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Original Research

Assessment of Ethnicity in Indian Population using Tooth Crown Metric Dental Traits

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Abstract:

Background: Tooth crown dimensions vary between different ethnic groups, providing insights into the factors controlling human dental development. This present study compares permanent mesiodistal (MD) and buccolingual crown dimensions between four ethnic groups, highlighting patterns of tooth size between these groups and considers the findings in relation to genetic and environmental influences.

Materials and Methods: MD and buccolingual tooth crown dimensions were recorded using digital vernier calipers on dental casts derived from four different human population: Iranians, Hindus, Muslims, and Christians.

Results: Obtained measurements were subjected to statistical analysis. The Christian sample was found to have the largest teeth overall, whereas the Iranian sample generally displayed the smallest MD and buccolingual crown dimensions ($P < 0.001$). Comparisons of coefficients of variation for teeth within each class showed that the later-forming teeth displayed greater variation in MD size than the earlier-forming teeth.

Conclusion: The different patterns of tooth size observed between the study samples are thought to reflect differences in the relative contributions of genetic and environmental influences to dental development between the four population. Using a standardized methodology, significant differences in MD and buccolingual crown dimensions have been demonstrated between four human ethnic groups. There were also distinct differences in the patterns of crown size between the groups, with the later-forming teeth in each type generally showing greater size variation.

Key Words: Buccolingual, genetic and environmental factors, mesiodistal

Introduction

Teeth are shown to be distinctive organs made of the most persistent mineralized tissues in the human body. Teeth are known to be resistant to mechanical, chemical, physical, and thermal types of devastations. Therefore, teeth play a vital role in identification of skeletal remains, chiefly in cases where there is a poor preservation of skeletal remains, the identification is not possible by standard methods.[1-4]

Dental profile comprises a group of specific individual characteristics related to the teeth and surrounding tissues. These characteristics help in the estimation of age, sex, race, socio-economic status, personal habits, oral and systemic health, occupation and dietary status of the person. The variations in tooth form are a common occurrence in permanent dentition, and these variations have an ethnic, forensic, and anthropological significance.[1,3-6]

The study of tooth form is achieved by measurements and out of the two proportions-widths and length, the former is considered more important. Any measurement on teeth unaccompanied by age, race, and sex must be treated with great reserve. Based on the Tooth Crown Metric Traits, tooth morphology is studied from an interdisciplinary perspective (biology, anthropology, dentistry, paleopathology, archeology, forensic science) because teeth can be used in the assessment of biological relationships between population. This is can achieved by comparatively analyzing past and present human groups in an attempt to explain the historical, cultural, and biological macro and micro-evolutionary processes that lead to an understanding of the origin, formation, contacts, displacements, migrations pathways, and isolates that have led to the populating of the planet and ethnic variation of humanity.[7]

In general, population have been grouped as microdontic, mesodontic, and megadontic. Hence, measurements of dental crown size, provide greater objectivity and provide the most comprehensive and discriminatory description of human dentitions. But metric variations of the human dentition have not been utilized to their full possibility by anthropologists concerned with patterns of human biological variation in Indian population.[6,8,9]

Hence, this study forms part of a larger investigation aimed at using dental crown features - mesiodistal (MD) and buccolingual crown dimensions between four ethnic groups, to develop a probabilistic model to distinguish individuals from specific human population, particularly for forensic purposes. Highlighting patterns of tooth size between these groups and consider the findings in relation to genetic and environmental influences.

Materials and Methods

The study samples consisted of 400 individuals from four different ethnic groups including Hindu, Islam, Christian, and Iranians. Dental casts were obtained from all the participants using alginate impressions that were poured up with high-quality dental stone.

Measurements were obtained from all the permanent maxillary and mandibular central incisors, lateral incisors, canines, first and second premolars, first and second molars using digital vernier caliper (Mitutoyo Corp - Japan) (Figure 1). All the third molars were excluded because impressions were taken before eruption of these teeth and the teeth that were not fully erupted, had carious lesions or restorations, or were crowded and/or exhibited any evidence of tooth wear or model damage were excluded from this study.

The maximum MD crown dimensions were assessed according to Moorrees *et al.* (1957), Brook *et al.* (1999) and Brook *et al.* (2005) as being the maximum distance between the mesial and distal proximal surfaces of the tooth crown (Figure 2). The maximum labiolingual or buccolingual (BL) crown dimension was defined as the greatest distance between buccal and lingual surfaces of the crown perpendicular to and bisecting the line defining the MD dimension (Brook *et al.*, 1999; Brook *et al.*, 2005) (Figure 2). Each tooth was measured on two separate occasions, and the mean value of the measurements was used. Different recording sheets were used on each occasion to ensure no access to the previous measurements. If there was a discrepancy >0.4 mm between the recordings, the measurements were discarded.

