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CORRELATION OF TOOTH HEIGHT WITH BODY HEIGHT: A COMPARATIVE STUDY

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ABSTRACT

INTRODUCTION

United Nations states that every freeborn has the right to be identified even after death. Stature is defined as the height of an individual in the upright posture. Stature is taken under consideration to be one of the "big four" of forensic anthropology. Stature is shown to possess a specific and proportional relationship with many parts of the human body just like the cranial and facial bones, long bones, trunk and foot bones.

OBJECTIVE

The study was undertaken to foresee the likelihood of predicting the peak of an individual using selected odontometric parameters as a forensic tool.

MATERIALS AND METHODS

The study sample consisted of 100 randomly selected subjects. The length of clinical crown of maxillary central, lateral and canine teeth of both right and left quadrants were made directly on the participant by means of a digital vernier caliper. Height (H) of patients was measured with anthropometer.

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RESULTS

Significant correlation was observed between height and crown length of maxillary anterior teeth (p > 0.01), but not a strong correlation (p > 0.05).

CONCLUSION

The crown length of maxillary anterior teeth shows a correlation with the stature of an individual but not a robust one.

KEYWORDS: Stature estimation, odontometric parameters, forensic anthropology, forensic odontology

1. INTRODUCTION

United Nations states that every freeborn has the right to be identified even after death.[1] Anthropometry comprises a series of systematized measuring techniques that expresses quantitatively the dimensions of the human body including skeletonized remains. it's a highly objective and reliable technique which can be used for the identification of individuals linked to a criminal offense scene. Somatometry, cephalometry, craniometry, osteometry and odontometry are the varied tools utilized in anthropometry and these tools been proved to be valid within the identification of human remains. Anthropometric difference varies between races and is influenced by national social and economic conditions.[2]

Stature is taken under consideration to be one of the "big fours" of forensic anthropology.[3] Identification of unknown human remains, stature estimation is a preliminary investigation. In cases where identification possesses to be performed supported skeletal remains, the foremost common stature estimates are derived from long bones. it's essential in preliminary screening and reconstructive identification of skeletal remains.[4, 5] Stature features a definite and proportional relationship with many parts of the physical body like the cranial and facial bones, long bones, trunk and foot bones.[6] Human identification becomes difficult when the body is heavily mutilated or destroyed because of accidents (like mass disaster, massive burn and airplane crash) or during war. Highly decomposed and mutilated dead bodies with fragmentary remains are also difficult to identify.[7] Teeth are extremely durable even at high temperatures and will be identified even when the remainder of the body has undergone decomposition. Thus, they're invaluable tool in forensic science. Amongst all the teeth within the human dentition, the canines are the least frequently extracted teeth (possibly due to the relatively decreased incidence of caries and periodontal disease). Also, canines are reported to withstand extreme conditions and have been recovered from human remains even after air disasters and hurricanes.[8, 9]

As stated by Fédération Dentaire Internationale, "Forensic Odontology" is the branch of dentistry which, in the interest of justice, deals with proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings. [10, 11] In genetics, anthropological, odontogenic and forensic investigations, teeth form an excellent resource of clinical study material in living and nonliving populations. Teeth are used in person identification during medicolegal issues and also in personal identification in natural and human‐ made disaster situations and in mass casualties such as aviation disasters as teeth are resistant to such disasters.[12] Forensic dentistry is important for human identification,

especially when conventional methods cannot be applied. In such cases, a post- mortem record is created by a forensic dentist to identify the victim by determining the age, stature, ancestry, sex and socio-economic class. [13]

Dental morphometrics is a quantitative analysis form of a concept that encompasses size and shape of teeth. Estimation of physical profile from dental morphometrics has been a subject of great interest in forensic odontology. Various studies have being attempted in determination of physical height using permanent tooth morphometrics in the past. The parameters used were tooth length, crown length (CL), mesiodistal width, and tooth labiolingual width, and correlation with the facial measurements has being attempted in the past. [4,12, 14] Jani et al (2018) concluded that out of maxillary intercanine distance, maxillary interpremolar distance and common width of maxillary anterior teeth; the maxillary intercanine distance can be used successfully to calculate the stature of an individual.[4]

On the contrary, Sterrett et al. attempted a correlation of the width, length, and width/length ratios of maxillary anterior sextant permanent dentition of Caucasians to the height of the individual. He could not find any statistically significant correlation between tooth dimensions and subject height.[15] Jayawardena et al. conducted a study in Sri Lankan Sinhalese individuals to find the association between tooth length and stature using permanent maxillary central and lateral incisors. There was no significant association between stature and incisor tooth lengths. [16]

Also, there is a paucity of literature which supports such studies conducted on the Gujarati population. Hence, this study was conducted to investigate the relationship of the height of a person with odontometric parameters like clinical crown length of maxillary teeth (central incisors, lateral incisors and canines).

