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International Journal of Current Research
Vol. 9, Issue, 09, pp.58403-58407, September, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

CASE STUDY

COMPARITIVE STUDY OF ESTIMATION OF STATURE USING CARREA'S INDEX AND CEPHALIC DIMENSIONS IN YOUNG ADULTS IN NORTH TELANGANA POPULATION

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ARTICLE INFO

Article History:
Received 11th June, 2017
Received in revised form
09th July, 2017
Accepted 16th August, 2017
Published online 30th September, 2017

Key words:

Carreas index,
Arch,
Chord,
Cephalic dimensions,
Regression equation.

ABSTRACT

Introduction: The stature prediction occupies relatively a central position in the identification necessitated by the medico legal experts or medical jurisprudence and also in the anthropological research. Assessing the height of an individual, from measurements of different parts, has always been of immense interest to forensic medicine experts. Tooth and skull are useful in providing valuable clues for forensics for intricate identification in stature estimation.

Aims and objective: The present study was conducted to evaluate and compare the reliability of tooth and head dimensions in the estimation of stature of an individual.

Material Methods: 300 subjects between ages 18-30 participated in the study. Stature was taken as standing height and measured using metric tape. They were subjected to carreas index for right lower hemi arch and measurements *(arch and chord)* were made with divider caliper for cephalometric skull dimensions. Head length was measured as occipitofrontal distance and breadth as maximum biparietal distance using cephalostat. Head circumference was measured using metric tape, data obtained was analysed using SPSS 20 software.

Results: Males were taller and had higher mean arch and chord values. Male subjects had significantly greater maximum head length ($P<0.05$), maximum head breadth ($P>0.05$), head circumference ($P<0.001$), and stature ($P<0.001$) when compared to the females.

Conclusion: When other body parts are not found, It is seen that Carrea's formula shows good reliability and applicability of estimatimation of stature and head dimensions also are helpful completely in females in the estimation of stature.

Citation: Dr. G. Madhulatha, Dr. P. Manasa, Dr. M. Mahesh, Dr. N. Vijayalaxmi and Dr. T. Harshavardhan, 2017. "Comparitive study of estimation of stature using carrea's index and cephalic dimensions in young adults in north telangana population", *International Journal of Current Research*, 9, (09), 58403-58407.

INTRODUCTION

The term "forensic" is a Latin word, meaning forum or a place where legal matters are discussed. Forensic dentistry or Forensic odontology is the science of dentistry as related to the law. (Puerini, 2005; Singh *et al*., 2012) "No two mouths are alike" is the key principle behind forensic dentistry. It involves dentists' participation in assisting legal and criminal issues. It refers to the proper handling, examination and evaluation of dental evidence, which will be then presented in the interest of justice. (Chowdhry, 2008; Deebaei *et al*., 2008) The scope of forensic dentistry is broad & ever-challenging which involves identification of human beings, either dead or alive especially in case of mass disaster, explosions and assault cases where the body is mutilated, dismembered to conceal the identity of the victim. (Kolude *et al*., 2010) Here comes the role of teeth which by virtue of their durability play a vital role in identification of an individual as they are the quintessential last organs to disintegrate by postmortem decay or incineration long after the remainder of body parts has disappeared .The morphology of teeth provides clues of familial and racial evidence of identification as they are genetically inherited. Unknown remains of human being can also be identified using factors of dental caries, missing or extra teeth, alignment of the dental arches, spacing between teeth, crowding. Humans can be analyzed both metrically and morphologically. Ritz-Timme *et al*. (Literature review survey chapter 2, 2015) studied metrical and morphological assessment on facial features of three European populations. The morphological approach is largely affected by the subjective opinion of the observer, which can be mitigated by the application of descriptive atlases where as Metric characteristics of human faces have been investigated using different technologies which are almost stable (Literature review survey chapter 2, 2015). In India many attempts are made to build a widespread database covering different population. M Kumar *et al* (Literature review survey chapter 2, 2015) and S.K. Rathee (Literature review survey chapter 2,

