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Dental Age Assessment Using Demirjian's Method in Patients Visiting A Dental School in Uttrakhand

Shally Raina[1*], Karnika Yadav[2], Upender Malik[3], Abhishek Kumar[4]

[1]Assistant Professor, Department of Oral Medicine and Radiology, People's Dental College and Hospital Kathmandu Nepal.

[2]Assistant Professor, Department of Public Health and Community Dentistry, People's Dental College and Hospital Kathmandu Nepal.

[3]Professor, Department of Oral Medicine and Radiology, Teerthanker Mahaveer Dental College and Research Center Moradabad, Uttar Pradesh, India.

[4]Assistant Professor, Department of Oral Medicine and Radiology, People's Dental College and Hospital Kathmandu Nepal.

Original Article

Address for Correspondence Author
Dr. Shally Raina; Department of Oral Medicine and Radiology, People's Dental college and Hospital Kathmandu Nepal.
E-mail: Shally.raina806@gmail.com
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ABSTRACT

Background: Age estimation forms one of the most important sub-disciplines of forensic sciences and is of paramount importance in medico-legal issues.

Material and Methods: The study comprised 200 subjects aged 14 to 24 years. By purposive sampling method the study subjects were divided into 10 groups starting from 14 years to 24 years with a class interval of 1 year (e.g. Group I:- 14.01- 14.99 years, Group II:- 15.01- 15.99 years…… Group X: - 23.01- 23.99 years). Each age group consisted of 20 subjects with equal distribution of 10 subjects in both genders. Chaillet and Demirjian's method with Acharya's formula was used to compare the chronological and the estimated dental age.

Results: The study showed a significant p-value ($p < 0.005$) in all the age groups in both the genders except for group v (18.01-18.99) in males and group III (16.01-16.99) and group V (18.01-18.99) in females. Also, the difference in the estimated dental age varied between + 4.18 years and – 2.02 years for males and +4.08 years and – 0.20 years in females. The results depicted an overall underestimation of the dental age by 0.60 years in males and 1.26 years in females.

Conclusion: we concluded that Chaillet and Demirjian's radiographic method with Acharya's formula can be a reliable method in the assessment of dental age in the mentioned study group consisting of the Uttarakhand population.

Keywords: Chaillet and Demirjian's Method, Acharya's Formula.

Introduction

Age estimation is an important requisite in some judicial proceedings. Circumstances where age assessment is required are; asylum seekers of unknown age, young people accused of criminal activities, and convicted

