Original Article

Gender Determination using Odontometric Diagonal Measurements of Teeth: An Analytical Study

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ABSTRACT

Background: Gender determination is one of the prime parameters in forensic identification. The feasibility of the nonreactive, mineralized part of teeth to resist mutilation and to survive deliberate, accidental, or natural change has led forensic experts to focus on the teeth as a possible source as forensic data in cases of fragmentary and mutilated human remains.
Aim: The aim of this study is to determine gender using odontometric diagonal measurements of permanent maxillary and mandibular teeth.
Objectives: To measure and evaluate sexual dimorphism by odontometric diagonal measurement of teeth.
Materials and Methods: The study sample included a total of 80 maxillary and mandibular dental casts obtained by alginate impression from 40 participants (20 males and 20 females) in the age range of 19–35 years selected from the Central Indian population. Mesiobuccal-distolingual (MBDL) and distobuccal-mesiolingual (DBML) measurements of the right permanent maxillary and mandibular teeth excluding third molars were taken separately. All the measurements were taken using a Digital Vernier Caliper. Data were analyzed using discriminant function analysis.
Results: It is found that the diagonal measurements are significantly greater in males than females. The highest percentage of overall accuracy rate of maxillary MBDL is followed by maxillary DBML, mandibular MBDL, and mandibular DBML. All the values of the mean tooth dimension of MBDL were greater than DBML. The overall accuracy rate of maxillary MBDL is 97.2% and mandibular MBDL is 95.2%. The overall accuracy rate of maxillary DBML is 96.56% and mandibular DBML is 94.21%.
Conclusion: Diagonal measurements of teeth can be used for sex determination. The most significant variable is found to be MBDL measurements of maxillary and mandibular second premolars. It is the strongest predictor for gender determination.

Key Words: *Dental cast, diagonal measurements, distobuccal-mesiolingual, forensic odontometry, gender determination, mesiobuccal-distolingual, sexual dimorphism*

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Introduction

Teeth are known for being the most resistant mineralized tissue against different agents for destruction.[1,2] They are, therefore, often used as a part of reconstructive identification.[3] They are particularly useful in the determination of gender by using different odontometric techniques,[4] and are of real interest in case of major catastrophes when bodies are often damaged beyond recognition.[5,6] Teeth are used for the estimation of age, sex, and the identification of an individual.[7] There are various methods used for the determination of sex of an individual, such as mandibular canine index and mesiodistal width measurements of maxillary incisor, canine, and first molar.[5,8] Sex determination is one of the prime parameters in forensic identification.[9,10] In general male teeth have found to be larger than those of the female.[5,11] Sexual dimorphism refers to those differences in size, stature, and appearance between males and females that can be applied to dental identification because no mouths are alike.[12-15]

However, width measurements, i.e. mesiodistal and buccolingual dimensions many a times pose problems in taking the measurements due to crowding, cervical abrasions, attrition, and interproximal wear facets, presence of dental calculus, etc., In such situations, diagonal teeth measurements are of utmost use and importance.[1,6,15] Therefore, the present study is aimed to determine gender by using the diagonal measurement of

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teeth and discriminant function. The objective of this study is to measure and to evaluate mesiobuccal-distolingual (MBDL) and distobuccal-mesiolingual (DBML) crown measurements of permanent maxillary and mandibular teeth for sexual dimorphism.

Materials and Methods

The study comprised a total of 80 upper and lower jaw dental casts of 40 participants (20 males and 20 females) in the age group ranging from 19 to 35 years from a Central Indian population.

