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Carrea's Index: A Reliable Tool for Estimation of Stature?

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Abstract

Introduction: The teeth are one of the durable parts of our body which can withstand more assaults than any other part of the body and there exists a relation between tooth crown length and body height. The study aims to determine the possible correlation between tooth dimensions and stature estimation using Carrea's index. *Materials and methods:* The study group comprised about 67 subjects above 18 years. Alginate impressions were made for mandibular arch and height was assessed. The mesiodistal widths of mandibular anterior teeth were measured and substituted in the formula given by Carrea to obtain the minimum and the maximum estimated height of a person. *Results:* On comparison of the Carrea's index in right side, females showed 9.3% successful prediction, on left side 8.3% showed successful prediction in males than in females. The height was accurately predicted when average values of left and right side were considered. Females showed 55.8% accuracy and males showed 37.5% which was statistically significant. *Discussion:* Teeth could be used as a reliable source for stature estimation especially in those forensic cases where other body parts are not available. In the present study the average values from right and left side were considered for both genders to predict the height of the individual. Our findings could be explained on the basis that perfect bilateral symmetry seldom exists on right and left side arches which could be due to congenital or environmental factors or both. The Carrea´s index for stature estimation is a convenient, simple and inexpensive method, and can provide valuable information to the forensic investigation.

Keywords: Carrea's index; Stature; Forensic Odontology.

Introduction

The teeth are one of the most durable parts of our body which can withstand more assaults than any other part of the body. This is particularly useful in the identification of bodies in mass disasters and natural calamities. The principal advantage of dental evidence is that, like other hard tissues, it is often preserved after death. Forensic odontology is primarily concerned with the use of teeth and oral structures for identification in a legal context.

The four essential factors usually represented in determining personal identification are age, sex, stature and ethnicity. Among this 'big fours'[1] of the biological profile, determination of stature is considered as one of the main parameter of personal identification in forensic examinations. Stature is the height of a person in the upright posture and has a definite and proportional biological relationship with each and every part of the human body which helps the forensic experts to identify along with other evidences like dentition, footprints and hand dimensions.[1]

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There exists a possible relation between tooth crown length, especially of the anterior teeth, and the facial and body height. The study aims to determine the possible correlation between tooth dimensions and stature estimation using Carrea's index. Carrea has proposed an index to estimate the stature of an individual based on the measurements made from mandibular anterior teeth.[2]

Materials and Methods

The study group comprised about 67 subjects of age group above 18 years after their informed consent and after Institutional ethical committee approval. Subjects with intact mandibular dentition, with normal growth and development were included in the study. Subjects were excluded if they had restoration in mandibular anterior teeth, malocclusion, those who underwent orthodontic treatment and who were physically and mentally challenged.

Measurement of Height

The measurements of height was made using standard anthropometer by making the subject stand erect on the horizontal plane, barefooted, in the anatomical position according to the Frankfort plane, aligning the posterior surface of heels, pelvic girdle, scapular girdle, and occipital region to the vertical plane. The distance of the subject from the ground to the highest point of the vertex in the median sagittal plane were recorded.[3]

Odontometric measurements for Carrea's index

The patient plaster models mandibular arches of each subject were obtained using alginate impressions. For the Carrea's index, the mesiodistal widths of mandibular central incisor, lateral incisor and canine were recorded from the labial aspect and summed using a digital caliper. This is termed the 'ARCH'. Linear distance between the ends of the arch, represented by the mesial edge of central incisor and the distal edge of canine on the same side, measured on the lingual surface with a digital caliper. This is termed as 'CHORD' [Fig. 1]. The maximum and minimum statures of an individual were estimated according to Carrea's index as follows:

Formula:

$$\text{Maximum stature} = \frac{\text{arch (in mm)} \times 6 \times 3.1416 \times 100}{2}$$

$$\text{Minimum stature} = \frac{\text{chord (in mm)} \times 6 \times 3.1416 \times 100}{2}$$

