Original Study

COMPARISON OF CLINICAL AND RADIOLOGICAL METHOD IN ESTIMATING STATURE: A PRELIMINARY STUDY

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ABSTRACT

Aim: To estimate the stature of an individual using both clinical and radiological methods and to evaluate the most accurate method in estimating stature of an individual.

Materials & Method: Dental stone models obtained from 20 individuals of both sexes were subjected to the measurement of right lower arch were performed as described by Carrea (1939). Their original height were measured by asking them to stand in bare feet in front of height measuring scale, adjustments were made to stabilize the head and the height was measured in centimetres. Then digital orthopantomogram was taken and the distance between the alveolar crest of mandibular right second molar and superior border of inferior alveolar canal were measured.

Results: The statistical analysis was done using SPSS version 16 to evaluate the data using, Student's unpaired't' test, and Regression analysis was attained. The non-significant p-value of the regression model infers that there is no linear relationship exists between the radiological method and the height of the subject. Intra- class correlation for absolute agreement level has been 0.2236, which indicates less agreement level exists between the original and estimated height of the subjects using the clinical method. Further the non-significant p-value reveals that the mean deviations from the actual height are similar for the two methods.

Conclusion: The two methods are similar in predicting the height of the subjects and the level of prediction has been comparatively less in both the clinical and radiological method.

Key words: Carrea' s index, Forensic Anthropology, Radiological Method, Stature Estimation.

Introduction

Forensic anthropology is a branch of forensic medicine which involves the application of physical anthropology in legal issues. In narrowing the search for a person's identification, stature estimation serves as an imperative component of forensic anthropology.[1] The anatomical landmarks are standard, well developed and easy to locate and this stays as an advantage of measuring teeth and skull for forensic purposes. An estimate must then be made based on the known relationship of the remains to stature and gender. Teeth form an excellent material for anthropological, genetic, odontologic and forensic investigations.[2]

Stature is the total height of a person, and it varies according to sex, age, ancestry, individual development, and hormonal influence. Stature is fundamental in personal identification for forensic and physical anthropologists.[3] In the deceased, 9 to 17 mm must be added to the measurement of the body in the supine position due to the natural flattening of the intervertebral discs, varying according to sex, ancestral background, nutrition, body composition, climate, and day length.[4] The stature is often estimated from various parts of the body, and more commonly from long bones.[5] When a full skeleton is not available, stature can be estimated from incomplete human remains.[3] Teeth form an excellent material for anthropological, genetic, odontologic and forensic investigations.[6]

In many forensic investigations, the skull and the mandible may stay as the only recovered human remains. Thus, the examination of skull and teeth becomes very important. Carrea created a formula that allows the stature to be estimated from measurements of the lower anterior teeth.[7]

There are few radiological studies for estimation of stature from the skull anthropometry.[8] Most of these studies were done using lateral cephalogram. Very few studies have been conducted to estimate the stature by measuring the anatomic landmarks like maxillary sinus, inferior alveolar nerve canal etc. Also, the assessment of location of vital anatomic structures such as maxillary sinus and mandibular canal in the jaws are required while enterprising quality dental care during simple extractions, impactions, surgeries of the involved, and dental implants.[2] Shahnin *et al*[9] conducted a study to estimate the stature of an individual using the location of maxillary sinus and inferior alveolar canal. The study revealed in height-wise there was a very highly statistical significance in the location of maxillary sinus.

Estimation of stature from the skeleton is vital to medicolegal investigations. According to many anthropologists, the stature displays population specific variation and therefore there is a need for conducting studies in major population around the world.[10] With this background an attempt is made to compare a clinical method (using Carrea's index) and a radiological method (measuring alveolar crest- inferior alveolar canal distance) in estimating the stature of an individual.

Aims & Objective

- To estimate the stature of an individual using both clinical and radiological methods.
- To evaluate the most accurate method in estimating stature of an individual.

Materials & Method

The study was conducted in the Department of Oral Medicine and Radiology at our institute. This study

includes 20 individuals of both sexes in the age group of 20-25 years who came for general check-up. We included the individuals with full complement of teeth in lower arch and with well aligned lower teeth. We excluded individuals with crowding or diastema in lower teeth, who had history of facial trauma. Individuals with periodontal problems, who underwent orthodontic management and individuals with any growth hormone dysfunction and with kyphosis and scoliosis were also excluded.

After obtaining the consent the individuals were asked to stand in bare feet in front of height measuring scale, adjustments were made so that the head was stabilized and the height was measured in centimetres. [Figure 1]

Figure 1: Measurement of stature of an individual

To estimate the stature using clinical method, individuals' mandibular impressions were made using alginate and the casts were obtained. The measurement of right lower arch was performed as described by Carrea (1939) using digital vernier caliper.

