CARREA`S METHOD APPLICATION TO ESTIMATE STATURE IN INDIVIDUALS USING TEETH MEASURES IN BRAZILIAN POPULATION

ABSTRACT

AIM: The purpose of the present study was to evaluate a methodology to estimate the stature in orthodontically treated individuals using odontometric data obtained from digitalized 3-dimensional image. **MATERIAL AND METHODS:** The sample consisted of 46 Brazilian people from the southern of the country, aged between 22 and 37 years and divided into two groups; group 1 (control) composed by 24 individuals with no orthodontic treatment and adequate alignment of the six anterior mandibular teeth and group 2 (experimental) composed by 22 individuals with crowding of the anterior mandibular teeth before the orthodontic treatment (Group 2A) and after orthodontic alignment (Group 2B). The odontometric data was obtained from their digitalized cast models. Mathematical formulas were used to obtain the stature range between the minimum and maximum estimated stature. **RESULTS:** The descriptive analysis of the percentage of people with real stature within the estimated stature range showed an average between the right and left hemiarchs of 44%, 75% and 52% for groups 1, 2A and 2B, respectively. **CONCLUSION:** It was concluded that this method can be used for the stature estimation in orthodontically treated patients but as an auxiliary tool together with other methodologies.

SILVA, Marcos Andre*
SAKAGUTI, Nelson*
FERNANDES, Mario*
MAZZILLI, Luiz Eugenio*
SILVA, Ricarda*
OLIVEIRA, Rogerio*

KEYWORDS

Stature estimation. Human identification. Forensic anthropology. Forensic dentistry. Digital models.

University of Sao Paulo, Sao Paulo, SP, Brazil*
Correspondence: nsakagut@usp.br (SAKAGUTI N)

| **Received** 02 May 2014 **Received in revised form** 06 May 2014 **Accepted** 07 May 2014

INTRODUCTION

Identifying is determining the individuality, in other words, proving through technical and scientific methods that a person is that person and not another one.[1,2] The Forensic Dentistry has in the human identification an area of great support for the forensic medicine due to the excellent results obtained through the use of refined techniques and precise conclusions. It is in body recognition that the human identification reaches its highest application value.[3]

In cases of great disasters and collective accidents the bodies of the victims suffer destructive actions and are commonly found carbonized, dismembered and decomposed. So the identification is established through the analysis of parts of the body, bones, skeletal remains as well as teeth,[2,4] using anthropometric methods.[2] In such cases the identity investigation has to be started by the biotypologic data that present less variation such as species, age, sex, stature and weight.[5]

The measurement of the long bones using Broca's osteometric board and its comparison with the already renowned tables such as Orfila's and Étienne-Rollet's,[6] measures obtained from other bones of the body,[7] skeletal remains[8] and size of the feet,[9] are the basis of the stature estimation studies. Some studies tried to correlate the human height with the dental size with no much success.[10,11,12] Others using the studies of the Argentinean professor Juan Ubaldo Carrea[1,13] as a method to estimate the stature reported good results,[4,14,15] or at least satisfactory ones.[16]

Carrea[1] described a mathematical calculation to determine the stature considering the size of anterior mandibular teeth, however its applicability as a method to estimate the stature was not scientifically tested. The studies that used Carrea's calculation[1] as a method to estimate the stature used samples of individuals with the anterior mandibular teeth aligned[14,15,16] crowded with diastema[14,15] also with no distinction in relation to alignment.[4] The applicability of this method on orthodontically treated individuals was not yet studied.

One of the measurement used in this method[1] 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. This has led to the need of comparing the situation of crowding and alignment in orthodontics patients.

The present study aimed to verify the applicability of the mathematical calculations of Carrea[1] to estimate the stature in orthodontically treated individuals using odontometric data obtained from digitalized 3-dimensional images.

MATERIAL AND METHODS

The research was submitted and approved by

the ethics committee in researches involving human beings of the Dentistry College of the University of São Paulo and conducted in the facilities of the Latin American Institute of Dental Research and Education - ILAPEO, in the city of Curitiba (Brazil) in 2011. All the individuals who composed the study sample agreed to participate in the research and signed a term of free and informed consent.

