeth provide the best sample of the size of the teeth because early adulthood dentition has less mutilation and less attrition in most of the individuals. Therefore, the effect of these factors on the width of the actual mesiodistal teeth will be minimal. Thus, only subjects in the age group of 11–14 years were included in the study sample.

In the present study, tooth crown area of boys showed statistically significant difference in comparison to girls. The mean of permanent maxillary central incisor of right side in boys is 8.34 (±0.36 SD) and girls showed a mean of 7.73 (±0.48 SD). Whereas the mean of permanent maxillary central incisor of left side in boys is 8.32 (±0.38 SD) and in girls is 7.76 (±0.47 SD). The mean of permanent maxillary canine of right side in boys is 7.34 (±0.30 SD) and in girls showed a mean of 6.90 (±0.44 SD). Whereas in permanent maxillary central canine of left side in boys is 7.36 (±0.28 SD) and in girls is 6.88 (±0.53 SD). The mean of the IMW of maxillary arch in boys was 45.50 (±0.85 SD) and in girls was 43.15 (±0.85 SD).

Garn *et al.*,[14]. examined the magnitude of sexual dimorphism by measuring the mesiodistal dimensions of canine teeth and showed that "the mandibular canine showed a greater degree of sexual dimorphism than maxillary canine" However, Minzuno *et al.*,[15] reported that the maxillary canine showed a higher level of sexual dimorphism compared to the mandibular canine in Japanese people. Maxillary left canine in a study by Pratibha *et al.*,[16] also found similar level of sexual dimorphism like studies conducted in Turkey by the Iscan[12].

A study by Otuyemi and Noar[17] shows dimorphism in both maxillary canines. The results were similar to that of our study which showed that maxillary canines showed a sexual dimorphism between boys and girls.

Hashim and Murshid[18], in 1993, conducted research on Saudi men and women aged 13-20 to find the teeth in human dentition with a very high dimorphism and found that only canines on both jaws showed great significant. sexual differences while other teeth did not. They also determined that there were no statistically significant differences between the left and right sides suggesting that dental measurements on one side could actually represent when the corresponding measurements on the other side were not available. Similarly in the present study, it was found that there was no significant difference between left and right canines.

Madhavi *et al.*,[19] conducted a study on 100 cases of 17-21 years in Central India with the mean maximum canine width of males and females of 8.02 mm and in the present study it was 7.12 mm. Kaushal *et al.*,[20] surveyed 180 participants by taking amaxillary arch impression. An important sexual dimorphism was observed in the M.D dimensions and the intercanine width of the maxillary canine teeth. The sexual dimorphism was 4.2% and 3.6% right and left respectively. A study by Khangura *et al.*,[21] also revealed an important sexual dimorphism in maxillary canines. In the present study, the right canine showed a sexual dimorphism of 6.38% and the left canine of 6.98%.

The univariate analysis of the study by Khangura *et al.*,[21] showed that the M-D dimensions of the central incisors of the male dentition were greater than that of the females. In the Chilean population, the mesiodistal dimensions of teeth 1.1, as well as 2.1, showed statistically significant sex differences between males and females, indicating that they were sexually dimorphic. With the exception of 2.1 teeth in the Nepalese sample, the average mesiodistal diameter was greater in males than females in all populations[22]. In the present study, similar results were found to mean that 11 and 21 mesiodistal width values were larger in males, than in females and there was no statistically significant difference between the left and right sides. This is similar to the conclusions of Sherfudhin *et al.*,[23] and Parekh *et al.*,[24]. However, Kalia *et al.*,[25] did not find a gender dimorphism between men and women in her study, which is related to M-D sizes 11 and 22, in contrast, the current study showed a gender dimorphism between males and females i.r.t. 11 and 22.

Singh *et al.*,[26] conducted a study to obtain general data on the size of the mesiodistal crown of permanent teeth in Punjabis, people from the Northern region of India. The study was performed on 110 people, 40 men and 70 women, aged 12-18. The results revealed that the size of the mesiodistal crown of male teeth was greater than that of women. In addition, the average mesiodistal crown dimension of maxillary lateral incisors to maxillary central incisors was 80% for females and 78% for males, and the total arch length for males was 117.77 mm for maxilla and 111.60 mm in the mandible. However, in the present study, the mesiodistal size of the maxillary incisors and canines were significantly larger in males than in females, which was consistent with previous studies.

Richardson *et a1.*,[27] found that male teeth are usually larger than females in each type of tooth in both arches. Sanin and Savara[28] reported differences in crown size patterns even among the good occlusion cases. Howe *et a1.*,[29] in their study found the combined mesiodistal range in males to be comparable to females. It is noted that the permanent canine and the permanent molar arch contribute to the identification of sexuality by dimorphism. The range of intercanine and intermolar width is usually recorded on the cement model but can also be recorded using copies and digital models of the models.[30]

According to a study by Daniel *et al.*,[31] the maxillary archintermolar width group in the 18–25 year age group was significantly higher in males than in females. In the present study also the width of the intermolar width in maxillary arch was found to be higher in boys than girls with a sexual dimorphism of 4.96% (P = <0.01). A similar study by Bano *et al.*,[32] found that the range of arch intermolar was higher in males than in females with a sexual dimorphism of 1.34%.

The strength of our investigation is likely to be that the age in the sample was 12.5 years, which is the maximum limit for the under-21 age, as recommended by Wangpichit *et al.*,[33] in 2001. The benefits of considering a younger age include: Absence tooth decay, periodontal problems that may change the size of the tooth. In almost all analyzed studies, the study sample included adults over 21 years: Ayoub *et al.*,[34] in 2007 (years 18-25 years old), Banerjee *et al.*,[35] in 2016 (19-23 years), Filipovic *et al.*,[36] in 2016 (18-25 years old). The limitations of the study were small sample size and more parameters are to be considered. Further research should be done with additional samples to support and compare the exact values of gender identification with reference to the arch width between both men and women.

Conclusion

The aim of the presentstudy was to assess the tooth crown area of Permanent Maxillary Central Incisors and Canines and Maxillary Intermolar Width; and to evaluate the extent of sexual dimorphism; with the present study, we concluded that:

- There was statistically significant difference between boys and girls in relation to the mean mesiodistal dimensions of permanent maxillary central incisors and canines
- The highest mesiodistal width was shown by permanent right maxillary central incisor for both boys and girls ($p<0.05$).
- There was statistically significant difference between mean intermolar width in boys and girls.
- The highest percent sexual dimorphism was obtained for permanent maxillary right central incisor.
- Therefore, mesiodistal width of permanent maxillary central incisors and canines and maxillary intermolar width can be used as an aid for sex determination in Davanagere population.

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