Determination of Sex and Stature in Ethnics of South Indian Population using Tooth Crown Dimensions and Intercanine Distance

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ABSTRACT

Objective:To determine the sex and stature of an individual using tooth crown dimensions (Mesiodistal & Buccolingual) and intercanine distance in ethnics of South Indian Population, by using Pearson correlation and linear regression.

Methods:Dental casts of 70 male and 70 female individuals between 17-30years of age made with strict standardization were subjected to analysis of intercanine distance, mesiodistal & buccolingual dimensions of upper and lower teeth. Individualsupto 2 generations included were those whose ethnic origin was from South India with their history recorded and height were measured in centimetres using standard anthropometer. Teeth dimensions were measured upto two decimal places with a digital calliper. Intra- and inter-observer reliability was done.

Results:The statistical analysis of the data obtained was done using SPSS for Windows [Version 17]. The descriptive statistics such as mean and standard deviation were calculated. Correlation between tooth measurements and height and gender was done using Pearson's correlation and linear regression method was applied to arrive at a formula to predict stature and gender using inter-canine distance.

Conclusion: There is definite usefulness of dentition in gender and stature prediction and this data could be used in forensic investigations.

Keywords: Gender, Intercanine distance, Stature, Forensic Odontology

Introduction

Forensic odontology is one of the most unexplored and intriguing branches of forensic sciences that primarily deals with identification, based on recognition of unique features present in an individual's dental structures. Forensic dentistry plays a major role in identification of manmade or natural disasters and many other events that result in multiple fatalities that may not be identifiable through conventional methods such as fingerprints.[1]

The basis for dental identification is based on the theory that human dentition is never the same in any two individuals. The morphology and arrangement of teeth vary from person to person. If, instead of considering the whole tooth, the surfaces were taken individually, the variations produced would be astronomic. In fact, a possible combination of 32 teeth being intact, decayed, missing or restored would be in the range of $1.8x10^{19}$.[2,3]

Hence, dental identity has been defined by Acharya and Taylor as the total of all characteristics of the teeth and their associated structures which, while not individually unique, when considered together provide a unique totality.[4]

Teeth are the hardest tissue in the human body and therefore they are the tissue that is most resistant to trauma, decomposition, water immersion, chemicals and fire making them an invaluable evidential source. To match these natural requirements, the foreign materials subsequently placed in the mouth by the dental practitioner such as fillings, dentures, crowns, bridges and implants must be equally resistant to the intense mechanical demands placed upon them and therefore their survivability. Recent evidence supports the view that the potential for post-mortem and post-excavation contamination of teeth is much lower than for bones.[5]

Sexual dimorphism represents a group of morphologic characteristics that differentiate a male from a female. Among these dimorphic traits, tooth size has been evaluated in various populations for its applicability in anthropologic and forensic investigations. The morphological differences of the teeth between males and females have been reported and can be applied to identify the gender from dental remains.[6,7]

Estimating stature, along with age, sex and race, is one of the four pillars of the anthropological protocol and may be essential in preliminary screening and reconstructive identification of skeletal remains. Stature is shown to have a definite and proportional relationship with many parts of the human body such as the cranial and facial bones, long bones, trunk and foot bones. Stature estimation from the dentition, however, has seldom been explored.

Dentin which forms the bulk of the tooth determines the dimension of the tooth and originates from the ectomesenchyme (neural crest cells) and long bones from the mesoderm. Both are basically mesenchymal tissues (connective tissue) and have similar structural components with collagen forming the organic matrix and hydroxyapatite crystals being the inorganic component.

Hence, it is reasonable to presume a correlation between tooth dimensions and stature in an individual.[8]

Hence, the purpose of this study is to determine the dentition's usefulness in stature & gender prediction. This study might serve as reference data in forensic odontology as well as informative to dental practitioners in providing clinical information and education in this part of the world.

Materials & Methods

Ethical Considerations: The study was approved by the ethical committee of SRM Institute of Science of Technology. The details of the study were explained to all subjects and written & verbal informed consent was obtained from all subjects before entering into the study.

Study Group& Sample size: Subjects for the study were recruited from the outpatient department of SRM Dental College and students of SRM Dental College. The study group included a totoal of 140 adults comprising of 70 males and 70 females.

