ORIGINAL ARTICLE

Evaluation of skeletal and dental age using third molar calcification, condylar height and length of the mandibular body

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Abstract

Aim: To identify the most reliable method for age estimation among three variables, that is, condylar height, length of mandibular body and third molar calcification by Demirjian's method. **Materials and Methods:** Orthopantomograms and lateral cephalograms of 60 patients with equal gender ratio were included in the study, among each gender 15 subjects were below 18 years and 15 subjects were above 18 years. Lateral cephalograms were traced, height of condyle and mandibular body are measured manually on the tracing paper, OPG's were observed on radiographic illuminator and maturity score of third molar calcification was noted according to Demirjian's method. All the measurements were subjected to statistical analysis. **Results:** The results obtained are of no significant difference between estimated age and actual age with all three parameters ($P > 0.9780$ condylar height, $P > 0.9515$ length of mandibular body, $P > 0.8611$ third molar calcification). Among these three, length of mandibular body shows least standard error test (i.e. 0.188). **Conclusion:** Although all three parameters can be used for age estimation, length of mandibular body is more reliable followed by height of condyle and third molar calcification.

Key words: Lateral cephalograms, mandibular measurements, orthopantomograms, tooth calcification

Introduction

Age estimation is an important part in personalization, especially when information regarding the deceased is unavailable. Estimating the age narrows down the search among the missing profiles and enables a more efficient and time saving approach. Teeth are the important aids in estimation of age, as they are least affected by variation in nutritional and endocrine status, therefore teeth can be used as accurate indicators of chronological age.[1]

Dental radiography is, a non-destructive and simple technique, routinely employed in methods of age estimation.[2] Maturation stages of developing third molars can be used in estimation of chronological age of sub-adult individuals.[3] The mandibular body and ramus show marked remodeling changes during growth and are sexually dimorphic.[4]

The main aim of the study is to identify the most reliable method for age estimation among height of condyle (HOC), length of mandibular body (LMB) and third molar maturation (MTM) by Demirjian's method using simple linear regression analysis.

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Materials and Methods

The study sample consisted of 60 subjects (30 males and 30 females) who visited the Department of orthodontics in our college. Out of 30 subjects in each gender 15 were below 18 years and 15 were above 18 years.

Lateral cephalograms were used to calculate the height of mandibular condyle and the length of the mandibular body. Orthopantomograms were used to evaluate the third molar calcification.

Orthopantomograms were placed on the radiographic illuminator and tracings were done for third molar. The tracings obtained were compared with modified Demirjians comparison chart and maturity score was obtained following this the age was estimated after introducing the values in the formula derived using linear regression analysis [Figure 1].

Lateral cephalograms of 60 subjects were traced using the same view box, HOC was obtained by marking reference points at the maximum HOC and minimum point at the tubercle, a line was drawn from maximum to minimum reference points and distance between two points was measured using a ruler [Figure 2].

LMB was obtained by marking reference points on most antero-inferior part of mandible, that is, gnathion (Gn) which is the constructed point between menton and pogonion, another point is marked at the gonion (Go) that is the constructed point at the junction of ramus plane and the mandibular plane. Line drawn from Go to Gn was measured with ruler and values were noted in millimeters. The values obtained were subjected to statistical analysis. Age estimation formula was derived for each parameter by simple linear regression analysis [Table 1]. Estimated age was calculated using the derived equation and compared with chronological age which was obtained by decoding the radiographs. All the data was subjected to statistical analysis using SPSS 14.0 software (software package used for statistical analysis).

Results

The chronological age of the each subject was compared with the estimated age by three parameters (HOC, LMB and third molar calcification) of the respective subjects using a Students "t" test.

Table 2 shows the comparison of estimated age with the chronological age of the patients.

When the chronological age was compared with the estimated age using HOC, LMB and third molar calcifications, the *P* values were 0.978, 0.9515, and 0.8611, respectively.

All the values were more than 0.05, which indicates that there was no significant difference between the chronological age and the estimated age of the patients. Hence, all the three variables can be used in estimation of the age.