The sample size was derived using a formula (key article by Shankar *et al.*[10]) as follows:

$$n_1 = \frac{(\sigma_1^2 + \sigma_2^2 / k)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

The notation for the formulae are:

n_1 = sample size of Group 1

n_2 = sample size of Group 2

σ_1 = standarddeviation of Group 1

σ_2 = standarddeviation of Group 2

Δ = difference in group means

k = ratio = n_2/n_1

$z_{1-\alpha/2}$ = two-sided z value (e.g. z = 1.96 for 95% confidence interval)

$z_{1-\beta}$ = power

Standard deviation (SD) of MBDL in males for tooth no 65 = 0.634

SD of MBDL in females for tooth no 65 = 0.521

Δ = Difference in mean value = 10.76 – 10.38 = 0.38

k = 1

$$N = \frac{(0.634\times0.634+0.521\times0.521)(1.96+0.84)}{0.38\times0.38}$$

=36.23 patients needed for the study

Therefore, 40 patients included in the study.

The sample patients were selected by convenience sampling from outpatient department (OPD) from Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur having fully erupted teeth from right permanent central incisor to the right second molar, without restoration, crowding of teeth, fractured teeth or orthodontic appliance and no developmental abnormalities that could affect odontometric measurements. The study was approved by the Institutional Ethics Committee, and the written consent was obtained from the participants.

Upper and lower jaw impressions were taken with alginate impression material followed by the preparation of models with dental stone. Study cast was labeled by putting OPD registration number. The investigators were single-blinded to the subsequent procedure. Using these models, mesiobuccal-distolingual or mesiolabioincisal-distolinguoincisal (MBDL) and distobuccal-mesiolingual or distolabioincisal-mesiolinguoincisal (DBML) measurements of seven right permanent teeth of each jaw except third molars were measured using Digital Vernier Caliper by one investigator at a different time and recorded in the pro forma. All values were rounded to two decimal places.

While placing the caliper parallel to the occlusal or incisal surface, the following points as defined by Hillson *et al.*[16] were considered as a guide during the measurements:

- MBDL: The largest distance between the mesiobuccal corner of cement enamel junction points to the distolingual corner
- DBML: The largest distance between the distobuccal corner of cement enamel junction point to the mesiolingual corner.

To assess the reliability of measurements, of 80 casts, 40 casts were randomly selected from the original sample casts, and the diagonal measurements were again obtained by the same observer in the presence of another observer. The obtained measurements were tallied with the first measurements. It was found that there was no difference in recorded measurements.

The collected data were subjected to the statistical analysis. The data were subsequently processed and analyzed using the Wintrap SPSS software version 24.0, USA (Wintrap Basic Polar Engineering and Consulting, USA Copyright 2014). Independent sample *t*-test was used to compare mean tooth sizes between males and females. The discriminant function analysis was carried out using various coefficients.

If the values obtained were greater than the sectioning point, the individual was considered a male, and if less than the sectioning point, the individual was considered a female.

The percentage of sexual dimorphism was calculated using the following equation:

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

where x_m = mean male tooth dimension; x_f = mean female tooth dimension.

Statistical significance was kept at $P \leq 0.05$.

Results

A total of 28 measurements were taken on 14 teeth (seven teeth from each jaw) of each individual included in this study. Measurements on the teeth of 40 individuals were analyzed using SPSS software, different test, and discriminant function.

Table 1 shows descriptive statistics, percentage sexual dimorphism, *t* values and *P* values for MBDL and DBML crown diameters, respectively, for the seven teeth of all males and females. The highest percentage of sexual dimorphism for maxillary MBDL crown diameter is 22.41% seen in the second premolar, followed by 20.14% in the first premolar, and the lowest percentage of sexual dimorphism is 5.2% seen in central incisor. The highest mean tooth dimensions in male for maxillary MBDL is 11.53 mm and in the female is 10.26 mm seen in the first molar. The lowest mean tooth dimensions in male for maxillary MBDL is 6.41 mm and in the female is 5.90 mm seen in lateral incisor. The *P* value was found statistically highly significant for all seven teeth.

The highest percentage of sexual dimorphism for mandibular MBDL crown diameter of 18.64% is seen in the second premolar, and the lowest percentage of sexual dimorphism is 6.90% seen in lateral incisor. The highest mean tooth dimension in males for mandibular MBDL is 11.22 mm and in the female is 9.92 mm seen in the first molar. The lowest mean tooth dimension in males for mandibular MBDL is 5.69 mm and in the female is 5.04 mm seen in central incisor. The *P* value was found statistically highly significant for all seven teeth [Table 2].