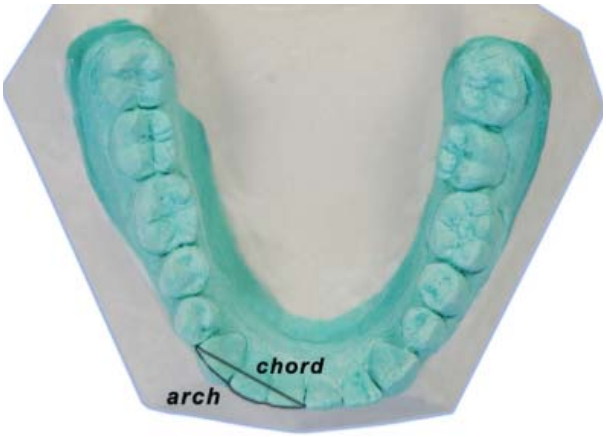

Fig. 1: Arch and chord dimensions

The chord and arch values for each tooth were substituted in the formula given by Carrea to obtain the minimum and the maximum estimated height of a person. These values were compared with real stature.[2]

Successful prediction: The real stature measurements coincided with the interval between the minimum (chord) and maximum (arch) estimated stature measurements (tooth dimensions).

Unsuccessful prediction: The real stature measurements which does not coincide with the interval between the minimum (chord) and maximum (arch) estimated stature measurements (tooth dimensions).[3]

Statistical Analysis

The data was analyzed using the SPSS software (version 20). The accuracy of the height measurement was predicted if the actual height was between the minimum and maximum height predicted values. The frequencies of accurate height assessment were described in proportions and comparison according to gender was done using chi-square test. Pearson's correlation coefficient was used to assess the correlation of the predicted height (left, right and average) with the actual height. A p-value of <0.05 was taken as statistically significant.

Results

A total of 67 samples were selected which included 43 females and 24 males. Right side and left side hemi arches were measured separately. Figure 2 showed the distribution of successful and unsuccessful predictions of arches according to sex.

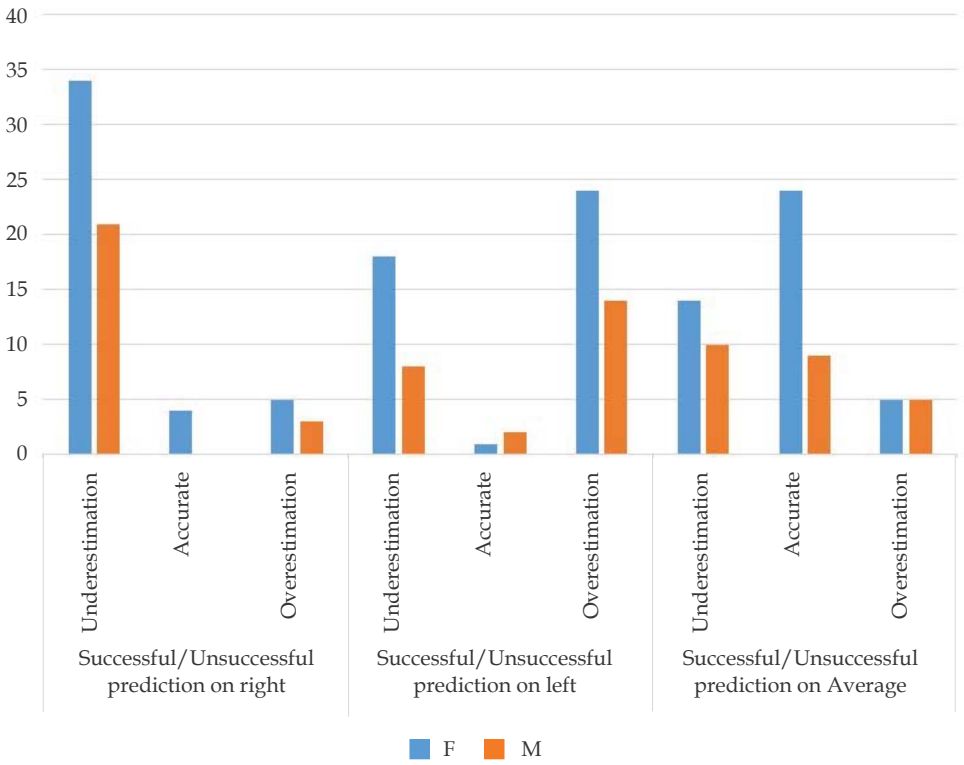

Fig. 2: Distribution of successful and unsuccessful predictions of arches according to sex.