1 SAMPLE:

The study carried out on 46 Caucasian Brazilian people (28 female, 18 mal e) aged between 22 and 37.

The inclusion criteria was the presence of the six higid mandibular anterior teeth, the absence of the diastema, no interproximal tooth wear during orthodontic treatment and no diseases, syndromes or anomalies that could interfere in the body growth.

The sample was divided into two groups: control group (Group 1) constituted by 24 individuals with no orthodontic treatment with the six mandibular anterior teeth aligned and a experimental group composed by 22 individuals with mandibular anterior teeth crowded before the orthodontic treatment (Group 2A) and with the normal position of these teeth after the orthodontic treatment (Group 2B). For a better standardization of the dental crowding quantity (Group 2A) the index of Little[17] was used, accepting a moderate or severe degree of irregularity in the position of the teeth (at least 4mm).

2 DENTAL MEASUREMENTS:

Odontometric measurements were obtained on 3-D digital images. It was used the 3Shape Ortho SystemTM (3Shape A/S, Copenhagen, K Denmark) which is composed by the R700 scanner developed for the high precision digitalization of plaster models and the 3D OrthoAnalyserTM software (3Shape A/S, Copenhagen, K Denmark).

Carrea[1] proposed two measurements of the mandibular arch to obtain the stature: the arch (Figure 1) and the radius-chord (Figure 2).

All the measurements were obtained for both hemiarch with an approximation of 0.01mm. The localization of the landmarks was facilitated by either the possibility of rotating the digitalized model on the three planes of space or the zoom tool of the software. After obtaining the radius-chord and arch value for each cuspid, their values were inserted in the formula developed by Carrea[1] to obtain the minimum and the maximum statures in centimeters.

$$\text{Minimun stature} = \frac{\text{radius-chord} \times 6 \times 3.1416}{2}$$

$$\text{Maximum stature} = \frac{\text{arch} \times 6 \times 3.1416}{2}$$

Fig. 1. Arch measure: image of the digitalized model showing the greatest mesiodistal distance of the right lower central incisor (41), right lower lateral incisor (42) and right lower canine (43).

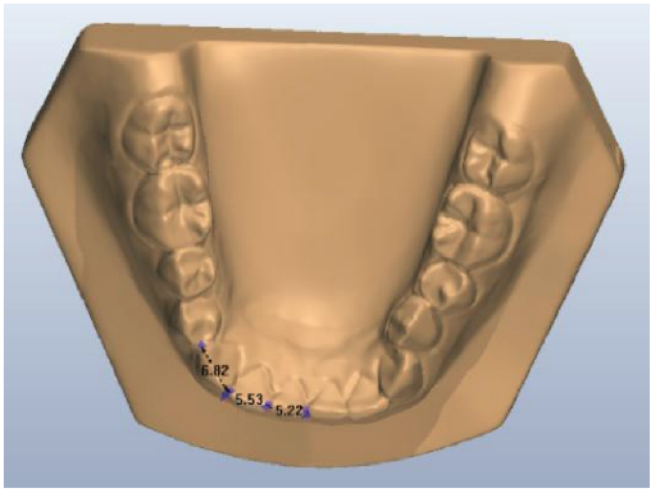
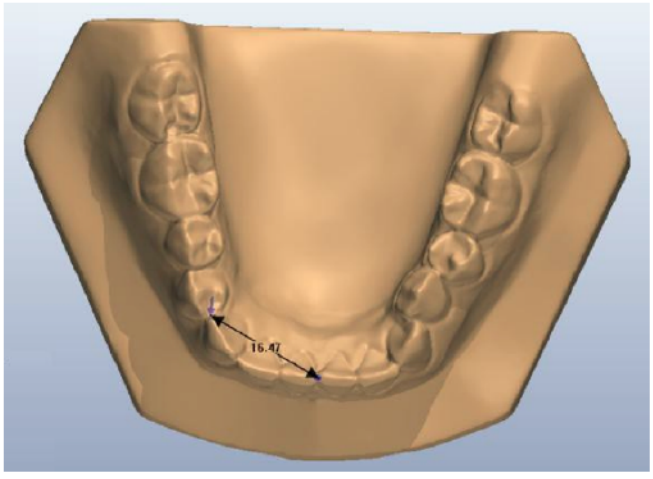


Fig. 2. Radius-chord measure: image of the digitalized model showing the linear distance from the most mesial point of the interproximal face of the right lower incisor (41) to the most distal point of the interproximal face of the right lower canine (43).



