Original Article

Age Estimation using Cephalometrics—A Cross-Sectional Study among Teenagers of Salem District, Tamil Nadu

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ABSTRACT

Background: Age estimation is important not only in identifying dead body of a person but also in living persons since there is an increasing rate of juvenile delinquencies recorded every year. To avoid foul play by age fabrication, legal age estimation becomes important. Facial growth alteration takes place in the jawbones as age advances which can be observed with lateral cephalometry. Thus, the aim of the study is to create a regression formula for age estimation using cephalometrics of teenagers in Salem population. **Materials and Methods:** A cross-sectional study was done using 770 lateral cephalometrics of teenagers (13–19 yrs) in Salem population. Nine cephalometric points with two linear hard tissue measurements (condylion to mandibular plane (AFH) and palatal plane to menton (PFH)) and one angular soft tissue measurement (z angle) were recorded as predictor variables using a digital lateral cephalometric software (Carestream CS8100 SC) which were subjected to regression analysis using SPSS version 21.0 to develop a formula for age estimation. **Results:** Significant association on age was obtained for the two linear measurements. The regression formula generated for estimating the age was Age = 7.146 + 0.044 (AFH) + 0.146 (PFH) with R2 value = 0.674 **Conclusion:** Within the limitations of the present study, age estimation of teenagers in Salem population can be estimated. The predictability of the age can be increased by taking more cephalometric variables in generating the formula with increase in sample size.

KEYWORDS: *Age estimation, Cephalometrics, Forensic*

INTRODUCTION

Forensic anthropology is all about identifying an individual—be it dead or alive. The dentist has the responsibility to escalate the field of forensic odontology, which is very much concerned about teeth and its associated structures which are playing an inevitable role in identifying the major physical features of an individual.

The basic approach for identification is to determine a visual profile for the individual primarily by accurate estimation of the physical properties that are unique to the individual.[1-3] In this regard, sex determination, age estimation, stature, and ancestry are of great importance, which are regarded as the four major features in forensic anthropology.

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Among the four major features in forensic anthropology, the estimation of age is second only important to sex determination in the dead individuals. Whereas when it comes to living, individuals estimation of age becomes primarily important in medicolegal crimes, young asylum seekers in determining the legal age of subjects and refugees who do not have a valid identity document.[4-6]

In the recent past, we are facing an alarming increase in the rate of juvenile delinquencies that are recorded every year and would have definitely suspected a foul play by age fabrication to show the suspects under the age of 18 in case of male or 16 in case of female to bring them under the juvenile law where the punishments are much less. So, in these cases the legal age of the suspects has to be estimated. Based on the previous literatures and studies, it was concluded that there is a marked age-related change that occurs in the dentofacial structures during the early and middle teenage which is commonly called as the facial growth.[7]

The methods that are available to record changes are

- Cephalometric radiographs are an asset of being more explicit when correlated to morphologic methods.
- Lateral cephalogram is exemplary for the analysis of skull as it provides information of a variety of anatomical points in a single radiograph, and also, it supplies the details of morphological architectures and intracranial niceties for evaluation.[8,9]

In spite of various methods like odontometrics, lip prints, rugae pattern available for sex and age identification, radiographic methods are of great help when it comes to deriving formula for age and sex determination as retrospective data availability and precision of measurements with softwares used in it make it more easy and accurate in doing the same. Hence, the aim of the study is to evaluate the correlation between various lateral cephalometric parameters and chronological age of teenagers in Salem population and derive regression equations of age estimation from the various parameters.

Materials and Methods

A cross-sectional study was conducted using lateral cephalometric radiographs of 770 teenagers within the age group of 13–19 years in Salem population. The sample size is calculated based on the prevalence formula for population sample for the designated age group. It was 680 derived from the formula taking 10% into attrition, and it was calculated as 770 as total sample.

