

An Establishment of Sexual Dimorphism by Odontometric Study of Permanent Maxillary Canines Among Dental Students : A Cross Sectional Study.

Abstract:

Aim & Objectives: To investigate sexual dimorphism by odontometric study of permanent maxillary canine teeth & to establish the effectiveness of maxillary canine index in sexual dimorphism. Materials and Method –A total of 100 dental students aged 17- 25 years were finalized for study. Following verbal consent, impressions of the upper arch were made using alginate material and casts were poured in dental stone. Mesio-distal diameter (MD) and inter-canine width (ICW) measurements of permanent maxillary canine were obtained using a sliding digital caliper and maxillary canine index was calculated.

Results: The mesio-distal diameter of maxillary canines for both right ($p=0.001$) and left sides ($p=0.005$) was significantly higher among male subjects than females, Similar observation was found for inter-canine width too ($p=0.0001$). In contrast, the maxillary canine index (MCI) for right and left was statistically insignificant ($p>0.05$) for both male and female subjects.

Conclusion: Maxillary canines can be used in gender identification as an aid for forensic odontology.

Key-words: Alginate impression, Maxillary canines, odontometric study, Sexual dimorphism, sliding digital caliper .

Introduction:

Sexual dimorphism refers to the differences in appearance between males and females of the same species, such as in colour, shape, size and structure that are caused by the inheritance of one or the other sexual pattern in the genetic material.[1] The sexual dimorphism is explained by different effects of the human X and Y chromosome genes on various somatic features, such as the frequency of some dental anomalies and the tooth crown size.[2]

Sex determination is an important step in determining the biological profile of unidentified human.[3] Sex differentiation in forensic investigation utilizes craniofacial morphology, tooth dimensions and DNA analysis. It has been suggested that odontometric plays an important role in determination of sex in young individuals where secondary sexual characteristics have not developed. In addition, the resistance of teeth to postmortem insults render them as a valuable tool in forensic investigation.[4]

Odontometric study is the measurement and study of tooth size. Odontology is an anthropological science that can distinguish different groups and populations based on their dental parameters[5]

Human identification is the mainstay of civilization, and the identification of unknown individuals always has been of paramount importance to society. Identification of an individual living or dead is based on the theory that all

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individuals are unique. When an unidentified body is found, it is assumed that it could be anybody. By classifying the individual into characteristic groups (age, sex, race, height), the possibilities are narrowed. Although DNA analysis is the most precise technique to determine the sex, sometimes, lack of facilities and the cost factor may be a hindrance. In such cases, teeth provide excellent models for the study of relationship between phylogeny and ontogeny.[6]

Identification of humans using the unique features of the teeth and jaws has been used since Roman times. Study of the permanent canine teeth offers certain advantages. These advantages emanate from the fact that they are the least frequently extracted teeth and being less affected by periodontal disease. The canines are commonly referred to as the 'corner stones' of the dental arches as four canines are placed at the 'corners' of the oral cavity. The shape of the crowns, with their single pointed cusps, their locations strongly developed roots make these canines resemble those of the carnivore. This resemblance to the prehensile teeth of the carnivore gives rise to the term 'canine'.⁷ Canine teeth have also been reported to survive in air and hurricane disasters.[8]

Sex assessment constitutes an important step in constructing a postmortem profile, considering the fact that most teeth complete development before skeletal maturation makes them a useful adjunct as a sex indicator, particularly in young individual's dentition.[9]

Teeth being the hardest and chemically the most stable tissue, exhibit the least turnover of natural structure in the body. Maxillary canines are used in gender identification using mesiodistal canine width and inter-canine width.[10]

Teeth 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 gender.[11]

Hence, this study was to investigate the gender of a sample of dental students utilizing the mesio-distal width of maxillary canines, intercanine width and standard maxillary canine index, and to determine dimorphism as an aid in forensic odontology.

Aim & Objectives:

Aim:

- To investigate sexual dimorphism by odontometric study of permanent maxillary canine teeth.

Objectives:

- To evaluate maxillary canine for sexual dimorphism.
- To estimate the level of accuracy of the maxillary canine used for sexual dimorphism.
- To establish the effectiveness of maxillary canine index in sexual dimorphism.

Materials and Method:

Study was carried out among dental students of K.D Dental College & Hospital, Mathura. The ethical clearance for the present study was obtained from the Ethical Review Committee of K.D Dental College. A verbal consent was obtained from all the willing participants. The data was collected using convenient sampling technique. The study was carried out in the month of November & December 2022.