criminals whose age is claimed to be less than 18 years prior to sentencing.[1] Age assessment is, on occasions, required to assist in the identification process, especially of subjects from mass disasters.[2] The oldest known example of the identification of an individual confirmed by teeth was reported by the Roman historian Cassius Dio (c. 165–c. 235 A.D.). Agrippina the Younger, wife of Emperor Cassius and mother of future Emperor Nero, contracted for the killing of a perceived rival, Lollia Paulina.[3] Their number and individuality of shape and content may be the only way of determining identity when other features have long disappeared. The teeth that are present may have unusual characteristics of size, shape or surface contour.[4] Age estimation of an unknown person based on the examination of bodily remains can be performed either by osteological or stomatological methods. Because the teeth are frequently better preserved than other material, their use for identification of an individual's age at death is very important.[5] The most useful methods using skeletal maturity are based on radiographs of specific structures such as epiphysis-diaphysis fusion of long bones, medial extremity of the clavicle, epiphyseal head of the first rib, epiphyseal union of the anterior iliac crest and the fusion of the sphenoid bone with the basilar part of the occipital bone.[6] The use of radiographs is ideal to determine the stages of mineralization, degree of formation of root and crown structures, and stages of eruption which are reliable and helpful in predicting the age of an individual.[7] Dental maturity has played an important role in estimating the chronological age of individuals because of the reported low variability of dental indicators.[8] Various radiographic images that can be used in age identification are intraoral periapical radiographs, lateral oblique radiographs, cephalometric radiographs, panoramic radiographs, digital imaging and advanced imaging technologies.[9] Several authors have shown that dental parameters are more suitable for age estimation in children because the variability is lower since calcification rates are more controlled by genes than by environmental factors.[10] A widely used method is that proposed by Demirjian, Goldstein and Tanner put forth in 1973 based on eight calcification stages which span from the first sign of tooth calcification to apex closure for the seven left permanent mandibular teeth. A score is allocated for each stage, and the sum of the scores provides an estimation of the subject's dental maturity. The overall maturity score may then be converted into a dental age by using available tables and percentiles curves.[11] Though this method was considered reliable, several studies showed high dependence on the characteristics such as race, ethnicity of the specific population in question.[12] To overcome this and to expand the scope and duration of age prediction, this method was modified to facilitate evaluation of third molar and application of derived regression formula. The so called modified Demirjian's method uses the development stages of eight left mandibular permanent teeth and a regression formula for age estimation.[13] When the modified Demirjian's method was applied for estimation of age in Asian populations, there were variations in the predicted age. Diverse ethnicity was considered to be the cause of this large variation.[12] To overcome this variation Acharya thus derived an Indian specific regression formula using 8-teeth method demonstrated a mean absolute error much lesser than the modified Dermirjian's method.[14] Hence the present study was undertaken to assess the age using Demirjian's method with Acharya's specific regression formula for the patient visiting the department of Oral Medicine and Radiology, Seema Dental College and Hospital, Rishikesh, Uttarakhand, India.

Materials: A cross-sectional study was performed in the outpatient department of Seema Dental College and Hospital Rishikesh, Uttarakhand from May 2015 to Feb 2016 200 Participants from 14-24 years with their written consent were considered for the study. Institutional Research Committee (IRC) approval was taken before carrying on the study. The inclusion criteria of the study are healthy volunteers in the age group of 14-24 years with no history of medical or surgical disease that could affect the presence and development of wisdom teeth. Subjects below 14 years and above 24 years.

- Subject diagnosed of congenital anomalies or syndromes, metabolic disorders, malignancies and treatment for the same.

- Subjects whose mandibular tooth shows periapical pathology and cysts/ tumors affecting the mandible.
- The patient is checked properly for alignment and image acquisition process is started. It involved creating a new patient record.

After all the settings are done, the radiographer vacated the room and the exposure button was pressed from outside the room after sliding the lead door. The patient was watched for any movement during the X-ray procedure through lead incorporated viewing glass. After the image acquisition is complete the radiographic image is checked for any faults. If needed, the radiograph is repeated or digital subs traction is done and is a view on screen.

Image interpretation: In the panoramic images the calcification stages of all the eight permanent teeth on the left (3rd) quadrant were assessed and graded from 0-9 based on Demirjian's method (Table 1 & Fig 1.). In the absence of any tooth on the 3rd quadrant, the corresponding tooth on the 4th quadrant was considered for the assessment. Statistical package for social science (SPSS) version 20.0 was used for the data entry and analysis. The data were presented as means and standard deviations and the outcome were analyzed using Pearson's Correlation. *P*-value was calculated under the predetermined level of significance of 0.05 at the confidence level of 95 %.

