



ORIGINAL RESEARCH

SEXUAL DIMORPHISM AND ODONTOMETRIC ANALYSIS OF PERMANENT MAXILLARY AND MANDIBULAR FIRST MOLAR: AN ANTHROPOMETRIC STUDY

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ARTICLE INFO

Article History:

Received 20<sup>th</sup> January, 2017  
Received in revised form  
10<sup>th</sup> February, 2017  
Accepted 26<sup>th</sup> March, 2017  
Published online 30<sup>th</sup> April, 2017

Key words:

Bucco-lingual width,  
Dental cast,  
Mesio-distal width,  
Permanent first molar,  
Personal identification,  
Sexual dimorphism.

ABSTRACT

**Background:** Sexual variations in human skeleton and dentition have been of great concern for both odontologists and anthropologists. The tooth crown size is a valuable tool and provides significant information on human evolution and biological alterations in forensic evaluation.

**Objectives:** To determine the mesio-distal (MD) and bucco-lingual/palatal (BL) crown width of all permanent maxillary and mandibular first molars on dental cast for sex determination.

**Material and Method:** A prospective study was undertaken in 200 participants of age 16-35 years. The BL and MD crown width of all the permanent first molars was measured on maxillary and mandibular dentalcast by using digital vernier calliper, separately by two investigators. The measurements were subjected to statistical analysis, using Pearson's correlation coefficient, Kappa test, Chi Square Test, linear regression model.

**Results and Observations:** The maximum number of participants were between the age group of 16-20 years (16%). The male participants (55%) outnumbered the female participants (45%). The MD crown width of maxillaryfirst molar ( $10.51 \pm 0.761$  for males,  $10.24 \pm 0.586$  for females) and for mandibular first molar ( $10.68 \pm 0.750$  for males,  $10.38 \pm 0.671$  females) and the BL crown width for maxillary first molar ( $9.91 \pm 0.858$  males,  $9.63 \pm 0.668$  for females) and for mandibular first molar ( $9.75 \pm 0.756$  for males,  $9.51 \pm 0.649$  for females), was highly significant ( $p < 0.05$ ). An equation was derived for estimating sex from the tooth crown measurement and the sectioning points were determined based on maxillary and mandibular first molar. The accuracy for determining sex from maxillary and mandibular first molar crown was 64.0 % and 66.5 % respectively.

**Conclusion:** The maxillary and mandibular first molar exhibited sexual dimorphism. But mandibular first molar is the most significant tool for determining sex.

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Citation: Dr. Chandramani B. More, Dr. Rao Naman Rajeshkumar, Dr. Ruchita Peter and Dr. Pranay T. Patel, 2017. "Sexual dimorphism and odontometric analysis of permanent maxillary and mandibular first molar: An anthropometric study", *International Journal of Current Research*, 9, (04), 49364-49367.

INTRODUCTION

According to Dorland's dictionary identity is the aggregate of characteristics by which an individual is recognized by himself and others. Establishment of personal identification of both, the living and the dead is often necessary for a variety of reasons. Identification of human remains during mass disasters is hindered by the state of the soft tissue. With relevant expertise, it is carried out on bones and teeth. (Fernandes et al., 2013; Suazo et al., 2008) Sexual variations in human skeleton and dentition have been of great concern for both odontologists and anthropologists. (Saboia et al., 2013; Vodanovic et al., 2007) Sexual dimorphism refers to the systemic difference in

the form between individuals of different sexes in the same species or it refers to those differences in size, stature and appearance between male and female that can be applied to dental identification because no two mouths are same. (Vodanovic et al., 2007) Teeth being resistant to post-mortem destruction and being chemically stable is an excellent material for odontologic and forensic investigations. Therefore, teeth can be used as a tool of reconstructive identification particularly in cases of major catastrophes. (Agarwal et al., 2015) Morphologically the structure of first molar is similar in male and female but it shows dimorphism in terms of the tooth size, which varies as per the culture, environment, racial and genetic factors. (Girija and Ambika, 2012) Odontometrics provides great deal of information on sex, as there is difference in odontometric features amongst same population and even in different population, hence first molar can be used in sex

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determination. The present study was designed to determine sexual dimorphism based on bucco-lingual and mesio-distal crown width of all permanent maxillary and mandibular first molars, and to determine the reliability of maxillary and mandibular first molar as a tool for determining sex. (Agarwal et al., 2015; Girija and Ambika, 2012)



Figure 1. Tooth crown measurements on dental cast with the help of digital vernier calliper