Study Area and Study Population:

The present study was conducted among the dental students (First, Second, Third, Final year BDS students and interns) of K.D Dental College & Hospital, Mathura.

Sample size:

$$N = Z^2 p (1 - p) / d^2$$
$$N = (1.96)^2 \times 0.6 \times (1 - 0.6) / (0.10)^2$$
$$N = 91$$

Z = confidence interval (here 95% taken as confidence interval, 95% = 1.96)

P = prevalence value (here P = 0.2)

d = precision value (here d = 0.04)

Based on the sample size determination it was necessary to take 91 as the minimum sample size . However, a higher sample size of 100 was selected to compensate for any kind of permissible error and to increase the accuracy of study.

The study population consisted of 100 dental students (50 males and 50 females) of K. D Dental college & Hospital, Mathura.

Inclusion criteria:

- Dental students who had full complement of permanent teeth with normal occlusion, no spacing & had mild crowding in anterior teeth were included in the study.

Exclusion criteria:

- Students who had severe crowding, impacted anterior teeth, untreated caries in anterior teeth and history of orthognathic or cranio-facial surgery were excluded in study.

Armamentarium:

- Mouth – mirror
- Impression trays
- Alginate impression material
- Dental Stone
- Rubber bowl
- Spatula
- Kidney tray



FIGURE 1: Armamentarium for study.



Figure 2 : Ten (five males and five females) casts for pilot study.

Pilot Study:

Prior to being finalised, study was pilot tested on 10 dental students out of which 5 students were males and 5 students were females.

Data Collection:

The sample for the study comprised of 100 dental students (50 males and 50 females) maxillary cast. All students were selected from the K.D Dental College & Hospital, Mathura. who completely fulfilled all inclusion and exclusion criterias .

Each subject was examined clinically to fulfill the inclusion criteria. Following verbal consent, impressions of the upper arch were made using alginate material and casts were poured in dental stone. Mesio-distal diameter (MD) and inter-canine width (ICW) measurements of permanent maxillary canines were obtained using a sliding digital calliper with calibration of 0.01 mm.



FIGURE 3 : Photograph showing maxillary arch impression with Alginate taken by investigator.

After preparing all the maxillary casts, Male & female cast were segregated in two different containers. These casts were allocated by random numbers by an observer depending on the male and female casts and then shifted in one single container.



FIGURE 4 : Photograph showing all study casts



FIGURE 5: Photograph showing the measurement done by investigator

Mesio-distal Measurement (MD) :

The greatest mesio-distal dimension between the approximate surfaces of the crown was measured with the calliper beaks placed occlusally along the long axis of the tooth. In case of tooth rotation or malposition, the measurements were taken between points on the approximate surfaces of the crown where it was considered that contact with adjacent teeth would have normally occurred.



FIGURE 6 : Photograph showing the measurement of mesiodistal diameter of permanent maxillary left canine.



FIGURE 7 : Photograph showing the measurement of mesiodistal diameter of permanent maxillary right canine.



FIGURE 8 : Photograph showing the measurement of inter – canine width of permanent maxillary right to left canine.

Inter-Canine Width (ICW) :

The other measurement consisted of the distance between the tips of the two maxillary canines in a straight line. To measure the distance, each of the calliper beak was kept over the centre of the tip of canine tooth of each side.

Maxillary Canine Index (MCI):

Maxillary Canine Index = Mesiodistal crown width of maxillary canine/Maxillary inter-canine width

Sexual Dimorphism (SD) Sexual dimorphism was calculated using formula given by Garn and Lewis as follows:

$$\text{Sexual Dimorphism} = [X_m/X_f]-1 \times 100$$

Where: X_m =Mean value for males; X_f = Mean value for female

In order to assess the reliability of the measurements, intra-observer error was tested. The same measurements were obtained from the original sample at a different time by the investigator to assess intra-observer error. Observer measured the same selected teeth done by investigator in order to test the inter-observer error. There was no statistically significant difference between the findings of the investigator and observer.

Statistical analysis:

All the data of the sample were subjected to a computerized analysis using SPSS program version 26.0. The statistical analysis included:-

- Descriptive statistics: means, standard deviation, coefficient of variation, frequency, percentages and statistical tables.
- Inferential statistics: Independent sample t-test was used to evaluate the gender's difference. Percentage of dimorphism i.e. the percentage by which the tooth size of males exceeded that of females {it equals to = $[X_m/X_f]-1 \times 100$ where X_m was the mean dimension of males and X_f was the mean dimension of females}.