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2015) evaluated data on facial and cephalic anthropometry of Haryanvi adults. It has been seen that population of Mumbai (Literature review survey chapter 2, 2015), Odisha (Literature review survey chapter 2, 2015), Andhra (6) and North India (Literature review survey chapter 2, 2015) were studied for their mean cephalic index and were classified for their headform. Anthropometric measurements were used to assess cephalofacial proportions for morphological studies. Studies were also conducted on different samples of Indian population for deciding race and sex of an individual whose identity is unknown (Literature review survey chapter 2, 2015). Natural standing height of an individual is stature and it varies according to gender, chronological age, ancestry, individual development, and hormonal influence (Black and Ferguson, 2011). (Ukoha *et al*., 2015) It is important in anthropological research and forensics involving personal identification. Stature has a proportional biological relationship with every part of the human body, i.e. teeth, head, face, trunk, extremities. This relationship helps in calculating stature from dismembered and mutilated body parts like teeth in forensic examinations (Krishan, 2008a) (Krishan, 2008). Agnihotri *et al* (Literature review survey chapter 2, 2015) aimed to model stature for both male and female separately on the basis of craniofacial dimension. Anthropologists have investigated multiple bones of body on stature estimation long bones (Rollet1889), cranial height (Ryan and bidmos2007), scapula clavicle (shulin and fangwu (19883), metacarpels (Hameja1978), metatarsal (byyers*et al* 1989), tarsals (Holland 1995), vertebrae (nagesh and kumar 2006) even foot and shoe print by (Giles 1991) (Kalia *et al*., 2008). Almost all studies are focused on the reliability of dimensions of body in estimation of stature where as present is unique where it focused on the reliability and applicability of tooth & cephalic dimensionsin the estimation of stature.

Aims and objectives

- The aims and objectives of the present were to evaluate the reliability of tooth and head dimensions in the estimation of stature of an individual.
- Compare the reliability of tooth and head dimensions in the estimation of stature of an individual.

Inclusion criteria

All the subjects willing to participate and who had dimensionally stable teeth i.e, intact crowns without any loss of enamel and without any skeletal abnormalities were taken into the study.

Exclusion criteria

The subjects having any of the anterior teeth missing, any structural abnormalities of teeth, wasting diseases, periodontal diseases, subjects who had undergone or currently undergoing orthodontic treatment were excluded.

Materials and methods

A total of 300 subjects participated in the study both males and females of age 18-30 years. Informed consent was taken from all the subjects and following measurements were taken. Stature was measured as vertical distance from the vertex to the floor, where vertex is the highest point on the head when head is held in Frankfort horizontal plane. It was measured in millimeters with a height meter where the subjects stood erect on the horizontal resting plane with bare foot with back of the shoulders and buttocks touching the wall. Modified Carrrea's index using divider and a stainless steel scale was used for measuring tooth dimensions. The mesiodistal width of the lower central incisor, lateral incisor and canine on one side were recorded and summed. This was termed as ARCH. Later linear distance between mesial edge of central incisor and distal edge of canine of same side was measured. It was termed as CHORD.

Stature was estimated using formulas as given below
Maximum stature: - arch in mm x 6 x 3.14 x 100/2
Minimum stature: - chord in mm x 6 x 3.14 x 100/2

Cephalic dimensions were taken by making the subjects sit or stand erect with head in stationary position using cephalostat.
Maximum head length (occipitofrontal distance):- It was measured from glabella to opsithocranium.

Maximum head breadth (biparietal distance):- It was measured between two euryas (the most lateral points of parietal bones).

Horizontal head circumference: - it is the maximum circumference of the head which was measured from just above the glabella area to the area near the top of the occipital bone using a soft metric tape.

Figure 1. Arch

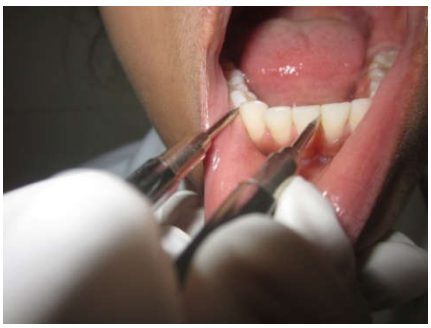


Figure 2. Chord

Figure 3. Head circumference

Figure 4. Height meter

All the obtained values were sent for statistical analysis where mean, SD, t-value, p-value and correlation coefficient were calculated using Karlpearson's Correlation & Linear regression Analysis.