## MATERIALS AND METHODS

A prospective cross sectional study was undertaken in 200 participants between agegroup of 16-35 years. The Permission was obtained from Institutional Ethics committee of Sumandeep Vidyapeeth University, Vadodara with approval no. SVIEC/ON/Dent/RP/15024dtd.08/04/2015 and study completion no. SVIEC/ON/Dent/RP/16009 dtd. 10/05/2016. Participants having completely erupted all the permanent first molars with mesial and distal contacts and which are free from dental caries, dental anomalies and wasting diseases were included in the study. After obtaining informed consent, each participant was subjected to maxillary and mandibular arch impression with irreversible hydrocolloid (alginate) material, from which a dental cast of type II dental stone was prepared for study purpose. The two investigators separately studied and measured the bucco-lingual and mesio-distal crown width of all the permanent first molars on the dental cast by using digital vernier calliper (Figure 1). The recorded data was statistically analyzed, using Pearson's correlation coefficient, Kappa test, Chi Square Test, linear regression model. The probability 'p' value was  $p < 0.05$ .

## RESULTS AND OBSERVATION

In the present study, the maximum number of participants were between the age group of 16-20 years (34.5%) and the mean age of  $23.91 \pm 4.863$  years. The study had maximum number of male participants (55%). The MD crown width of maxillary first molar ( $10.51 \pm 0.761$  for males,  $10.24 \pm 0.586$  for females) and for mandibular first molar ( $10.68 \pm 0.750$  for males,  $10.38 \pm 0.671$  females) and the BL crown width for maxillary first molar ( $9.91 \pm 0.858$  males,  $9.63 \pm 0.668$  for females) and for mandibular first molar ( $9.75 \pm 0.756$  for males,  $9.51 \pm 0.649$  for females), was highly significant ( $p < 0.05$ ). (Table no. 1) The verification of gender variability in relation to the width of maxillary and mandibular first molar tooth was made through Box's M statistics. The application of F test resulted in obtaining approximate value for maxilla and mandible as 4.115 and 1.000 respectively. The degree of freedom, df1 and df2, for maxillary and mandibular first molar was 3 and 2.346E7 respectively. The obtained 'p' value for maxilla (0.006) was statistically significant ( $p < 0.05$ ) whereas for mandible (0.392) was not significant. This intergroup difference proves that male and female sex can be differentiated easily from the maxillary first molar. (Table no. 2) An equation was derived for estimating sex from the tooth crown measurement and the sectioning points were predicted through Canonical discriminant function analysis (Table no. 3), and the formula was derived as:

### For Maxillary first molar-

$$\text{Estimated Sex} = -16.132 + 0.923 (\text{mesio-distal width}) + 0.669 (\text{bucco-lingual width})$$

### For Mandibular first molar-

$$\text{Estimated Sex} = -16.451 + 1.035 (\text{mesio-distal width}) + 0.574 (\text{bucco-lingual width})$$

From maxillary first molar, out of 110 males, 67 males were correctly predicted as 'Male' and out of 90 females, 61 females were correctly predicted as 'Female'. From mandibular first molar, out of 110 males, 70 males were correctly predicted as 'Male' and out of 90 females, 63 females were correctly predicted as 'Female'. (Table no. 4) Thus, the accuracy for determining sex from maxillary and mandibular first molar crown was 64 % and 66.5 % respectively. (Table no. 5)

Table 1. Correlation of mean values of tooth crown dimensions in Males & Females

Tooth	Parameters	Sex	Mean $\pm$ SD (in mm)	Obtained 'p' value	Significance
Maxillary	MD	Male	$10.51 \pm 0.761$	0.006	Highly Significant ( $p < 0.05$ )
		Female	$10.24 \pm 0.586$		
	BL	Male	$9.91 \pm 0.858$	0.010	
		Female	$9.63 \pm 0.668$		
Mandibular	MD	Male	$10.68 \pm 0.750$	0.004	
		Female	$10.38 \pm 0.671$		
	BL	Male	$9.75 \pm 0.756$	0.019	
		Female	$9.51 \pm 0.649$		

(MD- mesio- distal width, BL- bucco-lingual width, p- probability value)

**Table 2. Verification of gender variability in relation to the width of maxillary and mandibular first molar tooth by Box's M statistics**

Arch		Maxilla	Mandible
Box's M		12.485	3.033
F	Approx.	4.115	1.000
	df1	3	3
	df2	2.346E7	2.346E7
	P-value	0.006	0.392

**Table 3. Canonical discriminant function for male and female using parameters of maxillary and mandibular first molar**