On comparison of mean tooth dimensions between males and females for maxillary DBML, the highest percentage of sexual dimorphism is 25.47% seen in the second molar, and the lowest percentage of sexual dimorphism is 6.66% seen in lateral incisor. The highest mean tooth dimension in males for maxillary DBML is 10.59 mm and in the female is 8.53 mm seen in the first molar. The lowest mean tooth dimension in males for maxillary DBML is 6.45 mm and in the female is 6.02 mm seen in lateral incisor. The *P* value was found statistically highly significant for all seven teeth [Table 3].

The highest percentage of sexual dimorphism for mandibular DBML is 17.59% seen in the second premolar, and the lowest percentage of sexual dimorphism is 3.14% seen in lateral incisor. The highest mean tooth dimension in males for mandibular DBML is 10.74 mm and in the female is 9.54 mm seen in the first molar. The lowest mean tooth dimension in males for mandibular DBML is 5.48 mm and in the female is 5.21 mm seen in central incisor. The *P* value was found

Table 1: Comparison of mean tooth dimensions among males and females for maxillary mesiobuccal-distolingual

Maxillary MBDL	Mean (mm)±SD		*t*	*P*	Percentage dimorphism
	Female (*n*=20)	Male (*n*=20)			
CI	7.69±0.54	8.06±0.23	2.83	0.007*	5.20
LI	5.90±0.65	6.41±0.42	2.89	0.006*	7.95
C	6.58±0.47	7.54±0.59	5.58	0.0001*	12.73
FP	6.58±0.60	8.24±1.17	5.60	0.0001*	20.14
SP	6.54±0.61	8.43±1.13	6.55	0.0001*	22.41
FM	10.26±0.96	11.53±1.31	3.49	0.001*	11.01
SM	8.75±1.20	10.57±1.37	4.46	0.0001*	17.21

*Highly significant. MBDL: Mesiobuccal-distolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 2: Comparison of mean tooth dimensions among males and females for mandibular mesiobuccal-distolingual

Mandibular MBDL	Mean (mm)±SD		*t*	*P*	Percentage dimorphism
	Female (*n*=20)	Male (*n*=20)			
CI	5.04±0.42	5.69±0.53	4.23	0.0001*	11.42
LI	5.53±0.42	5.94±0.45	2.96	0.005*	6.90
C	5.99±0.63	6.83±0.63	4.15	0.0001*	12.29
FP	6.01±0.66	7.02±1.07	3.56	0.001*	14.38
SP	6.37±0.79	7.83±1.07	4.90	0.0001*	18.64
FM	9.92±0.58	11.22±0.89	5.42	0.0001*	11.58
SM	8.65±0.88	10.34±1.12	5.26	0.0001*	16.34

*Highly significant. MDBL: Mesiobuccal-distolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 3: Comparison of mean tooth dimensions among males and females for maxillary distobuccal-mesiolingual

Maxillary DBML	Mean (mm)±SD		*t*	*P*	Percentage dimorphism
	Female (*n*=20)	Male (*n*=20)			
CI	7.19±0.36	7.85±0.46	5.03	0.0001*	9.17
LI	6.02±0.70	6.45±0.44	2.27	0.029*	6.66
C	6.35±0.56	7.13±0.48	4.73	0.0001*	10.93
FP	6.93±0.41	8.38±0.85	6.81	0.0001*	17.30
SP	6.60±0.64	8.18±0.93	6.22	0.0001*	19.31
FM	8.53±0.87	10.59±1.40	5.55	0.0001*	19.45
SM	7.11±0.97	9.54±1.55	5.93	0.0001*	25.47

*Highly significant. DBML: Distobuccal-mesiolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 4: Comparison of mean tooth dimensions among males and females for mandibular distobuccal-mesiolingual