3 REAL STATURE:

The real stature of the subjects of the research was obtained with the aid of stadiometer (Sanny American Medical do Brasil Ltda, São Bernardo do Campo/SP, Brazil) placed behind the individual. The individuals were barefooted, in an upright position, with the face oriented forward, looking at the horizon, with the head directed by the auriculo-orbital plane parallel to the ground, the feet over a flat surface and the tip of the feet forward with the heels together[18]. The measurements were taken in the first hours of the morning and the distance from the ground to the highest point of the head in the median sagittal plane[19] was recorded.

4 ACCURACY OF THE MEASUREMENTS OBTAINED ON THE DIGITAL MODELS:

It was defined as accuracy the agreement of the values obtained on the digital models with the ones obtained directly in the cast models using a digital caliper rule (Mitutoyo, Mitutoyo American Corporation, USA) with precision scale of 0.01 mm. All the measurements were repeated twice with an interval of at least one week on 20 cast models randomly selected.

5 EVALUATION OF THE INTRA AND INTER-OBSERVER ERROR:

Intra and inter-observer error was calculated. Two different operators retook all the measurements twice, with an interval of at least a week, on 20 digitalized models randomly.

6 STATISTICAL ANALYSIS:

The normality of the data was tested by Shapiro-Wilks test. It was calculated the maximum error considering the size of the available sample with a confidence level of 95%.

The descriptive analysis was made by determining the real stature comprised within or outside the established stature range between the minimum and the maximum estimated stature for each hemiarch of the same digitalized model.

The statistical analysis was made using the software Statistica 9.0 (Statsoft® SouthAmerica) and Microsoft Excel®. The significance level used was established in 5%.

RESULTS

It was verified that the measurements produced from the digital models were statistically equal to the measurements produced from the plaster models and that there was no intra and inter-operator statistically significant difference. In relation to the size of the sample, accepting an error of 4.5 cm within a confidence level of 95%, the available sample was considered consistent.

The descriptive data are shown in Table 1. It is observed that for Group 1, 50% of the sample presented the real stature within the calculated stature range considering the left hemiarch, but for the right hemiarch it was 37.5%. Studies that used the calculations of Carrea[1] to estimate the stature in individuals with aligned teeth presented better results.

DISCUSSION

Lima et al.[14,15] verified an accuracy level between the real stature and the estimated stature range of 82.6% for the right side and of 72.2% for the left side. Silva[16] also reported having found values around 70%, however these researches used methodologies to obtain the arch and radius-chord measurements different from the ones used in this study.

Group 2A presented a high percentage of individuals with real stature within the estimated stature range, 86.4% for the left hemiarch and 63.6% for the right hemiarch (Table 1). The explanation for such values was the fact that the individuals with the crowded teeth (Group 2A) presented lower values for the radius-chord measure in relation to Group 1 with the aligned teeth, and consequently lower minimum estimated statures and a larger range between the minimum and maximum estimated statures (Table 2) therefore increasing the chances of the real stature being within this range. Lima et al.[14,15] in a sample of individuals with the crowded anterior mandibular teeth found even higher values of the percentage of individuals whose real height was within the estimated stature range, however it was not described in the

study the degree of dental crowding of the sample. Cavalcanti[4] drawing no distinction in relation to the dental irregularity quantity in the sample of his research verified that the real stature was within the estimated stature range in 36% of the cases for the right side and 48% for the left side.

In the Group 2B it was observed that the real stature was within the estimated stature range in 59% of the cases for the left hemiarch and in 45% of the cases for the right hemiarch (Table 1). When Group 1 and Group 2B were compared, it was verified a similarity between both groups in relation to the relative quantities of individuals whose real height was within the estimated range, however with more favorable results for the group with teeth aligned by the orthodontic treatment. Group 2B also presented the size of the estimated stature range smaller than the one of the Group 1 (Table 2).

