



Correlation of Stature with Incisoapical Length of Anterior Teeth Using Cone-Beam Computed Tomography (CBCT)

Aditi Shinde¹ Mamatha GS Reddy¹ Rohan Gawali²

¹Department of Oral Pathology and Microbiology, Dr. D.Y. Patil Vidyapeeth's, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune, Maharashtra, India

²Department of Forensic Odontology, Maulana Azad Institute of Dental Sciences, MAMC Complex, B. S. Zafar Marg, New Delhi, India

Address for correspondence Mamatha GS Reddy, MDS, PhD, Department of Oral Pathology and Microbiology, Dr. D.Y. Patil Vidyapeeth's, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune 411018, Maharashtra, India (e-mail: drmamatha78@gmail.com).

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Abstract

Background Estimating stature is essential for the purpose of identifying human remains after death. It is common for the extremities or the head to be amputated from the trunk when the body has been severely disfigured. Odontometry's association with stature determination in forensic odontology required an estimate to be established.

Objective The objective of this study was to investigate and correlate stature (height) of the individual with the incisoapical length of the tooth

Material and Method The study was conducted on 106 participants, in which 53 were female and 53 male cases aged between 21 and 45 years. The study parameters included incisoapical length of maxillary and mandibular central incisor, lateral incisor and canine of both sides measured using cone-beam computed tomography, and height of an individual recorded using stadiometer. Pearson's correlation coefficient was calculated to study the correlation.

Results It is observed that the cervicoapical measurement of teeth does not show statistically significant correlation with the stature of the individual with the exception for tooth 22 ($r = -0.31, p = 0.02$), 41 ($r = -0.28, p = 0.04$), and 42 ($r = -0.30, p = 0.02$) among females and tooth 31 ($r = -0.35, p = 0.009$) among males.

Conclusion A very small number of research on an individual's stature in relation to incisoapical length has been identified in the literature. The majority of an individual's anterior teeth's height was not significantly correlated with height.

Keywords

- ▶ height
- ▶ incisoapical length
- ▶ maxillary and mandibular anterior teeth

Introduction

Age, sex, stature, and ethnicity are the "big four" key characteristics that define a person's identity.¹ Stature is an individual's height in upright position.^{2,3} It is one of the most significant aspects of a person's biological profile. For the purpose of identifying human remains after death, estimation of stature is crucial.^{4,5} Frequently, only the skull

or just the facial remains are brought for identification and medical-legal examination. Estimating stature is a first step in the identification of unidentified human remains.

Extremely deteriorated, disfigured bodies, and fragmented remains present a great challenge in the process of forensic identification.^{4,6,7} Many disasters and mishaps leave bodies that are difficult to identify, such as terrorist attacks, animal attacks in remote forests, war, and aeroplane

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accidents.^{1,4,8} An essential component of the forensic and medical examination is measuring one's height. Every part of the body has a roughly consistent relationship with height, and each one is crucial for identifying individuals and speeding up the screening procedure. Many anthropologists and researchers have focused their research on determining the distinct relationship of one part of the human body with the other.⁷ Each part of the human body, including the head, face, trunk, and limbs, has a proportionate biological relationship with the stature.⁹ This is very significant in forensic examination of fragmented and dismembered remains.

The most prevalent method of estimating stature when identifying someone based on skeletal remains comes from long bones.^{2,3,10} Teeth are a great source of information for forensic, odontologic, genetic, and anthropological studies.¹⁰ Long bones and even sections of long bones have been utilized by forensic anthropologists to estimate stature.⁹

Dental morphometrics is a quantitative analysis that includes the size and shape of the teeth into a concept.⁸ In forensic odontology, the estimation of physical profile using dental morphometry has attracted a lot of attention. Several studies have been made in the past to estimate stature using permanent tooth morphometry. Length of tooth and crown, mesiodistal and labiolingual diameter of tooth were the criteria employed, and association with height measures had previously been attempted.