Inclusion & Exclusion criteria for samples

Inclusion Criteria

1. Individuals of age between 17-28 years.
2. South Indian Population.
3. Complete set of fully erupted, periodontally healthy, non-carious, non-worn, intact & satisfactorily aligned teeth.
4. No history or clinical evidence of cleft palate or crown restorations, orthodontic treatment, orthognathic surgery, trauma or any surgery of skull.
5. No history of endocrinal disorders, metabolic disorders, developmental disorders, or any history of prolonged illness.

Exclusion Criteria

1. Individuals who wear bridges, crowns, removable partial denture, and other appliances or had any anomalies that could influence the measurements.
2. Individuals with anodontia, partially edentulous, malformed/hypoplastic teeth and positional variations of teeth.
3. Individuals with clinical features suggestive of developmental disturbances, metabolic disorders, history of prolonged illness and medically compromised states.

Method for Stature & Tooth Measurements

Stature

Stature was measured as the vertical distance from the vertex to the floor. The measurement was obtained by making the subject stand erect and barefooted with the heels in close contact with each other on a firm horizontal resting plane. The subject's back was positioned as straight as possible, and achieved by rounding or relaxing the shoulders, with the shoulder blocks and buttocks touching the vertical plane. The head was oriented in the Frankfurt Horizontal plane, which was achieved by adjusting the face such that the lateral palpebral commissure and the tip of the pinna were in a horizontal plane parallel to that of the feet. An Anthropometer with one arm sliding against the vertical plane was brought down on to the subject's head and the stature read off the scaled vertical plane. Stature was re-measured on 20 randomly selected subjects, also to assess possible intra-observer differences.

Standardization

Strict standardization of the dental materials and impression procedure was adhered to. Irreversible hydrocolloid material [Alginate] of the dustless, normal setting variety [Plastalgin^{TM}, Septodont^{R}] was selected for the impression procedure. Die stone [Pearl Stone] was used to pour the impressions. Impression trays and other instruments were cleaned and sterilized as recommended.

Fabrication of Dental Casts

After verbal and written consent, dental casts were made using alginate impression material and die stone with the aid of vibrator as per manufacturers' recommendations. The casts were removed from the impression to prevent damage after they reached their dry 24 hours strength.The impressions were not disinfected so as to avoid any dimensional change of the casts that might result due to the procedure, because in the present study, the clinical acceptability was not a consideration but the prime interest was to acquire casts with maximum possible dimensional stability as measurements upto two decimal places were of prime importance. Therefore, standard recommended sterilization was maintained with regard to the procedure and gear used for subject and professional protection.

Measurements

Mesio-Distal (MD) diameter of the crown: the greatest distance between the proximal surfaces of the crown measured parallel to the occlusal plane of the crown

Bucco-Lingual (BL) diameter of the crown: the greatest distance between the height of contour of labial and lingual surfaces of the crown, measured at right angle to the mesio-distal diameter

Inter-Canine (IC) distance (canine arch width): measured between the tips of both canines in each of the maxillary and mandibular casts. Cusp tips were taken as guidance.

The above measurements were made in the casts in millimetres with a digital Vernier calliper up to two decimal places and readings were taken. 28 teeth of each subject were taken into account, each tooth being measured in 2 dimensions [BL & MD] therefore 28 x 2 = 56 variables per subject. After every measurement, the calliper was brought back to zero reading and then proceeded for the next measurement.The primary/basic examination of 140 subjects [70 male and 70 female] was performed by the first examiner. 10 male casts and 10 female dental casts were randomly selected by lottery method and the secondary / intra observer examination was performed in which all the teeth in these cases were re-measured by the first examiner. All the teeth in the same 20 casts were then measured by the second examiner, who reported the inter observer observations.

Statistical Analysis

The sample size was calculated using n-Masters Software, with a power of 80% and alpha error of 5%, and the correlation coefficient equal to 0.24, and a sample size of 139 was arrived at.The statistical analysis of the data obtained was done using SPSS for Windows [Version 17]. The descriptive statistics such as mean and standard deviation were calculated. Correlation between tooth measurements and height and gender was done using Pearson's correlation and linear regression method was applied to arrive at a formula to predict stature and gender using inter-canine distance.Cronbach's alpha method was used to calculate intra-observer reliability and for

inter-observer reliability, Intra class coefficient correlation method was used. For both intra and inter-observer reliability, a value between the ranges of 0 to 1 is considered acceptable**.**

Results

The present study included a sample size of 140 subjects, out of which 70 were male and 70 were female. The age range for the individuals enrolled in the study was between 17 to 28 years.The sample size was calculated using n-Masters Software, with a power of 80% and alpha error of 5%, and the correlation coefficient equal to 0.24, and a sample size of 139 was arrived at.