TDS*	Single Rooted teeth and Multi-Rooted Teeth (Description)
0	Absence of crypt
1	Crypt development
2	In both uniradicular and Multiradicular teeth, the initiation of calcification is seen at the superior level of the crypt in the form of an inverted cone or cones. There is no fusion of these calcified points.
3	Fusion of the calcified points forms one or several cusps which unite to give a regularly outlined occlusal surface.
4	**a.** Enamel formation is complete at the occlusal surface. Its extension and convergence towards the cervical region is evident.
	b. The beginning of dentinal deposit is visible.
	c. The outline of the pulp chamber has a curved shape at the occlusal border.
5	**a.** Crown formation is complete to the level of the cemento-enamel junction.
	b. The superior border of the pulp chamber in the uniradicular teeth has a definite curved form, being concave towards the cervical region. The projection of the pulp horns (if present) results in outline shaped like an umbrella top. In the molars the pulp chamber has a trapezoidal form.
	c. Beginning of root formation is apparent in the form of a spicule.
6	**Uniradicular Teeth:** **a.** The walls of the pulp chamber now form straight lines, whose continuity is broken by the presence of the pulp horn, which is larger than in the previous stage.
	b. The root length is less than crown height.
	Multiradicular Teeth: **a.** Initial formation of the radicular bifurcation is evident in the form of either a calcified point or a semi-lunar shape.

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	b. Root length is still less than crown height.
7	**Uniradicular Teeth:** **a.** The walls of the pulp chamber now form a more or less isosceles triangle. The apex ends in a funnel shape.
	b. Root length is equal to or greater than crown height.
	Multiradicular teeth: **a.** The calcified region of the bifurcation has developed down further from its semi-lunar stage to give the roots a more definite and distinct outline with funnel shaped endings.
	b. Root length is equal to or greater than crown height.
8	The walls of the root canal are now parallel and the apical end is still partially open-distal root in molars.
9	**a.** The apical end of the root canal is completely closed (distal root on molars).
	b. The periodontal membrane has a uniform width around the root and the apex.