2. AIM AND OBJECTIVES

Considering studies concerning estimation of stature from odontometry in India and usefulness of those studies in forensic and legal medicine, this study was designed to elucidate the anthropometric correlation of multiple odontometric parameters with stature and also to plot regression formulae for stature estimation.

- To correlate stature with crown length of maxillary right central incisor (11H)
- To correlate stature with crown length of maxillary right lateral incisor (12H)
- To correlate stature with crown length of maxillary right canine (13H)
- To correlate stature with crown length of maxillary left central incisor (21H)
- To correlate stature with crown length of maxillary left lateral incisor (22H)
- To correlate stature with crown length of maxillary left canine (23H)
- To obtain a linear regression formula for every correlating odontometric parameter
- To check the reliability of the derived regression of y on x on an equivalent population.

3. MATERIALS AND METHOD

The study sample consisted of 100 participants (50 males and 50 females) selected from the OPD of the institute. The participants were selected based on the subsequent criteria:

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Inclusion Criteria:

• Age 18-30 years

• A complete set of fully erupted, periodontally healthy, non-carious, intact, satisfactorily aligned maxillary teeth

Exclusion Criteria:

• History or clinical evidence of congenital defect, crown restoration, orthodontic treatment, trauma or oral destructive habit

• History or clinical features suggestive of endocrinal disorders, metabolic disorders, developmental disorders, or history of prolonged illness.

After obtaining informed consent, all the maxillary anterior teeth crown length CL (11H, 12H, 13H, 21H, 22H, 23H) was measured and recorded with the assistance of a digital vernier caliper accurate up to 0.01 mm (Insize Digital Caliper, China). The length of clinical crown of maxillary central, lateral and canine teeth of both right and left quadrants were measured. The space between the tines were read off from the display and recorded.

The length of the clinical crown (CL) for central and lateral incisors were measured as the distance from the incisal edge to the highest point of gingival margin along the long axis of the crown on the labial aspect (Figure- 1& 2). For canines it was measured from tip of the cusp to the highest point of gingival margin along the long axis of the crown on the labial aspect (Figure- 3).

The stature (H) of every subject was measured as the vertical distance from the vertex to the floor using a standard anthropometer. Measurements were taken by making the participant stand erect on a horizontal resting plane barefooted. Anthropometer was placed in straight vertical position on the top of the head with the head oriented with ala tragus line parallel to floor and shoulder blocks and buttocks touching the vertical limb of the instrument. The movable rod of the anthropometer was brought in touch with the vertex in midsagittal plane (Figure- 4).

All the measurements were done by one examiner to eliminate inter-observer error. All the measurements were measured 3 times for every tooth and therefore the average was recorded so as to attenuate the intra-observer error.

All the recorded measurements were calibrated in millimetres (mm) up to 0.01mm accuracy. Statistical comparisons were made between the recorded odontometric measurements with respect to males and females. The data collected was subjected to statistical methods for correlation by applying pearson correlation test and the linear regression formula was obtained for each parameter separately. The SPSS software package version 22.0 was used for statistical analysis. The linear regression equation was derived as $y = mx + c$, where y-axis is the height recorded equivalent to the odontometric measurements on the x-axis.