The individuals who were enrolled in the study were verbally explained about the study and written consent was obtained. The height of each individual was measured in centimetres using standard stature anthropometer, and then the maxillary and mandibular teeth impressions were taken. The study casts were obtained and from these casts inter-canine (IC) distance and mesiodistal (MD) and buccolingual (BL) dimensions of all maxillary and mandibular teeth except third molars were measured in millimetres using a digital vernier calliper.

The statistical analysis of the data obtained was done using SPSS for Windows [Version 17]. The descriptive statistics such as mean and standard deviation were calculated. Correlation between tooth measurements and height and gender was done using Pearson's correlation and linear regression method was applied to arrive at a formula to predict stature and gender using inter-canine distance.

Intra and Inter-observer reliability:Cronbach's alpha method was used to calculate intra-observer reliability, and the reliability value was 0.6. For inter-observer reliability, Intra class coefficient correlation method was used and the reliability value was 0.6. For both intra and inter-observer reliability, a value between the ranges of 0 to 1 is considered acceptable.

Table 1: Descriptive Statistics for Inter-Canine Distance

Descriptive statistics for Inter-canine distance (mm)				
	Gender	**N**	**Mean**	**SD**
Maxilla	Male	70	35.51	1.98
	Female	70	33.23	1.75
Mandible	Male	70	27.09	1.98
	Female	70	25.65	1.59

Table 2: Descriptive Statistics for Height

Descriptive statistics for Height (cm)			
Gender	**N**	**Mean**	**SD**
Male	70	169.29	6.78

Female	70	155.29	5.78

Table 3: Descriptive Statistics for Mesiodistal and Buccolingual Tooth measurements

Tooth No.	Gender	Mesiodistal dimension (mm)		Buccolingual dimension (mm)	
		Mean	SD	Mean	SD
11	Male	8.67	.48	7.20	.55
	Female	8.41	.44	7.01	.48
12	Male	6.82	.51	6.56	.64
	Female	6.68	.52	6.32	.60
13	Male	7.92	.53	8.20	.60
	Female	7.5	.47	7.63	.57
14	Male	6.97	.60	9.82	.53
	Female	6.70	.48	9.09	.61
15	Male	6.50	.57	9.64	.64
	Female	6.21	.60	9.19	.47
16	Male	9.98	.50	11.35	.64
	Female	9.84	.60	10.93	.51
17	Male	9.86	.60	11.36	.78
	Female	9.45	.63	10.85	.69
21	Male	8.56	.78	7.20	.55
	Female	8.33	.69	7.01	.48
22	Male	6.82	.51	6.56	.64
	Female	6.68	.52	6.32	.60
23	Male	7.92	.53	8.20	.60
	Female	7.55	.49	7.63	.57
24	Male	6.97	.60	9.82	.53
	Female	6.70	.48	9.09	.61
25	Male	6.50	.57	9.64	.64
	Female	6.21	.60	9.19	.47
26	Male	9.98	.50	11.35	.64
	Female	9.84	.59	10.93	.51
27	Male	9.86	.60	11.36	.78
	Female	9.45	.63	10.85	.69

Tooth No.	Gender	Mesiodistal dimension (mm)		Buccolingual dimension (mm)	
		Mean	SD	Mean	SD
31	Male	5.35	.35	6.24	.64
	Female	5.22	.38	5.66	.53
32	Male	5.72	.40	6.37	.68
	Female	5.63	.43	5.97	.49
33	Male	7.05	.45	7.59	.66
	Female	6.55	.48	7.01	.65
34	Male	7.09	.48	8.49	.66
	Female	6.81	.61	7.80	.62
35	Male	6.78	.46	8.87	.71
	Female	6.51	.54	8.36	.57
36	Male	10.95	.73	10.81	.69
	Female	10.69	.67	10.41	.64
37	Male	10.39	.67	10.28	.76
	Female	9.83	.74	9.87	.73
41	Male	5.35	.35	6.24	.64
	Female	5.22	.38	5.66	.53
42	Male	5.72	.40	6.37	.68
	Female	5.63	.43	5.97	.49
43	Male	7.05	.45	7.59	.66
	Female	6.54	.48	7.01	.65
44	Male	7.10	.47	8.49	.66
	Female	6.80	.60	7.80	.62
45	Male	6.77	.46	8.87	.71
	Female	6.51	.54	8.36	.57
46	Male	10.95	.73	10.81	.69
	Female	10.69	.67	10.41	.64
47	Male	10.39	.67	10.28	.76
	Female	9.83	.74	9.87	.73