Arch

Arch is the sum of the mesiodistal diameters of the mandibular central incisor, lateral incisor, and canine, measured by the labial surface. [Figure 2]

Chord

Chord is the linear distance between the ends of the arch, represented by the mesial edge of the central incisor and the distal edge of the canine on the same side, measured by the lingual surface. [Figure 2]

As given by Carrea, the measurements of the arch and the chord, can be used to estimate the individual stature by the so named Carrea´s index, calculated by the formula below:

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

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

*Figure 2: **Arch**- sum of the mesiodistal diameters of the mandibular central incisor, lateral incisor, and canine, measured by the labial surface. **Chord**- linear distance between the ends of the arch, represented by the mesial edge of the central incisor and the distal edge of the canine on the same side, measured by the lingual surface.*

To estimate stature using radiological method, the digital orthopantomogram was taken for the individuals. Radiographs of good qualities without any magnification and artifacts were selected and the distance between the alveolar crest of mandibular right second molar and superior border of inferior alveolar canal were measured using dimaxis classic 2.4.9 software. [Figure 3]

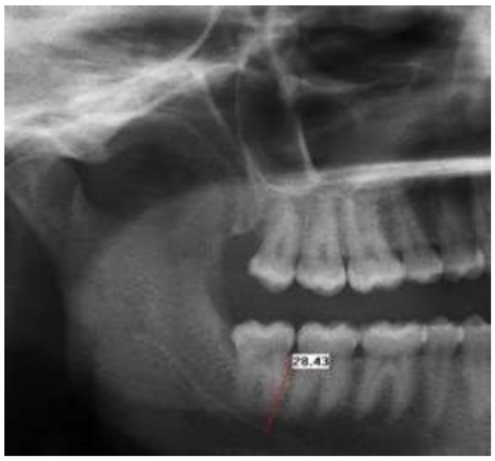

Figure 3: Cropped Digital Orthopantomogram- Distance between the alveolar crest of mandibular right second molar and superior border of inferior alveolar canal.

Statistical Analysis

All the measurements were noted and the statistical analysis was done using SPSS version 16 to evaluate the data using, Student's unpaired't' test, and Regression analysis was attained.

Results

Table no.1 shows the linear regression analysis between height of the subjects and crestal- canal distance. R2=

0.065 indicates only 6% of the variations of the height has been explained by the predictor variable Crest- canal distance. The above finding is also shown in figure no.4.

Variables	Unstandardized Coefficients		Standardized Coefficients	T	Sign.
	B	Std. Error	Beta		
Constant	150.585	10.553		14.27	0.000
CREST Distance	0.487	0.433	0.256	1.125	0.275

R^2 value: 0.065

Table 1: Predicting the height of an individual using the distance between the alveolar crest of mandibular second molar and superior border of inferior alveolar canal

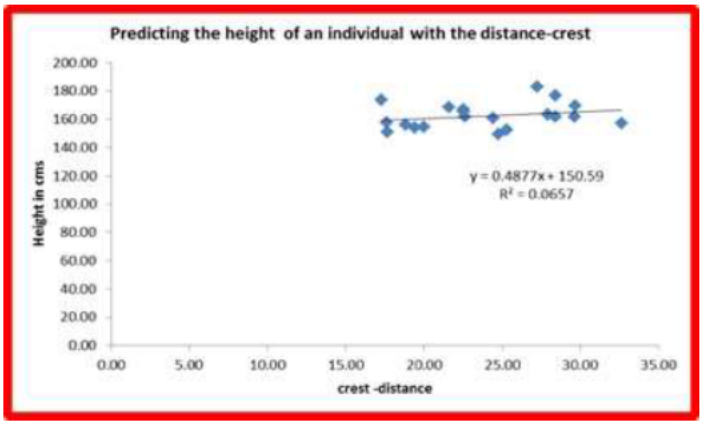

Figure 4: Scatter diagram of the crest distance and height of an individual with linear regression equation.

Table no.2 shows the distribution of the subjects with the deviations in the prediction of the height. The range of deviations has been between -16.68 to 24.93. i.e., for at least one observation, the clinical method predicts less than 16.68 cm than actual height and for at least one observation it predicts 24.93 cm higher than the actual height. In 45% observations it predicts above or below 5 cm of the actual height. Similarly the agreement level between the actual and estimated height of the subjects based on the method radiological method indicates less agreement exists between them.

Further the agreement level has been assessed by using Bland Altman plot. Figure no.5 shows the Bland Altman plot between the actual height and height predicted by the standard method.

