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Revealing Stature and Facial Proportions from Teeth: An Adjunct to Forensic Science

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Abstract

Background: Teeth and skull remains are often some of the evidences available that can be used reliably for identification in medicolegal cases. Determination of Stature and facial proportions from teeth dimensions have not been utilised fully in the field of forensics. This study was designed with the aim to estimate stature as well as facial proportions from teeth and head measurements. **Objectives:** To correlate height of an individual to combined mesiodistal width (CMDW) of maxillary anterior teeth and head circumference and to correlate the facial height and facial width to the cervicoincisal and mesiodistal dimensions of maxillary central incisor. **Methodology:** This was a descriptive cross-sectional study conducted among 1000 patients of age group 18–30 years of Kerala origin by birth and domicile who fulfilled the inclusion and exclusion criteria. Study variables included length and width of the face, combined mesiodistal (MD) width of maxillary anterior teeth, mesiodistal and cervicoincisal dimension of maxillary central incisor, circumference of the head and height of the individual. The results were statistically analysed using Karl Pearson's correlation coefficient. **Results:** Correlation between height and head circumference, height and combined mesiodistal width of maxillary anterior teeth, width of face to mesio-distal width of maxillary central incisor showed significant correlation with p value <0.05, but the correlation coefficients were very weak. But while correlating facial length to cervicoincisal length of maxillary central incisor the values obtained were not statistically significant.

Introduction

For medicolegal examination, fragmented body remains are produced for person identification. Teeth and skull remains are often some of the evidences available that can be used reliably for identification. A proportional biological relationship of stature exists with every part of human body including head, face, trunk, extremities etc., which plays a vital role in forensic examination to calculate the stature from dismembered and mutilated body parts. Stature is an important anthropometric parameter for establishing the identity. Stature thus could be estimated from teeth remains when no other data is available. In the field of prosthodontics various relationships have been established between tooth dimensions and facial proportions. But determination of facial proportions from teeth dimensions have not been utilised fully in the field of forensics. With this rationale, this study was designed with the aim to estimate stature as well as facial proportions from teeth and head measurements.

Objectives

To estimate the stature and facial proportions from odontometric and skull anthropometric measurements among the adult Keralites visiting the OP of Government Dental College, Kottayam and to correlate height to combined mesiodistal width (CMDW) of maxillary

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anterior teeth and head circumference; facial height and facial width to the cervicoincisal and mesiodistal dimensions of maxillary central incisor.

Materials and Methods

This was a descriptive cross-sectional study conducted among 1000 individuals visiting the OP of Government Dental College Kottayam of Kerala ethnicity and domicile. The study was conducted over a period of one year 6 months. The sample size was calculated by the formula $N = [(Z\alpha+Z\beta)/C]^2 + 3$. The value obtained was 723. But we kept the sample size as 1000(500 men and 500 women) to validate the sample size.

Individuals without any clinical evidence or history of cleft palate, trauma, crown restorations, orthodontic treatment or orthognathic surgery, and surgery of the skull or face, missing maxillary anterior teeth, gingival or periodontal pathology, maxillary anterior tooth restoration of any kind were included. Individuals with physical and mental disabilities, developmental disorders, endocrinal disorders, metabolic disorders, and history of prolonged illness were excluded from the study.

Length of the face was measured from upper hair line to chin (Figure 1), width of the face measured as bizygomatic width (Figure 2), combined mesiodistal (MD) width of maxillary anterior teeth, mesiodistal (Figure 3) and cervicoincisal dimension of maxillary central incisor (Figure 4) were measured, circumference of the head measured using measuring tape (Figure 5) and height of the individual using an anthropometer (Figure 6). Karl Pearson's correlation coefficient of combined mesiodistal width of maxillary anteriors and head circumference with stature and mesiodistal and cervicoincisal length of maxillary central incisors with facial proportions was obtained. For each parameter, regression equation was derived using simple linear regression analysis.

Results and Discussion

A. Correlation between height and head circumference were analyzed and calculated using the Pearson correlation coefficient (r) in total population, males and females. Though all the parameters showed significant correlation with p value <0.05, the correlation coefficients(r) of all parameters were very

Figure 1. Measurement of length of face using scale.

Figure 2. Measurement of width of face using scale.

Figure 3. Measuring mesiodistal width of maxillary central incisor using digital vernier calliper.

Figure 4. Measuring cervicoincisal length of maxillary central incisor using digital vernier calliper.

