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Sexual Dimorphism Using Canine Width and Inter-Canine Distance in South Indian Population: A Cross Sectional Study.

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ABSTRACT

Background: Teeth provide excellent materials for forensic investigations intended for sex identification as they are the hardest and chemically most stable tissues in the body. The aim of this study was to evaluate the existence of sexual dimorphism in maxillary and mandibular permanent canines and also to estimate the level of accuracy with which they could be used for sex determination. **Methods:** The study sample consisted of 300 healthy adult patients aged between 20-30 years. Using sliding vernier calliper and divider, the maxillary and mandibular inter-canine distances and mesio-distal widths (MD) of left and right permanent maxillary and mandibular canines were recorded. The data was then subjected to Student's t-test. **Results:** Mandibular canine width (MnCW) in males was significantly higher as compared to females. The mesio-distal widths of all the canines (MxRC, MxLC, MnLC, MnRC) were significantly higher in males than in females. Both maxillary right as well as left canine index (MxRCI, MxLCI) was significantly higher in males than the females. Statistically significant difference between male and females subjects was not observed pertaining to Maxillary canine width (MxCW) and mandibular canine index (MnRCI, MnLCI). Sexual dimorphism was exhibited by two teeth: maxillary right canine (8.34%) and maxillary left canine (13.04%). **Conclusion:** We evaluated a simple and inexpensive linear method as canine measurement for sexual dimorphism. Maxillary canines (particularly, maxillary left canine) showed a greater percentage of sexual dimorphism. Thus, maxillary canines can be used as an adjunct along with other accepted procedures for sex determination.

Keywords: Canine width, Inter-canine distance, Sexual dimorphism.

INTRODUCTION

Forensic identification plays an important role in mass fatality incidents where reconstructing an individual's profile from unidentified skeletal remains is crucial. Sex determination is an important parameter in forensic identification.[1,2] Teeth are known to resist post-mortem, mechanical, chemical, physical and thermal types of destruction.[3,4] Being the hardest and chemically most stable tissues in the body, they have proven to be excellent materials for forensic investigations intended for sex identification. Sexual dimorphism refers to the systemic difference in the form (either in shape or size) between individuals of different sexes in the same species.[5] In many species, teeth exhibit sexual dimorphism. Varying degree of sexual dimorphism in human dentition has been shown in many studies.[6]

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Hence, tooth size standards based on odontometric investigations can be used in sex determination.[7] In many studies on contemporary human population, it has been shown that tooth crowns are larger in males than in females in possibly due to a longer period of amelogenesis for both deciduous as well as permanent teeth in males.[1,8] It has also been suggested that there is slow maturation in males because of Y chromosome.[9] According to some, canines, particularly, mandibular canines are found to exhibit the greatest sexual dimorphism amongst all teeth.[10,11] Usually, canines are the last teeth to be extracted with respect to age since they are least affected with abrasion from brushing, bear lesser occlusal loading and are less severely affected by periodontal disease. Due to these factors, canines, particularly the mandibular canines are considered as the "key teeth" for personal identification.[12-14] However, cultural, environmental, racial and genetic factors also have a large influence on the change in tooth size.[15]

The aim of our study was to evaluate sexual dimorphism in permanent maxillary and mandibular canines. It also assessed the differences in mesio-distal (MD) dimensions of canines, maxillary and

mandibular canine widths and indices in males and females.

MATERIALS AND METHODS

The study sample consisted of 300 healthy adult patients aged between 20-30 years who reported to the department of Oral Medicine & Radiology of Vydehi Institute of Dental Sciences and research center. The samples were chosen in a 1:1 ration with 150 males and 150 females. The following were the inclusion and exclusion criteria:

Inclusion criteria:

1. Age 20-30 years
2. Complete set of fully erupted teeth
3. Periodontally healthy teeth
4. Non-attrited and intact teeth
5. Non-carious teeth
6. Non-hypoplastic teeth
7. No history or clinical evidence of trauma, restorations, orthodontic treatment or prosthesis
8. Satisfactorily aligned teeth without spacing, diastema or crowding

Exclusion criteria: Age below 20 years or above 30 years**.** Carious teeth, restored teeth, fractured teeth, hypoplastic teeth, teeth with prosthesis, attrited teeth, mobile teeth.