Table 1: **Demirjian's description of developmental stages of teeth**

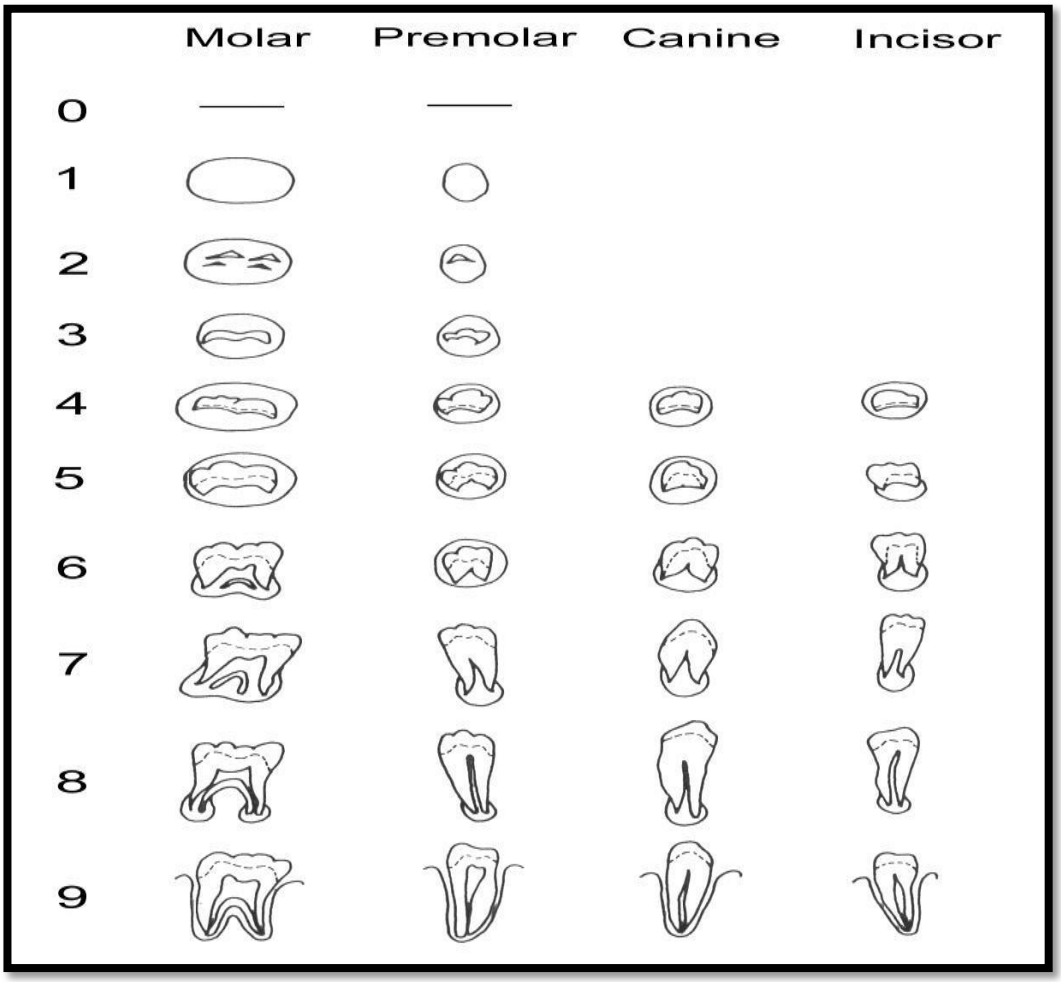

Figure 1: Pictorial representation of the developmental stages of the permanent dentition

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Tooth	Stage									
	0	1	2	3	4	5	6	7	8	9
M3	6.19	7.64	8.28	8.86	9.89	11.17	12.25	13.66	14.07	15.32
M2	1.7	2.98	3.41	4.74	4.88	6.69	7.89	9.08	11.13	13.63
M1						2.13	3.73	4.94	7	11.22
PM2		1.69	2.2	3.41	3.41	5.59	6.96	8.68	10.64	13.11
PM1			1.7	1.98	3.52	5.19	6.47	8.18	9.84	12.57
C				1.7	2.67	4.34	6.47	7.59	9.52	12.56
I2						2.55	4.71	5.75	6.97	10.91
I1						2.31	4.35	5.16	6.56	10.68

Table 2: Demirjian's individual maturity score assigned for each tooth as per their developmental stage for boys[15]

Tooth	Stage									
	0	1	2	3	4	5	6	7	8	9
M3	6.4	7.74	8.92	9.31	10.22	11.04	12.65	13.77	14.45	16.65
M2		2.57		2.65	4.1	6.51	8	9.13	11	13.84
M1						2.58	3.25	4.25	6.88	10.94
PM2			2.43	3.43	3.83	5.75	6.81	8.7	10.8	12.79
PM1				2.56	3.54	5.09	6.31	8.09	9.82	12.29
C					2.55	3.15	5.4	7.19	9.22	11.99
I2						2.65	4.54	5.4	7.02	10.89
I1						2.58	3.1	5.02	6.66	10.61

Table 3: Demirjian's individual maturity score assigned for each tooth as per their developmental stage for girls[15]

The individual maturity score allotted to each tooth on the 3rd quadrant was then summed up to obtain the total maturity score (S). This value was then substituted in the Acharya's Indian formula that was derived using the data obtained from the South Indian population. The Acharya's Indian formula is as follows:

Age (Males) = $27.4351 - (0.0097 \times S^2) + (0.000089 \times S^3)$
Age (Females) = $23.7288 - (0.0088 \times S^2) + (0.000085 \times S^3)$

Results: Among 200 subjects taken up for the study, 100 were males and 100 were females. The individual gender group was further divided into 10 groups with a class interval of 1 year (Group I:- 14.01-14.99 yrs, Group II:- 15.01-15.99yrs……Group X:- 23.01-23.99).

Table 4 shows the comparison of male study subjects on the basis of chronological and dental age. All the age groups showed a significant p-value (i.e. < 0.05) except for group V (18.01-18.99) where p-value was found to be statistically insignificant (p-value = 0.4226).