Figure 5. Measurement of head circumference using measuring tape.

weak with values 0.233, 0.269 and 0.189 respectively for total population, males and females.

B. Correlation between height and combined mesiodistal width of maxillary anterior teeth, were analysed. For total population and females the correlation between height and combined mesiodistal width of maxillary anterior teeth showed significant correlation with p value <0.05, but for males the value was not significant with p value 0.802 which was greater than 0.05. The correlation coefficients(r) of all parameters were very weak with values 0.091, 0.093 respectively for total population, females. For males it showed a negative correlation value of 0.011.

Figure 6. Measurement of height using anthropometer.

The dependent variable height, thus could be estimated as,

Estimation of height of the total population (mm) = $1036.958+0.994\ x_1+1.582\ x_2$,

where, x_1 = head circumference in mm and x_2 = combined mesio distal width of anterior teeth in mm with R square value 0.057 and regression model significant with p value <0.05.

a) Estimation of height of males (mm) = $1017.981+1.172\ x$,

where, x= head circumference in mm with R square value 0.072 and regression model significant with value 0.000. As the correlation for combined mesiodistal width of anterior teeth was not significant for males, regression equation could not be made for that parameter.

b) Estimation of height of females (mm) = $1126.479+0.788\ x_1+1.876\ x_2$

where, x_1 = head circumference in mm and x_2 = combined mesio distal width of anterior teeth in mm with R square value 0.040 and regression model significant with p value <0.05

C. Correlation between length of face to cervico incisal length of maxillary central incisor, were analysed. The correlation coefficients of length of face to cervico-incisal length of maxillary central incisor was not significant for total population, males and females with p values >0.05. Hence it was not ideal to formulate regression equations for the parameters.

D. Correlation between width of face to mesiodistal width of maxillary central incisor, were analysed. The correlations obtained between width of face to mesio-distal width of maxillary central incisor was significant for the total population and females with p value <0.05. But for males, the correlation was not significant with p value >0.05. The correlation obtained was negative for total population, males and females and the values were very weak. Thus regression equations could be formulated only for total population and females

The dependent variable facial width in mm , thus could be estimated as,

a) Estimation of facial width of the total population (mm) = 137.412-0.935 x
where, x = mesiodistal width of maxillary central incisor in mm with R square value 0.010 and regression model significant with value 0.002.

b) Estimation of facial width of females (mm) = 140.421-1.267 x
where x = mesiodistal width of maxillary central incisor in mm with R square value 0.013 and regression model significant with value 0.011.

For males, regression equations could not be derived as the correlation was not significant.

Discussion

Dimensional relationship between body segments and stature has been the focus of forensic research for many years. All such studies were based on the fact that body segments exhibit consistent ratios relative to the stature and these ratios are linked to age, gender and ethnicity. Regression equations for estimating stature have been derived by researchers mainly from measurements of long bones of the upper and lower extremities with good results and reliability. It is common to have remains which are often fragmented, like the skull with some teeth or broken jaws with some teeth. In this situation, the stature estimation can be determined if a relationship between fragmented remains and stature is known. Cranial measurements have several advantages over others, as the anatomical landmarks are standard, well defined and easy to locate, making them highly predictable and reproducible. It is an established fact that each race requires its own values for stature estimation because of ethnic, dietary and climatic variations. Hence, results of studies done in one population may not be applicable to other populations entirely.

Variety of factors such as age, race, gender and nutritional status affect human development and growth and therefore, different nomograms are required for different populations. In the current study 1000 individuals (500 males and 500 females) belonging to Kerala ethnicity were chosen to study the correlation of stature and facial proportions with that of tooth measurements and head circumference. This was the first study to analyse the same using large sample size and with minimum armamentarium in this population.

When height was correlated to head circumference for the total population, males and females separately, the correlations were statistically significant with p value <0.05 in the present study. But the correlation coefficients were weak with values nearing 0.269 for males and 0.189 for females and the R^2 obtained was also very weak with value 0.05 suggesting that the equations derived for this population can only be used as a supplementary tool when no other evidences are available.

Kalia *et al.*[1] showed a correlation coefficient of 0.53 on 100 Mysorean patients when head circumference was correlated to stature. This value was indeed higher than the value we obtained in our study.