Armamentarium:

Divider

Sliding vernier calliper (with a resolution of 0.02 mm)

Methodology:

Maxillary and mandibular canine widths:

After obtaining informed consent, the maximum MD dimension of all four permanent canines (MxRC for maxillary right canine, MxLC for maxillary left canine, MnLC for mandibular left canine, MnRC for mandibular right canine) were measured between the anatomic contact points directly on the subject, using a sliding vernier calliper held parallel to the occlusal plane [Figure 1]. In a situation where the placement of the sliding vernier calliper was found to be difficult, a manual divider with very fine tips was used. Later the divider distance was measured with the same vernier calliper.

Maxillary and mandibular inter-canine distance:

It was measured as the linear distance between the tips of right and left maxillary (MxCW) and mandibular (MnCW) canines.

All the measurements were done by a single examiner to eliminate inter-observer error. Each reading was taken thrice and the average of three values was obtained in order to minimize intra-observer error. The data thus collected was tabulated as shown in tables 1, 2 and subjected to statistical analysis (SPSS software package version 22). The mean, range and standard deviation (SD) were calculated for the size of the teeth. Univariate analysis using Student's unpaired t-test was used to test for statistical difference between the means.

Maxillary and mandibular canine index:

The formula used to calculate the maxillary canine index (MxCI) and mandibular canine index (MnCI) was adapted from that used by Parekh et al (2012) and Rao et al (1989).[8,16]

Maxillary canine index (MxCI) =

$$\frac{\text{Mesio-distal crown width of maxillary canine}}{\text{Maxillary canine inter-canine distance}}$$

Mandibular canine index (MnCI) =

$$\frac{\text{Mesio-distal crown width of mandibular canine}}{\text{Mandibular canine inter-canine distance}}$$

Percentage of sexual dimorphism was calculated using the formula given by Garn et al (1967)[17]:

Percentage of sexual dimorphism =

$(X_m / X_f) - 1 \times 100$

Where,

X_m – Mean value of males

X_f – Mean value of females

RESULTS

It was observed that, maxillary canine width (MxCW) in females was slightly more that of males but the difference was not statistically significant. However, the mandibular canine width (MnCW) in males was significantly higher as compared to females [Table 1]. The mesio-distal widths of all the canines (MxRC, MxLC, MnLC, MnRC) were significantly higher in males than in females [Table 1].

Both maxillary right as well as left canine indices (MxRCI, MxLCI) was significantly higher in males than the females. But, the means of right and left mandibular canine indices (MnRCI, MnLCI) were almost the same. Hence, no statistically significant value was obtained [Table 1, Figure 2,3].

Table 2 gives the sexual dimorphism calculated based upon the range of mesio-distal dimensions of maxillary and mandibular right and left canines in males and females. In this study, statistically significant sexual dimorphism was exhibited by two teeth [Figure 4] maxillary right canine (8.34%) and maxillary left canine (13.04%).

Table 1: Description of each tooth selected for the study (Mean value, standard deviation and p values)

Parameters (mm)	Sex	N	Mean	SD	SE	Mean Diff	95% CI		t	df	P-Value
							Lower	Upper			
MxCw	Males	150	34.48	2.48	0.20	-0.493	-1.103	0.116	-1.593	298	0.112
	Females	150	34.97	2.87	0.23						
MnCw	Males	150	27.89	1.54	0.13	1.167	0.668	1.665	4.604	298	<0.001*
	Females	150	26.72	2.70	0.22						
MxRC	Males	150	8.83	0.63	0.05	0.647	0.515	0.778	9.685	298	<0.001*
	Females	150	8.18	0.52	0.04						
MxLC	Males	150	8.84	0.63	0.05	0.693	0.558	0.828	10.119	298	<0.001*
	Females	150	8.15	0.56	0.05						
MnLC	Males	150	7.66	0.65	0.05	0.42	0.281	0.559	5.959	298	<0.001*
	Females	150	7.24	0.56	0.05						
MnRC	Males	150	7.66	0.63	0.05	0.513	0.374	0.653	7.238	298	<0.001*
	Females	150	7.15	0.60	0.05						
MxRCI	Males	150	0.26	0.02	0.00	0.021	0.017	0.026	9.009	298	<0.001*
	Females	150	0.24	0.02	0.00						
MxLCI	Males	150	0.26	0.02	0.00	0.023	0.018	0.027	9.123	298	<0.001*
	Females	150	0.23	0.03	0.00						
MnLCI	Males	150	0.27	0.02	0.00	0.001	-0.005	0.007	0.432	298	0.666
	Females	150	0.27	0.03	0.00						
MnRCI	Males	150	0.27	0.02	0.00	0.005	-0.001	0.011	1.535	298	0.126
	Females	150	0.27	0.03	0.00						