Exclusion criteria

- Congenital anomalies and developmental disorders of teeth or jaw.
- Cephalometry that showed missing teeth, syndromes, cleft lip or palate, or other craniofacial pathology.
- Orthodontic treatment.

Inclusion criteria

- Teenagers aged between 13 and 19 years
- Healthy individuals with no systemic disease

All the lateral cephalometric radiographs were traced and analyzed digitally by using Carestream CS 8100 SC software.

ANB stands for angle formed by Point A, Nasion and point B angle was estimated and was divided into the following groups based on the ANB value

- Class I – 0 –5
- Class II - >5
- Class III - <0

A total of nine cephalometric points [Figure 1] were traced which included

- Condylion (Co)
- Menton (Me) / Gonion (Go) } Mandibular plane
- Orbitale (Or) / Porion (Po) } Frankfort horizontal plane
- Anterior nasal spine (ANS)
- Posterior nasal spine (PNS) Palatal plane
- Soft tissue pogonion (Pog') / Labialis superior } Ls-Pog' plane

Using the above cephalometric points

- Two linear hard tissue measurements
- Anterior facial height (palatal plane to menton)
- Posterior facial height/mandibular ramus height (condylion to mandibular plane)
- 1 angular soft tissue measurement
- Z angle (FHP, Ls-Pog' plane)

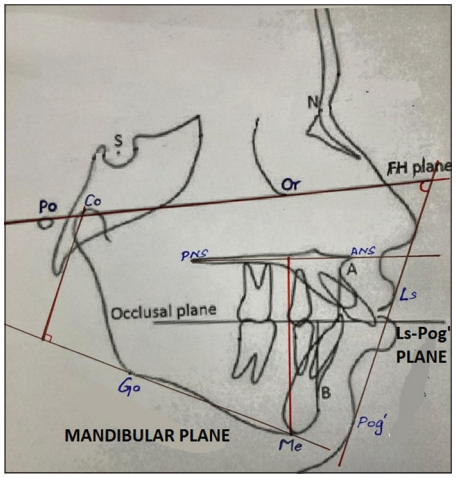


Figure 1: Parameters used in the study

Therefore, three predictor variables were taken for the age estimation.

Statistical analysis

Normality of distribution of anthropometric measurements was assessed with Kolmogorov–Smirnov normality test. Pairwise relations between age and anthropometric measurements were examined with Pearson's correlation coefficient. In order to obtain gender and non-gender-specific formula for estimating age, linear regression analysis was performed.

Results

The study comprised of 770 participants in Salem population. Among those participants, 320 were males and 450 were females within the age group of 13–19 years.

Table 1 describes the mean difference of cephalometric measurements between the gender in the whole sample. The mean difference for the two linear hard tissue cephalometric measurements such as anterior facial height and posterior facial height was significantly greater in males than females for the whole sample. There was a significant difference between the two linear hard tissue measurements such as anterior facial height and posterior facial height among male and female. The mean difference for one angular soft tissue measurement (z angle) was significantly greater for females than males and had a significant difference among male and female in the whole sample.

Table 2 represents the mean difference between genders in angles class I sample. The mean difference for the two linear hard tissue cephalometric measurements such as anterior facial height and posterior facial height was significantly greater in males than females for angles class I sample. There was a significant difference between anterior facial height measurement among males and females in angles class I sample. Significant difference was not observed when comparison was done between posterior facial height and gender in angles class I population. The mean difference for one angular soft tissue measurement (z angle) was significantly greater for females than males and had a significant difference among males and females in angles class I sample.

Table 3 shows the correlation between the age and the anthropometric measurements in the whole sample. Statistically significant correlation with age was observed for the two linear measurements and one angular measurement when evaluated for the whole sample.

