ORIGINAL ARTICLE

Comparison of sexual dimorphism of permanent mandibular canine with mandibular first molar by odontometrics

Aditi Agrawal, Bhari Shranesha Manjunatha[1], Bhavik Dholia[2], Yousef Althomali[3]

Department of Oral and Maxillofacial Pathology, Ahmedabad Dental College and Hospital, Ahmedabad, [2]Department of Oral and Maxillofacial Pathology, KM Shah Dental College and Hospital, Vadodara, Gujarat, India, [1]Department of Dental Anatomy and Oral Biology, Basic Dental Sciences, [3]Department of Orthodontics and Dentofacial Orthopedics, [1,3]Faculty of Dentistry, University of Taif, Kingdom of Saudi Arabia

Address for correspondence:
Dr. Manjunatha BS, Basic Dental Sciences, Faculty of Dentistry, University of Taif, Al-Hawiyah, Taif - 21944, Kingdom of Saudi Arabia.
E- mail: drmanju26@hotmail.com

Abstract

Background and Objectives: Sexual dimorphism is one of important tool of forensic science. The objective of this study is to assess the dimorphic status of mesio-distal (MD) and bucco-lingual (BL) diameter of mandibular canine with mandibular first molar among the students of dental college. This study is of definite significance as sex chromosomes and hormonal production influenced tooth morphology. **Materials and Methods:** The descriptive study adopted the purposive sampling technique, of 50 male and 50 female aged 17-25 years, using study casts for mesio-distal and bucco-lingual dimensions of mandibular canine with mandibular first molar were taken using digital Vernier caliper. The data obtained were subjected to statistical analysis using descriptive statistics and *t*-test to compare MD and BL dimensions in male and female populations and $P \leq 0.05$ was found statistically significant. **Results:** Sexual dimorphism can be predicted by measuring mesiodistal dimension of mandibular canine and mandibular first molar. The left mandibular canine showed more sexual dimorphism (12.66%) in comparison to left mandibular first molar (0.824%) only. Right mandibular canine showed greater dimorphism in MD dimensions (10.94%) in comparison to right mandibular first molar (6.96%). In bucco-lingual dimensions mandibular canine showed less variability when compared with mandibular first molar, thus our study showed more significance on mesio-distal dimensions of both teeth. **Conclusion:** The present study concludes statistically significant sexual dimorphism in mandibular canine over mandibular first molar on study casts. The MD dimensions in mandibular canine and mandibular first molar can help in determining sex and identification of unknown person.

Key words: Bucco-lingual dimension, mesio-distal dimension, odontometrics, odontometry, sexual dimorphism, study casts, vernier caliper

Introduction

In recent years, great interest has been generated in determining the usefulness of teeth for sex determination in different species and populations. Identification of human remains during mass disasters is mainly carried out on bones and teeth as of hindered state of the soft tissues.[1] Forensic dentistry has played crucial, often key role in the identification of victim of mass disasters.[2] In massive tragedies and disasters caused by nature, the dentition is most often preserved, even when the bony structures of the body destroyed as of its physical characteristics.[3] Because teeth are protected by jaw bones so it has the ability to resist better than any skeletal structures, the destructive action of the medium in which they are found.[4] In post mortem destruction and fragmentation, the use of dental morphology to determine sexual dimorphism, a procedure

Access this article online

Website: www.jfds.org

DOI: 10.4103/0975-1475.172449

Quick Response Code

established in anthropological and biological studies have played a significant role.[5] Research on sexual dimorphism and its application to human identification have been few when compared with those of bones. Yet many forensic scientists frequently confront isolated teeth and are asked to determine the sex.[6] Therefore teeth are of great importance because each individual's tooth may represent an opportunity to determine sex on its own unlike a long bone or skull from which a limited number of assessments can be made. The purpose of study is to investigate tooth size differences between the sexes to compare it by odontometry in mandibular canine and mandibular first molar.