Stature Prediction

Table 4: Correlation between Intercanine Distance & Height

Correlation between IC Distance and Height				
		r-value	**p-value**	**Level of significance**
Height (cm)	Maxilla IC Distance	.530	0.000*	**Significant at 99.9%**
	Mandible IC Distance	.388	0.000*	**Significant at 99.9%**

The correlation between inter-canine distance & height was done using Pearson correlation statistical analysis

- Correlation between height and maxillary inter-canine distance shows significance at the level of 99.9% [p value less than 0.001].
- Similarly, there is a significant correlation between height and mandibular inter-canine distance.
- Hence inter-canine distance is directly proportional to the height of an individual.
- Both maxillary & mandibular inter-canine distance correlates with the height of the individual, but maxillary inter-canine distance is more significant than the mandibular inter-canine distance.

Linear regression analysis to determine height using
Inter-canine distance

For determining the height of an individual using the inter-canine distance, linear regression statistical method applied. Using linear regression statistical analysis unstandardized coefficient values were calculated and substituted in the formula derived.

Table 5: Using Maxillary Inter-Canine Distance

Coefficient[a]	
	Unstandardized coefficients
	B
Constant	**14.427**
Height (cm)	**.123**

$$\text{Height} = \frac{\text{Maxillary Inter-canine Distance} - \text{Unstandardised Coefficient Value Constant}}{}$$

$$\text{Height} = \frac{35.576 - 14.427}{\text{Unstandardised Coefficient B Value } 0.123} = 172 \text{ cms}$$

For example,

Table 6: Mandibular Inter-Canine Distance

Coefficient	
	Unstandardized coefficients
	B
Constant	**13.413**
Height (cm)	**.080**

$$\text{Height} = \frac{\text{Mandibular Inter-canine Distance} - \text{Unstandardised Coefficient Value Constant}}{\text{Unstandardised CoefficientB Value}}$$

For example,

$$\text{Height} = \frac{25.13 - 13.413}{0.080} = 146 \text{ cms}$$

Table 7: Correlation between Tooth Dimensions [Mesio-Distal and Bucco-Lingual Dimensions] & Height

	Tooth No.	**Mesiodistal dimension (mm)**		**Buccolingual dimension (mm)**	
		r value	**p value**	**r value**	**p value**
Height	11	.243**	.004	.181*	.033
	12	.126	.138	.219**	.009
	13	.351**	.000	.271**	.001
	14	.323**	.000	.464**	.000

	15	.204*	.016	.340**	.000
	16	.130	.127	.303**	.000
	17	.331**	.000	.331**	.000
	21	.199*	.018	.181*	.032
	22	.126	.138	.220**	.009
	23	.349**	.001	.272**	.001
	24	.324**	.000	.465**	.000
	25	.204*	.016	.341**	.000
	26	.131	.123	.304**	.000
	27	.332**	.000	.332**	.000
	31	.052	.539	.341**	.000
	32	-.002	.984	.287**	.001
	33	.469**	.000	.305**	.000
	34	.345**	.000	.384**	.000
	35	.291**	.000	.313**	.000
	36	.196*	.020	.202*	.017
	37	.341**	.000	.167*	.049
	41	.053	.535	.341**	.000
	42	-.002	.985	.286**	.001
	43	.469**	.000	.309**	.000
	44	.354**	.000	.384**	.000
	45	.291**	.000	.309**	.000
	46	.196*	.020	.202*	.017
	47	.341**	.000	.167*	.049

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level

The reliable tooth for height prediction is predicted by the ‘r’ value from correlation table.