While correlating height to the combined mesiodistal width of maxillary anterior teeth in our study, the correlations were statistically significant in females and in total population with p values <0.05. However for males the value was statistically insignificant. The regression models showed weak R^2 values suggesting that height estimation from tooth measurements in this population was not reliable in a mass disaster scene, but can be used when the only evidence obtained are skull and teeth.

Estimation of stature from cranial measurements is easy, economical and convenient where specialized equipment or training is not required. Head circumference was considered for the study since Anthropologists, forensic experts and investigating officers could use the formula derived for stature estimation when only head or part of the head or only a dry skull is available,

though it cannot be used as a good predictor of height in Kerala population but only as a supplementary tool. The variations from other studies could be due to the ethnic variability and growth pattern in this population or the difference in sample size with other studies.

The correlations between stature and head dimensions; stature and combined teeth dimension were statistically significant ($P < 0.05$) in both males and females among the Efik and Ibibio of South-South Nigeria, coefficients of correlation were very low and reliability of the models were on the low side in the majority of the data studied[2]. This was consistent with the results we obtained in our study.

On height versus teeth dimensions, Gupta *et al.*[3] reported that "combined mesiodistal width of maxillary anterior teeth had no significant contribution to height estimation."

In another study when height was correlated with the combined MD width of the anterior teeth, using regression model; P value was found to be 0.068. It was found that MD dimension determines the height up to 11% ($R^2 = 0.107$) and the correlation between these two variables was 0.327[4].

Thus on comparison with the above studies it could be stated that the results are population specific. Also most of these studies had a smaller sample size compared to our study. Hence, the results from this study would be more specific to Kerala population.

On correlating length of face to cervicoincisal length of maxillary central incisor in our study, the results showed that the correlations were not significant with p value greater than 0.05 and having very weak correlation. Arthur *et al.*[5] found a ratio of 1:16 between incisor length and facial height. But we could not establish any such relationship in our study. The sample sizes analysed were less in the previous studies.

In 372 Dravidian subjects Sunitha *et al.*[6] found a correlation of 0.069 when facial height was correlated to incisor height. Though they got significant correlation the value was very weak. Thus it may be concluded that compared to other population, length of face cannot be obtained from the cervicoincisal length of the maxillary central incisor in this population.

On correlating width of face to mesiodistal width of maxillary central incisor, the correlations obtained in the present study was significant for the total population and females with p value < 0.05. But for males, the correlation was not significant with p value > 0.05. The correlation obtained was negative for total population, males and females and the values were very weak. Regression equations could be formulated only for significant parameters. But when the model analysis was done for regression, the R^2 values obtained were very weak with a value of 0.01. From these results it can be concluded that facial width can be obtained from mesiodistal width of maxillary central incisor, only when no other methods are available as a supplementary tool.

Among 100 students of Kothamangalam, Kerala, the correlation between the upper central incisor width and the bizygomatic width was inferred to have a good positive correlation with a value 0f 0.613 on analysing the bite marks[7]. This was not in accordance with our study which could be due to the difference in methodology and the smaller sample size used in their study.

Findings obtained from this study and previous studies point out that for all the variables, the correlation coefficients obtained were very weak for the total population, males and females. Thus the present study with a large sample size of 1000 and age group of 18-30 years, confirms that stature and facial proportions have very weak correlation with tooth dimensions and head circumference and is not of much value in person identification in the mass disasters in central Kerala population. The population being homogeneous gives more reliability to this study. Ethnic variations, genetic factors or growth patterns of the population studied could be the reason why these parameters studied cannot be used as a reliable tool in person identification.

India being a country where rich diversities exist between different populations and also among the same population, the variable stature differs not just region wise but also caste and tribe wise. Since stature is population specific and can be influenced by various factors like genetics, environmental and climate variations, the necessity for deriving regression formula in both population as well as gender is of great value in forensic field.

Conclusion

There have been a lot of studies on the estimation of stature from odontometrics and skull anthropometrics of different populations. This was the first study attempted to estimate stature as well as facial proportions from odontometrics and skull anthropometrics among Kerala

population. Like many previous studies, the present study also proved that unlike long bones, odontometry and skull anthropometry can only aid as supplementary tools in stature and facial proportion estimation for Kerala population. As this study included a large sample of 1000, the results were much more reliable than the studies with short sample size. The difference in values of correlation would be due to race or ethnic variation, genetics or climate factors specific to the population.

Hence findings of this study suggest that skull with teeth when obtained as evidence in a mass disaster scene can only serve as a supplementary tool for person identification when no other data is available.

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