According to Boaz *et al*. (2009), teeth are known to have sexual dimorphism as is the systematic difference in form (shape, size and color) between different genders in same species.[7] Sex dimorphism in tooth size and the accuracy of odontometrics, sex prediction is found to vary in different region and researchers have advocated the need of population specific data.[8]

Accordingly, estimation of sex does not represent a problem when a complete skeleton is found. Nevertheless, if only the mandibular bone along with the teeth is found or mandible fragments or even the teeth by themselves are available in the site, so estimation of sex may be performed with the help of teeth dimension.[9]

Mandibular canines have a mean age of eruption of 10.87 years and are least affected than any other teeth by periodontal diseases. They are last teeth to be extracted with respect to age. So, mandibular canine consider to have high degree of sexual dimorphism. But anterior teeth including canine are more prone to be fractured as compared to posterior teeth in trauma such as air disaster, hurricanes, and conflagration or road traffic accidents. So need arise to find sexual dimorphism for mandibular posterior teeth.[10] Thus, comparing sexual dimorphism of permanent mandibular canine with mandibular first molar by odontometry need arises.

Materials and Methods

Total 100 participants aged between 17-25 years were included as this age is appropriate for a study as such because teeth do not show remodelling as in bone and therefore remain unchanged other than attrition and other dental diseases. Blinding of sampling was done and participants' identification number, gender and date of birth were recorded in computer. Intra-oral examination was carried out according to inclusion and exclusion criteria.

Inclusion criteria

Individuals aged between 17-25 years having fully erupted dentition upto first permanent mandibular molar, restorations free, caries free healthy bilateral permanent mandibular first molars and mandibular canine with healthy periodontium.

Exclusion criteria

Individual having any oral habits and teeth with orthodontic wire, attrition, abrasion or erosion, restored or carious adjacent tooth, malposition teeth and developmental anomalies were not included.

Procedure

Impression of the mandibular arch was made with alginate (irreversible hydrocolloid impression material) in perforated trays (no 2, 3, 4). Written consents were obtained from the students who underwent examinations and or impression making. Alginate impressions were poured immediately with type IV dental stone to minimize dimensional changes. Dental cast were trimmed to remove excess dental stone. Buccolingual and mesiodistal dimension of the permanent mandibular canine and mandibular first molar were measured by using digital vernier caliper (resolution 0.01 mm). Crown was measured bucco-lingual by measuring greatest distance between facial and lingual surfaces of the crown and parallel to long axis of tooth from both sides' right and left and crown mesio-distal between its contact points [Figures 1-4].

MD diameter of crown:- This measurement is the greatest mesio-distal dimensions between contact points of teeth on either side of jaw.

BL diameter of crown:- This measurement is the greatest distance between buccal and lingual surfaces of crown taken at right angle to the plane in which mesio-distal diameter is taken.

The measurements were performed by one person and all values were taken to two decimal places. Intra-observer error was assessed by using vernier caliper on 50 male and 50 female student study casts at a different time by the same observer. Good quality study casts were made. The mean value of MD and BL dimensions of male and female were subjected to following formula to calculate sexual dimorphism.

Percentage of sexual dimorphism = $[(X_m/X_f)-1] \times 100$

Where X_m = mean male tooth dimension, X_f = mean female tooth dimension.

Results

The following parameters were measured and compared on study casts for MD and BL dimensions for right and left mandibular canine and mandibular first molar.