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4. RESULTS

Table 1 shows minimum and maximum values with mean and standard deviation of each odontometric parameter in millimeters. Maximum clinical crown height of 11 recorded was 13.87 mm; minimum clinical crown height of 11 recorded was 5.41 mm with mean(SD) being 1.31510±1.729 mm. Maximum clinical crown height of 12 recorded was 11.93 mm; minimum clinical crown height of 12 recorded was 3.12 mm with mean(SD) being 1.26592±1.603 mm. Maximum clinical crown height of 13 recorded was 12.41 mm; minimum clinical crown height of 13 recorded was 2.73 mm with mean(SD) being 1.43224±2.051 mm. Maximum clinical crown height of 21 recorded was 13.07 mm; minimum clinical crown height of 21 recorded was 4.91 mm with mean(SD) being 1.32145±1.746 mm. Maximum clinical crown height of 22 recorded was 11.28 mm; minimum clinical crown height of 22 recorded was 3.69 mm with mean(SD) being 1.35509±1.836 mm. Maximum clinical crown height of 23 recorded was 12.10 mm; minimum clinical crown height of 23 recorded was 2.95 mm with mean(SD) being 1.39820±1.955 mm. Maximum height recorded was 1883 mm; minimum height recorded was 1485 mm with mean(SD) being 1645.53 ± 90.76 mm.

Table 2 shows correlation coefficient between height and odontometric parameters. Correlation coefficient for 11 is 0.179 with P value being 0.01 which is ≤ 0.05 suggestive of being statistically significant. Other correlation coefficients for 12, 13, 21, and 23 are respectively 0.150, 0.177, 0.148, and 0.159 with P values being respectively 0.03, 0.01, 0.04 and 0.01 which is ≤ 0.05 suggestive of being statistically significant. Correlation coefficient of 22 is 0.124 with p value being 0.08 which is greater than 0.05 suggestive of being statistically non – significant.

Table 3 shows value of constant (c) and regression coefficient (m) for eachparameters and regression formula. Formula for 11 derived from the study is 1550.07 + 12.78x. The formulae derived for other parameters like 12, 13, 21 and 23 are respectively 1584.47 + 11.16x, 1571.17 + 11.62x, 1573.30 + 10.48x and 1555.06 + 13.12x. The formula derived for 22 is 1603.51 + 8.60x mentioned in the table; but it is statistically non-significant.

TABLE 1
MINIMUM, MAXIMUM, AND MEAN VALUES OF EACH ODONTOMETRIC PARAMETER (IN MM)

PARAMETERS	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION
11 H	5.41	13.87	9.8648	1.31510±1.729
12 H	3.12	11.93	8.2183	1.26592±1.603
13 H	2.73	12.41	9.0391	1.43224±2.051
21 H	4.91	13.07	9.8180	1.32145±1.746
22 H	3.69	11.28	8.4522	1.35509±1.836
23 H	2.95	12.10	9.2309	1.39820±1.955
HEIGHT	1485	1883	1676.17	1645.53 ± 90.76

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TABLE 2:
CORRELATION COEFFICIENT BETWEEN HEIGHT AND ODONTOMETRIC PARAMETERS

PARAMETER	CORRELATION COEFFICIENT	p Value
11H	0.179	0.01 (S)
12H	0.150	0.03 (S)
13H	0.177	0.01 (S)
21H	0.148	0.04 (S)
22H	0.124	0.08 (NS)
23H	0.159	0.01 (S)

TABLE 3
VALUE OF CONSTANT (C) AND REGRESSION COEFFICIENT (M) FOR EACH ODONTOMETRIC PARAMETERS AND REGRESSION FORMULA

Parameter	**Constant (C)**	**Regression coefficient (M)**	**t-value**	**p value**	**Y = c+ mx**	**S/NS**
11 H	**1550.07**	**12.78**	**6.652**	**0.01**	**1550.07 + 12.78X**	**S**
12 H	**1584.47**	**11.16**	**4.589**	**0.03**	**1584.47 + 11.16X**	**S**
13 H	**1571.17**	**11.62**	**6.423**	**0.01**	**1571.17 + 11.62X**	**S**
21 H	**1573.30**	**10.48**	**4.404**	**0.04**	**1573.30 + 10.48X**	**S**
22 H	**1603.51**	**8.60**	**3.097**	**0.08**	**1603.51 + 8.60X**	**NS**
23 H	**1555.06**	**13.12**	**7.865**	**0.01**	**1555.06 + 13.12X**	**S**
Mean H	**1423.06**	**1.803**	**1.738**	**0.085**	**1423.06 + 1.803x**	**NS**

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Figure 1: Measurement of clinical crown length (CL) of Central Incisor

