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Original Article

Age Estimation using Orthopantomographs by Demirjian's Method

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Abstract

Objectives: The aim of this study was to pursue a survey on age estimation for dental patient using for orthopantomographs (OPGs). The 30 OPGs were selected by us with respect to criteria and evaluated. The results were compared to chronological ages (CAs). The accuracy of estimates synchronously made using OPGs.

Materials and Methods: This is a retrospective study, the OPGs of 30 individual children of age group 3–16 years of non CA were measured using the Demirjian's Method of age estimation on the bases of development of 7 mandibular molars on the left side using radiographs.

Results: The results indicate that the Demirjian method is most accurate method for Age estimation using OPGs and it is also most reliable method for age estimation. There is no significant difference between CA and dental age.

Conclusion: Age estimation with OPGs can be used to make a significant percentage of forecasts in areas such as forensic medicine and forensic dentistry, especially in young patients.

Key words: Age estimation, Orthopantomigraphs, Demirjian's Method

INTRODUCTION

Age estimation is a scientific process/method that estimates and individual's True chronological age (CA) by evaluating skeletal and dental development and maturation.[1] Age estimation is one of the essential factors in human identification.[2]

Age determination versus it's used in several situations in forensic odontology such as ~Identification of unknown individuals, In scenes of crime and accidents, it is probably used to estimate the CA of children of unknown birth records.[3] There are other methods available, but dental age (DA) plays an important role in the age estimation of the individual. *Other methods: skeletal maturation, physical examination using anthropometric measurement, combination of all.[3]

Tooth formation is broadly used to evaluate maturity and anticipate age, also this information aids in diagnosis and treatment planning.[4]

In archeology and forensic odontology, this method can aids the estimation of age at that of a deceased child and also give importance with regard to past population.[5] Nowadays, the radiographic method of age estimation on basis of tooth development has been found to be an accurate method, because the eruption of teeth into oral cavity is generally influenced by local factors e.g.: lack of space, systemic sectors, hands dental maturity is considered as a more accurate master of biologic maturity in children because tooth mineralization stages are much less affected by nutritional and endocrine status.[3] In this article, the study aimed to determine possibility of age estimation with the Orthopantomographs (OPGs).

The study was done retrospectively at the "Oral Medicine and Radiology, Department, Siddhpur Dental College and Hospital (SDCH), Gujarat, India."

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MATERIALS AND METHODS

In this study panoramic radiographs of 30 individual children of known CA, with ages ranging from 3 to 16 years in which 18 females and 12 males are included.

There are various methods of age estimation. *This study is based on "Radiographic methods:" it is a Simple, Non-invasive technique used in forensic odontology for living and unknown dead.

The Demirjian *et al.* Method has been the most commonly used method for DA estimation using radiographic technique as it is based on tooth developmental changes and easy to apply.

In this method, development of 7 mandibular teeth on the left side as it appears on the radiograph were divided into 10 stages for each stage; different maturity scores were given for the tooth[6,7].

Study Groups

The selected dental patients were divided into two main groups according to biological sex (Group A [Males] and Group B [Females]).

There are at least two participants per age group.

Data Collection

Dental patients and personal information related to the CA of each subject, such as the date of birth (DOB) and date of radiograph (DOR), were collected from the existing records.

The CAs of the participants were calculated by subtracting the DOB from the DOR and were recorded as years with two decimal places. All of the dental patients were scored independently and randomly by one of the authors, who was blinded to the CA and sex of each subject. The DA was calculated using Demirjian's method. All of the 7 teeth in the lower left jaw (with the exception of the third molar) were assessed. The DA was calculated according to the tables proposed by Demirjian *et al.* [Tables 1-4].[8] When a tooth on one side was missing or difficult to read, the contralateral tooth was assessed.

Reproducibility

About 20% of the dental patients were randomly selected and the tooth developmental stages were re-evaluated 2 weeks later (retest) to test the inter-examiner and intra-examiner reliability. Then, the intra- and inter-examiner agreement was calculated.

Statistical Testing

All data were collected, tabulated, and statistically analyzed. Quantitative data are presented as the range, mean, and standard deviation (SD), and qualitative data are presented as the number (*n*) and percentage (%). The statistical analyses were performed using an independent samples student *t*-test for analysis of quantitative data.