- In maxilla, the reliable tooth for height prediction using
  - Mesiodistal dimension - Maxillary canine [r value - 0.351]
  - Buccolingual dimension - Maxillary 1st premolar [r value - 0.465]

- In mandible, the reliable tooth for height prediction using
  - Mesiodistal dimension - Mandibular canine [r value - 0.469]
  - Buccolingual dimension - Mandibular1st premolar [r value - 0.384]

Gender Determination

Table 8: Correlation between Intercanine Distance & Gender

Correlation between IC Distance and Gender				
	IC Distance (mm)	**r-value**	**p-value**	**Level of significance**
Gender	Maxilla IC Distance	-.522	0.000	**Significant at 99.9%**
	Mandible IC Distance	-.374	0.000	**Significant at 99.9%**

The correlation between inter-canine distance & gender was done using Pearson correlation statistical analysis

- Correlation between gender and maxillary inter-canine distance shows significance at the level of 99.9% [p value less than 0.001].
- Similarly, there is a significant correlation between gender and mandibular inter-canine distance.
- Both maxillary & mandibular inter-canine distance correlates with the gender of the individual, but maxillary IC distance is more significant than the mandibular IC distance.

Linear regression analysis to determine gender using

Inter-canine distance

For statistical purpose, male gender was coded as 1 and female gender coded as 2. For determining the gender of an individual using the inter-canine distance, linear regression statistical method was applied and a formula arrived at to predict the gender of the individual. When values falls within a range of 0.51 to 1.49 it is male gender and if the value falls within 1.51 to 2.49 then it is female. Using linear regression statistical analysis unstandardized coefficient values were calculated and substituted in the formula derived.

Table 9: Using Maxillary Inter-Canine Distance

Coefficients[a]	
	Unstandardized coefficients
	B
Constant	**37.787**
Sex	**- 2.274**

$$\text{Gender} = \frac{\text{Maxillary Inter-canine Distance} - \text{Unstandardised Coefficient Value Constant}}{\text{Unstandardised CoefficientB Value}}$$

For example,

$$\text{Gender} = \frac{35.573 - 37.787}{-2.274} = 1 \text{ [male]}$$

$$\text{Gender} = \frac{33.239 - 37.787}{-2.274} = 2 \text{ [female]}$$

Table 10: Using Mandibular Inter-Canine Distance

Coefficients[a]	
	Unstandardized coefficients
	B
Constant	**28.536**
Sex	**- 1.443**

$$\text{Gender} = \frac{\text{Mandibular Inter-canine Distance} - \text{Unstandardised CoefficientValue Constant}}{\text{Unstandardised Coefficient B Value}}$$

For example,

$$\text{Gender} = \frac{26.88 - 28.536}{-1.443} = 1 \text{ [male]}$$

$$\text{Gender} = \frac{25.96 - 28.536}{-1.443} = 2 \text{ [female]}$$

Table 11: Student 't' Test Method: To Predict Gender Using Tooth Dimensions [Mesiodistal and Buccolingual Dimensions

	Tooth No.	Mesiodistal dimension (mm)	Buccolingual dimension (mm)
		t value	t value
Gender	11	3.26	2.18
	12	1.56	2.30
	13	4.14	5.66
	14	2.86	7.45
	15	2.91	4.75
	16	1.52	4.30
	17	3.84	4.12
	21	1.84	2.18
	22	1.56	2.30
	23	4.24	5.66
	24	2.86	7.47
	25	2.91	4.77
	26	1.53	4.31
	27	3.86	4.13
	31	2.08	5.75
	32	1.15	3.92
	33	6.33	5.19
	34	3.00	6.38
	35	3.07	4.65
	36	2.18	3.54
	37	4.63	3.20
	41	2.08	5.74
	42	1.15	3.90
	43	6.38	5.27
	44	3.17	6.38
	45	3.06	4.55
	46	2.18	3.54
	47	4.63	3.20

Using the student "t" test statistical method, the reliable tooth for Gender prediction is predicted by the "t" value

- In maxilla, the reliable tooth for Gender prediction using
  - Mesiodistal dimension is canine [t value- 4.14]
  - Buccolingual dimension is 1st premolar [t value- 7.45]

- In mandible, the reliable tooth for gender prediction using
  - Mesiodistal dimension is Mandibular canine [t value- 6.38]
  - Buccolingual dimension is Mandibular1st premolar [t value- 6.38]

Discussion

Dental identification of humans occurs for a number of different reasons and in a number of different situations. The bodies of victims of violent crimes, fires, motor vehicle accidents and work place accidents, can be disfigured to such an extent that identification by a family member is neither reliable nor desirable. Persons who have been deceased for some time prior to discovery and those found in water also present with unpleasant and difficult visual identifications.

