

Stature estimation and its reliability in different types of dental alignment using the Carrea's Index

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Abstract

Introduction: Estimation of stature holds a special place in the field of forensic medicine. **Objectives:** This study was designed to investigate the ability of estimating stature from the dimensions of lower anterior teeth. **Method:** The study was carried out by taking the measurement from the mesio-distal widths of lower central incisor, lateral incisor and canine of 100 undergraduate students for examination. Each hemiarch was considered separately equaling 200 inferior hemi-arches, which were divided according to the dental alignment into normal, crowded and diastema and the measurements (arch and chord) were made with a 'divider caliper'. **Result:** A statistically significant difference between the types of dental arch was obtained for both males and females with regards to the different dental alignments; higher correlation between stature the arch for normal alignment ($r=0.9658$; $r =0.8347$); moderate correlation for crowded alignment ($r=0.8097$; $r =0.6958$); and a weaker correlation for diastema ($r = 0.656$, $r = 0.3938$) for male & female respectively. The left side of the hemiarch showed a higher success rate (82%) in comparison to right side (72%). Statistically significant differences were also found between the types of arches for both right and left side ($p<0.005$). **Conclusion:** The present study would be useful for stature estimation to the forensic experts.

Keywords: Forensic Anthropology, Forensic dentistry, Carrea's Index, Dental arch, Stature measurement.

Introduction

The identification of human cadavers in official investigations has received innumerable contributions from legal dentistry. The dental arch has uncountable individual variables that make it impossible for two different individuals to have identical dental elements. This fact often allows irrefutable proof of identification for legal purposes [1, 2].

The importance of teeth in identification processes owes to their peculiar characteristics, such as resistance to the effects of time, fire and trauma, which is of great value in large catastrophes and mass disasters. Furthermore, teeth can provide information on species, racial group, gender, age, height and individual cadaver data [2-4]. In the processes of identifying bones, and carbonized or decomposed human remains, estimating height is important as an objective characteristic of identity.

Height can be estimated by analyzing the long bones of the body. However, there are situations in which only part of the skeleton or a single bone is available. In cases where only the head has been found, height can be estimated by examining the teeth.

Carrea⁴ developed a mathematical model that allows for calculating of an individual's height by measuring the dimensions of some mandibular teeth. However, Carrea's index has originally been suggested for dental arches with normal tooth position [2, 4, 7, 8]. One of the measurements used in this method is the linear distance between the mesial of central incisor and distal of the canine. So it's evident that anterior teeth alignment can interfere with the stature estimation. The aim of the present study was to estimate the height range of a person through measurements of his teeth using the Carrea's index and check its accuracy in different types of dental alignment; also, to compare accuracy between both sexes and sides of the arch.

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Material and Methods

This is a standardized quantitative clinical trial, in which, 100 subjects of 20 to 25 years of undergraduate students were selected to give a sample size of 200 hemi-arches in the Institute of Dental Science and Technology, Modinagar [U.P]. Each hemi-arch was considered separately and was divided into three categories: normal, crowded and spaced. All the dentition was inclusive of intact vital teeth, free of periodontal disease, and any coronal damage. The subjects who were having missing mandibular anterior teeth, any tooth anomaly, any loss of enamel, had undergone or currently undergoing orthodontic treatment excluded in this study.

Digital Vernier Caliper and Standard Anthropometer was used for the measurements. The greatest mesiodistal crown widths of the mandibular anterior permanent teeth and the chord were measured using the modified method for Carrea’s index. For the Carrea’s index, the mesio-distal widths of lower central incisor,

lateral incisor and canine were recorded and summed. This was termed the ‘ARCH’. The linear distance between the ends of the arc, represented by the mesial edge of central incisor and the distal edge of canine on the same side, measured on the lingual surface were also measured. This was termed as the ‘CHORD’.

The estimated height was calculated using the formulas below:

$\text{Maximum Stature} = \text{arch (in mm)} \times 6 \times 3.1416 \times 100 \div 2$ <hr style="border: 0.5px dashed black;"/> $\text{Minimum Stature} = \text{chord (in mm)} \times 6 \times 3.1416 \times 100 \div 2$

Statistical analysis was done using Excel & SPSS (Version-18), Frequencies of correct height estimation were calculated. Proportion of correct estimations were compared according to gender, side of arch and the types of dental alignment using Chi square test.

Results

There were 100 students of 20-25year age group were considered for the study. Which included 50 male and 50 females, in which having normal dentition 20, crowded were 18 and having diastema were 12 males. In case of female subjects, 31 were of normal dentition, 15 were having crowded dentition and only 4 females with diastema type of dentition as shown in table 1 and bar diagram 1.

Table-1: Descriptive statistics relating to sex & kind of dental alignment.

Gender	Normal	Crowded	Diastema
Male	20 [40%]	18 [36%]	12 [24%]
Female	31 [62%]	15 [30%]	04 [8%]

Table-2: Mean and standard deviation of the actual height, arch (mm) and chord (mm) values in the study population.

	MEAN (SD)		
	Male	Female	Total
Actual Height (cm)	173.1.3 (4.60)	1562.0 (5.02)	164.66 (6.05)
Arch (mm)	19.68 (1.94)	19.63 (2.21)	19.65 (1.98)
Chord (mm)	18.01(2.49)	17.82 (1.10)	17.91 (1.51)

Table-3: correlation coefficient between types of tooth alignment and gender

	r- values		
	Normal	Crowded	Diastema
Male	0.9658	0.8097	0.6568
Female	0.8347	0.6958	0.3989

Table-4: showing Correlation coefficient between right & left arch and chord with stature

	Arch		Chord	
	Right	Left	Right	Left
r- value	0.7274	0.8221	0.8986	0.8884
Correlation	Moderate	Strong	Highly strong	

Mean and standard deviation of the actual height, arch (mm) and chord (mm) values in the study population was calculated, the mean value of height of male was higher than female with a slightly higher standard deviation for females. The mean value for arch of both gender was near about similar with a slight higher difference in standard deviation of female subjects. The chord for male was having slightly higher mean value with a significantly higher value of standard deviation, as shown in table 2.