- It was observed that the mean values of MD diameter showed statistically significant differences between male and female with $P < 0.05$ measured both in mandibular canine and mandibular first molar teeth when compared to bucco-lingual dimensions
- The mean values of the parameters were greater for mesio-distal width on the left side than on right side when it is measured for male mandibular canine than male mandibular first molar
- The student *t* test showed that the difference in mean values of the parameters between the right and left side of mandibular canine were statistically significant with $P < 0.001$ when compared to mandibular first molar
- Sexual dimorphism was found to be 10.94% and 12.66% in MD dimensions of right and left mandibular canine respectively [Table 1]. When compared to 6.96% and 0.824% of right and left mandibular first molar [Table 2]
- Sexual dimorphism was found 8.33% and 12.65% in BL dimensions of the right and left mandibular canine respectively when compared to 6.62% and 6.75% of right and left mandibular first molar [Tables 1 and 2]
- Among the mandibular first molar right side was found to exhibit more dimorphism 6.96% in terms of mesio-distal dimensions
- Mandibular first molar on left side has less dimorphism 6.75% in terms of bucco-lingual dimensions
- When compared, MD dimensions of mandibular canine exhibit greater dimorphism with mandibular first molar
- The present study is an attempt to establish sex differentiation through simple odontometrics technique. This study focused on bucco-lingual and mesio-distal measurements for male and female on permanent mandibular canine and mandibular first molar. Thus, bucco-lingual and mesio-distal diameter of right and left of mandibular canine and mandibular first molar in male and female were measured on study casts. The comparison of mean values of parameters measured between male and female showed highly significant differences of $P < 0.005$. According to statistical values mandibular canine showed more significance in Garn's

Figure 1: Photograph showing bucco-lingual width of mandibular canine using digital vernier caliper

Figure 2: Photograph showing mesio-distal width of mandibular canine using digital vernier caliper

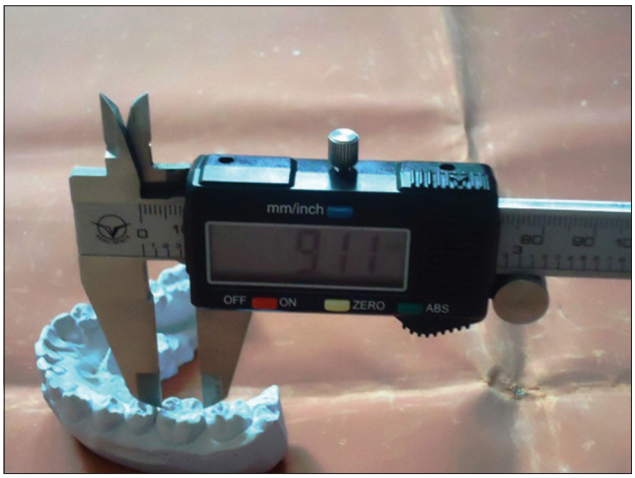

Figure 3: Photograph showing mesiodistal width of mandibular first molar using digital vernier caliper

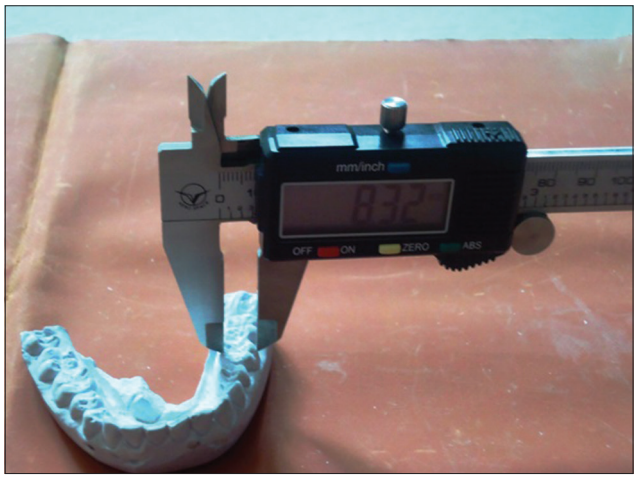

Figure 4: Photograph showing bucco-lingual width of mandibular first molar using digital vernier caliper

ratio of MD dimensions when compared to mandibular first molar [Table 3]
- Student *t* test showed MD of mandibular canine 4.85 more than BL 3.61 and mandibular first molar MD dimension 3.901 > than BL dimensions 3.145 [Tables 4 and 5]
- The mean MD of right and left mandibular canine are significantly different in male and female. Student *t* test for mesiodistal width of left mandibular canine is more than the right mandibular canine [Table 6]. which is supported by Vishwakarma and Guha[11] study
- Application of student *t* test and *P* value suggest that mandibular canine showed high degree of sexual dimorphism over mandibular first molar in terms of MD dimension [Table 6].