The dental age was overestimated for males in group I, II, III, and IV where the Mean age difference was found to be -2.02 yr, -1.41 yr, -0.41 yr, and -0.06 yr and Mean absolute error (MAE) was found to be -0.20 yr, -0.14 yr, -0.14 yr and -0.06 yr respectively and the underestimation of the dental age was found in group VI, VII, VIII, IX, and X where Mean age difference was found to be 0.05 yr, 0.15 yr, 0.50 yr, 1.55 yr, 2.18 yr, 3.27 yr, and 4.18 yr and Mean absolute error (MAE) was found to be 0.05 yr, 0.15 yr, 0.21 yr, 0.32 yr, and 0.41 yr respectively.

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Table 5 shows the comparison of female study subjects on the basis of chronological and dental age. All the age groups showed a significant p-value (i.e. < 0.05) except for group III and V where the p-value was found to be statistically insignificant (p-value = 0.2750 and 0.0700 respectively).

The dental age was overestimated for females in group I and II where the Mean age difference was found to be -0.75 yr and -0.87 yr respectively and Mean absolute error (MAE) was found to be -0.07 yr and -0.08 yr respectively and the underestimation of the dental age was found in group IV, V, VI, VII, VIII, IX, and X where Mean age difference was found to be 0.96 yr, 0.57 yr, 1.27 yr, 2.20 yr, 2.16 yr, 3.19 yr, and 4.08 yr respectively and Mean absolute error (MAE) was found to be 0.09 yr, 0.05 yr, 0.12 yr, 0.22 yr, 0.21 yr, 0.32 yr, and 0.41 yr respectively.

Table 6 shows the overall comparison of the study sample on the basis of chronological and dental age. Both males and females showed an overall significant p-value with a Mean age difference of 0.603 years and 1.263 years respectively and Mean absolute error (MAE) of 0.006 years & 0.012 years respectively.

SL NO.	AGE GROUP (in years)	MCA	MDA	Mean Difference	MAE	95% CI Lower	95% CI Upper	t	df	SED	p
1	I (14.01-14.99)	14.27	16.29	-2.02	-0.20	-2.55	-1.50	8.77	9	0.23	0.0001
2	II (15.01-15.99)	15.47	16.88	-1.41	-0.14	-1.70	-1.12	11.13	9	0.12	0.0001
3	III (16.01-16.99)	16.38	17.80	-1.42	-0.14	-1.93	-0.90	6.19	9	0.22	0.0002
4	IV (17.01-17.99)	17.63	18.29	-0.65	-0.06	-0.90	-0.39	5.79	9	0.11	0.0003
5	V(18.01-18.99)	18.33	18.49	-0.15	-0.01	-0.56	0.25	0.84	9	0.18	0.4226
6	VI(19.01-19.99)	19.47	18.96	0.50	0.05	0.15	0.85	3.26	9	0.15	0.0097
7	VII(20.01-20.99)	20.45	18.90	1.55	0.15	1.16	1.93	9.19	9	0.16	0.0001
8	VIII(21.01-21.99)	21.35	19.17	2.18	0.21	1.80	2.56	13.16	9	0.16	0.0001
9	IX (22.01-22.99)	22.62	19.35	3.27	0.32	2.90	3.63	20.33	9	0.16	0.0001
10	X(23.01-23.99)	23.62	19.44	4.18	0.41	3.94	4.42	39.05	9	0.10	0.0001

Table 4: Comparison of Male Study Subjects on the Basis of Chronological and Dental Age

