Carrea's index in dental students at the Federal University of Paraíba

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Received for publication: October 15, 2008
Accepted: December 02, 2008

Abstract

Aim: To determine the applicability of Carrea's index in arches with normal tooth position and diastema and to evaluate its use in the maxillary arch. **Methods:** 51 pairs of plaster models made by dental students from the Federal University of Paraíba were analyzed. The arches and hemiarches were divided according to dental position and measured with a manual caliper and a digital caliper. With these measurements, maximum and minimum heights were estimated, comparing the values to the real height of the subjects. The data were then submitted to Pearson's chi-square test and Fischer's Exact test (CI = 95%). **Results:** In the mandibular hemiarches, there was statistically significant difference ($p = 0.017$) between the types of dental position only in women, with crowded teeth obtaining the highest number of hits (95.2%), followed by diastema (50.0%). Only the left hemiarch was significantly different ($p = 0.049$) and crowded teeth had the highest index of hits (82.6%), whereas diastema accounted for 40.0%. In the maxillary arch, the error percentage was 100% in the three types of dental position. **Conclusion:** Carrea's index is applicable in normal and crowded teeth. However, it was not efficient in the maxillary arch and in hemiarches with diastema.

Keywords: Forensic Anthropology. Legal Dentistry. Dental Arch.

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[2-5].

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.

Carrea[6] developed a mathematical model that allows for calculating of an individual's height by measuring the dimensions of some mandibular teeth[2,4,7,8]. However, Carrea's index has originally been suggested for dental arches with normal tooth position.

Considering the scarcity of information in the literature and the fact that a large part of the population presents some type of malocclusion, mainly tooth crowding with frequent diastema, the actual applicability of this index must be investigated. Some studies have also indicated its use in the maxillary arch[7,9-11]. The aim of using Carrea's index in the maxilla is to establish a new identification method to aid in cadaver examinations because the skulls are frequently found fragmented and with missing mandible. In addition, because of its anterior and medial location, the mandible is often more damaged in accidents, which would preclude the use of the method[12].

Therefore, the purpose of this study is to determine the applicability of Carrea's index for use in official investigations to identify human remains in arches with normal tooth position and diastema and to evaluate its use in the maxillary arch.

Material and Methods

This study was conducted in accordance with the

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regulations established by Resolution 196/96 and the research protocol was approved by the Research Ethics Committee of the Health Sciences Center at the Federal University of Paraíba on May 28, 2008 (protocol #. 0061). A pilot study was carried out to calibrate the examiner. Twelve plaster models were used (6 mandibular and 6 maxillary). In both the 6 mandibular and 6 maxillary models, 2 were of normally positioned teeth, 2 of crowded teeth and 2 of teeth with diastema. These models provided 24 measurements, since each unit included a right and left hemiarch.

The examinations were repeated after 8 days and statistical analysis showed 21 matches (87.5%), Kappa's index of 0.74 and confidence interval of 95% (0.47 to 1.00). The agreement was considered good, according to this index, since it lies in the 0.61 to 0.80 range. A blind cross-sectional study was performed, using a comparative procedure and descriptive statistics. The sample was composed of 102 plaster models (51 maxillary and 51 mandibular) belonging to students from the course of Dentistry at UFPB. The subjects were 27 women and 24 men. All participants were submitted to anthropometric analysis.

The maxillary and mandibular arches and the right and left hemiarches were evaluated separately, for a total of 204 hemiarches. Each hemiarch was then divided, according to tooth position, into three groups: normal, crowded and with diastema. The lower level of crowded teeth and diastema was considered. Of the 102 maxillary hemiarches, 60 had normal tooth position, 23 were crowded and 19 had diastema. Of the mandibular hemiarches, 41 had normal position, 43 were crowded and 18 had diastema.

The arch and the string described by Carrea[6] were measured. The arch consists of the sum of the mesial-distal diameters of the central incisor, lateral incisor and mandibular canine, measured on the buccal surface of these teeth. The string of this arch corresponds to the measure of the straight line located between the initial and final points, represented by the mesial edge of the central incisor up to the distal edge of the ipsilateral canine, measured on the lingual surface of the aforementioned teeth.