For all tests, probability (*P*) was categorized as follows:

- Non-significant if ≥0.05
- Significant if <0.05

Table 1

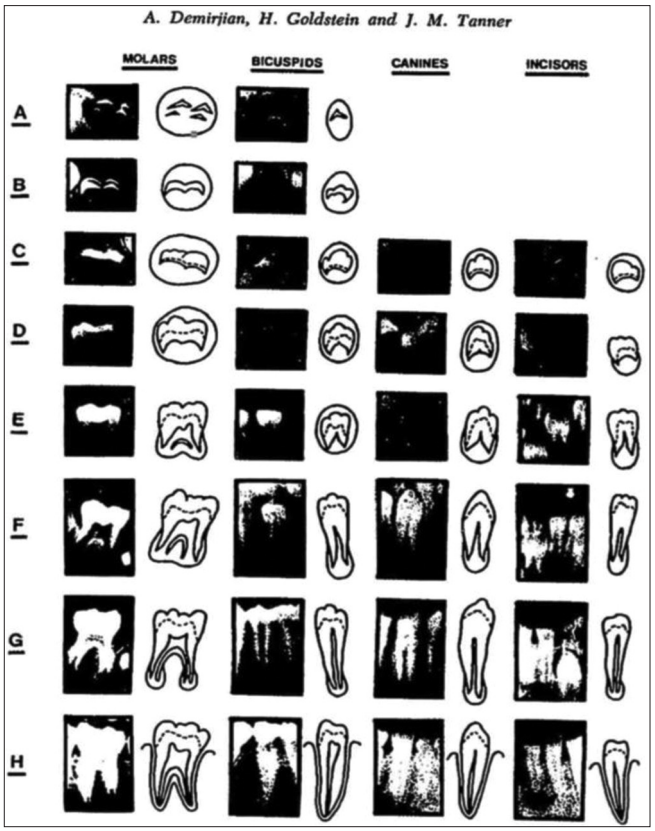

Table 2

Self-Weighted Scores for Dental Stages
7 Teeth (Mandibular Left Side)

Boys									
	Stage								
Tooth	0	A	B	C	D	E	F	G	H
M_2	0.0	2.1	3.5	5.9	10.1	12.5	13.2	13.6	15.4
M_1				0.0	8.0	9.6	12.3	17.0	19.3
PM_2	0.0	1.7	3.1	5.4	9.7	12.0	12.8	13.2	14.4
PM_1			0.0	3.4	7.0	11.0	12.3	12.7	13.5
C				0.0	3.5	7.9	10.0	11.0	11.9
I_2				0.0	3.2	5.2	7.8	11.7	13.7
I_1					0.0	1.9	4.1	8.2	11.8

Girls									
	Stage								
Tooth	0	A	B	C	D	E	F	G	H
M_2	0.0	2.7	3.9	6.9	11.1	13.5	14.2	14.5	15.6
M_1				0.0	4.5	6.2	9.0	14.0	16.2
PM_2	0.0	1.8	3.4	6.5	10.6	12.7	13.5	13.8	14.6
PM_1			0.0	3.7	7.5	11.8	13.1	13.4	14.1
C				0.0	3.8	7.3	10.3	11.6	12.4
I_2				0.0	3.2	5.6	8.0	12.2	14.2
I_1					0.0	2.4	5.1	9.3	12.9

NB: Stage 0 is no calcification

Table 3

Conversion of Maturity Score to Dental Age 7 Teeth (Mandibular Left Side)