There found to be a consistently higher correlation between stature estimation and the arch for normal alignment ($r=0.9658$, $r=0.834732$) for male & female respectively. There was a consistently moderate correlation between stature estimation and the arch for crowded alignment ($r=0.8097$, $r=0.6958$) for male & female respectively. There was a slightly weaker positive correlation between stature estimation and the arch in this study for diastema ($r=0.6568$, $r=0.39389$) for male & female respectively.

There found to be a consistently higher correlation between stature estimation and the arch & chord in this study for both gender. There found to be a consistently higher correlation between stature estimation and the arch in this study for normal alignment ($r=0.9658$, $r=0.8347$) for both the gender male & female respectively. There was a consistently moderate correlation between stature estimation and the arch in this study for crowded alignment ($r=0.8097$, $r=0.6958$) for both the gender male & female respectively. There was a slightly weaker positive correlation between stature estimation and the arch in this study for diastema ($r=0.6568$, $r=0.3938$) for both gender male & female respectively.

There found to be a consistently higher correlation between stature estimation and the arch & chord for both gender. Left arch found to higher success rate compared to right but it is not statistically evident. A consistently higher correlation There found to be between stature the arch for normal alignment ($r=0.9658$; $r=0.834732$); moderate correlation for crowded alignment ($r=0.8097$; $r=0.6958$); and a weaker correlation for diastema ($r=0.656$, $r=0.3938$) for male & female respectively.

The left side of the hemiarch showed a higher success rate (82%) in comparison to right side (72%). There was a consistently higher correlation between stature estimation and the arch and chord in this study in both gender ($r=84.96$). P - Value <0.05 at 5% level of significance with 95% confidence interval. Results statistically found to be significant.

Discussion

A statistically significant difference between the types of dental arch was obtained for both males and females with regards to the different dental alignments; where the highest success rates obtained for normal dentition (96.03% in males and 83.07% for females) and weaker for diastema (65% for male & 39% for female). Left arch found to have higher success rate compared to right but it was not statistically significant.

In the study by Silva et al, had measured the chord with a caliper, and the arch with a millimeter tape. A 70% success rate was observed when actual height was compared with the estimated height however no difference found between normal and crowded types. Lower success rates (50%) with diastema. Our study showed similar success rates for both sexes in all the 3

types of arches normal - 96.58 & 83.47%; crowded – 80.97% & 69.58%; diastema – 65.68% & 39.38% for male and female respectively [5]. In comparison with a study conducted by Rekhi et al in subjects among young adult Indian population in the age group of 20 to 25 years, a higher success rate was seen for males (94.03%) as compared to females (87.5%) for normal alignments, which was not statistically significant ($p=0.235$). Recent study showed a higher success rate for males compared to females, but statistically not significant. [1]

In comparison with a study conducted by Lima et al on South American subjects among with age range between 18 to 30 years, Higher success rates for right side (82.6%) compared to left side (72.2%) were

obtained. Recent study showed contrast results i. e. higher success rate (82%) for left side as compared to the right side (72%)[1,2].

Cavalcanti et al had used two methods of measuring cast dental elements for estimating height through the Carrea's index [12,13]. In the one he called conventional, the arch was measured with a millimeter tape, and the chord, with a caliper; in the modified method, the arch and the chord were measured with a divider caliper.

The study observed that, in the modified method, the rate of success was higher in males (100%) than in females (93.3%), with equivalent rates in both sides. The conventional method has shown lower rates of matching: 35 and 45% for males (right and left sides), and 36.7 and 50% for females (right and left sides, respectively).

It should be noted that normal and crowded arches were analyzed together, with no distinguishing between them. The paper does not provide the result of statistical tests between sexes. There was a consistently higher correlation between stature estimation and the right-hemiarch in this study, even though not statistically significant. This finding is in contradiction to the results of Cavalcanti et al which has shown equivalent success rates for both sides by the modified method, and higher correlation to the left hemiarch by the conventional method. [1, 13]

Prabhu S. et al [13] conducted a study regarding the estimation of stature from teeth dimensions however the buccolingual and mesiodistal dimensions of all teeth (except third molars) were assessed instead of just the mandibular anterior teeth where correlation analysis revealed that 21 of the 56 tooth crown variables had a low statistically significant correlation to stature ($p < 0.05$). In our study P -value was < 0.05 at 5% level of significance with 95% confidence interval, even the measurements were taken only of mandibular anterior teeth (canine to canine) in mesiodistal width and canine to canine width calculated.[14]

Conclusion

Height is a useful element in human identification and its estimation is not an easy task. As study shows higher success rate for normal & crowded teeth as compared to diastema. Since the index considers the metric relation between mesiodistal widths of anterior elements, the presence of diastema affects the final result, making the estimated minimum stature higher than the maximum stature. Therefore, in hemi arches with diastema, the

method presented the lower rate of success. Left arch found to have slight beet of more success rate compared to right but it is not statistically evident. The present study concludes that, teeth can also be a reliable tool for estimation of stature in forensic applications when remains of other body parts are not found.

Thus, Carrea's index appears as a practical, easy and low-cost method, requiring only the presence of mandibular teeth. Further research with more sample size required for highly significant results.

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