Dental identification has always played a key role in natural and manmade disaster situations and in particular the mass casualties normally associated with aviation disasters. Because of the lack of a comprehensive fingerprint database, dental identification continues to be crucial in identification. Thus Forensic dentistry plays a major role in identification of those individuals who cannot be identified.[9]

Forensic dentistry is a multidisciplinary team effort by forensic pathologist, forensic anthropologist, forensic dentist, serologists, criminalists, and law enforcement officials. It is an interdependent science where all of the above mentioned branches have their responsibilities to share.[10]

Teeth are the strongest structures in the human body and find prominent application in post-mortem identification procedures. Not only teeth are useful in comparative identification methods, but also in eliciting a biologic profile of the decedent when only skeletal remains are recovered. Sex determination, in addition to race, stature and age, is an important step in building a physical profile of the decedent. While sex can be predicted with high degrees of accuracy from the pelvic and cranial bones, the tendency of these bones to be fragmented may preclude accurate sex determination. The teeth are considered useful adjuncts in such scenarios since they are frequently recovered intact from skeletonised remains and have the ability to estimate sex correctly with accuracy rates that range between 76 and 92.5%.[11]

Dentin is a part of the tooth originating from the ectomesenchyme and is similar to the long bones in the fact that both are connective tissue origin and have similar structural components (with collagen forming the organic matrix and hydroxyapatite crystals being the inorganic component). Hence, it is logical to assume there exists a correlation between tooth dimensions and stature in an individual.[8]

Odontometric methods for gender and stature determination possess several benefits relative to their morphological counterparts as they are considered objective because they rely on standard landmarks. Hence, the value of this study is in the very fact that it presents methods for gender and stature determination from odontometric measurements of teeth.[6]

In the earlier period, there were no studies found for gender and stature prediction together using odontometric measurements. Thus, this study took effort to predict the gender and stature of an

individual using odontometrics (tooth dimensions and inter-canine distance) and to arrive at a reasonably acceptable formula for clinical usage using inter-canine distance and tooth dimensions with the help of linear regression statistical analysis.

Stature Prediction

Correlation of Intercanine Distance & Height

Predicting stature along with age, gender and race, is one of the four pillars of anthropology and may be used in screening and identification of skeletal remains. Previously, stature prediction was done using length of cranial sutures, maxillofacial anthropometry and tooth dimensions.

Jagadish Rao et al estimated height from length of coronal and sagittal sutures of the skull and reported that sutural length studies are useful in estimating stature.[12]

Wankhede et al used maxillofacial anthropometry for stature estimation and observed that in males the total facial height had greater correlation with stature. In females, nasal height had greater correlation with stature. However, percutaneous facial dimensions are not good predictors of accurate stature estimation and can be used when other parameters are not available.[13]

The present study was the first to come out with correlation between inter-canine distance & height. Correlation between height and maxillary inter-canine distance shows significant positive correlation. Similarly, there is a significant correlation between height and mandibular intercanine distance. Hence intercanine distance is directly proportional to the height of an individual.Both maxillary and mandibular intercanine distance correlates with the height of the individual, but maxillary intercanine distance is more significant than the mandibular intercanine distance.

With the current data of inter canine distance, linear regression analysis was done and a formula was derived for prediction of height of an individual. The results obtained by the use of this formula showed reliability in the prediction of height.

However, the formula is highly reliable when the correlation 'r' value falls above 0.8. In our study we arrived at a correlation "r" value of 0.530 (maxillary intercanine distance) and 0.388 (mandibular intercanine distance). Our study used samples of height ranging from 140 to 180 cm, and hence in order to arrive at an accurate correlation, heights of variable categories must be used. However, validation of this formula should be done with more number of samples to use intercanine distance as a predictor of height.