Tooth	Parameter	Values of Discriminant function coefficient	Values of Constant	Sectioning point	
				Male	Female
Maxillary first molar	mesio-distal width	0.923	- 16.132	0.199	- 0.243
	bucco-lingual width	0.669			
Mandibular first molar	mesio-distal width	1.035	- 16.451	0.200	- 0.245
	bucco-lingual width	0.574			

**Table 4. Classification result using study parameters in predicting accuracy for determining sex**

Result	Predicted group membership							
	Maxillary First Molar				Mandibular First Molar			
	Male (n=110)		Female (n=90)		Male (n=110)		Female (n=90)	
	N	%	n	%	n	%	n	%
Positive	67	60.9	61	67.8	70	63.6	63	70
Negative	43	39.1	29	32.2	40	36.4	27	30
Total	110	100	90	100	110	100	90	100

**Table 5. Accuracy rate for determining sex from maxillary and mandibular first molar crown:**

Result	Maxillary First Molar		Mandibular First Molar	
	Male (n=110)	Female (n=90)	Male (n=110)	Female (n=90)
	n	n	n	n
Positive	67	61	70	63
Accuracy	64 %		66.5 %	

## DISCUSSION

Human identification is based on scientific principles mainly involving fingerprints, dental records and DNA analysis. (More *et al.*, 2015; More *et al.*, 2009) The DNA profile will provide accurate results but the measurements in anthropometric or odontometric studies used for sex determination, are simple, reliable, inexpensive, and easy to measure. When compared, the dental record provide durable evidence in post mortem identification. (Gupta and Daniel, 2016; Acharya, 2008) The structure and morphology of the teeth in men and women is usually same except the size. Hence, crown is an important part which provides considerable information on human evolution and in forensic assessment. (Ahmed *et al.*, 2014) The degree of dimorphism differs with different population. By using certain metric and non-metric dental traits, various studies have proved that teeth have greatest sexual dimorphism, especially with permanent canines and molars. (Ahmed *et al.*, 2014) The present study was conducted to establish the sexual dimorphism through odontometric analysis from all permanent first molars. Tooth crown dimensions are reasonably accurate predictors of sex and are good adjuncts for sex differentiation. (Ahmed *et al.*, 2014) In the present study, the difference of mesio-distal and bucco-lingual width of maxillary and mandibular first molar in male and female was highly significant ( $p < 0.05$ ). Our findings matched with the findings of Sonika *et al.* (2011), Narang *et al.* (2015), Rani *et al.* (2009), and Banerjee *et al.* (2016). Thus it is assumed that the comparison of sexual dimorphism in teeth among different groups will differ and also between different populations. The

degree and pattern of sexual dimorphism in relation to size of teeth will vary between one generation to another and also in population. (Narang *et al.*, 2015; Banerjee *et al.*, 2016) It is significant to note that the BL dimension showed sexual difference between males and females, wherein the male dimensions were larger and statistically significant ( $p < 0.05$ ). This suggests that males had nearly square dimensions. In contrast to this, females had lesser BL dimensions than MD dimensions. This observation can be attributed to the difference in the thickness of enamel in males and females, as the amelogenesis in males is for longer duration. Also, in females the calcification of the crown is completed very early as compared to males. Information concerning tooth size aids in age and sex assessment of human remains. With the standard tooth size, the identification is simplified. In the present study, the verification of gender variability in relation to the width of maxillary and mandibular first molar tooth by Box M statistics was statistically significant in maxillary first molar and not significant for mandibular first molar. (Narang *et al.*, 2015; Lakhanpal *et al.*, 2013) Thus confirming that male and female sex can be differentiated easily from the maxillary first molar. Our this finding matched with the findings of Lakhanpal (2013) There is variation in odontometric features in particular population and even in the same population. In relation to historical, evolutionary and forensic context, it is necessary to determine specific population values for easy identification on the basis of tooth measurements. (Narang *et al.*, 2015) In the present study, the sex was determined through canonical discriminant function analysis, and the formula was derived. Further, the accuracy in determining the sex from maxillary

and mandibular first molar was 64 % and 66.5 % respectively. Our findings were quite similar to the findings of Indian studies- Ahmed *et al.* (2014) (71%), Narang *et al.* (2015) (67.5 to 88%), and Rani *et al.* (2009) (66.7%). Thus, it may be concluded that sexual dimorphism of teeth is population specific. The BL and MD dimensions of maxillary first molar and BL dimension in mandibular first molar can assist sex determination. It is recommended to conduct studies with univariate and multivariate analysis of permanent first molars along with other odontometric and skeletal traits on various populations for sex assessment. (Narang *et al.*, 2015; Rani *et al.*, 2009; Lakhanpal *et al.*, 2013)

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