Table 3 shows the comparison of estimated age by condylar height, LMB and third molar calcification between males and females by Student "t" test. There was no significant difference observed in condylar height and third molar calcification with *P* values of 0.0548 and 0.5721 but little difference was observed with LMB with a *P* value of 0.0492.

Tables 4-6 show comparison of age groups and gender with estimated age calculated by length of condylar height, LMB and maturity score of third molar respectively by two-way ANOVA test.

Table 7 shows comparison of age assessed on combination of length of condylar height and LMB with chronological age, where there was no statistical significant difference.

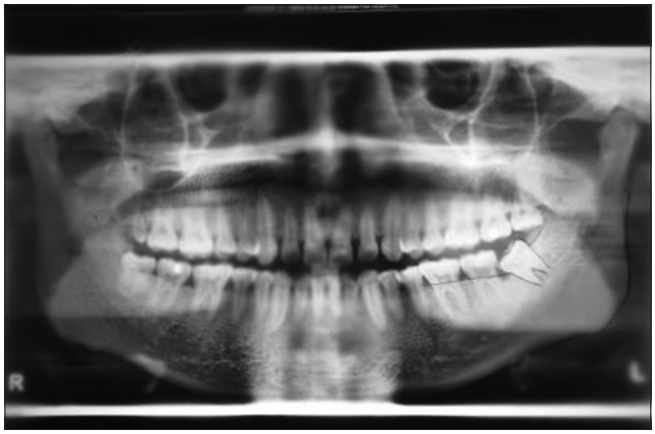


Figure 1: Third molar traced on orthopantomograph placed on an illuminator

Figure 2: Lateral cephalogram placed on a view box

Table 1: Estimation or prediction of actual age by different independent variables (i.e. length of condylar height, length of mandibular body, maturity score of third molar) by simple linear regression analysis method-total, male and female samples

Samples	Predictive Equations	R	F	*P*
Total	Actual age=3.5021+0.2107 (LCH)	0.3776	9.6427	0.0029*
	Actual age=1.2849+0.2081 (LMB)	0.3657	8.9469	0.0041*
	Actual age=–4.6469+1.6789 (MTM)	0.8084	109.43	0.00001*
Male	Actual age=–11.1984+0.4110 (LCH)	0.4419	22.1716	0.0001*
	Actual age=–3.5370+0.2614 (LMB)	0.1521	5.0238	0.0331*
	Actual age=–12.1344+2.2535 (MTM)	0.7255	73.9972	0.00001*
Female	Actual age=16.3766+0.0268 (LCH)	0.0026	0.0734	0.7884
	Actual age=2.9059+0.1923 (LMB)	0.1428	4.6662	0.0395*
	Actual age=–0.3926+1.3583 (MTM)	0.6683	56.4020	0.00001*

*$P<0.05$, HOC=Height of condyle, LMB=Length of mandibular body, MTM=Maturation of third molar

Table 2: Comparison of chronological age with estimated age by length of condylar height, length of mandibular body and third molar calcification in total samples

Variables	Mean	SD	*t*	*P*
Actual age	18.19	3.98		
Estimated age by height of condyle	18.17	1.51	0.0276	0.9780
Actual age	18.19	3.98		
Estimated age by length of mandibular body	18.16	1.46	0.0610	0.9515
Actual age	18.19	3.98		
Estimated age by third molar calcification	18.31	3.61	-0.1754	0.8611

Table 3: Comparison of estimated age by height of condyle, length of mandibular body and third molar calcification between male and females by t test

Variable	Gender	*N*	Mean	SD	*t*	*P*
Height of condyle	Male	30	18.55	1.51	1.9596	0.0548
	Female	30	17.80	1.44		
Length of mandibular body	Male	30	18.52	1.35	2.0089	0.0492*
	Female	30	17.79	1.48		
Third molar calcification	Male	30	18.58	3.65	0.5681	0.5721
	Female	30	18.04	3.62		