Mandibular DBML	Mean (mm)±SD		*t*	*P*	Percentage dimorphism
	Female (*n*=20)	Male (*n*=20)			
CI	5.21±0.40	5.48±0.46	2.03	0.049*	4.92
LI	5.55±0.34	5.73±0.38	1.50	0.14**	3.14
C	6.12±0.78	6.45±0.49	1.61	0.11**	5.11
FP	5.63±0.90	6.78±0.87	4.08	0.0001*	16.96
SP	6.37±0.60	7.73±1.00	5.17	0.0001*	17.59
FM	9.54±0.87	10.74±1.16	3.70	0.001*	11.17
SM	8.27±0.92	9.93±1.17	4.95	0.0001*	16.71

*Highly significant, **Not significant. DBML: Distobuccal-mesiolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 5: Comparison of mean tooth dimensions among patients for maxillary and mandibular mesiobuccal-distolingual

Maxillary and mandibular	Mean (mm)±SD		*t*	*P*
	Maxillary MBDL (*n*=40)	Mandibular MBDL (*n*=40)		
CI	7.88±0.45	5.36±0.57	21.60	0.0001*
LI	6.15±0.60	5.74±0.48	3.42	0.0001*
C	7.06±0.72	6.41±0.75	3.93	0.0001*
FP	7.41±1.24	6.51±1.02	3.53	0.001*
SP	7.49±1.31	7.10±1.18	1.40	0.16**
FM	10.89±1.30	10.57±0.99	1.22	0.22**
SM	9.66±1.57	9.50±1.31	0.50	0.61**

*Highly significant, **Not significant. MBDL: Mesiobuccal-distolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 6: Comparison of mean tooth dimensions among patients for maxillary and mandibular distobuccal-mesiolingual

Maxillary and mandibular	Mean (mm)±SD		*t*	*P*
	Maxillary DBML (*n*=40)	Mandibular DBML (*n*=40)		
CI	7.52±0.53	5.35±0.44	10.71	0.0001*
LI	6.24±0.62	5.64±0.37	5.17	0.0001*
C	6.74±0.65	6.29±0.66	3.06	0.003*
FP	7.66±0.99	6.21±1.04	6.35	0.0001*
SP	7.39±1.12	7.05±1.07	1.39	0.16**
FM	9.56±1.55	10.14±1.18	1.86	0.06*
SM	8.32±1.77	9.10±1.33	2.21	0.030*

*Highly significant, **Not significant. DBML: Distobuccal-mesiolingual, SD: Standard deviation, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

statistically "not significant" for lateral incisor and canine teeth [Table 4].

The mean tooth dimension among all participants for maxillary and mandibular MBDL, it showed that the highest mean tooth dimension of maxillary MBDL is 10.89 mm and mandibular MBDL is 10.57 mm seen in the first molar. The lowest mean tooth dimension of maxillary MBDL is 6.15 mm seen in lateral incisor, and mandibular MBDL is 5.36 mm seen in the central incisor. The *P* value for the second premolar, first molar, and second molar was found statistically not significant [Table 5].

On comparison mean tooth dimension among all subjects for maxillary and mandibular DBML, it is observed that the highest mean tooth dimension of maxillary DBML is 9.56 mm, and mandibular DBML is 10.14 mm seen in the first molar. The lowest mean tooth dimension of maxillary DBML is 6.25 mm seen in lateral incisor, and mandibular DBML is 5.35 mm in central incisor. The *P* value for the second premolar and first molar found to be statistically not significant [Table 6].

It is found that the second premolar (0.412) is the strongest predictor to determine sex, followed by first premolar (0.316), canine (0.219), second molar (0.212), and lateral incisor (0.003) which are the next important predictors for sex determination, whereas central incisor (−0.415) and first molar (−0.067) are less successful predictors [Table 7].

It is observed for mandibular MBDL that the second premolar (0.513) is the strongest predictor to determine sex followed by canine (0.319), first molar (0.215), second molar (0.060) and lateral incisor (0.051) which are the next important predictors for sex determination, whereas first premolar (−0.161) is less successful predictor [Table 8].

