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Original Article

Reliability of Odontometric Variations as an Important Aid in Gender Determination

Bhuvan Nagpal[1]*, Sreeshyla H.S.[2], Mukesh Yadav[3]

[1]Consultant Oral Pathologist, Manglam Diagnostics, Hisar, Haryana, India
[2]Senior Lecturer, Department of Oral Pathology and Microbiology, JSS Dental College & Hospital, Mysuru, Karnataka
[3]Principal & Professor, Department of Forensic Medicine & Toxicology, N. C. Medical College, Panipat, Haryana, India
*Corresponding author email id: dr.bhuvannagpal@gmail.com

ABSTRACT

Introduction: Determination of gender of human remains in forensic context constitutes an important and essential step in medico-legal examination. The ability of the calcified and inert structures of teeth to resist post-mortem degradation and to survive natural or accidental change has led forensic science experts to focus on the teeth as a possible source for valuable forensic data in poorly preserved human remains. Gender variations in human dentition have been of great help for both forensic odontologists and anthropologists. Assessment of gender from tooth measurements acts as a useful adjunct to identify forensic specimens, as the sizes of teeth show differences between gender of an individual and among different populations. **Objectives:** The present study aims to determine gender of an individual based on buccolingual, mesiodistal and cervicoincisal dimensions of teeth and analyse if any sexual variations existed in any of the dimensions of maxillary and mandibular teeth except third molars. **Materials and methods:** The study examined 110 individuals which included 55 males and 55 females in the age group of 18–24 years. Buccolingual, mesiodistal and cervicoincisal dimensions of teeth were measured using digital vernier calliper (.01-mm calibration). Using SPSS version 20, independent *t* test and stepwise discriminant analysis were applied to the significant mean value and reliability of tooth dimensions. **Results:** Buccolingual, mesiodistal and cervicoincisal dimensions were larger in males than females. The difference between the means of all the three tooth dimensions in both arches between males and females was statistically significant. All the three different dimensions are independent of each other. There is no relation between the dimensions. **Conclusion:** Both the arches were studied, and all the three dimensions were evaluated. All the three dimensions were larger in males than females for both the arches. Reliability of buccolingual dimension was found to be more than other dimensions for both the arches of both genders. Mesiodistal and cervicoincisal dimensions were reliable only for maxillary teeth of both the genders.

Keywords: Buccolingual, Mesiodistal, Cervicoincisal, Odontometric, Gender, Tooth, Dimensions

INTRODUCTION

Gender determination is a vital step in reconstructing a biologic profile from unidentified skeletal remains. Identification of gender is crucial as it halves the number of possible matches[1]. The great concern for forensic specialists is to determine variations in gender in human skeleton and dentition. Various methods have been used for gender determination from skeletal remains[2]. Determination of gender has been of profound importance in situations where bodies are damaged beyond recognition like massive burns, bomb blasts, natural calamities and mass disasters[3]. The major advantage of using teeth as an excellent material for anthropological, forensic, genetic and odontologic investigations is that they are the hardest and chemically most stable tissue in the body[4].

Teeth are known to be unique organs as they are made of the most enduring mineralised tissues in the human body[5]. They are resistant to mechanical, chemical,

physical and thermal types of destruction. Therefore, teeth are very important elements in the identification of skeletal remains, especially in cases when, due to poor preservation of skeletal remains, the identification is not possible by standard methods[6].

Due to this, the use of odontometrics to determine variations in gender is a procedure established in anthropological and biological studies[7]. Odontometrics has been explored as a tool for gender assessment in the field of forensic science mostly in the last 25 years[8]. Tooth size standards based on odontometric investigations are population specific and have shown varying degree of sexual dimorphism[9]. Although not as accurate as the skeleton, odontometrics are reasonably accurate gender predictors and are useful adjuncts in gender assessment[10].

The present study is aimed to determine gender of an individual based on buccolingual, mesiodistal and cervicoincisal dimensions of permanent teeth and analyse if any gender variation existed in all these dimensions of maxillary and mandibular permanent teeth except third molars. In addition to this, the study is also intended to evaluate the reliability of dimensional variations of teeth in determining gender among individuals.