Individual tooth sizes of the arch were measured with a manual caliper (ICE® - Cajamar, SP, Brazil), transferred to a millimeter ruler (Angelus®, Londrina, PR, Brazil) and totaled. The string was measured with a digital caliper (Digimess®, São Paulo, SP, Brazil) by tracing a straight line from the mesial of the central incisor to the distal of the canine. From these measurements, maximum and minimum heights were estimated, according to Carrea's index (Figure 1). The resulting values were compared to the real height of the subjects.

SPSS (Statistical Package for the Social Sciences, SPSS Inc., Chicago, IL, USA), version 13.0 was used to obtain statistical calculations and data analysis was performed using Pearson's chi-square and Fischer's Exact tests, at a confidence interval of 95.0%.

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

$$\text{Minimum Height} = \frac{\text{string-radius (in mm)} \times 6 \times 3.1416 \times 100}{2}$$

Fig. 1 - *Equations to calculate maximum and minimum height*
Source: Carrea14

Results

Table 1 shows the distribution of hits and misses obtained in the mandibular arch for normal tooth position, crowded teeth and teeth with diastema, evaluated separately by gender. There was no statistically significant difference in men ($p=0.221$), different from that observed in women ($p=0.017$). The crowded group recorded the highest number of hits (95.2%), followed by the diastema group (50.0%).

Table 2 shows the analysis of different tooth positions according to the hemiarch, in which statistically significant difference was found only on the left side ($p=0.049$), with the highest percentage of hits in the crowded hemiarches (82.6%), and the lowest in the hemiarches with diastema (40.0%).

Tables 3 and 4 show that in the maxillary arches the percentage of misses was 100% for all types of tooth position in both genders and hemiarches, respectively.

Discussion

In contrast to the findings of previous studies[7,8,10], which ruled out the use of Carrea's index in crowded dental arches, we found a significant percentage of hits in the hemiarches that exhibit this type of tooth position. Indeed, this percentage was even higher than that found in women with normal tooth position (Table 1) and on the left side (Table 2), where there was statistically significant difference among the three types of position. The high percentage of hits obtained in the crowded hemiarches might have been due to the individual measurement of each tooth with manual caliper, resulting in a more reliable arch value.

Cavalcanti et al[13] compared two forms of measuring teeth in plaster models to estimate the height of 50 dental students using Carrea's index. In the first method, called conventional, the arch was measured with a metric tape measure and the string with a caliper; in the second method, called modified, the string and the arch were measured with a manual caliper, with the value of the arch represented by the sum of the individual measurements of each tooth.

The authors[13] concluded that the results between the two methods were statistically significant ($p<0.01$), given that in the modified method the percentage of hits was 96.0% for both sides, while the conventional method obtained 36.0% and 48.0% of hits on the right and left sides, respectively. In the same study[13], it was found that,

Table 1 - Distribution of hits and misses for normal tooth position, crowded teeth and teeth with diastema, in the mandibular arch, according to the gender of the study subjects. João Pessoa, Brazil, 2008

Hits/Misses								
Gender	Tooth Position	Hits		Misses		Group Total		*P value*
		n	%	n	%	n	%	
Men	Normal	13	81.3	3	18.7	16	100.0	0.211
	Crowded	17	77.3	5	22.7	22	100.0	3.173
	Diastema	5	50.0	5	50.0	10	100.0	
TOTAL		35	72.9	13	27.1	48	100.0	
Women	Normal	19	76.0	6	24.0	25	100.0	0.017*
	Crowded	20	95.2	1	4.8	21	100.0	7.423
	Diastema	4	50.0	4	50.0	8	100.0	
TOTAL		43	79.6	11	20.4	54	100.0	

(*): Significant association at 5.0%. Fisher's Exact test

Table 2 - Distribution of hits and misses for normal tooth position, crowded teeth and teeth with diastema, according to hemiarch, in the mandibular arch of the study subjects. João Pessoa, Brazil, 2008

Side	Tooth Position	Hits		Misses		Group Total		*P value*
		n	%	n	%	n	%	
Right	Normal	19	82.6	4	17.4	23	100.0	0.223$^{(1)}$
	Crowded	18	90.0	2	10.0	20	100.0	2.852$^{(1)}$
	Diastema	5	62.5	3	37.5	8	100.0	
TOTAL		42	82.4	9	17.6	51	100.0	
Left	Normal	13	72.2	5	27.8	18	100.0	0.049*$^{(2)}$
	Crowded	19	82.6	4	17.4	23	100.0	6.131$^{(2)}$
	Diastema	4	40.0	6	60.0	10	100.0	
TOTAL		36	70.6	15	29.4	51	100.0	

