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Sexual Diamorphism-An Odontometric Approach

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Abstract

Background: Teeth being the most stable tissue in the body provide one of the best records for forensic investigation. Tooth morphology is influenced by cultural, environmental and racial factors. Present study attempts to establish the applicability of human dentition in sexual dimorphism in Indian population. It focuses to measure the odontometric parameters (i.e. mandibular canine width, mandibular intercanine distance, incisor width, mandibular premolar and molar arch width,), calculate dental indices (i.e. mandibular canine index, mandibular premolar and molar indices) and thereby prove their efficacy in determining the sex of an individual.

Materials and Methods: This cross sectional prospective study was carried out on 200 MBBS students of Kasturba Medical College, Mangalore. After taking written informed consent the intraoral odontometric parameters were measured and the data was then analysed using SPSS version, 11.5.

Results: Results showed that mandibular canine width, mandibular canine index, mandibular premolar arch width, mandibular molar arch width, premolar index and molar index shows significant difference (p value< 0.001) between males and females. Maximum sexual dimorphism exists in mandibular canine width (12.678) and mandibular canine index (12.639), while incisor width and intercanine distance have no applicability in sex identification. Maximum correlation is shown by mandibular canine width (0.657) and least by molar index (0.393). The predictive value of sexing a person is highest by using mandibular canine width alone (43.2%) and least by molar index(15.5%), this predictiblity increases considerably (56.4%) when all the parameters are combined together.

Conclusion: Thus, the usefulness of dentition as an aid in gender determination by odontometric analysis is well supported. Mandibular teeth and in particular the mandibular canine can form the key in gender differentiation.

Keywords: Odontometrics; Sexual diamorphism; Mandibular teeth

Introduction

Identification of living as well as the dead using skeletal remains and dentition is of paramount importance in routine forensic practice. The only method that can give the most accurate result is DNA technique, but it cannot be employed in all cases. Teeth being hardest and chemically the most stable tissue in the body are selectively preserved and fossilized, thereby providing the best record for evolutionary change and forensic investigation. Their durability in the phase of fire and bacterial decomposition makes them invaluable for identification of age, sex and race based on odontometric parameters [1].

"Sexual Diamorphism" refers to differences in size, stature and appearance between male and female. This definition can be applied even in dental identification as it is said that 'no two mouths are alike [2]. In the field of forensic odontology, permanent canine teeth and their arch width (distance between the canine tips) have been reported to show sexual diamorphism [3]. The study of permanent mandibular and maxillary canine teeth is advantageous as they are the least extracted teeth, least affected by periodontal disease and are the the last teeth to be extracted even in process of ageing [4]. Maxillary molar and premolar arch width, combined width of the incisors and the respective molar and premolar indices have also been reported to have statistically significant sexual dimorphism [5].

This study aims to establish the sexual diamorphism on Mandibular odontometric parameters (canine width, intercanine distance, canine index, premolar and molar arch width, incisor width, premolar and molar indices). The study being based on intraoral measurements can provide a quick and easy method to identify deceased on autopsy tables. The purpose of this study is to investigate the accuracy with which gender can be differentiated by using odontometric measurements of the permanent dentition.

Materials and Methods

This prospective cross sectional study was carried out in 200 MBBS students (100 male and 100 female), belonging to the age group 18-25 years, of Kasturba Medical College, Mangalore after obtaining the permission of Institutional Ethics committee. Subjects with healthy state of gingivae and peridontium, normal over bite and jet bite, normal molar and canine relationship, caries free teeth were included in the study while the subjects with visibly worn out, missing and restored teeth were excluded from the study. After taking written informed consent the various parameters as mentioned below were measured on mandible using divider with a fixing device and were subsequently read on the measuring scale. After taking each measurement the divider was cleaned with cotton soaked in surgical spirit to maintain the hygiene of the instrument.

The various measurements were taken as follows:

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The mandibular canine width

The mandibular canine width or the maximum width of canine teeth was taken as the greatest mesico-distal width on either side of the jaw [6] (Figure 1c, 1d).

