Assessment of various odontometric parameters in accuracy of sexual dimorphism

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Abstract
Sex identification is one of the most important procedures in the forensics. Teeth are a potential source of information in this process. This study describes sexual dimorphism in various parameters derived from the oral cavity. A total number of 200 subjects in the age range of 17 to 25 years were studied with the help of study casts to study the following parameters for sexual dimorphism- mesio-distal dimension of maxillary central incisor, maxillary first molar, mandibular canine, mandibular first molar; cervico-incisal dimension of maxillary central incisor, bucco-lingual dimensions of mandibular canine and mandibular intercanine width. Sexual dimorphism in the various parameters was assessed using statistical analysis. The p-value, specificity and sensitivity of various parameters were calculated and compared. Results showed mesiodistal diameter of upper and lower molars, cervico-incisal diameter of central incisor and canine index were most accurate parameters for determining sexual dimorphism.

Keywords: Dimorphism, Intercanine width, Canine index.

Introduction
Despite leaps in modern technology, medical breakthroughs and the geographical changes that the last century has brought, crime still persists in all aspects of our lives. Through the specialty of forensic odontology, dentistry plays a small but significant role in this process. By identifying the victims of crime and disaster through dental records, dentists assist those involved in crime investigation. The most common role of the forensic odontologist is the identification of deceased individuals.[1,2] Sex assessment from tooth measurements is a useful adjunct to identify forensic and anthropological skeletal specimens.[3] Consequently, teeth being relatively resistant to decay therefore, careful study of teeth can enable determination of gender. Sexual dimorphism in tooth size has been explored over the past half-century, with odontologists and anthropologists focussing on the use of buccolingual (BL) and mesiodistal (MD) dimensions termed linear measurements.[4] Dental indices are shown to have evolutionary, developmental and clinical significance.[5] However, their use in forensic sex identification has not been explored fully. The present study has, therefore, ventured to explore sexual dimorphism which includes various dental parameters, indices and their specificity.

Materials and Methods
A total number of 200 subjects served as a sample for the present study. The study was conducted on the patients visiting for regular check up in the age range 17 to 25 years in the Department of Dentistry, Govt. Medical College. Impressions of maxillary and mandibular arches were made with the alginate material (normal set type), and were poured immediately with type II dental stone so as to minimize the dimensional changes in the study casts.

The following parameters were recorded on the casts
1. Mesio-distal dimensions of maxillary central incisor
2. Mesio-distal dimensions of maxillary first molar.
3. Cervico-incisal dimension of maxillary central incisor.
4. Mesio-distal dimensions of mandibular canine
5. Mesio-distal dimensions of mandibular first molar
6. Bucco-lingual dimensions of mandibular canine.
7. Mandibular intercanine width.
8. Canine index.

Mesio-distal (MD) diameter of incisor, canine and molars were measured using digital vernier caliper measuring the greatest mesiodistal dimension between the contact points of the tooth. Cervico-incisal (CI) measurement of incisor was measured from tip of the incisal cusp to cervical part of crown. Bucco-lingual (BL) measurement of canine was measured from buccal ridge to the cingulum. The mandibular canine index was calculated by dividing the mean value of mesio-distal width of the lower canine model with that of mean value of inter-canine arch distance in lower models.

Results
The findings were subjected to statistical analysis and the results were tabulated as follows:

Table 1: Measurements of different parameters on study casts

Parameter	Gender	Measurement (in mm)	
Max. molar MD	Male	Minimum	10.00
		Maximum	12.50
	Female	Minimum	9.00
		Maximum	11.50
Mand. molar MD	Male	Minimum	10.50
		Maximum	13.00
	Female	Minimum	9.50
		Maximum	12.00
Mand. canine MD	Male	Minimum	6.50
		Maximum	8.00
	Female	Minimum	6.00
		Maximum	8.00
Max. incisor MD	Male	Minimum	8.00
		Maximum	11.50
	Female	Minimum	8.00
		Maximum	10.50
Max. incisor CI	Male	Minimum	9.00
		Maximum	13.00
	Female	Minimum	8.50
		Maximum	11.00
Mand. canine BL	Male	Minimum	6.50
		Maximum	9.00
	Female	Minimum	6.50
		Maximum	8.50
Mand. Intercanine width	Male	Minimum	25.00
		Maximum	33.00
	Female	Minimum	27.00
		Maximum	33.50
Canine index	Male	Minimum	0.22
		Maximum	0.28
	Female	Minimum	0.20
		Maximum	0.27

Table 2: Comparison of mean values of different parameters in males and females

Parameters	Gender	N	Mean(mm) ± S.D	t test	p value
Max. molar MD	M	100	11.4700±.66218	13.459	<.0001**
	F	100	10.2950±.56896		
Mand. molar MD	M	100	12.0700±.66674	12.520	<.0001**
	F	100	10.9700±.57217		
Mand. canine MD	M	100	7.1400±.38323	2.242	.026*
	F	100	7.0150±.40486		
Max. incisor MD	M	100	9.6800±94152	5.314	<.0001**
	F	100	9.1300±.43006		
Max. incisor CI	M	100	10.5100±.95341	9.523	<.0001**
	F	100	9.4000±.67044		
Mand. canine BL	M	100	7.6650±.73531	2.991	.003**
	F	100	7.3950±.52366		
Mand. Intercanine width	M	100	28.0600±1.76280	-6.542	<.0001**
	F	100	29.5800±1.51378		
Canine index	M	100	.2533±.01349	10.091	<.0001**
	F	100	.2339±.01370		