In the statistical evaluation, the following levels of significance were used:-

- NS → non significant
- ≤ 0.05 → significant
- ≤ 0.001 → highly significant.

Results:

Figure 1: Distribution of participants according to age groups:
n=100

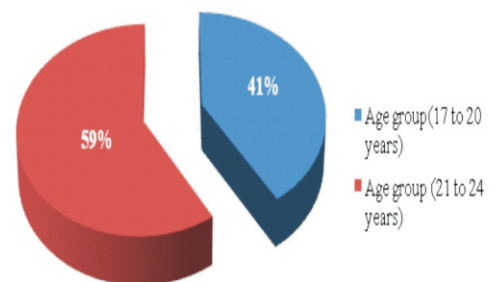


Figure-2:- Distribution of participants according to genders:-

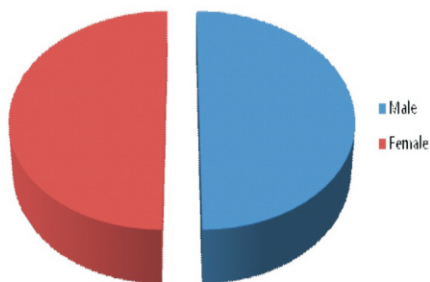


Table 1:- Descriptive statistics and gender's differences for the measured variables (mm)

Variables	Genders	Descriptive statistics		CV(%)	Gender's difference	
		Mean	SD		t-test	p-value
Age	Males	20.7	3.52	16.9	3.18	0.027*
	Females	19.5	3.85			
Maxillary Right Canines	Males	8.13	0.31	3.8	8.72	0.0012**
	Females	7.92	0.21	2.6		
Maxillary Left Canines	Males	8.0	0.43	5.3	8.34	0.0023**
	Females	7.61	0.11	1.4		
Inter-canine width	Males	39.34	2.67	6.7	5.61	0.031*
	Females	37.44	1.33	3.5		
Right Maxillary Canine Index	Males	0.205	0.022	10.7	1.44	0.091
	Females	0.197	0.012	6.1		
Left Maxillary Canine Index	Males	0.198	0.021	10.6	1.61	0.132
	Females	0.193	0.011	5.7		

p-value ≤ 0.05; ** highly significant; * significant; NS- non-significant.

- q The mean age for males were 20.7(± 3.52) whereas, the mean age for females were 19.5 (± 3.85).
- q The mean value of the mesio – distal diameter of right maxillary canine (RMC) for males were 8.13(± 0.31) with CV 3.8% and females were 7.92(± 0.21) with CV 2.6%. The mean value of the mesio – distal diameter of left maxillary canine (LMC) for males were 8.0(± 0.43) with CV 5. 3% and females were 7.61(± 0.11) with CV 4 %.
- q The mean value of the inter-canine width (ICW) for males were 39.34(± 2.67) with CV 6. 7% and females were 37.44 (± 1.33) with CV 3.5 %.
- q The mean value of the Right Maxillary Canine Index (RMCI) for males were 0.205 (± 0.022) with CV 10.7% and females were 0.197 (± 0.12) with CV 6.1 %. The mean value of the Left Maxillary Canine Index (LMCI) for males were 0.198 (± 0.021) showing CV 10.6% and females were 0.193 (± 0.011) showing CV 5.7 %.

Table-2:- Sexual dimorphism in maxillary canines:

Parameter	Sexual dimorphism
Right mesiodistal diameter of maxillary canine	2%
Left mesiodistal diameter of maxillary canine	5%
Inter canine width	5%
Right maxillary canine index	4%
Left maxillary canine index	2%

Statistical Analysis:

All the data of the sample were subjected to a computerized analysis using SPSS program version 26.0. The statistical analysis included:-

- Descriptive statistics: means, standard deviation, coefficient of variation, frequency, percentages and statistical tables.
- Inferential statistics: Independent sample t-test was used to evaluate the gender's difference. Percentage of dimorphism i.e. the percentage by which the tooth size of males exceeded that of females {it equals to = $[(Xm/Xf)-1] \times 100$ where Xm was the mean dimension of males and Xf was the mean dimension of females}.