The mean values of the four groups were compared pair-wise using the SPSS Statistical Software Package for Analysis of Variance. The level of difference between groups was automatically given when significant.

Results

Reliability testing across the four ethnic groups showed similar results, indicating that each set of data was reliable to 0.1 mm and that valid comparisons between the groups could be made. The mean MD dimensions of all the maxillary and mandibular teeth together with descriptive statistics are presented in Tables 1 and 2 and also buccolingual dimensions of all the teeth are presented in Tables 3 and 4.

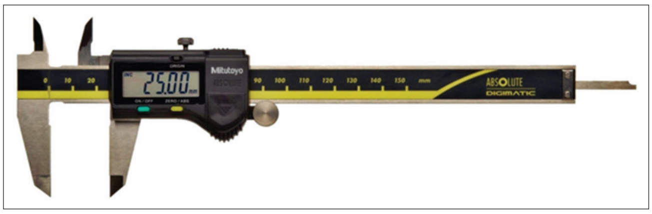

Figure 1: Digital Vernier Caliper (Mitutoyo - Japan Corp.) used to measure buccolingual and mesiodistal tooth dimensions.

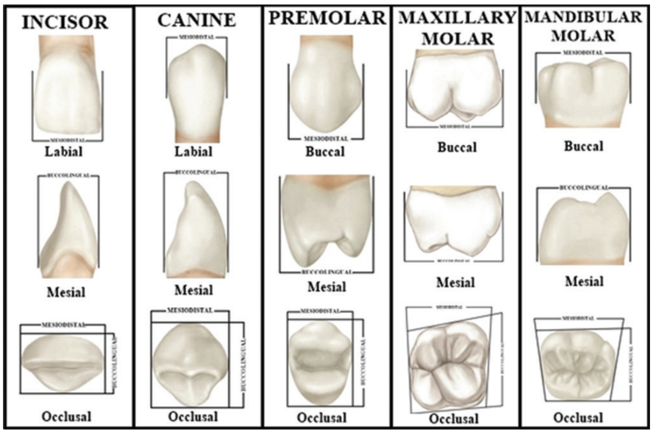

Figure 2: Measurement of tooth crown dimensions.

The combined MD and buccolingual crown dimensions for the Christian sample were largest overall compared with the other three groups while those of the Iranians sample were the smallest. There was also a great range of dimensions in all the groups and the difference observed between these groups was seen to be statistically significant. Comparison of coefficients of variation between the first and second teeth of each tooth type, e.g., upper central incisor versus upper lateral incisor, showed the later forming teeth usually demonstrated greater variation.

Discussion

Teeth can provide evidence about the nature and extent of diversity between human population and variations in dental crown size have been reported between different population.[1,2] Numerous factors can contribute to variation in tooth size, and these may be described broadly as genetic, epigenetic, and environmental influences.[3-5] Previous studies have confirmed the presence of sexual dimorphism within the human dentition[8-10] and examples of ethnic differences and geographic variability in tooth size have been documented.[2]

In the present study, we found significant differences in tooth size between the four ethnic groups studied, with Christians having generally larger MD crown dimensions. The variations in crown dimensions observed in the four groups are likely to reflect genetic and environmental differences between this group and the other three considered here. A synthesis of data on dental dimensions from different population

Table 1: Comparison of mean values of mesiodistal tooth dimensions of maxillary teeth between four different ethnic groups.

Mesidistal dimensions of maxillary teeth										
Teeth	Iranian		Hindu		Muslim		Christian		*P* value (one-way ANOVA)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Central incisor	8.44 (0.51)	8.37 (0.69)	8.48 (0.77)	8.42 (0.50)	8.53 (0.60)	8.58 (0.81)	8.50 (0.70)	8.46 (0.73)	0.8826	0.1899
Lateral incisor	6.51 (0.56)	6.57 (0.50)	6.56 (0.39)	6.46 (0.45)	6.64 (0.41)	6.50 (0.60)	6.88 (0.52)	6.74 (0.54)	<0.001	0.0042
Canine	7.60 (0.50)	7.53 (0.52)	7.80 (0.45)	7.73 (0.55)	7.60 (0.52)	7.40 (0.51)	7.52 (0.53)	7.67 (0.76)	0.0156	0.0001
First premolar	6.80 (0.51)	6.74 (0.48)	7.04 (0.80)	7.03 (0.54)	6.81 (0.51)	6.83 (0.47)	6.65 (0.57)	6.89 (0.78)	0.0016	0.0442
Second premolar	6.21 (0.46)	6.61 (0.42)	6.53 (0.75)	6.54 (0.52)	6.63 (0.45)	6.31 (0.48)	6.39 (0.51)	6.67 (0.49)	<0.001	<0.001
First molar	9.62 (0.71)	9.84 (0.55)	9.68 (0.44)	9.60 (0.59)	9.67 (0.56)	9.61 (0.78)	9.72 (0.60)	9.76 (0.61)	0.7546	0.025
Second molar	9.18 (0.72)	9.28 (0.64)	9.15 (0.48)	9.19 (0.63)	9.10 (0.54)	9.20 (0.68)	9.39 (0.51)	9.52 (0.84)	0.0471	0.0289