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SL NO.	AGE GROUP (in years)	MCA	MDA	Mean Difference	MAE	95% CI Lower	Upper	t	df	SED	p
1	I (14.01-14.99)	14.52	15.27	-0.75	-0.07	-1.14	-0.35	4.33	9	0.17	0.0001
2	II (15.01-15.99)	15.4	16.27	-0.87	-0.08	-1.46	-0.27	3.30	9	0.26	0.0090
3	III (16.01-16.99)	16.42	16.62	-0.20	-0.02	-0.58	0.18	1.16	9	0.17	0.2750
4	IV (17.01-17.99)	17.44	16.48	0.96	0.09	0.17	1.75	2.77	9	0.34	0.0216
5	V(18.01-18.99)	18.52	17.94	0.57	0.05	-0.05	1.20	2.05	9	0.27	0.0700
6	VI(19.01-19.99)	19.59	18.32	1.27	0.12	0.53	2.10	3.88	9	0.32	0.0037
7	VII(20.01-20.99)	20.52	18.32	2.20	0.22	1.63	2.76	8.81	9	0.24	0.0001
8	VIII(21.01-21.99)	21.45	19.28	2.16	0.21	1.76	2.56	12.16	9	0.17	0.0001
9	IX(22.01-22.99)	22.48	19.28	3.19	0.32	2.76	3.62	16.72	9	0.19	0.0001
10	X(23.01-23.99)	23.52	19.44	4.08	0.41	3.86	4.30	41.52	9	0.09	0.0001

Table 5: Comparison of Female Study Subjects on the Basis of Chronological and Dental Age.

AGE	MEAN DIFFERENCE	MAE	95% CI LOWER	UPPER	t	df	SED	P
MALES	0.603	0.006	0.189	1.017	2.889	99	0.209	0.0047
FEMALES	1.263	0.012	0.918	1.60	7.27	99	0.174	0.0001

Table 6: Overall Comparison of Study Sample on the Basis of Chronological and Dental Age

Discussion: The broadening frontiers of dentistry have taken the dentist as an expert witness in legal room proceedings and in the field of forensic sciences, but forensic odontology for long had been a less explored area of dentistry. Age estimation forms one of the most important sub disciplines of forensic sciences and is of paramount importance in medico-legal issues.[16] There are various methods (skeletal, dental, anthropological, and psychological) that have been employed for estimation of age; of which- the skeletal and dental methods are frequently used. Among the two, age estimation by skeletal method presents some drawbacks in view of the variations in bone maturation due to environmental influences such as nutritional deficiencies. In

contrast, dental parameters are more suitable for age estimation in children because the variability is lower since calcification rates are more controlled by genes than by environmental factors.[10]

Although the radiographic method estimated dental age accurately in various age groups in both males and females with a mean age difference of 1 yr, large variations were observed in estimated dental ages of other age groups. Group's I-III showed overestimated dental age and Groups VII-X showed underestimated dental age in males whereas Groups VI-X showed underestimated dental age in females. There was a mean underestimation of dental age of 0.60 years for males and 1.26 years for females.

The underestimation observed in our study is probably due to 3 reasons: a) In the study using the South Indian population multiple regression formulae were derived by Acharya[14] hence the demographic variation in the study population could be one of the reasons b) Assignment of tooth development stage (TDS) during age assessment. Underestimation of dental age is directly related to the lower scoring of the TDS. As per the criteria laid down by Demirjian for TDS, a lower score has to be assigned to the calcification stage when in doubt 11c) third possible reason could be that the study was evaluated by a single observer and intra-observer evaluation was missing from the inclusion criteria.

As compared to the mean age difference between the clinical and chronological age, mean absolute error is considered more reliable. Hence the mean absolute error for both males, females, and the entire study group was calculated. The overall MAE for males and females was found to be 0.006 years and 0.012 years. MAE was found to be 0.0046 years for the entire sample (n=200). This implies that in any clinical situation during a forensic investigation, the age estimated for Uttarakhand population by Chaillet and Demirjian method using Acharya's formula is likely to be accurate with a difference within 1 year to the chronological age and is in accordance with the study done by Acharya[17]and Sonali Sarkar et al[18,19] wherein the MAE was less than 1 year.

Conclusion: Chaillet and Demirjian's radiographic method with Acharya's formula can be a reliable method in the assessment of dental age in the mentioned study group consisting of the Uttarakhand population. As the parameters used in the study group was for particular strata of population similar type of multicentric studies with larger sample size and intra-observer evaluation should be carried out in order to derive a definitive modification as per the variations in the demographics in the specific population group under study.

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