It is observed for maxillary DBML that the first premolar (0.491) is the strongest predictor to determine sex followed by second molar (0.219), first molar (0.191), lateral incisor (0.168), canine (0.002) and which are the next important predictors for sex determination, whereas central incisor (−0.412) and second premolar (−0.006) are less successful predictors [Table 9].

It is observed for mandibular DBML that the second molar (0.512) is the strongest predictor to determine sex followed by second premolar (0.492), central incisor (0.192), lateral incisor (0.104), first premolar (0.081) and first molar (0.018), which are the next important predictors for sex determination, whereas canine (−0.121) is less successful predictors [Table 10].

Tables 7-10 describe the distribution of seven of maxillary and mandibular teeth parameters with their standardized coefficient, structure matrix, unstandardized coefficient, raw coefficients,

Table 7: Canonical discriminant function coefficient for maxillary mesiobuccal-distolingual

Maxillary MBDL	Standardized coefficient	Structure matrix	Unstandardized coefficient	Raw coefficients	Group coefficient		Sectioning point
					Female	Male	
CI	−0.415	0.822	−1.071	−8.96	41.21	38.21	0
LI	0.003	0.817	0.026		1.97	2.01	
C	0.219	0.497	0.519		10.61	14.52	
FP	0.316	0.385	0.613		0.01	4.12	
SP	0.412	0.396	0.815		6.21	10.02	
FM	−0.067	0.215	−0.051		9.21	7.02	
SM	0.212	−0.219	0.125		1.16	1.99	

MBDL: Mesiobuccal-distolingual, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 8: Canonical discriminant function coefficient for mandibular mesiobuccal-distolingual

Mandibular MBDL	Standardized coefficient	Structure matrix	Unstandardized coefficient	Raw coefficients	Group coefficient		Sectioning point
					Female	Male	
CI	0.216	0.512	0.769	−18.51	12.12	15.22	0
LI	0.051	0.538	0.121		28.56	29.51	
C	0.319	0.576	0.695		9.21	12.13	
FP	−0.161	0.496	−0.101		−1.96	−3.51	
SP	0.513	0.785	0.816		0.29	4.02	
FM	0.215	0.741	0.416		14.12	16.01	
SM	0.060	0.617	0.086		5.02	5.13	

MBDL: Mesiobuccal-distolingual, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 9: Canonical discriminant function coefficient for maxillary distobuccal-mesiolingual

Maxillary DBML	Standardized coefficient	Structure matrix	Unstandardized coefficient	Raw coefficients	Group coefficient		Sectioning point
					Female	Male	
CI	−0.412	−0.412	−0.812	−11.21	38.21	39.31	0
LI	0.168	0.312	0.435		12.16	14.92	
C	0.002	0.321	0.019		8.01	9.23	
FP	0.491	0.815	1.216		40.02	45.91	
SP	−0.006	0.701	−0.015		−7.56	−9.02	
FM	0.191	0.791	0.219		5.21	7.01	
SM	0.219	0.621	0.251		−4.15	−596	

DBML: Distobuccal-mesiolingual, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

Table 10: Canonical discriminant function coefficient for mandibular distobuccal-mesiolingual

Mandibular DBML	Standardized coefficient	Structure matrix	Unstandardized coefficient	Raw coefficients	Group coefficient		Sectioning point
					Female	Male	
CI	0.192	0.319	0.513	−15.12	20.08	22.01	0
LI	0.104	0.317	0.201		36.52	38.11	
C	−0.121	0.301	−0.412		10.12	11.21	
FP	0.081	0.591	0.161		6.01	6.96	
SP	0.492	0.702	0.712		−5.02	−4.62	
FM	0.018	0.312	0.012		2.13	2.96	
SM	0.512	0.852	0.729		13.96	15.02	

DBML: Distobuccal-mesiolingual, CI: Central incisor, LI: Lateral incisor, C: Canine, FP: First premolar, SP: Second premolar, FM: First molar, SM: Second molar

group coefficient in each of the two groups, i.e. males and females and sectioning point for MBDL and DBML crown diagonal dimension, where the sectioning point is derived as 0.