*$P<0.05$

Table 4: Comparison of age groups with gender with estimated age calculated by length of condylar height by two-way ANOVA

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	*F*	*P*
Main effects					
Age groups	1	18.4482	18.4482	10.4985	0.0020*
Gender	1	8.3552	8.3552	4.7548	0.0334*
2-way interaction effects					
Age groups×gender	1	9.3378	9.3378	5.3139	0.0249*
Error	56	98.4049	1.7572		
Total	59	134.5461			

*$P<0.05$, ANOVA: Analysis of variance

Table 8 and Graph 1 show the comparison of chronological age with the estimated age along with the standard deviation and standard error test to identify the most reliable method for age estimation. The standard deviation for the age estimated using LMB, was 1.45, followed by age estimated using condylar height was 1.51 while the third molar calcification was 3.6. Standard error test for the age estimated using LMB was 0.188, condylar height was 0.194 while the third molar calcification was 0.466.

These values indicate that LMB is a more reliable method parameter for estimation of age followed by condylar height and third molar calcification.

Discussion

Age estimation is a sub-discipline of the forensic sciences and should be an important part of every identification process.[1] Estimation of age is important for differentiating the juvenile from the adults in criminal law cases, social benefits, employment and marriage.[5]

Determination of chronological age in persons within the range of 15-23 years remains a problem. Skeletal indicators such as diaphysis-epiphysis fusion, hand-wrist examination, cervical vertebrae maturation, amino acid racemization, changes in pubic symphysis, fusion of cranial bones, fusion of cranial sutures or changes in the secondary sexual characters are most commonly used for age estimation in this age group.[5]

Dental radiography is a non-destructive and simple technique used in dental practice for age estimation.[2] Comparison of ante-mortem and post-mortem radiographs is one of the cornerstones of positive identification of human remains. Antemortem orthopantomograms may be of great value in the identification of human remains.[6]

Morphological changes of the mandible are thought to be influenced by the occlusal status and age of the subject.[7] Various studies have shown a decrease in ramus height, mandibular body height and mandibular body length with increase in age. Hence, measurement of these parameters in the lateral cephalogram can be successfully used in estimation of age.[7]

Table 5: Comparison of age groups with gender with estimated age calculated by length of mandibular body by two-way ANOVA

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	*F*	*P*
Main effects					
Age groups	1	13.9202	13.9202	7.7860	0.0072*
Gender	1	8.1402	8.1402	4.5530	0.0373*
2-way interaction effects					
Age groups×gender	1	2.9482	2.9482	1.6490	0.2044
Error	56	100.1200	1.7879		
Total	59	125.1285			

*$P<0.05$, ANOVA: Analysis of variance

Table 6: Comparison of age groups with gender with estimated age calculated by maturity score of third molar calcification by two-way ANOVA

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	*F*	*P*
Main effects					
Age groups	1	397.3227	397.3227	61.4215	0.00001*
Gender	1	4.2667	4.2667	0.6596	0.4201
2-way interaction effects					
Age groups×gender	1	7.0727	7.0727	1.0934	0.3002
Error	56	362.2520	6.4688		
Total	59	770.9140			

*$P<0.05$, ANOVA: Analysis of variance

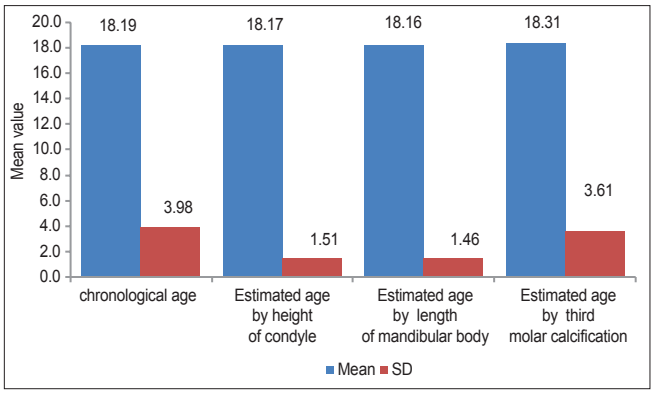
Table 7: Comparison of actual and estimated age calculated by length of condylar height and length of mandibular body in total, male and female sample by *t* test