From the two dental measures used in this study just the radius-chord value can be changed due to the orthodontic treatment. It was verified that in Group 2B the radius-chord measurements had an increase of 9.3% for the left hemiarch and 8.1% for the right hemiarch when compered to Group 2A, (Table 3). So the size of the estimated stature range was larger for the Group 2A than for the Group 2B (Table 2).

Table 1. Distribution of the individuals according to the criteria: real stature within or outside the estimated stature range for the left and right hemiarch.

	Group 1				**Group 2A**				**Group 2B**			
	Left		Right		Left		Right		Left		Right	
Criteria	N	%	n	%	n	%	n	%	n	%	n	%
Within	12	50	9	37.5	19	86.4	14	63.6	13	59	10	45.5
Outside	12	50	15	62.5	3	13.6	6	36.4	9	41	12	54.5
Total	24	100	24	100	22	100	22	100	22	100	22	100

Table 2. Stature ranges between the minimum and maximum estimated stature. Min SE - minimum stature estimation, Max SE - maximum stature estimation, SER stature - estimation range and ASR - average stature range.

	Left hemiarch			**Right hemiarch**			
	Min SE (cm)	Max SE (cm)	SER (cm)	Min SE (cm)	Max SE (cm)	SER (cm)	ASR (cm)
Group 1	156.56	176.57	20.01	157.78	175.57	17.79	18.9
Group 2A	147.08	179.71	32.63	150.53	179.27	28.74	30.6
Group 2B	160.79	177.95	17.16	162.65	176.32	13.67	15.4

For the human identification process the ideal situation should be the existence of a method of stature estimation which estimated values closer to the real ones. The range between the minimum and maximum estimated statures should be few centimeters. Despite the Group 2A presented a higher percentage of individuals with real

stature within the estimated stature range in relation to the groups analyzed (Table 1), its estimated stature range was also much larger than the one of the other studied groups (Table 2).

None of the studies found in the reviewed literature that used the calculation of Carrea[1] with the objective of estimating the stature,[4,14,15,16] considered the size of the estimated stature range to evaluate the applicability of this method.

There was no correlation of the results with sex of the sample. In the Group 1 and 2A the results were more favorable for female (Table 4 and Table 5); however, in the Group 2B male presented better results (Table 5).

When comparing the real and estimated stature according to the sex (Table 6), it was verified that for all the studied groups, the male sex presented the real stature closer to the maximum estimated stature than to the minimum one. On the other hand, the individuals of the female sex had the real stature closer to the minimum estimated stature. These results confirm the report made by Carrea[1] and Velasquez.[20]

The real proposal of Carrea[1] was not clear on his article of 1939. It seems that it was not his objective to determine a range between two statures where the real stature of a person should fit, but to calculate the human height proportional to the size of some teeth, as well as to calculate the maximum stature that a person could present maintaining this same proportionality relation with the teeth. Although researches relating exactly the mesiodistal size of the mandibular anterior teeth with the stature were not found on the reviewed literature, studies such as the ones of Fischer-Brandies and Butenandt,[11] Kalia et al.[12] and Filipson and Goldson[10] verified the existence of a low correlation between the human height and the size of the teeth. However, it is important to emphasize none of them used the same teeth of the mathematical calculation of Carrea[1].

Table 3. Behavior of the radius-chord measurements between the groups 2A and 2B.

	Group 2A		Group 2B		
Hemiarch	Average Radius-chord (mm)	Standard deviation	Average Radius-chord (mm)	Standard deviation	% of increase
Left	15.6	1.5	17.1	1.2	9.3%
Right	16.0	1.1	17.3	1.2	8.1%

Table 4. Distribution of the Group 1 according to the sex.

		Within		Outside		Total	
Sex	Side	n	%	n	%	n	%
Male	Left	3	30	7	70	10	100
	Rght	3	30	7	70	10	100
Female	Left	9	64.3	5	35.7	14	100
	Right	6	42.9	8	57.1	14	100

Table 5. Distribution of the Group 2A and Group 2B according to the sex. M – male. F – female.