*p<0.05

Table 2: Sexual Dimorphism

Tooth	Value of sexual dimorphism in %
Maxillary right canines (MxRC)	8.34
Maxillary left canines (MxLC)	13.04
Mandibular right canines (MnRC)	0
Mandibular left canines (MnLC)	0

DISCUSSION

Gender determination forms an important part of the process of identification. Identification becomes simplified whenever prediction of sex is possible because then missing persons of only that sex need to be considered. Assessment of the DNA profile is most accurate method in identification of individuals. But, linear measurements like odontometric parameters can be used for sex determination in larger populations because they are simple, reliable, inexpensive and easy to measure. However, there are differences in odontometric features in specific populations and also even within the same populations, owing to differences in cultural and environmental factors and also the eating habits.[17-20]

Many studies have been conducted to study the sexual dimorphism using other teeth (maxillary mandibular incisors, canines, premolars and molars).[1,21] Canines, among all the teeth have been found to exhibit greatest sexual dimorphism.[10] The involvements of both X and Y chromosomes in establishing sexual dimorphism based on canine size have been found by many workers.[17] Functionally, canine teeth have greatly evolved since primate days from serving as a tool of aggression to a tool of mastication.[4,22] We, hence, chose both maxillary and mandibular canines to be assessed for sexual dimorphism.

In the present study, the study sample comprised of 300 subjects (150 males and 150 females) from South India. Early permanent dentition provided the best sample for tooth size measurement as these teeth are least subjected to attrition and mutilation, thus minimizing the effect on their mesio-distal dimensions.[23] Therefore, in our study we chose individuals in the age group of 20 years-30 years. Direct measurements were taken on maxillary and mandibular permanent canines using sliding digital vernier calliper (0.02 mm precision). In situations where placement of the vernier calliper was difficult, a divider with fine tips was used and later the measurement was taken from the vernier calliper.

Since it is difficult to measure the bucco-lingual measurements of canines, only the mesio-distal dimensions along with canine widths of maxilla and mandible were measured to evaluate for sexual dimorphism. Acharya and Mainali have also indicated that mesio-distal dimension was better suited for discriminating sexes than bucco-lingual dimension.[9]

Figure 1: Sliding vernier calliper held parallel to occlusal plane.

By performing the univariate analysis on the values obtained, it was observed that the means of mesio-distal dimensions of all the four canine teeth (MxRC, MxLC, MnLC, MnRC) were significantly higher in males than in females. This finding is in accordance with several previously conducted studies.[1,5,8,9,17,21]

This could be because the antero-posterior jaw measurements are larger in males. Arch size influences tooth size, implying that larger jaws in males may attribute to greater mesio-distal dimensions of all the teeth in them as compared to females.[9]

In our study, the mean maxillary canine width (MxCW) in females was slightly more that of males but the difference was not statistically significant. However, the mandibular canine width (MnCW) in males was significantly higher as compared to females. The reason for MxCW to be higher in females in our study could be the random selection of subjects without exact age matching the male and female subjects.

Cassidy and co-workers studied 320 adolescent subjects and concluded that the mandibular arch dimensions were significantly larger in males than in females, medio-laterally as well as antero-posteriorly a sex difference largely established prior to the onset of the adolescent growth spurt.[24]

In the present study, both maxillary right as well as left canine index (MxRCI, MxLCI) was significantly higher in males than the females. However, no statistically significant value was obtained for mandibular right and left canine indices.