Figure no.6 shows the Bland Altman plot between the actual height and height estimated by the radiological method and it reveals variations of the intervals clearly indicate less agreement exists between the actual height and estimated values. Table no.3 shows the mean and standard deviation from actual height for the two methods. The average deviation is 0.14 with the standard deviation of 10.6 cms for the standard method. The non-significant p-value reveals that the mean deviations from the actual height are similar for the two methods.

Deviation Level	Clinical Method		Radiological Method	
	No.	%	No.	%
< - 10 cms	4	20.0	2	10.0
-10 cms to -5 cms	1	5.0	4	20.0
-5 cms to 5 cms	**9**	**45.0**	**9**	**45.0**
5cms to 10 cms	2	10.0	2	10.0
>10 cms	4	20.0	3	15.0
Range	-16.68 to 24.93		-13.05 to 18.82	
Intra class correlation agreement level:	0.2236		0.2285	

Table 2: Distribution of the subjects with the deviations in the prediction of the height for the two methods.

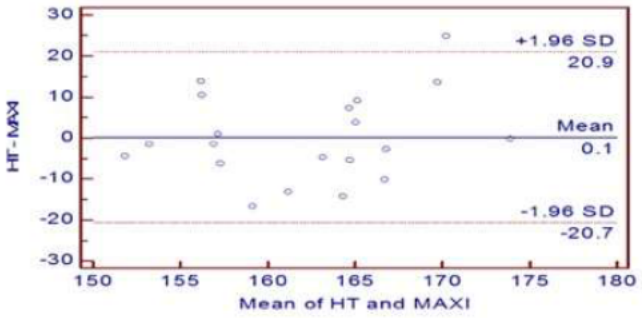

Figure 5: Agreement between the original height and estimated height by clinical method.

Method	Mean	SD	Paired t-test Value	Degrees of Freedom	p-Value
Crest Distance	0.000	8.521	-0.081	19	0.936
Standard	0.140	10.608			

Table 3: Mean and Standard deviation of the deviations from actual height for the two methods.

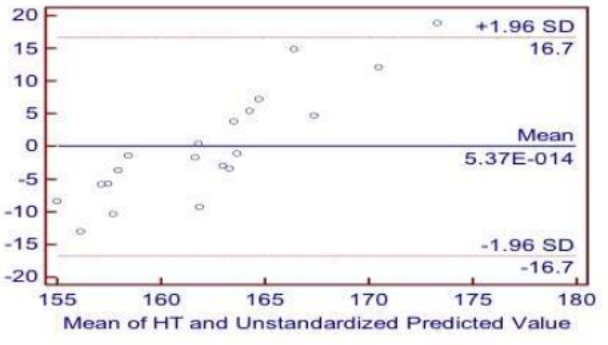

Figure 6: Agreement between the original height and estimated height by radiological method.

Discussion

The determination of the adult stature in forensic anthropology is one of the four key factors (sex, stature, age and race) in assessing biological profile, which is determinant for positive identification of skeletal remains. The anthropological analysis for stature using skeletal material provides relatively fast and accurate data narrowing the field of search thus playing an integral part in the identification process.[11]

Stature is usually estimated from the skeleton in one of two ways:

1) Measuring all bones constituting the components of stature, summing those measurements and correcting for the missing soft tissue, or
2) Employing a regression formula with the measurement of a complete bone. Other methods include employing incomplete limb bones, non-limb bones and alternative statistical methods.

Non-limb bones (e.g., skulls, innominates, and bones of the hands or feet) may also be used to estimate stature, and in combinations with limb bones may be as accurate as other approaches.[12]

Carrea has proposed an index to estimate the stature of an individual based on the measurements made from mandibular anterior teeth. A study conducted among Brazilian population reported that the Carrea's index was almost 100% valid in estimating the stature of an individual.[1]

The utilization of radiographs in identification is valuable if sufficient antemortem records are available. Various morphological and pathological alterations can be studied under radiographs. Crown and root morphology, decayed, missed, filled and fractured teeth, various stages of aids in identification.[13] Relating the association between the stature with the location of mandibular canal helps in identification of human remains as well as helps in various dental procedures and in careful selection of the length of the implant.[9]

This study is unique when compared with other studies to the best of our knowledge, wherein both clinical and radiological method have not yet been compared in estimating stature of an individual.

In this study 45% observation predicts above or below 5 cms of the actual height. Further intra- class correlation for absolute agreement level has been 0.2236, which indicates less agreement level exists between the original and estimated height of the subjects using the clinical method. This is in contrary with the study conducted by MA Silva *et al*[14] and L Lima *et al*[7] where they showed significant correlation existed between the estimated stature and original stature using Carrea's index. This variation in results may be due to the limited age group included in our study i.e. 20 – 25 years among young South Indian population when compared with the study conducted by Lima *et al*[7] and MA Silva *et al.*[14] They included subjects in the wide range of age group 18 to 30 years and 20- 37 years in the South American and Brazilian adult population respectively. This could be attributed to factors such as eruption sequences of teeth and racial differences. In the study conducted by MA Silva *et al,*[14] 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%. In our study we included the right hemiarch, which could have also been a reason behind the variation of results clearly indicating that the significancy depends on the hemiarch side being used in Carrea's index.