Intercanine distance

The intercanine distance was measured as the straight line distance between the 2 canines at the most pointed point or tip of both the canines [6] (Figure 1a, 1b).

The mandibular canine index

The mandibular canine index was obtained by dividing the mandibular canine width by intercanine distance [6].

The mandibular premolar arch width

The premolar arch width was taken as the straight line distance between the left first premolar right first premolar at the occlusal groove [5] (Figure 2a, 2b).

The mandibular molar arch width

The molar arch width was taken as the straight line distance between the left 1st molar to the right first molar at its mesial pit on the occlusal surface [5] (Figure 2c, 2d).

The combined width of the mandibular incisors

The combined width of the mandibular incisors (central and lateral) was taken at the distal contact points with the canines on either side [5] (Figure 1e, 1f).

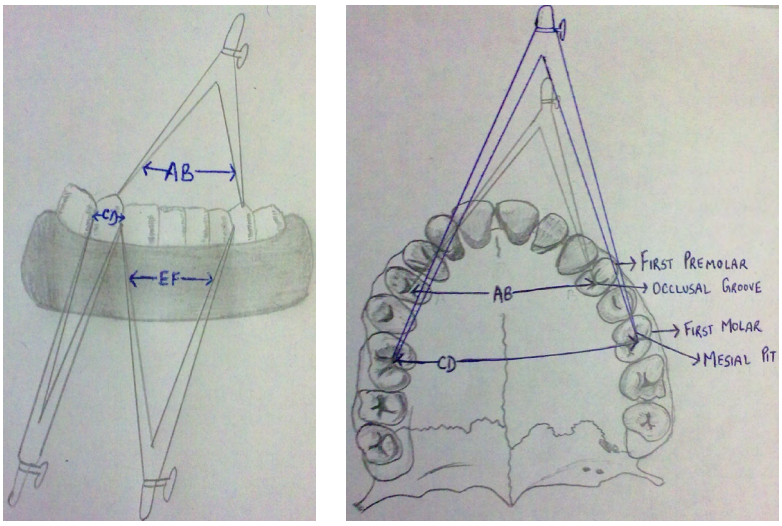
Premolar index

Mandibular premolar index is obtained by dividing the sum of the incisal widths X 100 by the premolar arch width [5].

Premolar Index = (Sum of incisal width/premolar arch width) x 100

Molar index

Mandibular molar index is obtained by dividing the sum of the incisal widths X100 by the molar arch width [5].



Figures 1 and 2: Diagrammatic representation for measurement landmarks.

Parameters	Sex	Minimum	Maximum	Standard deviation	Mean	P value	Sexual dimorphism
Mandibular canines width (mc)	Males	0.700	0.900	0.051	0.791	<0.001	12.678
	Females	0.600	0.800	0.051	0.702		
Intercanine distance(icd)	Males	2.100	3.100	0.217	2.621	0.948	0.000
	Females	2.000	3.100	0.212	2.623		
Mandibular canine index(mci)	Males	0.250	0.380	0.026	0.303	<0.001	<0.001
	Females	0.200	0.350	0.027	0.269		
Mandibular premolar arch width(mpm)	Males	2.700	3.600	0.185	3.204	<0.001	7.589
	Females	2.800	3.300	0.171	2.978		
Mandibular molar arch width(mm)	Males	3.900	5.000	0.247	4.207	<0.001	5.070
	Females	3.600	4.300	0.209	4.004		
Mandibular incisors width(mi)	Males	1.900	2.800	0.164	2.177	0.245	1.135
	Females	1.900	2.500	0.137	2.202		
Premolar index(pi)	Males	58.823	76.667	4.502	68.021	<0.001	8.298
	Females	61.290	82.758	6.690	74.175		
Molar index(molar i)	Males	40.000	59.523	3.485	51.810	<0.001	6.011
	Females	45.238	64.864	4.259	55.125		

Table 1: Descriptive analysis of odontometric measurements.