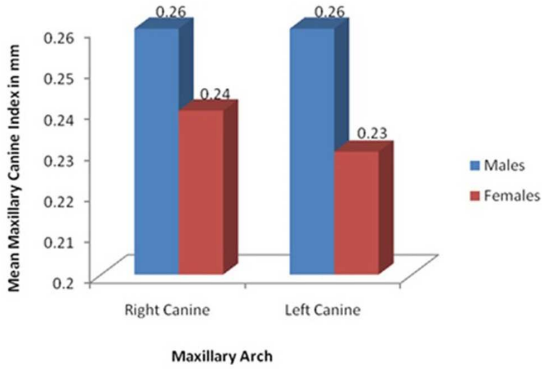

Figure 2: Mean maxillary canine index

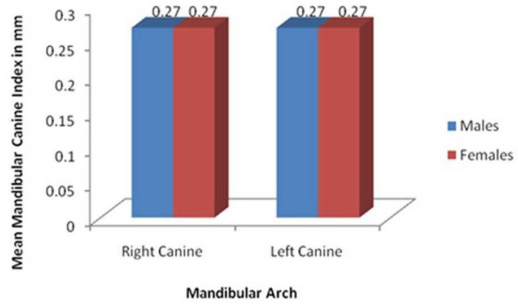

Figure 3: Mean mandibular canine index.

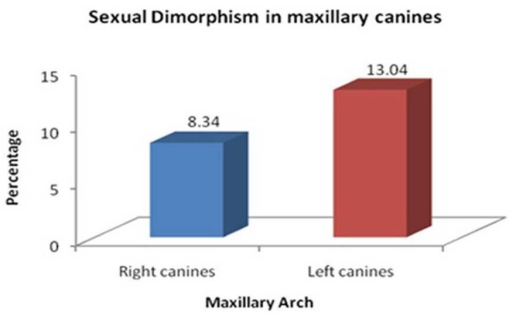

Figure 4: Sexual dimorphism in maxillary canines

In this study, statistically significant sexual dimorphism was exhibited by two teeth maxillary right canine (8.34%) and maxillary left canine (13.04%). This finding is in accordance with some other studies. Maxillary left canines exhibited sexual dimorphism in another study conducted on Indian

population by Parekh et al.[8] In another study on Japanese population, maxillary canines exhibited sexual dimorphism as compared to mandibular canines.[25] Iscan et al[26], Otuyemi et al[27] and Lund et al[28] also reported maxillary canines to have greater sexual dimorphism.

However, studies have been reported where canine teeth of female subjects were larger in all dimensions as compared to those of males indicating a reverse dimorphism.[9] This shows a great diversity that exists in different population groups and the influence of genetic, social, cultural, environmental and racial factors.

The present study was conducted on a small sample of 300 subjects. However, the results obtained are indicative of sexual dimorphism present in maxillary permanent canines. The study can also form a preliminary basis for conducting further research on this topic taking a much larger sample sizes into consideration.

Teeth, particularly, the permanent canines can be of great help in sex determination in cases of mass disasters for forensic identification of individuals. These teeth have been shown in various studies to be beneficial in sex determination. In our study, we tried to evaluate a simple and inexpensive linear method as canine measurement for sexual dimorphism. It was observed that maxillary canines (particularly, maxillary left canine) showed a greater percentage of sexual dimorphism. Thus, maxillary canines can be used as an adjunct along with other accepted procedures for sex determination in mass disasters where fragmentary remains are encountered and sex of individuals is to be determined.