MATERIALS AND METHODS

The study analysed the maxillary and mandibular dentition of 110 dental students (55 males and 55 females) in the age group of 18–24 years at JSS Dental College & Hospital, Mysuru, Karnataka, India. The study took 6 months to complete which included the procurement of casts, measurement of dimensions and statistical analysis. Ethical approval was obtained from the institutional ethical committee. Written, informed consent was obtained from each participant, and anonymity of the participant was maintained throughout the study. Convenience sampling was adopted. Students were informed about the nature

Table 1: Tooth dimensions for males and females in both arches

Tooth Dimensions (mm)	Males		Females	
	Maxillary	Mandibular	Maxillary	Mandibular
Buccolingual – central incisor	7.3	6.1	7.2	5.3
Buccolingual – lateral incisor	6.1	6.7	7.0	5.5
Buccolingual – canine	7.6	7.7	7.2	6.5
Buccolingual – first premolar	8.8	7.8	9.0	7.5
Buccolingual – second premolar	8.9	7.9	9.6	7.5
Buccolingual – first molar	11.2	10.4	10.8	9.6
Buccolingual – second molar	10.8	9.8	10.8	9.4
Mesiodistal – central incisor	8.7	5.9	8.7	5.8
Mesiodistal – lateral incisor	7.0	5.8	7.5	5.7
Mesiodistal – canine	7.2	6.8	7.4	6.5
Mesiodistal – first premolar	7.3	7.0	7.0	6.7
Mesiodistal – second premolar	6.9	7.2	6.6	7.5
Mesiodistal – first molar	10.2	11.0	10.0	9.6
Mesiodistal – second molar	10.5	10.6	10.2	10.2
Cervicoincisal – central incisor	10.7	9.1	9.4	7.8
Cervicoincisal – lateral incisor	8.5	9.6	7.5	7.8
Cervicoincisal – canine	10.0	11.0	8.9	8.0
Cervicoincisal – first premolar	8.6	8.7	7.6	8.5
Cervicoincisal – second premolar	8.5	8.2	6.5	7.9
Cervicoincisal – first molar	7.8	7.7	6.5	8.0
Cervicoincisal – second molar	7.1	7.2	6.2	7.6

of the study, and those who gave consent to participate were included in the study. Those having missing teeth, grossly decayed teeth and prosthesis were excluded from the study. All permanent maxillary and mandibular teeth were included except third molars. Buccolingual, mesiodistal and cervicoincisal dimensions were measured using a digital vernier caliper with .01-mm calibration. The measurements were made by two operators and were blinded as to the gender of the individual information corresponding to the model. Using the SPSS 20 software for Windows, descriptive statistics were obtained from the sample. The statistical significance of differences in mean in buccolingual, mesiodistal and cervicoincisal with *p* value is less than .05. Stepwise discrimination analysis was also done to evaluate the reliability of dimensional variation of teeth in determining the gender.

Table 2: Difference between the means of all the three tooth dimensions in both arches between males and females

Male maxillary teeth	Pearson correlation	.963
	Sig. (2-tailed)	.000
	N	21
Female maxillary teeth	Pearson correlation	.839
	Sig. (2-tailed)	.000
	N	21
Male maxillary teeth	Pearson correlation	.963
	Sig. (2-tailed)	.000
	N	21
Female maxillary teeth	Pearson correlation	.839
	Sig. (2-tailed)	.000
	N	21

RESULTS

Buccolingual, mesiodistal and cervicoincisal dimensions were larger in males than females (Table 1). The difference between the means of all the three tooth dimensions in both arches between males and females was statistically significant (Table 2). All the three different dimensions are independent of each other. There is no relation between the dimensions (Table 3). Buccolingual dimension was more reliable for both the genders and arches, whereas mesiodistal and cervicoincisal dimensions were more reliable for maxillary teeth of both the genders (Table 4).

DISCUSSION

The chief factor for identification of an individual in any medico-legal investigation is gender determination. Teeth, the most stable and hard human tissues, serve as an important valuable material for various investigations like forensic, anthropological and genetic. Being resistant to physical insults, teeth can be used in determination of gender in the cases where badly mutilated dead bodies or skeletal remains are found. In forensic odontology, determination of gender can be done by comparing tooth dimensions (odontometric analysis) or by comparing traits like cusp of carabelli's trait of upper first molar, deflecting

Table 3: Relationship among all the three different tooth dimensions for both arches

		Sum of Squares	Difference	Mean Square	*F*	Significance
Male maxillary teeth	Between groups	.963	2	.481	.196	.824
	Within groups	44.229	18	2.457		
	Total	45.191	20			
Male mandibular teeth	Between groups	3.917	2	1.959	.681	.519
	Within groups	51.803	18	2.878		
	Total	55.720	20			
Female maxillary teeth	Between groups	5.794	2	2.897	1.340	.287
	Within groups	38.929	18	2.163		
	Total	44.723	20			
Female mandibular teeth	Between groups	1.521	2	.760	.364	.700
	Within groups	37.566	18	2.087		
	Total	39.087	20			