Table 1: Mean difference between sex in whole sample using Student's *t* test

Variables	Male (mean±SD)	Female (mean±SD)	*P*
AFH	57.62±4.77	55.5±4.04	0.000
PFH	37.55±3.00	36.33±2.75	0.000
Z angle	65.67±8.33	67 0.16±7.84	0.011

Table 2: Mean difference between sex in angles class I sample using Student's *t* test

Variables	Male (mean±SD)	Female (mean±SD)	*P*
AFH	59.34±6.14	56.58±4.01	0.033
PFH	38.94±3.27	37.75±2.56	0.099
Z angle	74.61±8.30	78.51±7.71	0.045

Table 3: Correlations between age and anthropometric measurements in the whole population

Variables	*r*	R^2	*P*
AFH	0.706	0.683	0.000
PFH	0.772	0.740	0.000
Z angle	0.207	0.120	0.003

Formula for entire population:

- Non-gender-specific formula
  - 6.797 + 0.045(AFH) + 0.139(PFH) + 0.009(Z ANGLE)
  - R2 = 0.49
- Gender-specific Male
  - 5.675 + 0.075(AFH) + 0.194(PFH) + 0.008(Z ANGLE)
  - R2 = 0.62
- Gender-specific Female
  - 8.953 + 0.034(AFH) + 0.125(PFH)-0.003(Z ANGLE)
  - R2 = 0.51

Formula for Angles Class I Population:

- Non-gender-specific formula
  - 8.278 + 0.118(AFH) + 0.053(PFH)-0.025(Z ANGLE)
  - R2 = 0.55
- Gender-specific Male
  - 5.147 + 0.191(AFH)-0.018(PFH) + 0.007(Z ANGLE)
  - R2 = 0.51
- Gender-specific Female
  - 9.917 + 0.042(AFH) +.071(PFH)-0.060(Z ANGLE)
  - R2 = 0.68

The predictor variables for angles class II and III cases were not significant enough in formula generation for age estimation.

Discussion

The identification of chronological age of an individual is important for the medicolegal purposes.[10] The procedure for the estimation of age involves investigation of various remnant bony structures of the body, but the bony structures present near the maxillofacial area withstand the most environmental changes.[11] Among several maturational indicators, bones form a reliable source of information regarding growth and growth changes. Considerable attention has been paid to facial growth because it has been reported that facial bone enlarges the most during adolescence.[12]

The radiograph can be used as a tool for visualization of the facial bones. This study used cephalometric radiograph for the estimation of age. The facial bone and soft tissue landmarks on the cephalometric radiograph can be used for the measurement of various parameters. A total of nine points were traced including condylion (Co), menton (Mo), gonion, orbitale (Go), porion (Po), anterior nasal spine (ANS), posterior nasal spine (PNS), soft tissue pogonion (Pog'), and labialis superior (Ls). In this study, we evaluated two linear hard tissue measurements such as anterior facial height (palatal plane to menton) and posterior facial height (condylion to mandibular plane) and one angular soft tissue measurement, z angle (FHP, Ls-Pog' plane) for age estimation.

The age estimation by using lateral cephalogram is in support by the Jangam DK *et al*. in the article titled "Age Determination Using Lateral Cephalogram and Orthopantomography: A Comparative Study" where the author concluded that usage of lateral cephalometry is much reliable compared to OPG in age estimation.[13]

Among the three predictor variables in the present study, the PFH or the mandibular ramus height has the highest reliability of $R^2 = 0.74$ which is very close to the result obtained by Pelin *et al.*[14] ($R^2 = 0.713$) but is contrary to the study conducted by Mohitte *et al*.[11]

The soft tissue parameter (z angle) shows the least reliability among the predictor variables which could be attributed to the various influence of external factors on the soft tissue development in different individuals.

Conclusion

- No single formula for age estimation could be arrived for all age groups.
- Linear and angular parameters used in the study, when combined together, might prove to be of importance in estimating the age in teenagers.
- The predictability of the age can be increased by taking more cephalometric variables in generating the formula with increase in sample size.

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Conflicts of interest

There are no conflicts of interest.

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