		Group 2A						Group 2B					
		Within		Outside		Total		Within		Outside		Total	
Sex	Side	n	%	n	%	n	%	n	%	n	%	n	%
M	Left	6	75	2	25	8	100	5	62.5	3	37.5	8	100
	Rght	5	62.5	3	37.5	8	100	5	62.5	3	37.5	8	100
F	Left	13	93	1	7	14	100	8	57.1	6	48.9	14	100
	Right	9	64.3	5	35.7	14	100	5	35.7	9	62.5	14	100

Table 6. Calculation of the p-value for the comparison of the real stature (A1) with the minimum stature (A2) and maximum stature (A3) according to the sex.

	Group 1		Group 2A		Group 2B	
	Male	Female	Male	Female	Male	Female
Compared Variables	p-value	p-value	p-value	p-value	p-value	p-value
A1 x A2	0.0000	0.1822	0.0002	0.0002	0.0446	0.7554
A1 x A3	0.1192	0.0000	0.1719	0.00003	0.1998	0.0036

CONCLUSION

The use of the mathematical calculations developed by Carrea[1] to study the stature proportional to the size of the teeth can be applied as a method to estimate the human stature in the orthodontically treated individuals with reservations. This methodology should be used just as an auxiliary tool of other identification methods, once its applicability was around 50% in an estimated stature range of many centimeters.

REFERENCES

1 Carrea JU. Talla individual human en funcion al radio cuerda. Ortodoncia 1939;6:225-227.

2 Silva M. Compêndio de Odontologia Legal. Medsi (Ed.), Rio de Janeiro, RJ, 1997, pp. 93-107.

3 Daruje RJ. Reconstituição facial computadorizada e sua importância na identificação [Thesis]. UNICAMP/ FOP, Piracicaba, SP, 2000.

4 Cavalcanti AL, Porto DE, Maia AMA, Melo TRNB. Estimativa da estatura utilizando a análise dentária: estudo comparativo entre o método de Carrea e o método modificado. Revista de Odontologia da UNESP 2007;36:335-339.

5 Borborema ML. Determinação da estatura por meio da medida de ossos longos, secos, dos membros inferiores e ossos da pelve. Odonto 2010;18:113-125.

6 Abreu HT. Medicina forense aplicada a arte dentária. Francisco Alves (Ed), São Paulo, 1936, pp. 63-64.

7 Singh J, Pathak RK, Chavali KH. Skeletal height estimation from regression analysis of sternal lengths in a Northwest Indian population of Chandigarh region: A postmortem study. Forensic Sci Int 2011;206:211.e1-8.

8 Chibba K, Bidmos MA. Using tibia fragments from South Africans of European descent to estimate maximum tibia length and stature. Forensic Science International 2007;169:145-151.

9 Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: An indigenous population of North Bengal. Forensic Science International 2008;181:55.e1-e6.

10 Filipson R, Goldson L. Correlation between tooth width, width of the head, length of the head, and statur. Acta Odontol Scand 1963;21:359-365.

11 Fischer-Brandies H, Butenandt O. Odontometrische studie über die abhángigkeit von zahn-und körpergröbe. Fortschr 1988;49:96-107.

12 Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry, Indian J Dent Res 2008;19:150-154.

13 Carrea JU. Ensayos Odontométricos [thesis]. Buenos Aires, Universidad Nacional de Buenos Aires, 1920.

14 Lima LNC, Neves GLS, Rabello PM. Carrea`s index in dental students at the Federal University of Paraíba. Braz J Oral Sci 2008;7:1673-1677.

15 Lima L, Costa Y, Tinoco P, Rabello E. Daruge Junior E. Stature estimation by Carrea`s index and its reliability in different types of dental alignment. J Forensic Odontostomatol 2011;29:7-13.

16 Silva M. Estimativa da estatura do indivíduo com a utilização de um grupo de dentes da mandíbula., Rev Paul Odontol 1990;12:18-28.

17 Little RM. The irregularity index: a quantitative score of mandibular anterior alignment. Am J Orthod 1975;68:554-563.

18 Montagu MFA. An introduction to physical anthropology. Charles C Thomas Publisher, Springfield, Illinois, USA, 2011 pp. 444.

19 Longui CA. Previsão da estatura final - Acertando no ''alvo''? Arq Bras Endocrinol Metab 2003;47:636-637.

20 Velázquez AT, Gusieva IM, Acosta GP. Doctor Juan Ubaldo Carrea, ilustre figura em la odontologia latino-americana. Revista 16 de Abril, 2007.