RESULTS

In evaluating & comparing the reliability of tooth and head dimensions in the estimation of stature of an individual the results are as follows Males were taller and had higher mean arch and chord values. Male subjects had significantly greater maximum head length (P<0.05), maximum head breadth (P>0.05), head circumference (P<0.001), and stature (P<0.001) when compared to the females. Table 2 shows comparision of Regression Analysis of Arch versus Height and Chord versus Height in Gender that males has good correlation (-0.447) in stature estimation than and it is significant (0.000 –pvalue) Table 1 shows the comparision of minimum and maximum stature of an individual with arch and chord of teeth between males and females. Males were taller and had higher mean arch and chord values. Males had significantly greater maximum head length (P<0.05), maximum head breadth (P>0.05), head circumference (P<0.001), and stature (P<0.001) when compared to the females. Table 2 shows comparision of Regression Analysis of Arch versus Height and Chord versus Height in Gender

Table 1. Correlation Analysis between Stature and Arch, Chord

Measurements	Males		Females	
	Correlation Coefficient (R)	P Value	Correlation Coefficient (R)	P Value
Minimum Stature Vs Arch	0.914	0.000 S	0.925	0.000 S
Minimum Stature Vs CHORD	0.255	0.021 S	0.344	0.000 S
Maximum Stature Vs Arch	0.315	0.004 S	0.346	0.000 S
Maximum Stature Vs CHORD	0.907	0.000 S	0.943	0.000 S

Table 2. Regression Analysis of Arch Vs Height and Chord Vs Height in Gender

Gender	Measurements	Regression Equation	Correlation	P Value
Male	Arch Vs Height	Arch = 35.0 - 0.0827 Height	-0.447	0.000 S
	Chord Vs Height	Chord = 1.66 + 0.00113 Height	0.100	0.369 NS
Female	Arch Vs Height	Arch = 25.2 - 0.0200 Height	-0.098	0.151 Ns
	Chord Vs Height	Chord = 1.63 + 0.00136 Height	0.098	0.150 NS

Table 3. Mean comparison of Head Circumference (mm), Head Length (mm) and Head Breadth (mm) in Male and Female groups

Characteristics	MALE	FEMALE	DIFFERENCE	T VALUE	P VALUE
	MEAN±SD	MEAN±SD	MEAN±SD		
Head circumference (mm)	56.35±2.27	55.25±2.14	1.10±0.13	3.926	0.000 S
Head length (mm)	20.30±1.00	19.97±1.03	0.33±0.03	2.489	0.013 S
Head breadth (mm)	17.33±0.99	17.16±1.07	0.17±0.08	1.200	0.231 NS

Table 4. Height Estimation of Males by using H.C, HL and HB

Measurements in males group	Regression equation	R^2	P value
Height vs h.c	HEIGHT = 119 + 0.865 H.C	3.80%	0.079 NS
Height vs hl	HEIGHT = 87.8 + 3.94 H.L	15.30%	0.000 S
Height vs hb	HEIGHT = 113 + 3.15 H.B	9.70%	0.005 S
Height vs hc, h.l, h.b	HEIGHT = 29.1 - 0.086 H.C + 4.18 H.L + 3.39 H.B	26.30%	0.000 S

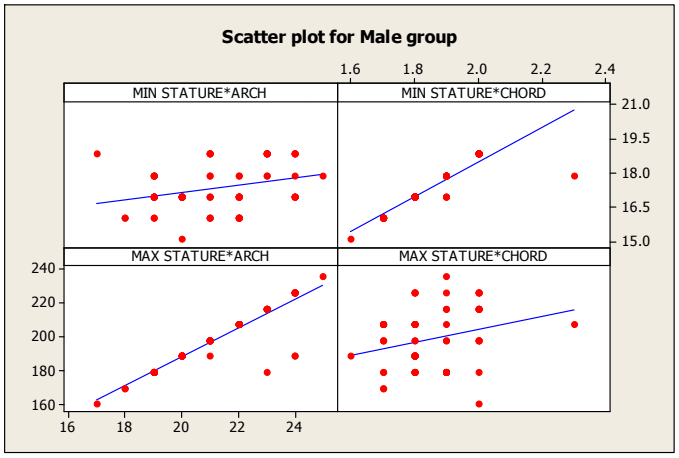
Table 5. Height Estimation of females by using H.C, HL and HB

Measurements in female group	Regression equation	R^2	P value
HEIGHT VS H.C	HEIGHT = 107 + 0.951 H.C	6.00%	0.000 S
HEIGHT VS HL	HEIGHT = 133 + 1.34 H.L	2.80%	0.014 S
HEIGHT VS HB	HEIGHT = 131 + 1.62 H.B	4.30%	0.002 S
HEIGHT VS HC, H.L, H.B	HEIGHT = 78.4 + 0.491 H.C + 1.30 H.L + 1.62 H.B	10.10%	0.000 S