In the statistical evaluation, the following levels of significance were used:-

NS non significant

≤ 0.05 significant

≤ 0.001 highly significant.

The present cross- sectional study was conducted among the dental students (First, Second, Third , Final year BDS students and interns) of K.D Dental College & Hospital, Mathura.

Distribution of Participants According to Age Groups:-

Among total 100 (100%) dental students, 59 (59%) were aged between 21 – 24 years and 41(41%) were aged between 17- 20 years. (Figure 1)

Distribution of Participants According to Gender:-

Among total 100 dental students, 50 dental students were males and 50 dental students were females. (Figure-2)

Table 1:- Descriptive Statistics and Gender's Differences For The Measured Variables (mm)

The mean age for males were 20.7(± 3.52) whereas, the mean age for females was 19.5 (± 3.85). The result came out to be statistically significant (p – value = 0.027*).

The mean value of the mesio – distal diameter of right maxillary canine (RMC) for males was 8.13(\pm 0.31) with coefficient of variation 3.8% , whereas, the mean value of the mesio – distal diameter of right maxillary canine (RMC) for females was 7.92(\pm 0.21) with coefficient of variation 2.6%. The results came out to be statistically significant (p – value 0.014*).

The mean value of the mesio – distal diameter of left maxillary canine (LMC) for males was 8.0(\pm 0.43) with coefficient of variation 5. 3% whereas, the mean value of the mesio – distal diameter of left maxillary canine (LMC) for females was 7.61(\pm 0.11) with coefficient of variation 4 % . The results came out to be statistically significant (p – value 0.0023**).

The mean value of the inter-canine width (ICW) for males was 39.34(\pm 2.67) with coefficient of variation 6. 7% whereas, the mean value of the inter-canine width for females was 37.44 (\pm 1.33) with coefficient of variation 3.5 % . The results came out to be statistically significant (p – value 0.031*).

The mean value of the Right Maxillary Canine Index (RMCI) for males was 0.205 (\pm 0.022) with coefficient of variation 10.7% whereas, the mean value of the Right Maxillary Canine index (RMCI) for females was 0.197 (\pm 0.12) with coefficient of variation 6.1 % . The results were not found to be statistically significant (p– value 0.091).

The mean value of the Left Maxillary Canine Index (LMCI) for males was 0.198 (\pm 0.021) showing coefficient of variation 10.6% whereas the mean value of the Left Maxillary Canine Index (LMCI) for females were 0.193 (\pm 0.011) showing coefficient of variation 5.7 % . The results were not found to be statistically significant (p – value 0.132). (**Table 1**)

Sexual Dimorphism In Maxillary Canines:

Sexual Dimorphism (SD) in right and left mesio– distal diameter of maxillary canine was 2% and 5% respectively. Inter-canine width (ICW) was 5%. In this study However, Sexual Dimorphism (SD) in Right and Left Canine Index showed values i.e. 4% and 2% respectively.

(**Table 2**)

Discussion:

The present cross- sectional study was conducted among the dental students (First, Second, Third , Final year BDS

students and interns) of K.D Dental College & Hospital, Mathura.

Distribution of Participants According to Age Groups:

In the study, majority of dental students i.e 59% belonged in the age group between 21 – 24 years and followed by 41(41%) who belonged to age group between 17- 20 years which was in contrast to the studies conducted by Shalini Gupta et al,¹ Mohammed Nahidh et al,⁷ and Mohsenpour K et al,¹⁷ in which all participants belonged to age group between 18 - 30 years, 17– 23 years and 18– 35 years respectively.

Distribution of Participants According to Gender:-

In the study, out of total dental students 50% were female dental students and 50% were male dental students which is in accordance to the studies conducted by Mohsenpour K et al,¹⁷ Shalini Gupta et al¹ , Mohammed Nahidh et al,⁷ in which also 50% were females and 50% were males.

Descriptive Statistics and Gender's Differences For The Measured Variables (mm)

In the study, the mean age for males was 20.7 (\pm 3.52) years whereas, the mean age for females was 19.5 (\pm 3.85) years . In study conducted by Shalini et al,¹ mean age for males was 23.13 (\pm 2.85) years and females was 20.27(\pm 1.25) years. In study conducted by Ticiana Medeiros Saboia et al² , mean age for males was 17.2(\pm 4.6) years and females was 19.8(\pm 6.3)years.