It has been noted that not all human bones are typically removed during forensic and archaeological excavation, and torsos are frequently found in mutilated condition.^{4,9} When only the skull is available, one component of human identity that has not got much attention from researchers is the calculation of stature using the size of the teeth. No individual has the same tooth characteristics and moreover the teeth are resistant to peri- and postmortem changes.¹

There are different form of human teeth in which the deciduous teeth are 20 and permanent teeth are 32. The size and shape of each person's teeth vary.^{7,8,11} Teeth size and shape are influenced by face structure, the size of the maxillary and mandibular arches, and the expression of a person's genes. It may vary from person to person based on their skeletal development.¹¹

Teeth are the most stable structures of human body. Thus, teeth are suitable to estimate an individual's stature during life, especially when the routine indicators of stature are not available. Teeth are able to last high temperature without significant damage.^{5,8} Due to these qualities, teeth are an important tool in forensic science. Among all the teeth, canines are least frequently extracted teeth and have been recovered routinely from assemblage of human skeletal remains.

It is a known fact that every human subpopulation shows variation in terms of their skeletal development by virtue of difference in the diet, gene pool, and exposure to environmental factors. Due to these reasons, various age estimation techniques, which rely on tooth development, consider population-specific formulae for age estimation. On similar lines, stature estimates too need to consider the population variations. Considering this, the current study was aimed to

investigate the correlation between stature (height) of an individual and incisoapical length of anterior teeth of the dentition among the western Indian population of Maharashtra using cone-beam computed tomography (CBCT).

Materials and Method

The study comprised of 106 participants. The inclusion criteria are as follows: individuals aged between 21 and 45 years; individuals with normal alignment of periodontally healthy and noncarious anterior teeth; individuals with fully erupted anterior teeth, while exclusion criteria are individuals with missing teeth; any kind of wearing of teeth, individuals with congenital anomalies of bone, teeth, and soft tissue including cleft lip and cleft palate; individuals giving history or showing clinical evidence of trauma to teeth, chipping of teeth and any dental treatment in the anterior teeth; individuals with a history of endocrinal or metabolic disorders.

The study was explained in detail to the participants and informed written consent was obtained. Only the demographic information such as the age and gender of each participant were recorded. Identity of the participants was not revealed at any stage of the study. The study parameters included incisoapical length of 12 maxillary and mandibular anterior teeth, namely, central incisor, lateral incisor, and canine of both sides measured using CBCT and height of an individual recorded using stadiometer. i-CAT vision software was used for recording tooth measurements. The stature of each study subject was recorded as the distance between the floor and highest point on head (vertex) using a stadiometer. The data was recorded in the excel sheet. It was statistically analyzed by computing the Pearson's correlation coefficient (r) between the incisoapical length and the height of the participant using SPSS (version 21). Level of significance was fixed at 95%.

Result

The study comprised 106 individuals in which 53 were males and 53 were females. The tooth measurements of the study group of both males and females ranged from 16 to 27 mm. Height of male and female participants ranged from 166 to 179 cm and 153 to 165 cm, respectively. From the data, it is observed that the cervicoapical measurement of teeth does not show statistically significant correlation with the stature of the individual with the exception for tooth 22 ($r = -0.31, p = 0.02$), 41 ($r = -0.28, p = 0.04$) and 42 ($r = -0.30, p = 0.02$) among females and tooth 31 ($r = -0.35, p = 0.009$) among males. The association seen is weak negative correlation.

► **Tables 1 and 2** show the measurements observed for the 12 anterior teeth among males and females of both arches.