Age	Score	Age	Score	Age	Score	Age	Score
			Girls				
3.0	13.7	7.0	51.0	11.0	94.5	15.0	99.2
.1	14.4	.1	52.9	.1	94.7	.1	99.3
.2	15.1	.2	55.5	.2	94.9	.2	99.4
.3	15.8	.3	57.8	.3	95.1	.3	99.4
.4	16.6	.4	61.0	.4	95.3	.4	99.5
.5	17.3	.5	65.0	.5	95.4	.5	99.6
.6	18.0	.6	68.0	.6	95.6	.6	99.6
.7	18.8	.7	71.8	.7	95.8	.7	99.7
.8	19.5	.8	75.0	.8	96.0	.8	99.8
.9	20.3	.9	77.0	.9	96.2	.9	99.9
4.0	21.0	8.0	78.8	12.0	96.3	16.0	100.0
.1	21.8	.1	80.2	.1	96.4		
.2	22.5	.2	81.2	.2	96.5		
.3	23.2	.3	82.2	.3	96.6		
.4	24.0	.4	83.1	.4	96.7		
.5	24.8	.5	84.0	.5	96.8		
.6	25.6	.6	84.8	.6	96.9		
.7	26.4	.7	85.3	.7	97.0		
.8	27.2	.8	86.1	.8	97.1		
.9	28.0	.9	86.7	.9	97.2		
5.0	28.9	9.0	87.2	13.0	97.3		
.1	29.7	.1	87.8	.1	97.4		
.2	30.5	.2	88.3	.2	97.5		
.3	31.3	.3	88.8	.3	97.6		
.4	32.1	.4	89.3	.4	97.7		
.5	33.0	.5	89.8	.5	97.8		
.6	34.0	.6	90.2	.6	98.0		
.7	35.0	.7	90.7	.7	98.1		
.8	36.0	.8	91.1	.8	98.2		
.9	37.0	.9	91.4	.9	98.3		
6.0	38.0	10.0	91.8	14.0	98.3		
.1	39.1	.1	92.1	.1	98.4		
.2	40.2	.2	92.3	.2	98.5		
.3	41.3	.3	92.6	.3	98.6		
.4	42.5	.4	92.9	.4	98.7		
.5	43.9	.5	93.2	.5	98.8		
.6	45.2	.6	93.5	.6	98.9		
.7	46.7	.7	93.7	.7	99.0		
.8	48.0	.8	94.0	.8	99.1		
.9	49.5	.9	94.2	.9	99.1		

Table 4

Conversion of Maturity Score to Dental Age (7 Teeth)

Age	Score	Age	Score	Age	Score	Age	Score
			Boys				
3.0	12.4	7.0	46.7	11.0	92.0	15.0	97.6
.1	12.9	.1	48.3	.1	92.2	.1	97.7
.2	13.5	.2	50.0	.2	92.5	.2	97.8
.3	14.0	.3	52.0	.3	92.7	.3	97.8
.4	14.5	.4	54.3	.4	92.9	.4	97.9
.5	15.0	.5	56.8	.5	93.1	.5	98.0
.6	15.6	.6	59.6	.6	93.3	.6	98.1
.7	16.2	.7	62.5	.7	93.5	.7	98.2
.8	17.0	.8	66.0	.8	93.7	.8	98.2
.9	17.6	.9	69.0	.9	93.9	.9	98.3
4.0	18.2	8.0	71.6	12.0	94.0	16.0	98.4
.1	18.9	.1	73.5	.1	94.2		
.2	19.7	.2	75.1	.2	94.4		
.3	20.4	.3	76.4	.3	94.5		
.4	21.0	.4	77.7	.4	94.6		
.5	21.7	.5	79.0	.5	94.8		
.6	22.4	.6	80.2	.6	95.0		
.7	23.1	.7	81.2	.7	95.1		
.8	23.8	.8	82.0	.8	95.2		
.9	24.6	.9	82.8	.9	95.4		
5.0	25.4	9.0	83.6	13.0	95.6		
.1	26.2	.1	84.3	.1	95.7		
.2	27.0	.2	85.0	.2	95.8		
.3	27.8	.3	85.6	.3	95.9		
.4	28.6	.4	86.2	.4	96.0		
.5	29.5	.5	86.7	.5	96.1		
.6	30.3	.6	87.2	.6	96.2		
.7	31.1	.7	87.7	.7	96.3		
.8	31.8	.8	88.2	.8	96.4		
.9	32.6	.9	88.6	.9	96.5		
6.0	33.6	10.0	89.0	14.0	96.6		
.1	34.7	.1	89.3	.1	96.7		
.2	35.8	.2	89.7	.2	96.8		
.3	36.9	.3	90.0	.3	96.9		
.4	38.0	.4	90.3	.4	97.0		
.5	39.2	.5	90.6	.5	97.1		
.6	40.6	.6	91.0	.6	97.2		
.7	42.0	.7	91.3	.7	97.3		
.8	43.6	.8	91.6	.8	97.4		
.9	45.1	.9	91.8	.9	97.5		

- Highly significant if <0.01
- Very highly significant if <0.001. Cohen's kappa test with a $P < 0.05$ indicating significance was used to test the inter- and intra-examiner reliability.

RESULTS

The study consisted of 18 females and 12 males. The student *t*-test is used for statistic evaluation for this study.[9] The mean CA of the sample was 10.13333 years, while the mean DA was 10.3866. The mean CA for male 10.64 ± 3.70 years and that for females was 9.75 ± 1.82 years. The mean DA for males was 10.92 ± 3.42 years and that for females was 10.03 ± 2.09 years [Table 5 and Figure 1]. Mean absolute error (MAE) in the age estimation was classified by dividing the sample into eight different age groups which ranged from 7 to 15 years. The highest MAE was in the age 12 years age group (0.46 ± 1.01),while lowest in the age group 7 years (–0.8 ± 2.1) [Table 6].