ANOVA: Analysis of variance

Table 2: Comparison of mean values of mesiodistal tooth dimensions of mandibular teeth between four different ethnic groups.

Mesidistal dimensions of mandibular teeth										
Teeth	Iranian		Hindu		Muslim		Christian		*P* value (one-way ANOVA)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Central incisor	5.10 (0.37)	5.09 (0.36)	5.12 (0.35)	5.18 (0.41)	5.83 (0.90)	5.67 (0.21)	5.16 (0.38)	5.33 (0.29)	<0.001	0.0049
Lateral incisor	5.72 (0.50)	5.69 (0.18)	5.65 (0.24)	5.67 (0.35)	5.85 (0.42)	5.70 (0.40)	5.69 (0.45)	5.91 (0.50)	0.003	<0.001
Canine	6.81 (0.39)	6.63 (0.37)	6.57 (0.44)	6.71 (0.44)	6.53 (0.39)	6.67 (0.58)	6.55 (0.53)	6.58 (0.36)	0.0019	0.2921
First premolar	7.02 (0.48)	7.07 (0.37)	6.88 (0.65)	7.10 (0.88)	6.82 (0.50)	7.03 (0.62)	6.90 (0.48)	6.73 (0.52)	0.1958	0.0001
Second premolar	6.88 (0.48)	6.72 (0.40)	6.63 (0.46)	6.96 (0.40)	6.60 (0.64)	6.73 (0.68)	6.84 (0.54)	6.78 (0.60)	0.0008	0.0732
First molar	10.41 (0.80)	10.52 (0.53)	10.63 (2.52)	10.59 (0.93)	10.42 (0.81)	10.56 (0.67)	10.87 (2.49)	10.65 (0.89)	0.0339	0.6693
Second molar	9.05 (0.96)	9.42 (1.78)	9.60 (0.75)	9.74 (0.75)	9.70 (0.72)	9.72 (0.47)	9.81 (0.46)	9.78 (1.01)	0.0134	0.1327

ANOVA: Analysis of variance

Table 3: Comparison of mean values of buccolingual tooth dimensions of maxillary teeth between four different ethnic groups.

Buccolingual dimensions of maxillary teeth										
Teeth	Iranian		Hindu		Muslim		Christian		*P* value (one-way ANOVA)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Central incisor	6.60 (0.73)	6.61 (0.72)	6.65 (0.72)	6.79 (0.87)	6.77 (0.77)	6.87 (0.76)	6.78 (0.65)	6.99 (0.59)	0.3466	0.0214
Lateral incisor	5.95 (0.68)	6.21 (0.55)	6.30 (0.69)	6.18 (0.54)	6.26 (0.71)	6.40 (0.58)	6.36 (0.56)	6.58 (0.96)	0.0036	0.0004
Canine	7.98 (0.60)	8.17 (0.52)	7.65 (0.85)	7.68 (0.87)	7.83 (0.79)	8.21 (0.67)	7.50 (0.95)	7.48 (0.83)	0.0029	<0.001
First premolar	9.30 (0.52)	9.15 (0.52)	9.28 (0.65)	9.19 (0.53)	9.33 (0.50)	9.33 (0.55)	9.15 (0.67)	9.25 (0.48)	0.17	0.1446
Second premolar	9.39 (0.46)	9.31 (0.38)	9.30 (0.58)	9.21 (0.63)	9.28 (0.46)	9.24 (0.50)	9.53 (0.60)	9.44 (0.53)	0.0042	0.0108
First molar	11.11 (0.55)	11.11 (0.44)	11.01 (0.64)	11.23 (0.47)	11.17 (0.49)	11.04 (0.49)	11.11 (0.57)	11.16 (0.64)	0.2355	0.0712
Second molar	11.03 (0.87)	10.97 (0.73)	9.84 (2.67)	10.41 (0.71)	10.71 (0.79)	10.45 (0.41)	10.68 (0.59)	10.62 (0.80)	<0.001	0.1646

ANOVA: Analysis of variance

Table 4: Comparison of mean values of buccolingual tooth dimensions of mandibular teeth between four different ethnic groups.