Discussion

Stature estimation is critical for postmortem identification of human remains. There are various odontogenic parameters studied in literature for the stature estimation. Very limited studies are in literature correlating incisoapical

Table 1 Maxillary tooth measurements and its correlation with stature among males and females

Tooth no (FDI)	Tooth measurements in mm						Stature in cm
	11	21	12	22	13	23	
Male	16–23	17–22	15–24	15–24	17–27	19–27	166–179
Female	16–22	16–22	15–21	15–23	17–27	19–27	153–165
Pearson's correlation (<i>p</i> -value) between tooth measurements and stature in males	-0.052 (0.71)	-0.076 (0.59)	-0.12 (0.40)	-0.02 (0.86)	-0.15 (0.26)	-0.07 (0.63)	
Pearson's correlation (<i>p</i> -value) between tooth measurements and stature in females	-0.22 (0.11)	-0.17 (0.21)	-0.23 (0.09)	-0.31 (0.02) ^a	-0.19 (0.17)	-0.10 (0.47)	

Abbreviation: FDI, Fédération Dentaire Internationale.

^aStatistically significant.

length with stature. Kalia et al² studied odontometry and skull anthropometry for stature estimation. Mesiodistal width of six maxillary anterior teeth, circumference of the skull, and height in males and females were the parameters recorded for the study and were found to be statistically significant. Sexual dimorphism was statistically significant, with regressive correlation noted in males for height of a person to mesiodistal width of anterior teeth. Gupta et al¹⁰ studied odontometry and skull anthropometry to assess their relation with the stature and gender in the age group of 15 to 25 using mesiodistal width of six maxillary anterior teeth, circumference of the skull, and height in males and females and concluded that the parameters they used chose had a statistically significant correlation with the stature. They also showed that the permanent mandibular left canine was statistically significant indicator of sex. Hinduja et al⁶ studied odontometry and skull anthropometry for stature estimation. Parameters recorded were width of six maxillary anterior teeth, circumference of the skull, and height in males and females. The researchers found a statically significant correlation when height and combined mesiodistal width of the maxillary anterior teeth were plotted against each other. Head circumference also showed a positive correlation with the height. Thus, both odontometric and anthropometric parameters combined showed higher correlation. Yadav et al⁹ studied anthropometric correlation of tooth dimensions with stature in the age group of 21 to 45 years. They utilized mesiodistal width of maxillary anterior teeth and found that the mesiodistal width of canine can aid in stature estimation when only teeth are available for

identification. Hossain et al⁷ studied estimation of stature using tooth crown dimension of maxillary anterior teeth and findings suggested weak positive correlation between stature and tooth crown dimensions. They concluded that estimation of stature from the tooth crown dimensions cannot provide accurate stature estimate as per forensic requirements. Gondivkar et al⁴ studied relation between head circumference and combined mesiodistal width of six permanent maxillary anterior teeth with an individual's height and found statistically significant correlation between the study parameters. Nalawade et al¹² studied correlation of dental and facial proportions like lower facial height, interincisal width, intercanine (IC), and inter commissural width with height of an individual and found significant correlation. Khangura et al³ assessed the suitability of four dental parameters to estimate stature. The parameters were IC width, interpremolar (IP) width, length of dental arch from canine to canine (AL), and mesiodistal dimension of six permanent maxillary anterior teeth (CW). They reported statistically significant correlation between height and IC and IP. The correlation between height and AL and CW was not significant. Similar study conducted by Jani et al⁸ reported significant correlation between height and maxillary IC width and nonsignificant correlation between height and other parameters including IP width. Shaikh and Perugu⁵ studied odontometric approach for stature estimation in which IC and IP were measured along with height of an individual. They found IC and IP have a positive correlation with stature and it can be used successfully to estimate stature of the individual. Rao et al¹³ studied the relationship

Table 2 Mandibular tooth measurements and its correlation with stature among males and females

Tooth no (FDI)	Tooth measurements in mm						Stature in cm
	31	41	32	42	33	43	
Male	15–22	17–22	16–22	16–25	17–26	17–26	166–179
Female	15–22	14–22	13–21	15–25	17–25	17–25	153–165
Pearson's correlation (<i>p</i> -value) between tooth measurements and stature in males	-0.35 (0.009) ^a	-0.27 (0.04)	-0.11 (0.40)	-0.12 (0.35)	-0.24 (0.07)	-0.19 (0.17)	
Pearson's correlation (<i>p</i> -value) between tooth measurements and stature in females	-0.19 (0.16)	-0.28 (0.04) ^a	-0.05 (0.69)	-0.30 (0.02) ^a	-0.17 (0.21)	-0.2 (0.10)	

Abbreviation: FDI,—.