The canonical discriminant function coefficient indicates the unstandardized scores concerning the independent variables. It is the list of coefficients of the unstandardized discriminant equation. Each subject's discriminant score would be computed by entering his or her variable values (raw data) for each of the variables in the equation.

The unstandardized coefficient (b) is used to create the discriminant function score (y) (prediction equation), to classify new cases and added to the raw coefficient constant (a).

The discriminant function score was evaluated by using the equation as follows:

$Y = a + b (x)$

where x is the dimension of the tooth in mm.

a is raw coefficient (constant)

b is the unstandardized coefficient

The standardized coefficient is used to calculate the discriminant score for a given case (sexes). The structure matrix gives the correlations between the variables and discriminant functions. Group centroids are the mean discriminant score for each sex. The sectioning point is the average of male and female group centroids.

The standardized canonical discriminant function coefficient can be used to rank the importance of each variable. A high standardized discriminant function coefficient might mean that the groups differ a lot on that variable. The sign indicates the direction of the relationship.

Standardized canonical discriminant function coefficients indicate the relative importance of the independent variables in predicting the dependent. They allow comparing variables measured on different scales. Coefficient is used to calculate the discriminant score for the given case. The score is calculated in the same manner as a predicted value from linear regression, using the standardized coefficient and the standardized variables.

The distribution of the scores from each function is standardized to have a mean of zero and SD of one. The magnitudes of these coefficients indicate how strongly the discriminating variables affect the score.

Table 11 illustrates the accuracy of sex determination with maxillary MBDL dimensions. It is observed that 100% of males and 95% of females were correctly classified with an overall accuracy of 97.2%. This demonstrates that a greater percentage of males were correctly identified using dimensions of maxillary MBDL.

Table 12 illustrates the accuracy of sex determination with the mandibular MBDL dimension. It observed that 100% of males and 90% of females were correctly classified with an overall accuracy of 95.2%. This demonstrates that a greater percentage of males were correctly identified using dimensions of mandibular MBDL.

Table 13 depicts the accuracy of sex determination with maxillary DBML dimensions. It is found that 95% of males and 85% of females were correctly classified with an overall accuracy of 96.56%. This demonstrates that a greater percentage of males were correctly identified using dimensions of maxillary DBML.

Table 14 depicts the accuracy of sex determination with mandibular DBML dimensions. It is found that 90% of males and 85% of females were correctly classified with an overall accuracy of 94.21%. This demonstrates that a greater percentage of males were correctly identified using dimensions of mandibular DBML.

In the present study, the overall accuracy rate of maxillary MBDL is 97.2%. The overall accuracy rate of mandibular MBDL is 95.2%. The overall accuracy rate of maxillary DBML is 96.56%. The overall accuracy rate of mandibular DBML is 94.21%. This suggests that the highest percentage of overall accuracy rate of maxillary MBDL is followed by maxillary DBML, mandibular MBDL, and mandibular DBML.

Discussion

Skull is possessed of hard structures, due to which it is the most maintained part of the skeleton. In addition to the skull, mandible along with teeth is also the commonly available

Table 11: Accuracy of sex determination with dimensions of maxillary mesiobuccal-distolingual

Maxillary MBDL Original	Gender	Predicted group membership		Total
		Correctly classified	Misclassified	
Count	Male	20	0	20
	Female	19	1	20
Percentage	Male	100.0	0	100.0
	Female	95	95	100.0

97.2% of original grouped cases correctly classified. MBDL: Mesiobuccal-distolingual

Table 12: Accuracy of sex determination with dimensions of mandibular mesiobuccal-distolingual