Discussion

Accurate sex prediction is perhaps the most important step in post-mortem reconstructive identification of skeletal remains since it excludes approximately half of the population. This allows investigators and law enforcers to undertake a more focused search of the missing persons' files, and a potentially swift recovery of ante-mortem records. Biological analysis of hard tissues is shown to produce virtually 100% accurate sex identification.[12,13]

Table 1: Comparison of dimensions (mean) for male and female in mandibular canine

Gender	Mandibular canine (width (mm))			
	Right side		Left side	
	Mesio-distal	Bucco-lingual	Mesio-distal	Bucco-lingual
Male	6.79	6.37	6.67	6.50
Female	6.12	5.88	5.92	5.77
Sexual dimorphism (%)	10.94	8.33	12.66	12.65

Table 2: Comparison of dimensions (mean) for male and female in mandibular first molar

Gender	Mandibular first molar (width (mm))			
	Right side		Left side	
	Mesio-distal	Bucco-lingual	Mesio-distal	Bucco-lingual
Male	10.44	9.65	9.80	9.64
Female	9.76	9.05	9.72	9.03
Sexual dimorphism (%)	6.96	6.62	0.82	6.75

Table 3: Garn 's ratio and sexual dimorphism in mandibular canine and mandibular first molar

Gender	Mandibular canine (width (mm))		Mandibular first molar (width (mm))	
	Mesio-distal	Bucco-lingual	Mesio-distal	Bucco-lingual
Male	6.73	6.32	10.34	9.64
Female	6.02	5.88	9.74	9.04
Garn's ratio	11.75	7.37	6.16	6.65

However, it is not uncommon for investigative agencies to advice against invasive procedures that result in destruction of evidentiary material, thus necessitating the use of anthroposcopic and/or anthropometric parameters.

Sexual dimorphism in tooth measurements has been evaluated for decades, with published reports on male and female odontometric differences available from various countries and diverse population groups. The most dimorphic dimension was bucco-lingual cervical diameter followed by buccolingual crown diameter. European population groups presented the highest degree in sexual dimorphism in teeth whereas native South Americans the lowest.[14] Surprisingly, though, studies that have gauged sex differences in tooth size in South Asians in general, and Indians in particular are few and recent ones. The fact that most teeth complete development before skeletal maturation makes the dentition a valuable sex indicator particularly in young individuals.[15]

Univariate analysis of the study showed that Mesio-distal dimensions of male dentition are greater than those of female which is in accordance to previous studies. Studies

Table 4: Student *t*-test and descriptive statistics in mandibular canine

Gender (width)	*N*	Mean	Standard deviation	Standard error mean	Student "*t*" test	Degree of freedom	*P*
Mesio-distal							
Male	50	6.73	0.66668	0.09430	4.854	98	0.000
Female	50	6.02	0.79134	0.11191			
Bucco-lingual							
Male	50	6.32	0.62843	0.088874	3.614	98	0.000
Female	50	5.88	0.58066	0.082118			

Table 5: Student *t*-test and descriptive statistics in mandibular first molar

Gender (width)	*N*	Mean	Standard deviation	Standard error mean	Student "*t*" test	Degree of freedom	*P*
Mesio-distal							
Male	50	10.33	0.72856	0.1030349	3.901	98	0.000
Female	50	9.74	0.791411	0.1119224			
Bucco-lingual							
Male	50	9.64	0.9111322	0.1288536	3.145	98	0.002
Female	50	9.04	0.9981178	0.1411552			