Correlation between Tooth Dimensions [Mesio-Distal and Bucco-Lingual Dimensions] & Height

In the past, only few studies subjected tooth dimensions for height prediction. Ashith B. Acharya, et al used tooth dimensions in stature prediction and found tooth crown dimensions showed correlation to stature and suggested that dentition may only be used as a supplementary method to other more accurate variables of the skeletal system.[8]

Similarly, Lima et al used dimensions of lower anterior teeth for stature estimation in dental arches with normal dentition, crowding and diastema and reported that the dimensions of lower anterior teeth is a reliable method for height estimation in normal dentition and crowding.[14]

In the present study, using Pearson correlation analysis the reliable tooth for height prediction was found separately for maxilla and mandible. In maxilla, using mesiodistal dimension, the reliable tooth for height prediction was maxillary canine and using buccolingual dimensions, the reliable tooth for height prediction was found to be maxillary 1st premolar.In mandible, the reliable tooth

for height prediction using mesiodistal dimension was found to be mandibular canine and using buccolingual dimension is mandibular first premolar.

Gender Determination

Correlation between intercanine distance & gender

Gender is important in determining the identity of an individual. Gender can be determined by various methods including canine dimorphism, dental index, Barr bodies, polymerase chain reaction (PCR), enamel proteins, skeletal structure and several other methods. In our study, both maxillary and mandibular intercanine distance correlates with the gender and is statistically significant. However, maxillary intercanine distance is more significant than the mandibular intercanine distance.

The results of this study is in accordance with Aliaa Omar et al who observed that maxillary intercanine distance showed statistically significant differences between both sexes.[15]Abdulla et al showed that intercanine distance of the upper and lower dental arches were significantly greater in males than in females in his Saudi population group study.[16]Contrary to results of the current study, Kaddah reported that no statistically significant differences were obtained between males and females while measuring the intercanine distance.[17]

With the current data of intercanine distance, linear regression analysis was performed and a formula was derived for prediction of gender of an individual. The results obtained by the use of this formula showed reliability in the prediction of gender. When values falls within a range of 0.51 to 1.49 it is male gender and if the value falls within 1.51 to 2.49 then it is female. If the value falls above the maximum or below the minimum cut-off point then this formula cannot be applied to predict the gender. The possible reason could be alteration of intercanine distance in exceptional cases where increased or decreased jaw growth and tooth dimension. However, validation of formula should be done with more number of samples to use inter-canine distance as a predictor of gender.

Additionally, the student "t" test statistical analysis was done and the reliable tooth for gender prediction using mesiodistal dimension in maxilla was the canine and using buccolingual dimension it is first premolar.

In mandible, the reliable tooth for gender prediction using mesiodistal dimension is the canine and using buccolingual dimension it is the first premolar.Among the maxillary and mandibular teeth, mesiodistal dimension of mandibular canine showed more significance in gender determination which is similar to the results obtained by Hemani S et al who used tooth dimensions for gender prediction.[18]

Rishabh Kapila et al in their study found that the mandibular left canine exhibited greater sex differentiation compared to the mandibular right canine.[19]Acharya &Mainali observed that mesiodistal dimensions had recognizably greater accuracy in gender identification than buccolingual measurements in Nepalese population. However, higher accuracy levels have been obtained when both types of dimensions were used concurrently.[20]

Overall, the present study suggests that the tooth dimensions show positive correlation with stature and gender and can be used as an economical method in stature and gender prediction. Though tooth has been found to be one of the reliable method in predicting stature and gender, it has its own limitations too. Aging is one of the most important limiting factors as it would result in attrition, abrasion or erosion of teeth which can alter tooth dimensions over a period of time.

Hence it may not be applicable in aged individuals. In addition, developmental abnormalities of teeth (like anodontia, malformed/hypoplastic teeth, positional variations), and the use of removable dentures, bridges, crowns (which would also influence the tooth dimension) will limit the use of tooth as an ideal predictor in stature and gender estimation.

Conclusion

The present study which is designed to correlate tooth measurements with gender and stature reinforces the earlier studies and emphasizes the fact that dental dimorphism may be used for assessment of the gender of an individual.However, there are limited studies in the literature regarding the role of tooth dimensions in predicting the stature of an individual. Regarding the role of tooth measurements and stature, the present study showed promising results in predicting the stature.

This study would create a platform for making the dimensional data as a standard that may have better applicability in educational, research and forensic arenas in India. However, the role of intercanine distance and tooth dimension in gender and stature prediction is limited and its utility can be ascertained by studying a larger set of population.This method of predicting gender and stature may be of relative importance, but not of absolute certainty, thereby making it an adjunct to various other methods of gender and stature prediction.

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