Molar Index = (Sum of incisal width/molar arch width) x100

Sexual dimorphism

According to Garn and Lewis Sexual dimorphism : (Xm / Xf) -1 x 100.

Xm= mean value of measurement for males.

Xf= mean value of measurement for females.

All the measurements were noted and the statistical analysis was done using SPSS version, 11.5 to evaluate the data using, Student's unpaired't' test, and Regression analysis. The data was normalized using Kolmogorov-Smirnov Z Test [3].

Results

According to Table 1, mandibular canine width, mandibular canine index, mandibular premolar arch width, mandibular molar arch width, premolar index and molar index shows significant difference (p value< 0.001) between males and females while the difference in intercanine distance (p value = 0.948) and mandibular incisor width (p value = 0.245) is insignificant. Maximum sexual dimorphism is shown by mandibular canine width (12.678%) followed by mandibular canine index (12.639%), premolar index (8.298%), mandibular premolar arch width (7.589%), molar index (6.011), mandibular molar arch width (5.070). The least sexual dimorphism is shown by combined width of mandibular incisors (1.135%) while intercanine distance do not show sexual dimorphism at all. Table 2 shows that maximum standard error of estimate is shown by molar index (0.462) and least by mandibular canine width (0.379). Maximum correlation is shown by mandibular canine width (0.657) and least by molar index (0.393). The predictive value of sexing a person is highest by using mandibular canine width alone (43.2%) followed by mandibular canine index (28.9%), mandibular premolar arch width (28.8%), premolar index (22.7%), mandibular molar arch width (16.6%) and least by molar index (15.5%). Intercanine distance and combined width of mandibular incisors are not considered to derive the linear regression equation as the values for these shows statistically insignificant variations among the two sexes. When all the above mentioned parameters are taken together to derive the multiple regression equation Table 3, then the standard error of estimate changes to 0.336 with correlation of 0.751 and predictive value of 56.4%. The accuracy of determination of sex by using odontometric parameters is shown in Table 4. Mandibular canine width gives the accuracy of 85.4% for boys and 82.7% for girls while mandibular canine index shows the accuracy of 86.3% for boys and 70.9% for girls. Least accuracy 51.0% for boys and 69.0% for girls is shown by mandibular molar arch width. When all the parameters are combined together accuracy changes to 77% for boys and 92% for girls.

Equation	Standard error of estimate	R	R^2
Sex=5.120-4.850(mc)	0.379	0.657	0.432
Sex=3.913-8.429(mci)	0.424	0.537	0.289
Sex=-1.126+0.370(pi)	0.442	0.477	0.227
Sex=5.441-1.275(mpm)	0.424	0.537	0.288
Sex=-0.997+0.047(molar i)	0.462	0.393	0.155
Sex=4.849-0.816(mm)	0.459	0.407	0.166

mc =mandibular canine width
mci =mandibular canine index
pi=premolar index
mpm= mandibular premolar arch width
molar i= molar index
mm= mandibular molar arch width

Table 2: Linear Regression Equation For Odontometric Parameters.

Equation	Standard error of estimate	R	R^2
Sex=[5.569-2.026(mc)-3.952(mci)-0.002(pi)-0.724(mpm)+0.025(molar i)-0.084(mm)]	0.336	0.751	0.564

mc =mandibular canine width
mci =mandibular canine index
pi=premolar index
mpm= mandibular premolar arch width
molar i= molar index
mm= mandibular molar arch width

Table 3: Multiple Regression Equation for Odontometric Parameters.