In this study the mean value of the mesio – distal diameter of right maxillary canine (RMC) for males was more than the mean value of the mesio – distal diameter for females which was in accordance with studies conducted by Shalini et al,¹ Mohammed Nahidh et al,⁷ Mohsenpour K et al,[17] and Saleh Nuhu et al,[12] in which also the mean value of the mesio – distal diameter of right maxillary canine (RMC) for males was more than the mean value of the mesio – distal diameter for females.

In this study the mean value of the mesio – distal diameter of Left maxillary canine (LMC) for males was more than the mean value of the mesio – distal diameter for females which was in accordance with studies conducted by Shalini et al,[1] Mohammed Nahidh et al,[7] Mohsenpour K et al,[17] and Saleh Nuhu et al,[12] in which the mean value of the mesio – distal diameter of Left maxillary canine (RMC) for males was more than the mean value of the mesio – distal diameter for females.

The mean value of the inter-canine width for males was 39.34(\pm 2.67)mm with coefficient of variation (CV) 6. 7% more than the mean value of the inter-canine width for females which was 37.44 (\pm 1.33)mm with coefficient of variation (CV) 3.5 %.The results were in accordance with studies conducted by Shalini et al,¹ Mohammed Nahidh et al,⁷ and Saleh Nuhu et al,¹² in which mean value of the inter-canine width (ICW) for males was more than the mean value of the females.

In this study the mean value of the Right Maxillary Canine Index (RMCI) for males was 0.205(\pm 0.022) and females 0.197(\pm 0.12) which was in contrast to study conducted by Shalini et al,¹ mean value of the Right Maxillary Canine Index (RMCI) for males i.e 5.96 (\pm 0.50) was less than females i.e 6.09 (\pm 0.58) and also in study Saleh Nuhu et al,¹² mean value of the Right Maxillary Canine Index (RMCI) for males was less i.e 5.96 (\pm 0.50), than females i.e 6.09 (\pm 0.58).

Left Maxillary Canine Index (LMCI) for males was 0.198 (\pm 0.021) and females was 0.193 (\pm 0.011) which was similar to study done by Saleh Nuhu et al,¹² in which mean value of the Left Maxillary Canine Index (LMCI) for males was 0.23 \pm 0.020 whereas, the mean value of Left Maxillary Canine Index (LMCI) for females was 0.22 \pm 0.020. Results were in contrast to study conducted by Shalini et al,¹ in which mean value of the Left Maxillary Canine Index (LMCI) for males was 6.02 (\pm 0.59) and females was 6.08 \pm 0.51.

Sexual Dimorphism In Maxillary Canines:

In this study Sexual Dimorphism (SD) in right and left mesio-distal diameter of maxillary canine was 2% and 5% respectively which was in contrast to the study conducted by Shalini et al,¹ in which Sexual Dimorphism (SD) in right and left mesio-distal diameter of maxillary canine was 4.2% and 3.6% respectively.

In this study Inter-canine width (ICW) was 5% and Sexual Dimorphism (SD) in Right and Left Canine Index showed positive values i.e. 4% and 2% respectively which was in contrast to study conducted by Shalini et al,¹ in which Inter-canine width (ICW) was 13.7%. and Sexual Dimorphism (SD) in right and left canine index showed negative values i.e. -2.1% and -0.9% respectively.

Limitations:

The present study was an odontometric study which can only be used as a supplemental tool & it is not a confirm investigation for sex determination.

Inaccuracy of instruments and investigator error could also have occurred.

Diversity can exist in different population groups and the influence of genetic, social, cultural, environmental and racial factors could have affected study results.

Suggestions & Recommendation:

Although canine reveals the greatest and most consistent sex dimorphism in the dentition but as the method is essentially dependent on one type of tooth, sex assessment can be best accomplished using measurements of as many teeth as are available rather than indices or individual teeth.

Conclusion:

In each variables i.e maxillary right and left mesio- distal canine width, Inter-canine width, Maxillary Canine Indices of males and females, the mean value came out to be more in males as compared to mean values of females. Males canine had greater dimension as compared to females. Maxillary canines could be used in gender identification as an aid for forensic odontology. Mesio-distal diameter and inter-canine width of permanent maxillary canine teeth showed that sexual dimorphism was more on left permanent maxillary canine teeth than right and also for inter-canine width.

So, canine can used for sex determination when more advanced methods are not available and also to supplement confirmation.

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