^aStatistically significant.

of IC, IP, AL, CW with the height. They concluded that only AL showed correlation with the individual's height. Study of estimation of stature from odontometric measurements of females in the age group of 18 and 20 years by Soorya et al¹¹ reported no correlation of maxillary IC distance with stature, but the mandibular IC distance showed moderate correlation to the stature on the other hand. Ramya et al¹⁴ study results showed mesiodistal width of anterior teeth, IC, IP, and maxillary AL had a significant correlation with stature. A study by Gopinath et al¹⁵ found positive correlation between stature and crown length of permanent maxillary left central incisor. Sunitha et al¹⁶ studied correlation between face length, palm length, foot length, and stature with tooth length between 18 and 25 age group and found weak to no correlation among these parameters. Jani et al¹⁷ studied the relation between height and clinical crown length of permanent maxillary anterior teeth and found weak correlation between them. Nandita et al¹⁸ studied Carrea's Index that is a reliable tool for stature estimation. After comparison of Carrea's index on right and left side of females, the stature estimation was accurate when an average of right and left side was considered. The accuracy of stature estimation was 55.8% in females and 37.5% in males. Salkar et al¹⁹ studied stature estimation using parameters such as bicondylar distance (BCD), bigonial distance (BGD), condylogonial distance, and gonion gnathion distance observed on a postero-anterior cephalogram. They found significant correlation between stature and BCD and BGD.

Narayanan et al²⁰ studied the determination of stature using tooth length. After examining all teeth on a digital orthopantomogram (OPG), with the exception of the third molars, the study concluded that stature and specific tooth characteristics are well correlated. Shalakizadeh et al²¹ studied the relationship between body height and length of the canine in terms of jaw and gender using the CBCT technique in the patients. In both genders, the maxillary canines were longer than the mandibular canines, according to the results. The height of the female subjects and the maxillary canine length were correlated. Mathew et al²² studied estimation of stature with the help of tooth length using CBCT. When height and length of four canines were measured using CBCT and concluded that tooth length measuring using CBCT has a very good correlation with the height of the individual, as it is closer to actual length.

In this study, CBCT was used for the measurement of odontometric parameter, that is, incisoapical length and significant correlation was seen in females with maxillary left lateral incisor (0.31472), mandibular right central incisor (0.2821), mandibular right canine and height of an individual (0.30881). In males, significant correlation is seen between height of an individual with mandibular left central incisor (-0.35234). One study in the literature found to be comparable with this study for correlation of stature as odontometric parameter used was same but digital OPG was used. The highest correlation with stature was seen with the length of the maxillary right molars followed by maxillary right premolars and maxillary right canine.²⁰ Due to limited data availability, the variations with the correlation could not be

explained. But this data could give some background that incisoapical length is one of the odontogenic parameters that could be used in stature estimation.

Conclusion

Estimation of stature using odontometrics and skull anthropometry is studied extensively using the parameters like incisal width, tooth crown dimensions, IC distance, IP width, and lower facial height and arch length. Very limited studies have been found on literature search in the area of stature of an individual with respect to incisoapical length. Most of the anterior teeth height were not significant with the height of an individual.

Limitations of the Study

Less number of participants included in the study and manual error can be possible while taking measurements.

Ethical Approval

The study commenced after approval of the institutional ethics committee (Ref no: DYPDCH/IEC/161/170/20).

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None.

Conflict of Interest

None declared.

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