** Highly significant, * Not significant.

Table 3: Sensitivity and specificity of various parameters

S.No.	Parameter	Senstivity	Specificity
1	Max. molar MD ≥10.75 (indicates probability will be of male)	88%	76%
2	Mand. molar MD ≥ 11.25 (indicates probability will be of male)	87%	72%
3	Mand. Canine MD ≥ 7.055 (indicates probability will be of male)	69%	73%
4	Max. incisor MD ≥ 9.25 (indicates probability will be of female)	69%	59%
5	Max. incisor CI ≥ 9.75 (indicates probability will be of male)	81%	68%
6	Mand. Canine BL ≥ 7. 25 (indicates probability will be of female)	68%	45%
7	Mand. Intercanine width ≥ 28.75 (indicates probability will be of female)	68%	63%
8	Canine index ≥ .245 (indicates probability will be of male)	77%	77%

Discussion

Sex determination is one of the prime factors employed to establish the identity of an individual. The accuracy of sex determination using diverse parameters of the body such as craniofacial morphology and measurement on the pubis ranges from 96% to 100%.[6,7]

Accurate sex assessment of skeletal remains has great importance in forensic and anthropological investigations. For optimal outcome, as many criteria as are available must be utilised. Teeth are the strongest structures in the human body and are known to resist post-mortem destruction. They are usually retained in skeletal specimens and, hence, can be used in sex differentiation. The dentition takes precedence particularly when preferred parameters such as the pelvis are unavailable and cranial and long bones are fragmentary as the fact that most teeth complete development before skeletal maturation.[5-8] However, since linear tooth measurements usually give different levels of accuracy in sex identification, therefore in our study we have related various parameters of tooth measurements according to their specificity and sensitivity.

In the present study 200 subjects (100 males and 100 females) in the age group ranging from 17 to 25 years were included to evaluate the existence of sexual dimorphism using mesio-distal dimensions of maxillary central incisor, mandibular canine, mandibular first molar, maxillary first molar, cervico-incisal dimension of central incisor, buccolingual dimensions of mandibular canine, mandibular intercanine width and canine index.

The age group of 17-25 years was included in the present study as this age group is the most suitable for studying sexual dimorphism, since antemortem insults like attrition and abrasion affecting occlusal and approximal tooth surfaces are minimal in this age group as stated by Iscan MY et al (2003), Kaushal S et al (2003), Rai B et al (2007) and Reddy VM et al (2008).[9-12] In this study the teeth we took into consideration include maxillary central incisors, mandibular canines and first molars.

Garn SM, Lewis AB (1967) concluded that amongst all teeth, the permanent mandibular canines are found to exhibit the greatest sexual dimorphism. Mandibular canine also offer an advantage that also these are the last teeth to be extracted with respect to age and are less affected than other teeth by periodontal diseases and trauma.[13] Rai B et al (2007) considered molars for sex determination as they are the first permanent teeth to erupt into the oral cavity and are less commonly impacted.[11]

Mesio-distal dimensions of maxillary central incisor, mandibular first molar, maxillary first molar, cervico-incisal dimension of central incisor, intercanine width, canine index, mesiodistal dimension of mandibular canine, buccolingual dimension of canine and rugae pattern were considered for comparing mean values between males and females and their p-values were calculated. After that specificity and sensitivity were calculated in these parameters to know the accuracy of each parameter using ROC curve.

Maxillary molar

Maxillary molar showed highly statistically significant p-value<0.0001 and these results were in agreement with the studies done by Perzigian et al(1976), Ghosh LJ et al(1979), Stroud JL et al(1994), Hattab FN et al(1996), Ates M et al(2006).[14-18] Statistically using ROC curve it was calculated that if maxillary molar MD≥10.75 then the person will be male and it showed sensitivity of 88% and specificity of 76%. These results were in contrast with the study done by Acharya AB et al(2008) and Iscan MY et al(2003).[6,9]

Mandibular molar

Mandibular molar showed highly statistically significant p-value<0.0001 and these results were in agreement with the studies done by Perzigian et al(1976), Ghosh LJ et al(1979), Stroud JL et al(1994).[14-16] Statistically using ROC curve it was calculated that if mandibular molar MD ≥11.25 then the person will be male and it showed sensitivity of 87% and

specificity of 72%. These results were in contrast with the study done by Iscan MY et al(2003).[9]

Mandibular canine

Mandibular canine showed less significant p-value (.026 MD & .003 BL) and these results were in agreement with the studies done by Perzigian et al(1976), Ghosh LJ et al(1979), Stroud JL et al(1994), Hattab FN et al(1996), Ates M et al(2006).[14-17] Statistically using ROC curve it was calculated that if mandibular canine MD ≥ 7.055then the person will be male and it showed sensitivity of 88% and specificity of 76%. These results were in contrast with the study done by Acharya AB et al(2008) and Iscan MY et al(2003).[6,9]

Canine index

Canine showed highly statistically significant p-value<0.0001 and these results were in agreement with the studies done by Rao NG et al(1989), Rifaiy M et al(1997), Abdullah MA (1998), Yadav S et al (2002).[19,20,3,21] Statistically using ROC curve it was calculated that if canine index ≥0.245 then the person will be male and it showed sensitivity of 77% and specificity of 77%.

Conclusion

Statistical analysis showed that mesiodistal diameter of maxillary molar, mandibular molar, mandibular canine and canine index showed higher degree of specificity and sensitivity. Thus, these parameters can be used as most accurate one for determining sexual dimorphism as compared to the others due to their high specificity and sensitivity. In future, further studies with large sample sizes should be done to establish standard dental morphometric measurements to determine gender for anthropological, legal, and forensic purposes.

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Conflict of interest

None.

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