Table 6: "*t*" test and *P* value

Value	Mandibular canine				Mandibular first molar			
	Right side		Left side		Right side		Left side	
	MD	BL	MD	BL	MD	BL	MD	BL
T test	4.181	3.567	4.734	2.806	3.738	2.731	3.032	2.941
P value	0.000	0.001	0.000	0.006	0.000	0.007	0.003	0.004

MD: Mesio-distal, BL: Bucco-lingual

on tooth morphology have in the past been conducted using either intraoral measurements or measurements on casts. Garn *et al*. (1967) and Nair *et al*. (1999) have found that the mandibular canines to exhibit the greatest sexual dimorphism among all teeth. Dahlberg consider mandibular canines as the 'key teeth' for personal identification.[16-18]

Hashim and Murshid (1993) conducted a study on Saudi males and females in the age group of 13-20 years to determine the highest likelihood of dimorphism and found that only the canines in both the jaws exhibited a significant sexual difference while the other teeth did not. They also concluded that there was no statistically significant difference between the left and right sides suggesting that measurements of teeth on one side could be truly representative when the corresponding measurements on other side were unavailable. A study by Kaushal *et al*. found a statistically significant sexual dimorphism in mandibular canines in 60 subjects of North Indian population and the mandibular left canine was seen to exhibit greater sexual dimorphism.[10,19]

Schield *et al*. observed sexual difference in tooth size among American black, European and Mongoloid populations. The degree of sexual dimorphism of mandibular canine width was more in Ohio Caucasians and Australian aborigines than in Pima Indians and Tristanite population.[20]

The present study also states that the sexual dimorphism in mandibular canines. Only two studies were reported where maxillary canines were studied. Mohd. Abdulla reported the difference in Saudi population but with a low degree of sexual dimorphism (not statistically significant).Latest study reported by Sharma and Gorea on North Indian population (Patiala) supported our findings that statistically significance sexual dimorphism in present in case of canine. Similarly low degree of sexual dimorphism was reported by Al Rifaiy *et al*. in Saudi Arabian population and by a study of human fossil excavated at Ra's Al-Hamra, Eastern Arabian Coast, which showed a general low degree of sexual dimorphism of mandibular canine teeth.[21,22]

Acharya and Mainalli found dimorphism in the mesio-distal dimension of mandibular second premolar in Nepalese population. The finding could be attributed to evolution resulting in a reduction in sexual dimorphism, causing an overlap of tooth dimension in modern males and females.[23]

In the present study, mean mesio-distal dimensions of males are found to be larger than those of females for mandibular canine and mandibular first molar [Tables 1 and 2] Significant differences are observed between sexes of teeth consistent with Garn *et al*.[16] who indicated that teeth of males were larger than females. According to Moss it is because of the greater thickness of enamel inn males due to the long period of amelogenesis as compared to females. However, in females the completion of calcification of crown occurs earlier in both deciduous and permanent dentition as quoted by de Vito. According to Pratiba *et al*.[24] sex chromosomes cause different effects on tooth size. The Y chromosome influences the timing and rate of body development, thus producing slower male maturation and acts additively to a greater extent than the X chromosomes.

Conclusion

Our study establishes the fact about permanent mandibular canine with mandibular first molar by odontometrics can be used as adjunct with other parameters for the comparison of sexual dimorphism for a limited value as in cases of highly damaged bodies where only teeth are available for sex determination. It is concluded that comparison of MD in mandibular canine and mandibular first molar showed a greater sexual dimorphism in males. It is recommended to consider the entity for sex determination along with odontometric and skeletal traits as it has shown moderate magnitude of dimorphism.