In the study conducted by Kauser Ara Shahin *et al*[9] the mean distance from the alveolar crest and the superior border of inferior alveolar canal was receding as it moved posteriorly (i.e.) the mean distance was very highly significant in the premolars, whereas in the first molar it was highly significant and in the second molars it was significant.

In our study, $R^2 = 0.065$ which indicates that only 6% of the population height have been correctly predicted by the Crest- IAN distance (Radiological method). The above findings indicate that the radiological method may not be a good predictor of measuring the height of an individual. This variation may be due to the methodology used, wherein Kauser Ara Shahin *et al*[9] adopted linear tomography (3D imaging) in calculating the canal- alveolar crest distance thus enabling them to take the mean distance from the buccal and lingual alveolar crest. But the panoramic radiograph (2D imaging) used in our study enabled to measure the canal distance from either buccal or lingual crest. Similarly, the study conducted by Frei C *et al*[15] on evaluation of mandibular canal from the alveolar crest in the Berne population showed that the average measured bone height from the mandibular canal to the alveolar crest in the panoramic radiograph was 13.9 ± 2.66 mm and the average bone height in linear tomography was 14.87 ± 3.3 mm suggesting the existence of variations in the methodology used. Also a wide range of age group, 15-45 years were included in their study would have significant influence in estimating stature when compared with our study which included 20-25 years of individuals. Additionally, the size and shape of the mandible is also influenced by variable lifestyles, chewing habits and ethnicity.[9]

Conclusion

This study was conducted with an objective to evaluate the most accurate method amongst the clinical and radiological method in estimating stature of an individual. To conclude, the two methods are similar in predicting the height of the subjects and the level of prediction has been comparatively less in both the clinical and radiological method. The level of prediction is mainly influenced by the difference in population, variable lifestyles and the methodology.

References

1. Anita P, Madankumar PD, Sivasamy S, Balan IN. Validity of Carrea's index in stature estimation among

two racial populations in India. J Forensic Dent Sci 2016;8(2)110.
2. Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res 2008;19(2):150-4.
3. Milani C, Milani R, Panattoni GL. Stature estimation for personal identification using mandibular morphometric parameters in Italian population: a preliminary report. J Biological Res 2014; 87(1):2130.
4. Coles RJ, Clements DG, Evans WD. Measurement of height: practical considerations for the study of osteoporosis. Osteoporos Int 1994;4(6):353-6.
5. Krishan K. Anthropometry in forensic medicine and forensic science -'Forensic Anthropometry'. Internet J Forensic Sci 2007;2(1):95-97.
6. Gupta A, Kumar K, Shetty DC, Wadhwan V, Jain A, Khanna KS. Stature and gender determination and their correlation using odontometry and skull anthropometry. J Forensic Dent Sci 2014;6(2):101-6.
7. Lima L, da Costa Y, Tinoco R, Rabello P, Daruge E Jr. Stature estimation by Carrea's index and its reliability in different types of dental alignment. J Forensic Odontostomatol 2011;29(1):7-13.
8. Patil KR, Mody RN. Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study. Forensic Sci Int 2005;147(2-3):175–180.
9. Shahin KA, Chatra L, Shenai P. Stature estimating the location of maxillary sinus and mandibular canal. N Am J Med Sci 2012;4(11):586–589.
10. Rosner B. Fundamentals of Biostatistics, 5th ed. Duxbury; 2000; 80-240.
11. Hsiao TH , Chang HP, Liu KM. Sex determination by discriminant function analysis of lateral radiographic cephalometry. J Forensic Sci. 1996;41(5):792-5.
12. Scientific Working Group for Forensic Anthropology (SWGANTH). Stature Estimation. 2012. Revision: 1.
13. Sholl SA, Moody GH. Evaluation of dental radiographic identification. An experimental study. Forensic Sci Int 2001;115(3):165-9.
14. Silva MA, Sakaguti N, Fernandes M, Mazzilli LE, Silva R, Oliveira R. Carrea`s method application to estimate stature in individuals using teeth measures in Brazilian population. J Research in Dentistry. 2014;2(4):298-306.
15. Frei C, Buser D, Dula K. Study on the necessity for crosssection imaging of the posterior mandible for treatment planning of standard cases in implant dentistry. Clin Oral Implants Res 2004;15(4):490–497.

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