Buccolingual dimensions of mandibular teeth										
Teeth	Iranian		Hindu		Muslim		Christian		*P* value (one-way ANOVA)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Central incisor	5.51 (0.48)	5.51 (0.40)	5.70 (0.47)	5.76 (0.50)	5.72 (0.47)	5.76 (0.60)	5.82 (0.48)	5.88 (0.53)	<0.001	0.0001
Lateral incisor	6.05 (0.42)	5.83 (0.36)	6.25 (0.38)	6.46 (0.51)	6.23 (0.57)	6.28 (0.53)	6.15 (0.52)	6.45 (0.46)	0.0299	0.0169
Canine	6.80 (0.65)	6.82 (0.71)	7.40 (0.70)	7.29 (0.75)	8.1 (00.69)	7.27 (0.74)	7.41 (0.81)	7.32 (0.68)	0.477	<0.001
First premolar	7.91 (0.83)	8.06 (0.59)	7.73 (0.47)	7.64 (0.67)	7.51 (0.79)	7.84 (0.63)	7.87 (0.60)	7.82 (0.46)	0.0004	<0.001
Second premolar	8.10 (0.73)	8.36 (0.46)	8.30 (0.56)	7.97 (0.96)	7.94 (0.98)	8.49 (0.70)	8.56 (0.66)	8.35 (0.52)	<0.001	<0.001
First molar	10.33 (1.15)	10.83 (0.68)	10.65 (2.8)	10.77 (0.47)	10.60 (0.66)	10.67 (0.70)	10.56 (2.29)	10.51 (0.78)	0.0158	0.028
Second molar	10.57 (0.90)	10.28 (0.86)	10.39 (0.60)	10.26 (0.45)	10.10 (0.52)	10.38 (0.89)	10.48 (0.76)	10.21 (0.83)	<0.001	0.5456

ANOVA: Analysis of variance

worldwide has indicated that Western Eurasian population tend to have the smallest teeth, with indigenous Australians, Melanesians, Micronesians, sub-Saharan Africans, and Native Americans tending to have large teeth. East and Southeast Asian population were found to be intermediate in tooth size between these groups.[11] The data presented here for the four modern population match this pattern.

Hanihara and Ishida have suggested that the distribution of tooth sizes observed in their study may be due to the impact of agriculture on the operation of natural selection on tooth size, with the use of agriculture reducing the effects of natural selection.[11] This hypothesis is not supported by the data for the Romano-British population, which showed smaller MD dimensions than were observed in any of the modern population. If the smaller tooth size in Western Eurasian population was due to a longer history of agriculture in these population, then it would be expected that the Romano-British population would have larger teeth than both the modern British and North American population. Instead, it is possible that genetic differences may be the contributing factor to the differences observed.[11-13]

We propose that the systematically varied MD and buccolingual tooth width seen in these population groups is associated with specific genetic and epigenetic factors. Although only young individuals were included in this study, it is possible that a limited amount of tooth wear may have occurred even in these young individuals. Hillson identified a series of factors affecting tooth wear.[14] These include masticator forces, non-chewing parafunctional activities, use of teeth as tools, and the nature of the diet. A tough fibrous diet requiring prolonged mastication, and the abrasivity of food consumed, could potentially contribute to tooth wear, as seen in older individuals.[14-20]

Patterns can also be detected within the dentition between the four population. Although the Christian population has the largest MD dimensions for most of the dentition, there are some exceptions to this trend. These included the maxillary central incisor, mandibular central and lateral incisors and mandibular canine, which are largest in the Muslim population, and the maxillary first and second molar, which are largest in the Hindu population. The extent of the differences in tooth dimensions varied from tooth to tooth, as shown in Tables 1-4. The overall pattern is seen to follow the morphogenetic field concept as recently revised by Townsend *et al.* with later-forming teeth in each tooth type being smaller and more variable.[3,4,8,10] The values of coefficients of variation (Tables 1-4) also showed that these later-forming teeth tended to be more variable in MD and buccolingual dimensions.

Hence, we propose that a there might be a strong genetic contribution to variation in tooth size but environmental factors may also play a role. For example, low birth weight has been linked to a reduction in the MD width of deciduous teeth.[21,22] Alvesalo has shown that there is sexual dimorphism displayed in the dentition, with males tending to have larger teeth than females, reflecting X chromosome linkage with the Y chromosome also having an impact. For example, both 47, XXY males and 47, XYY males have larger teeth than 46, XY males.[8-10]

Conclusion

By using a standardized methodology, significant differences in MD and buccolingual crown dimensions have been demonstrated between ethnic groups. There were varying patterns of tooth size between the groups and the later-forming teeth in each tooth type were smaller and showed greater variation. These differences reflect different contributions of genetic and environmental influences to tooth size variability within and between human population.

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