REFERENCES

1. Khangura RK, Sircar K, Singh S, Rastogi V. Sex determination using mesiodistal dimension of permanent maxillary incisors and canines. J Forensic Dent Sci.2011;3(2):81-5.
2. Baoz K, Gupta C. Dimorphism in human maxillary and mandibular canines in establishment of gender. J Forensic Dent Sci.2009;1(1):42-4.
3. Teschler-Nicola M, Prossinger H. Sex determination using tooth dimensions. In: Alt, K.W.Ro'sing and M.F.W. Teschler-Nicola (Eds.), Dental Anthropology, Fundamentals. Limits and prospects, Springer-Verlag,Wien,pp:479-501.
4. Kaushal S, Patnaik VVG, Agnihotri G. Mandibular canines in sex determination. J Anat Soc India. 2003;52(2):119-24.
5. Schwartz GT, Dean MC. Sexual dimorphism in modern human permanent teeth. Am J Physi Anthrop. 2005;128 (2):312-17.
6. Dahberg AA. Dental traits as identification tools. Dent Prog.1963;3:155-60.
7. Black GV. Descriptive anatomy of human teeth. 4th edition. Philadelphia: S.S. White dental Mfg. Co., 1902:pp 435-9.
8. Parekh DH, Patel SV, Zalawadia AZ, Patel SM. Odontometric study of maxillary canine teeth to establish sexual dimorphism in Gujarat population. Int J Biol Med Res.2012;3(3):1935-7.
9. Acharya BA, Mainali S. Univariate sex dimorphism in the Nepalese dentition and use of discriminant function in gender assessment. Forensic Sci Int.2007;173:47-56.
10. Ibeachu PC, Didia BC, Orish CN. Sexual dimorphism in mandibular canine width and inter canine distance of university of Port-Harcourt student, Nigeria. Asian J Med Sci.2012;4(5):166-9.
11. Vishwakarm N, Guha R. A study of sexual dimorphism in permanent mandibular canines and its implications in forensic investigations. Nepal Med Coll J.2011;13(2):96-9.
12. Mohammed QAR, Abdullah MA, Ashraf I, Khan N. Dimorphism of mandibular and maxillary canine teeth in establishing identity.SDJ,1997;9(1):17-20.
13. Anderson DL, Thompson GW. Inter-relationship and sex differences of dental and skeletal measurements. J Dent Res.1973;52:43-8.
14. Dahlberg AA. Forensic Dentistry. J Am Dent Assoc.1976;93:991-5.
15. Dempsey PJ, Townsend GC. Genetic and environmental contributions to variations in human tooth size. Heredity. 2001;86(6):685-93.
16. Rao GN, Rao NN, Pai ML, Kotian MS. Mandibular canine index- a clue for establishing sex .identity. Forensic Sci Int. 1989;42:249-54.
17. Garn SM, Lewis AB. Bucco-lingual size asymmetry and its developmental meaning. Angle Orthod. 1967;37(1):186-93.
18. Vodanovic M, Demo Z, Njemirovskij V, Keros J, Brkic H. Odontometrics: a useful method for sex determination in an archaeological skeletal population? J Arch Sci.2007;34:905-13.
19. Halim A, 2001. Regional and clinical anatomy for dental students: general principles of anthropology. 1st Edn., Modern Publishers, New Delhi, pp:362.
20. Harris EF, Lease LR. Mesiodistal tooth dimensions of the primary dentition: a worldwide survey. Amer J Phys Anthropol.2005;128:593-607.
21. Ruengdit S , Riengrojpitak S, Tiensuwan M, Santiwong P. Sex Determination from Teeth Size in Thais. The 6th CIFS Academic Day 2011; 14-15 September 2011; Impact Muang Thong Thani, Nonthaburi.
22. Eimerl S and Devore I. Physical anthropology and primatology. Time-life international, Cambridge University press, UK,1967;9(1):258-60.
23. Dorris JM, Bernard BW, Kuftinec MM, Stom D. A biometric study of tooth size and dental crowding. Am J Orthod.1981;79:326-36.
24. Cassidy KM, Harris EF, Tolley EA, Keim RG. Genetic influence on dental arch form in orthodontic patients. Angle Orthodontist 1998;5:445-54.
25. Minzuno O. Sex determination from maxillary canine by fourier analysis. Nihon Univ Dent J.1990;2:139-42.
26. Iscan MY, Kedici PS. Sexual variations in bucco-lingual dimensions in Turkish dentition. Forensic Sci Int.2003;137:160-4.
27. Otuyemi OD, Noar JH. A comparison of crown size dimensions of the permanent teeth in a Nigerian and British population. Eur J Ortho.1996;18:623-8.
28. Lund H, Monstad H. Gender determination by odontometrics in Swedish population. J Forensic Odontostomatol.1999;9:17-20.

29. Yuen KK, So LL, Tang EL. Mesiodistal crown diameters of the primary and permanent teeth in Southern Chinese: a longitudinal study. Eur J Orthod.1997;19:721-31.

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