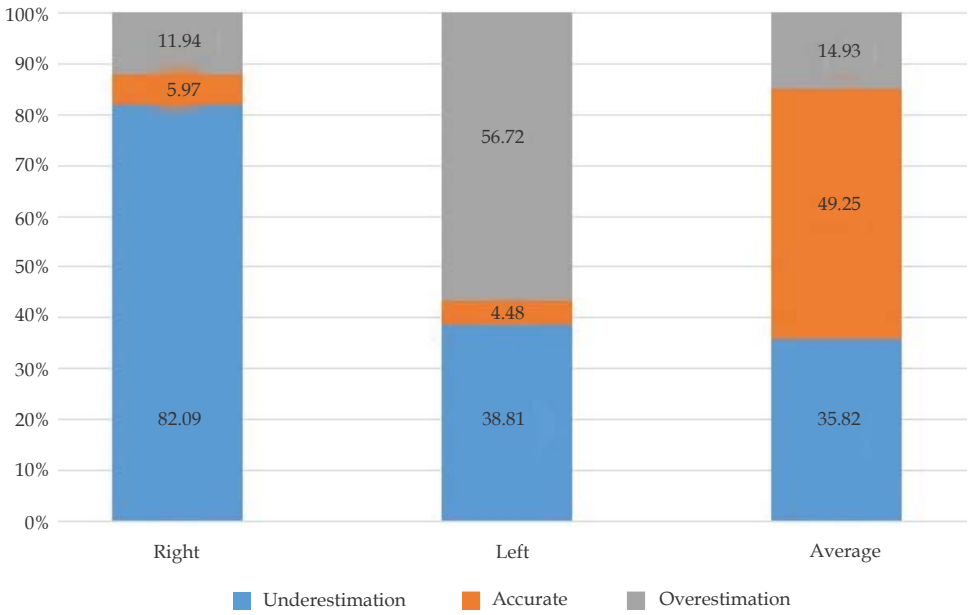

Fig. 3: Average values of left and right side arches

When the right sides were compared in males and females, females showed 9.3% successful prediction than males. Whereas on the left side 8.3% showed successful prediction that was seen in males than females (Fig. 2).

The height was accurately predicted when average values of left and right side were considered females showed 55.8% accuracy and males showed 37.5% which was statistically significant (Fig. 3).

Discussion

Dental measurements and stature can be useful in anthropology and forensic identification. Teeth

could be used as are liable source for stature estimation especially in those forensic cases where other body parts are not available. Long bones are considered for stature estimation. In many investigations of human remains, not all the bones are present; possibly nothing but the skull and mandible may be recovered. Therefore examination of skull and teeth becomes very important, and the stature of the subject can still be estimated based on the proportionality with tooth dimensions.[4]

In this study subjects belonging above 18 years were considered. The growth spurt is almost completed by 18 years of age ensuing the completion of stature and mandibular growth, hence 18 years was selected as the lower limit whereas 30 years was taken as the upper limit in the study.[5]

In the present study right side and left side semi arches were measured separately in both males and females. Females showed 9.3% successful predilection on right side and 2.3% on left side, whereas males showed 8.3% successful predilection on left side than right side which was not considered to be significant. But when the average values from right and left side was considered the height of the individual could be predicted.

According to *Rayapureddy Sruthi,* she explained that there were a correlation between teeth and stature, as both dentin that forms the bulk of the tooth and bones that determines the height are derived from mesenchymal tissue (Dentin-Ectomesenchyme; Long bones-Mesoderm) there could be an embryological relationship between tooth formations and long bones and also have similarities in structural composition. Henceforth, it is presumable to accept the mere relationship between teeth and stature exists.[3]

Our findings could be explained on the basis that perfect bilateral asymmetry seldom exists in living organisms. Always right and left side differences are present in nature. Right-left differences occur everywhere in nature where two congruent types are present. According to *Maen Mahfouz* in humans there is functional as well as morphological asymmetries, e.g. right and left handedness as well as preference for one eye or one leg. Some of these asymmetries are embryonically rooted and are associated with asymmetry in the central nervous system.[6]

Asymmetry of tooth size in right and left side would be due to congenital or environmental factors or both of them; All the asymmetries are divided in two classes: quantitative asymmetry or difference in number of teeth in each half-arch and qualitative asymmetry, which is due to difference in size of teeth mesiodistal width or their location in the dental arch.[7]

Dental asymmetries can be caused by local factors such as early loss of primary teeth, congenitally missing teeth, and habits such as thumb sucking. Lack of exactness in genetic expression affects the teeth on the right and left sides, causing asymmetries in mesiodistal crown diameters.[2]

Conclusion

The Carrea´s index for stature estimation is a convenient, simple and inexpensive method, and can provide valuable information to the forensic investigation when dental remains are present.

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