(*): Significant association at 5.0%. (1)Using Fisher's Exact test. (2)Using Pearson's chi-square test

in the modified method, the percentage of hits was greater for men (100%) than for women (93.3%), with no difference between the right and left sides. However, in the conventional method the number of hits was higher in women on both sides. It should be pointed out that Cavalcanti et al.[13] included normal and crowded arches, without assessing them separately and did not statistically evaluate the differences between genders, since neither the test value nor the p-value was found.

In a study conducted by Silva[8], the string was measured with a caliper and the arch with a metric tape measure. The author observed that the real height of an individual lay between the maximum and minimum heights in 70% of the cases. However, the author did not assess the genders or the hemiarch and did not consider the plaster models in which the arches displayed crowding or some other anomaly.

With respect to the low percentage of hits obtained in hemiarches with diastema, it must be underscored that in the present study, there was a wide range of diastema severity in the analyzed hemiarches. They varied between 0.5 and 3.0 mm and occurred between the canine and lateral incisor and/or lateral and central incisor. Large diastemas compromised the string value, given that the spaces between the teeth led to a greater measure than if they had been in contact with one another.

Table 3 - Distribution of hits and misses for normal tooth position, crowded teeth and those with diastema in the maxillary arch, according to the gender of the study subjects. João Pessoa, Brazil, 2008

Gender	Tooth Position	Hits		Misses		Group Total	
		n	%	n	%	n	%
Men	Normal	-	-	27	100.0	27	100.0
	Crowded	-	-	9	100.0	9	100.0
	Diastema	-	-	12	100.0	12	100.0
TOTAL		-	-	48	100.0	48	100.0
Women	Normal	-	-	34	100.0	34	100.0
	Crowded	-	-	13	100.0	13	100.0
	Diastema	-	-	7	100.0	7	100.0
TOTAL		-	-	54	100.0	54	100.0

Table 4 - Distribution of hits and misses for normal tooth position, crowded teeth and those with diastema, according to hemiarch, in the maxillary arch of the study subjects. João Pessoa, Brazil, 2008

Side	Tooth Position	Hits		Misses		Group Total	
		n	%	n	%		
Right	Normal	-	-	30	100.0	30	100.0
	Crowded	-	-	11	100.0	11	100.0
	Diastema	-	-	10	100.0	10	100.0
TOTAL		-	-	51	100.0	51	100.0
Left	Normal	-	-	31	100.0	31	100.0
	Crowded	-	-	11	100.0	11	100.0
	Diastema	-	-	9	100.0	9	100.0
TOTAL		-	-	51	100.0	51	100.0

Therefore, the string value, which estimates minimum height, was higher than that of the arch, which corresponds to maximum height. In the difference between the heights, the minimum was greater than the maximum because the arch value was not compromised, given that its measurement represents the individual sum of the teeth. These occurrences may have been a determinant for the low percentage of hits for the hemiarches with diastema, since the real height of the subjects lay within the maximum and the misses were observed when obtaining the minimum height.

However, based on the methodology used and on the results obtained, it may be inferred that Carrea's index is applicable in mandibular arches for normal and crowded tooth positions. In the mandibular hemiarches that present diastema, the severity of the diastema must be evaluated for the index to be considered useful in estimating height. However, in these cases, the method is not reliable owing to the low percentage of hits in the values obtained. Regarding the maxillary arches, the present findings showed that there were no hits in any of the types of tooth position for both men and women (Table 3), and on both the left and right sides (Table 4), demonstrating the ineffectiveness of the method when maxillary arch teeth are evaluated. Moreover, no theoretical reference was found on the use of Carrea's index in maxillary arches to compare the obtained results.

Height is an essential element when seeking the identity of an individual and determining it is no easy task. In contrast to the adversities found in human identification processes, especially those involving human fragments or pieces of bone remains, Carrea's index appears as a practical, easy and low-cost method to be used, requiring only the presence of a number of mandibular teeth.

Acknowledgements

This study received financial support from the Institutional Program for Scientific Initiation Grants (PIBIC), coordinated by the National Council of Scientific and Technological Development (CNPq).

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