Mandibular MBDL Original	Gender	Predicted group membership		Total
		Correctly classified	Misclassified	
Count	Male	95	0	95
	Female	18	2	95
Percentage	Male	100.0	0	100.0
	Female	90	10	100.0

95.2% of original grouped cases correctly classified. MBDL: Mesiobuccal-distolingual

Table 13: Accuracy of sex determination with dimensions of maxillary distobuccal-mesiolingual

Maxillary DBML Original	Gender	Predicted group membership		Total
		Correctly classified	Misclassified	
Count	Male	19	1	95
	Female	17	3	95
Percentage	Male	95	5	100.0
	Female	85	15	100.0

96.56% of original grouped cases correctly classified. DBML: Distobuccal-mesiolingual

Table 14: Accuracy of sex determination with dimensions of mandibular distobuccal-mesiolingual

Mandibular DBML Original	Gender	Predicted group membership		Total
		Correctly classified	Misclassified	
Count	Male	18	2	20
	Female	17	3	95
Percentage	Male	90	10	100.0
	Female	85	15	100.0

94.21% of original grouped cases correctly classified. DBML: Distobuccal-mesiolingual

intact bone. Thus, jawbones are used to differentiate sexes as they express strong sexual dimorphism.[17,18]

Teeth, being the main component of the masticatory apparatus of the skull, are the most steady and hardest tissue in the body. The feasibility of the nonreactive, mineralized part of teeth to resist mutilation in postmortem scenario and to survive deliberate, accidental, or natural change has led forensic experts to focus on the teeth as a possible source for valuable forensic data in fragmentary and mutilated human remains.[19]

Teeth are known to be peculiar organs as they are the most durable tissue in the body made of mineralized tissue. Their durability, even with fire or blast and bacterial decomposition, makes them indispensable for forensic investigations.[20]

The coronal morphology and dimension of permanent teeth remain unchanged during growth and development. Hence, odontometric measurements can be used in determining the sex after the tooth has erupted.[21]

The male teeth are usually larger as compared to females. In the present study, it is found that male teeth dimensions are larger than female teeth dimensions, thus, exhibiting sexual dimorphism. These results are in accordance with various other studies revealing clear dimorphic differences between male and female teeth.[8,22] In the present study, the overall accuracy rate of maxillary MBDL is 97.2%. The overall accuracy rate of mandibular MBDL is 95.2%. The overall accuracy rate of maxillary DBML is 96.56%. The overall accuracy rate of mandibular DBML is 94.21%. These findings concluded that the highest percentage of overall accuracy rate of maxillary MBDL is followed by maxillary DBML, mandibular MBDL, and mandibular DBML. In the present study, the overall classification accuracy rate for the male is 95% and for females 85%. This is also in concordance with the findings of a study by Rai and Anand (2007)[11] where in accuracy rate was 30.4% for males and 18.2% for females suggesting higher classification accuracy rate for males as compared to females.

Conclusion

From the present study, the following conclusions are drawn:

- Diagonal dimensions in all seven teeth of males exceeded that of females, thus exhibiting sexual dimorphism between the sexes
- Overall accuracy rate of maxillary MBDL is 97.2%
- Overall accuracy rate of mandibular MBDL is 95.2%
- Overall accuracy rate of maxillary DBML is 96.56%
- Overall accuracy rate of mandibular DBML is 94.21%
- The most significant variable contributing to sex determination is found to be maxillary and mandibular MBDL dimensions of the second premolar. This is the strongest predictor to determine sex
- For maxillary DBML, it is the first premolar, and for mandibular DBML, it is the second molar. These are the second strongest predictors to determine sex.

The method applied in the present study "crown diagonal measurements" is simple, easy to perform, and inexpensive. It can, therefore, be applied in forensic odontology for establishing the sex identity of an individual.

Limitations of the study

- The diagonal measurements might go wrong if the caliper is not positioned properly parallel to the tooth axis and requires more attention while taking measurements
- Since the sample size of the present study is less, it is recommended to conduct further studies with a large sample size.

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Conflicts of interest

There are no conflicts of interest.

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