Table 5: Descriptive statistics of male and female

Variable	Males (mean)	SD (*n*=30)	Females (mean)	SD (*n*=30)	*P*-value
CA	10.64	3.70	9.75	1.82	0.05*
DA	10.92	3.42	10.03	2.09	0.02*
P-value	0.01*		0.003*		

*Indicates statistically significance at *P*=0.05, CA: Chronologic age, DA: Dental age, SD: Standard deviation

Table 6: MAE in different age groups

Age groups (year)	No of subjects	Mean	SD
7	6	–0.8	2.1
8	4	–0.2	1.09
9	4	0.3	1.14
10	2	0.4	
11	4	0.3	0.95
12	6	0.46	1.01
14	2	0.1	
15	2	–1	

MAE: Mean absolute error, SD: Standard deviation

DISCUSSION

The age estimation of age is an important aspect in medico-legal practice.[10] The estimation of age is based on the developmental stages of teeth taking into consideration associated calcification process. The original Demirjian's method excluded the Third molar due to the variability in its development, eruption, and anatomy. However, the pitfall of its exclusion was that age prediction by the original Demirjian's

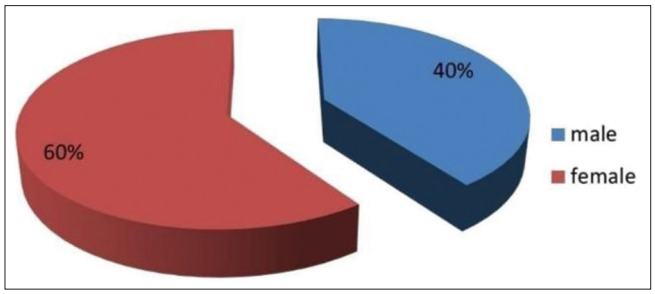

Figure 1: Graph showing gender distribution of the sample

method is not feasible after about 16 years of age, since by this age all the permanent teeth, except the third molar, would have completed their development. The tooth improvement is a continuous process, but determining the end point of tooth development is very difficult. Thus, the calculation of a mean age for each phase is difficult; further research is needed to determine the apex closure stage of teeth. Measurement using dental radiographs may be useful as a non-invasive technique for estimating the age of adults, both living and dead, in archeological studies and in forensic work, but the method should be tested on an independent sample.

DA estimation is commonly used worldwide and is thought to correlate with CA better than other maturity indicators of a child's development. Several methods have been introduced to estimate DA depending on either calcification (tooth development) or eruption patterns. Relying on eruption dates when attempting to assess DA is complicated by the fact that tooth emergence may be significantly affected by local exogenous factors, such as infection, obstruction, crowding, and premature extraction of the deciduous predecessor or adjacent permanent teeth. These mishaps can be avoided by interpreting radiographic data representing the tooth development stages.[11]

One of the most commonly used radiographic methods is the method reported by Demirjian *et al.*, which established a standard based on a large sample that included 1446 males and 1482 females of French-Canadian origin. Although observer agreement is usually reported when using Demirjian's method, there is an evident tendency toward overestimation of a subject's age, which may be a result of ethnic differences between populations 26 and a positive secular trend over the last 50 years. The debate regarding the applicability of Demirjian's method to all races and populations. Encouraged the authors to assess the applicability of Demirjian's method and to develop new prediction equations if needed.[11]

Prabhakar *et al.* tested the applicability of Demirjian's method among 151 Indian children living in Davangere. They found that the Davangere children were dentally more advanced and that Demirjian's method did not apply to their study group.[11]

Our study found that Demirjian's original standards accurately estimate the CA in our studied sample and that the exploratory data analysis generally almost similar to the CA on application of Demirjian's method. The authors strongly believe that each population requires its own adaptive dental maturity score. This concept of developing a specific prediction equation for each population is becoming more strongly supported.

CONCLUSION

Age estimation through the evaluation of OPG revealed the most reliable results for the first decade of life. Age estimation with OPGs can be used to make a significant percentage of forecasts in areas such as forensic medicine and forensic dentistry, especially in young patients. To achieve accurate and reliable age estimation, in addition to mill metric measurements of the teeth, skeletal measurements and examinations should be performed.

Demirjian's method was found most accurate method for age estimation and suitable for children living in Siddhpur, Gujarat.

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