Variable	Gender	*n*	Mean	SD	*t*	*P*
Total	Actual age	60	18.19	3.98		
	Estimated age	60	18.19	1.66	0.0000	1.0000
Male	Actual age	30	18.17	4.38		
	Estimated age	30	18.64	1.62	–0.5493	0.5849
Female	Actual age	30	18.20	3.60		
	Estimated age	30	17.73	1.61	0.6499	0.5183

SD: Standard deviation

Table 8: Standard error test to identify the most reliable method among height of condyle, length of mandibular body, third molar maturation

Variable	Statistic			Mean		Std. deviation
	n	Minimum	Maximum	Statistic	Std. error	Statistic
Height of condyle	60	15.50	21.80	18.1732	0.19495	1.51011
Length of mandibular body	60	15.20	21.60	18.1550	0.18801	1.45630
Third molar maturation	60	11.90	23.30	18.3100	0.46666	3.61474



Graph 1: Comparison of chronological age with estimated age by all three parameters

Teeth are the most useful material for age estimation and they remain unchanged for longer time because they are the most indestructible part of the body.[8] Compared to all teeth third molar is more useful in forensic dentistry because it continues to develop over a prolonged period and until a later age.[5]

In the present study, a comparison of the age estimation was done by measuring the LMB, HOC and by identifying the stage of third molar calcification. There was no statistically significant difference between the age estimated using height of the condyle, LMB and third molar calcification ($P > 0.05$) [Table 2].

Raghda *et al*.[7] estimated the age and determined the sex using three mandibular parameters, namely gonial angle, ramus height and bigonial width. They observed that the bigonial width increases with age, ramus height increases in 2nd and 3rd decade and then decreases with age.[7]

In the present study there was no statistically significant difference between males and females. But in a study conducted by Annamalai *et al*.,[6] on various measurements of mandibular ramus which aid in sex determination, they observed a significant difference between males and female subjects.[6]

Sisman *et al*.[5] found mandibular ramus height to be the best parameter in their study with 75.8% accuracy and in the present study HOC can also be used for age estimation but has less reliability than LMB and more reliability than third molar calcification.

Demirjian *et al*.[8] gave new method of age estimation by observing the radiological appearances of seven teeth on left side of the mandible and maturity score was given according to Tanner *et al*.,[8] method of skeletal maturity. Study conducted by Krailassiri *et al*.[9] in Thai individuals of age group 7-19 years showed that tooth calcification stages

from OPG can be useful as maturity indicator of pubertal growth period.[9]

Using this Demirjians system Willems *et al*.[10] studied the age estimation in Belgian children which showed over estimation of chronological age, which helps to state that there will be different rates of development in dental population.[10]

In 2004, Challiot and Demirjian modified original Demirjian's method by including third molar also.[11] Sisman *et al*.[5] conducted a study on the third molar development in relation to chronological age in Turkish children and young adults and concluded that development of third molar in Turkish people is rapid compared to other populations. Rai *et al*.[12] studied the role of development of mandibular third molar in age determination and sex identification in north Indian children and young adults, and concluded that third molar development occurs at an advanced age relative to other populations and development staging of third molar has a linear relation to age in both genders and statistical analysis shows stronger correlation for males than females.[12]

In the present study using the Demirjians Indian formula given by Acharya[13] estimated age was calculated and no significant difference observed between estimated age and chronological age. The present study has underestimated the chronological age by a mean of 0.02 years with HOC, 0.03 years by LMB and overestimated with mean of 0.12 years with third molar calcification.

Conclusion

Age estimated using calcification of third molar, condylar height, mandibular body length showed no significant difference with the chronological age of the patient. All three parameters can be used for estimating the age. However, length of mandibular body is the best parameter with least standard error.

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