Table 4: Reliability of the tooth dimension for both the genders and arches

For Buccolingual Dimensions			
Male mandibular teeth	Stepwise discrimination analysis	.996	.940
	Sig. (2-tailed)	.000	.002
	N	7	7
Female mandibular teeth	Stepwise discrimination analysis	.978	.980
	Sig. (2-tailed)	.000	.000
	N	7	7
Male maxillary teeth	Stepwise discrimination analysis	.942	.991
	Sig. (2-tailed)	.001	.000
	N	7	7
Female maxillary teeth	Stepwise discrimination analysis	.917	.952
	Sig. (2-tailed)	.004	.001
	N	7	7
For Mesiodistal Dimensions			
Male mandibular teeth	Stepwise discrimination analysis	.990	.801
	Sig. (2-tailed)	.000	.031
	N	7	7
Female mandibular teeth	Stepwise discrimination analysis	.969	.729
	Sig. (2-tailed)	.000	.063
	N	7	7
Male maxillary teeth	Stepwise discrimination analysis	.770	.935
	Sig. (2-tailed)	.043	.002
	N	7	7
Female maxillary teeth	Stepwise discrimination analysis	.707	.912
	Sig. (2-tailed)	.076	.004
	N	7	7
For Cervicoincisal Dimensions			
Male mandibular teeth	Stepwise discrimination analysis	1.000	.817
	Sig. (2-tailed)	.000	.025
	N	7	7
Female mandibular teeth	Stepwise discrimination analysis	.179	.088
	Sig. (2-tailed)	.701	.852
	N	7	7
Male maxillary teeth	Stepwise discrimination analysis	.744	.979
	Sig. (2-tailed)	.055	.000
	N	7	7
Female maxillary teeth	Stepwise discrimination analysis	.786	.944
	Sig. (2-tailed)	.036	.001
	N	7	7

wrinkles of the lower first molar, distal accessory ridge of upper and lower canines or shovelling of the upper central incisors (non-metric analysis)[11]. Odontometric analysis still remains the important method as it acts as an adjunct in gender determination and has an advantage of identification in large population as it is simple, reliable, easy to measure and inexpensive[12]. In the present study, both the arches in both the genders along with all the three dimensions of the tooth (buccolingual, mesiodistal and cervicoincisal) were measured which makes the present study unique from others. Reliability of the dimensions was also assessed. After applying descriptive statistics with the help of independent *t* test and stepwise discriminant analysis, it was found that in all the dimensions (buccolingual, mesiodistal and cervicoincisal), mean of males is higher than females which mean that males have larger teeth. It is in accordance with studies done by Lakhanpal *et al.*[12], Iºcan *et al.*[8], Garn *et al.*[13,14], Pratibha Rani *et al.*[15], Rai *et al.*[16], Sonika *et al.*[17], Narang *et al.*[18] and Agnihotri *et al.*[19]. To find a reliable result of gender determination, stepwise discrimination analysis was done. It was found that buccolingual dimension was more reliable for both the genders and arches which was similar with the studies done by Sonika *et al.*[17], Narang *et al.*[18] and Agnihotri *et al.*[19]. It was also found that mesiodistal and cervicoincisal dimensions were more reliable for maxillary teeth of both the genders which are in accordance with the studies done by Lakhanpal *et al.*[12] and Acharya *et al.*[9]. Considering all the facts and the results of the previous studies, it can be inferred that some studies show that the gender determination potential of buccolingual dimension is more than other dimensions, and some studies have proven that mesiodistal dimension is better gender predictor. Therefore, it is referred to go for both the dimensions rather than choosing a single dimension for gender prediction. The future prospects from the present study are estimating different measurement standards in Indian population and recording the dimensions in males and females separately.

CONCLUSION

Forensic odontology is an emerging field in India and relies a lot on inexpensive and easy means of identification of persons from fragmented jaws and remaining teeth. Tooth size standards based on odontometric investigations are population specific and have shown varying degree of sexual dimorphism. Yet it is not same in all humans, and tooth size show sexual variations which are in continuum rather than anything discrete. Hence, teeth are considered a valuable supplement and adjunct to sex determination and are not recommended as the sole indicator of sex. Nevertheless, teeth may be one of the very few biologic parameters available for gender determination due to destruction and fragmentation of bones. The present study evaluated the use of tooth dimensions for sexual dimorphism because of simplicity and reliability. It was finally concluded that males have larger teeth than females and buccolingual dimension was more reliable for both the genders and arches, whereas mesiodistal and cervicoincisal dimensions were more reliable for maxillary teeth of both the genders. Due to difficulty in measuring the mesiodistal dimensions due to close proximal contacts, there may be discrepancy in its measurement. Therefore, considering all the dimensions for gender determination would be better and more reliable.

DECLARATIONS

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