Figure 2: Measurement of clinical crown length (CL) of Lateral Incisor

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Figure 3: Measurement of clinical crown length (CL) of Canine

Figure 4: Measurement of height with anthropometer (H)

5. DISCUSSION

Identification of skeletal remains or mutilated bodies is of the utmost importance in medico-legal practice. In addition to sex, age, and ancestry, stature is an important biological parameter that characterizes individuals and is required to determine a biological profile. Estimation of those parameters accelerates the analysis of human remains by narrowing the pool of victims to match and provides more definitive markers for final confirmation. [17] In identification of unknown human remains, stature estimation is a preliminary investigation. Various methods are accustomed establish the identity of unknown human remains. A drawback to these techniques is limited applicability to fragmentary remains.[13]

Two methods (anatomical and mathematical) are generally being used to estimate stature, counting on the completeness and condition of remains. The anatomical method sums the superior-inferior measurements of skeletal remains to estimate stature, while the mathematical method involves extrapolation of living stature from one or multiple bones/parts.[18] Among the mathematical methods used to estimate stature, such as regression and multiplication factors, regression analysis is considered the best and most reliable method.[19] The correlation between stature and tooth dimension is controversial.[7] The tendency of tooth crown dimensions to have a moderate correlation to stature particularly when compared to long bones may be attributed to their differences in the time of growth completion. Although teeth and the long bones are mesenchymal in origin, the differences in their timing of growth completion probably renders tooth crown dimensions with only moderate correlation to stature.[4, 7] Stature correlation to skull and jaw dimensions is usually reported among various populations. One of the initial studies during this context was undertaken by Indian researchers. The literature, however, is lacking therein the derivation of the stature from an odontometric parameter has not been explored adequately. The studies correlating tooth dimensions with height as ratios or regression equations are sporadic.[20] Hussain MZ et al (2016) concluded that significant positive correlation was found for the length and mesiodistal diameters of clinical crown of central incisors and canines with the stature albeit the coefficient values are low to moderate in range. Regression equations obtained which upon application in the same and different sample of volunteers revealed certain range of errors in predicting stature from the crown dimensions. [7]

In this study, odontometric parameters were considered singly and in various sets of combinations. When each odontometric parameter was correlated singly with the height of an individual, only clinical crown height of 22 was found to be statistically non-significant. The regression equations thus obtained for other parameters like crown height of 11, 12, 13, 21, and 23 could be used for stature estimation.

Sunitha J et al (2015) have suggested that it has been postulated that stature can influence tooth height since it has an impact on face height. Human body parts have been shown to correlate with stature and biologic measurements are unique for the species Homo sapiens.[2] In the present study the clinical crown length of the maxillary anterior teeth have a positive and significant correlation with stature but the coefficient values are not strong enough to reproduce the data.

Yadav AB et al (2016) concluded that regression equations generated from odontometric parameters can be used as a supplementary approach for the estimation of

stature when extremities are not available but with caution as these are population specific and can't be used on other populations of the planet. However, canine width can aid in estimation of stature as an adjunct when only teeth are available for identification; further investigations should be administrated on large sample by considering ethnic and community background.[6]

On using derived regression equation on 10% of our data for significant parameters such as clinical crown height of 11, 12, 13, 21 and 23, when the actual height of individual was blind folded, no statistically significant difference was observed between the actual height and predicted height of an individual using regression formula at 1% level of significance indicating that all parameters except for clinical crown height of 22 can be used successfully for predicting the height of an individual.

Our results hypothesize that odontometry is reliable for stature estimation as an adjuvant but in situations when only teeth are available for identification, clinical crown height of maxillary anterior teeth can be used in the calculation of stature for Gujarati population irrespective of gender. However, there are few limitations of the present study like only anterior teeth have been included in the study.

6. CONCLUSION

Teeth are one amongst the common human remains; hence provide vital clues to human identification in forensic investigations. Hence, teeth and related odontometric features function as a vital marker to narrow the search of missing persons by the forensic experts. However, the literature reveals that the common odontometric parameters have not been evaluated as forensic tools in stature estimation. Out of clinical crown height of maxillary anterior teeth; except for clinical crown height of 22 all other parameters can be used successfully to calculate the stature of an individual. However, further studies with larger sample size and involving multiple ethnic groups are required to estimate the accuracy of this parameter in estimating the stature.

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