Discussion and Conclusion

Identification is the basis of individuality of a person. Numerous methods of identification are in use. Though these methods have their own merits, there are limitations too, as they might not fit in all situations. Dentition is one part of the body that resists all environmental insults for maximum time and thus can be a valuable tool in identification. In this study, an attempt was made to establish teeth as a useful parameter in sex differentiation, through simple odontometric techniques. This study focused on the mandibular measurements like canine width, intercanine distance, premolar arch width, molar arch width, combined width of the incisors and the respective indices of canines, premolars and molars. Data was analyzed using student t test, and linear and multiple regression equations were derived using these parameters. The present study shows that the mandibular canine width shows the maximum sexual dimorphism of 12.678%. This value is quite high as compared to the corresponding value of 7.954% computed for North Indian population by Kaushal et al. [7] and 6.2 % for South Indian population as estimated by Nair et al. [6]. Intercanine distance does not show any sexual diamorphism. The mean intercanine distance was found to be 2.621cm for males and 2.623cm for females. This value is in accordance with the study of Kaushal et al which gives value of intercanine distance of 2.580 in males and 2.500 in females [7]. It is also comparable with the value of 2.580cm in males and 2.480 in females as shown by Nair et al. [6]. The value of intercanine distance in the present study is high which may be attributed to the fact that the study is focused on the younger age group as compared to other studies and further because here no distinction was made in subjects on regional basis. The mandibular canine index (mci) was found to be 0.303 in males and .269 in females. This value is high as compared to .280 in males and .260 in females as found in north Indian population [7]. The value is also high as compared to the mci value for males of 0.296 and for females of 0.254 as shown by Rao et al. [8]. The results of the present study indicate that the mandibular

Parameters	Boys	Girls
mc	85.4%	82.7%
mci	86.3%	70.9%
pi	74.1%	67.8%
mpm	80.5%	71.2%
molar i	71.4%	61.5%
mm	51.0%	69.0%
mc + mci +pi +mpm +molar i +mm	77 %	92 %

mc =mandibular canine width
mci =mandibular canine index
pi=premolar index
mpm= mandibular premolar arch width
molar i= molar index
mm= mandibular molar arch width

Table 4: Accuracy of sex determination using odontometric parameters.

arch widths (both premolar and molar) are greater in males than in females. This is in agreement with the results obtained on maxillary teeth from North Indian population by Agnihotri and Gulati [9]. The present study gives the value of premolar index in males to be 68.021 and in females to be 74.175 and molar index to be 51.810 in males and 55.125 in females. Pont mentions a value of 80 and 64 for premolar and molar indices [5]. Agnihotri and Gulati showed the premolar index as 82 for males and 79.54 for females and molar index as 66.10 for males and 63.42 for females [9]. The present study also shows that the predictive value of sexing a person is highest by using mandibular canine width alone (43.2%) followed by mandibular canine index (28.9%). The results also show that the accuracy with which sex can be determined is high with mandibular canine width (85.4% for boys and 82.7% for girls) and mandibular canine index (86.3% for boys and 70.9% for girls). Maximum correlation is shown by mandibular canine width (0.657) followed by mandibular canine index (0.537). It is clearly seen that when all the six significant parameters (leaving intercanine distance and mandibular incisor width which are not significant) were combined the probability of sex determination came out to be 56.4% with standard error of estimate of 0.336 and correlation of 0.751. The accuracy of sex determination changed to 77% for boys and 92% for girls for the combination. This shows that calculations based on mandibular canine width and mandibular canine index alone are comparable in accuracy and predictability to the combination of all parameters. Hence this study is in accordance with the previous studies which states mandibular canines to be the "key teeth" in sex identification [6,7]. Hence the study and its result clearly prove that not only the mandibular canines are the "key teeth" for sex identification but all the mandibular teeth can be used as a tool of sex identification of an individual, which is in accordance with an another study which shows that mandibular teeth can help in determination of sex as high as 75.2% compared to teeth of both jaws taken together (74.3%) or using only maxillary teeth (62.9%) [10]. Linear and multiple regression equations derived in present study can predict sex of an individual. The measured value of parameter or the calculated value for index when fed into corresponding equation can determine the sex of an individual. Thus, the usefulness of human teeth as an aid in gender determination by odontometric analysis in, for example, forensic dentistry or anthropology is well supported. The study establishes the significance of morphometric criteria of sex determination using mandibular canines, mandibular premolar and molar arch widths. It proves that highly significant sexual dimorphism exists in mandibular teeth. Hence, mandibular teeth and in particular the mandibular canine can form the key in gender differentiation and subsequently in Identification.

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