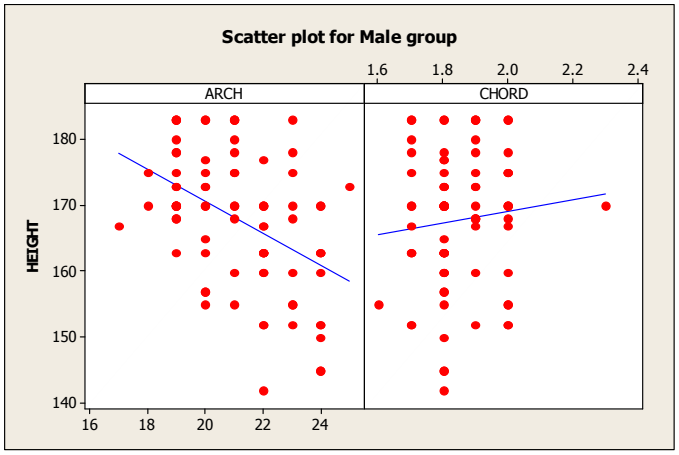
Table 6. Regression Analysis for comparision of stature with head dimensions and arch and chord in males and females

Measurements in	REGRESSION EQUATION	R^2	S.E	P value
Male group	HEIGHT = 29.1 - 0.086 H.C + 4.18 H.L + 3.39 H.B	26.30%	8.798	0.000 S
Female group	HEIGHT = 78.4 + 0.491 H.C + 1.30 H.L + 1.62 H.B	10.10%	7.938	0.000 S
Male group	HEIGHT = 188 - 2.75 ARCH + 20.7 CHORD	25.10%	8.812	0.000 S
Female group	HEIGHT = 155 - 0.701 ARCH + 10.4 CHORD	2.80%	8.235	0.001 S

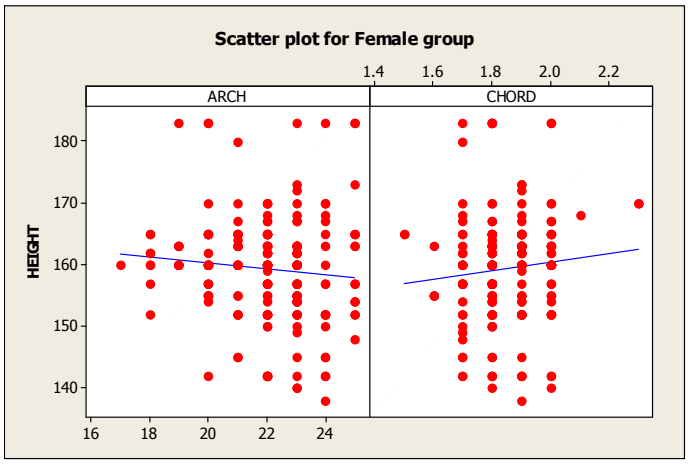
Table 3 shows Mean comparison of Head Circumference (mm), Head Length (mm) and Head Breadth (mm) in Male and Female groups. Table 4 shows Regression equation analysis of head dimensions to height in males where except head circumference all are significant. Table 5 shows Regression equation analysis of head dimensions to height in females where all the dimensions are significant (P<0.05). Table 6 shows Regression equation analysis of arch, chord & head dimensions to height in males females where all the dimensions are highly significant (P<0.05).



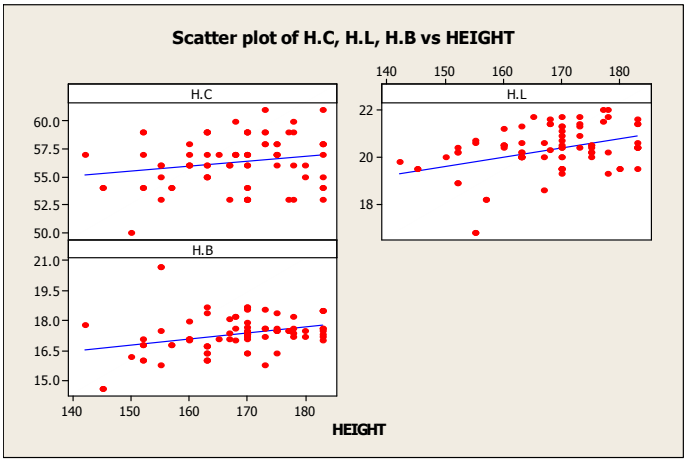
Scatter plot 1 of male group- min and max stature - arch and chord