References

1. Ndiokwelu E, Miquel JL, Coudert N. Identification of victims of catastrophes: Introduction to the role of forensic odontology. Odontostomatol Trop 2003;26:33- 6.
2. van der Kuijl B, van der Pols LC. Forensic odontological identification of disaster victims. Experience with the disaster of the Martinair DC-10 in Faro, Portugal. Ned Tijdschr Tandheelkd 1995;102:236-42.
3. Ermenc B, Rener K. Possibilities for dental identification in the case of mass disaster in Slovenia. Forensic Sci Int 1999;103(Suppl 1):S67-75.
4. Toribio SL, Soto IH. Forensic dentistry in disaster situations. Rev Cubana Estomatol 1995;32:41-4.
5. Edgar HJ. Prediction of race using characteristics of dental morphology. J Forensic Sci 2005;50:269-73.
6. Ateş M, Karaman F, Işcan MY, Erdem TL. Sexual Differences in Turkish Dentition. Leg Med (Tokyo) 2006;8:288-92.
7. Boaz K, Gupta C. Dimorphism in human maxillary and mandibular canines in establishment of gender. J Forensic Dent Sci 2009;1:42-4.
8. Prabhu S, Acharya AB. Odontometric sex assessment in Indians. Forensic Sci Int 2009;192:129.e1-5.
9. Kavitha B. Sex Determination in Teeth. Chennai, The Tamil Nadu Dr. M.G.R. Medical University; 2005. p. 23.
10. Kaushal S, Patnaik VV, Agnihotri G. Mandibular canines in sex determination. J Anat Soc India 2003;52:119-24.
11. Vishwakarma N, Guha R. A study of sexual dimorphism in permanent mandibular canines and its implications in forensic investigations. Nepal Med Coll J 2011;13:96-9.
12. Sivagami AV, Rao AR, Varshney U. A simple and cost-effective method for preparing DNA from the hard tooth tissue, and its use in polymerase chain reaction amplification of amelogenin gene segment for sex determination in an Indian population. Forensic Sci Int 2000;110:107-15.
13. Morikawa T, Yamamoto Y, Miyaishi S. A new method for sex determination based on detection of SRY, STS and amelogenin

gene regions with simultaneous amplification of their homologous sequences by a multiplex PCR. Acta Med Okayama 2011;65:113-22.

14. Zorba E, Moraitis K, Manolis SK. Sexual dimorphism in permanent teeth of modern Greeks. Forensic Sci Int 2011;210:74-81.
15. Lund H, Mörnstad H. Gender determination by odontometrics in a Swedish population. J Forensic Odontostomatol 1999;17:30-4.
16. Garn SM, Lewis AB, Swindler ADR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. J Dent Res 1967;46:963-72.
17. Nair P, Rao BB, Annigeri RG. A study of tooth size, symmetry and sexual dimorphism. J Forensic Med Toxicol 1999;16:10-3.
18. Dahlberg AA. Dental traits as identification tools. Dent Prog 1963;3:155-60.
19. Hashim HA, Murshid ZA. Mesiodistal tooth width. A comparison between Saudi males and females. Part 1. Egypt Dent J 1993;39:343-6.
20. Schields ED, Altschuller A, Choi EY, Michaud M. Odontometric variation among American black, European, and Mongoloid populations. J Craniofac Genet Dev Biol 1990;10:7-18.
21. Abdullah MA. A cross-sectional study of canine tooth dimorphism in establishing sex identity: A comparison of two different populations. Cairo Dent J 1998;14:191-6.
22. Al-Rifaiy MQ, Abdullah MA, Ashraf I, Khan N. Dimorphism of mandibular and maxillary canine teeth in establishing sex identity. Saudi Dent J 1997;9:17-20.
23. Acharya AB, Mainali S. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. Forensic Sci Int 2007;173:47-56.
24. Rani RM, Mahima VG, Patil K. Bucco-lingual dimension of teeth - An aid in sex determination. J Forensic Dent Sci 2009;1:88-92.

How to cite this article: Agrawal A, Manjunatha BS, Dholia B, Althomali Y. Comparison of sexual dimorphism of permanent mandibular canine with mandibular first molar by odontometrics. J Forensic Dent Sci 2015;7:238-43.

Source of Support: Nil, **Conflict of Interest:** The authors declare that they have no conflict of interest in the preparation andpublication of this article.