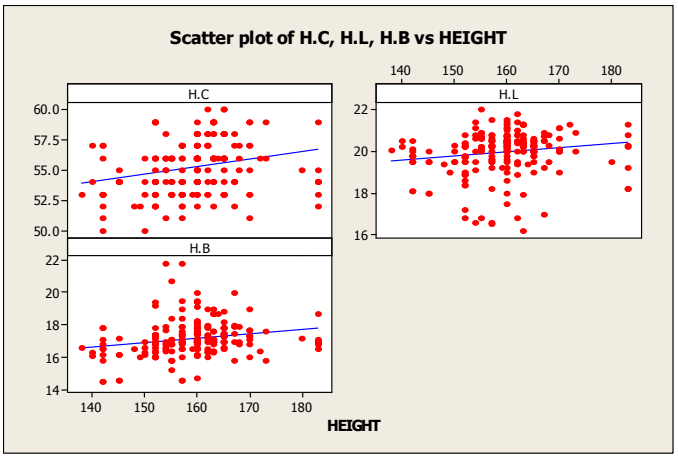
Scatter plot 2 of male group- min and max height-chord



Scatter plot 3 of female group- min and max height-arch and chord



Scatter plot 4 of H.C, H.L.H.B VS HEIGHT



Scatter plot 5 of H.C, H.L.H.B VS HEIGHT

DISCUSSION

There exists biological relationship between bones and body parts and is verymuch useful in determining the height from long bones (Krishan, 2008; Boldsen, 1984). However, this cannot be said to be true in case of teeth where no defined relation between the lengths of teeth exists in relation to body parts and the development of teeth is not directly related to the development of other body parts. Still, teeth could be used as a reliable source for stature estimation especially in those forensic cases where other body parts are not available for forensic examination (Lima *et al*., 2008). The type of the head and face depend on many factors, such as racial and ethnical affiliation, genetic influence, traditions, nutrition, environment and climate. The cephalofacial dimensions are different for different people (Rexhepi and Meka, 2008). Cavalcanti *et al* had used two methods of measuring cast dental elements for estimating height through the Carrea´s index. 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%) (Cavalcanti, 2007), which is in accordance with the presnt study where it utilized modified method. In comparison with a study conducted by Lima *et al* in subjects in the age group of 18 to 30 years, (Lima *et al*., 2008; Rayapureddy Sruthi *et al*., 2016), & observed higher success rates for right side. This is in same in case of present study where as these are contradictory to cavalcanti finding where left side was significant (Cavalcanti

et al., 2007). This finding could be attributed to factors such as plasticity of teeth, eruption sequences of teeth, dentition differences due to differences caused by favouring one side of the mouth. Positive correlation between stature and posterior tooth length in both males and females (Smitha Reddy *et al*., 2017). In the present study, it was discovered that the male subjects had significantly greater stature and cephalic dimensions when compared to the females (asha 2011, kumar 2011). (Kumar and Gopichand, 2013; Asha and Lakshmi, 2011) The findings of the study show that the two cephalic measurements femalemales) are significantly correlated with stature except head breadth. It was not in according to Krishan (2008a), ukohau (Krishan, 2008; Ukoha *et al*., 2015). Cephalo-facial measurements namely, maximum head length, maximum head breadth, bizygomatic breadth, morphological facial length, physiognomic facial length, total cephalo facial height and biocular breadth shows weak and statistically insignificant relation with stature as p-value>0 in the study conducted by shah which is contradiction to present study where all are signification except head breadth (Twisha Shah *et al*., 2015). From the present study through regression equation analysis overall arch, cord, head dimensions to height of individual are highly significant in males and females.

Conclusion

Estimation of stature of an individual from the decomposed body parts plays a conspicuous role in facilitating personal identification in incident of murder, accidents or natural disasters. When only skeletal remains are available with intact teeth, the results of regression analysis indicate that the head height, horizontal circumference of head width Carrea's index modified, can successfully and significantly predict the estimation of body height. Further studies need to be conducted for comparitive reliability between carrea's and cephalic dimensions in the estimation of stature.

Limitations of study

Study did not include the tooth dimensions for crowding and teeth with diastema.

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