Original Article

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Evaluation of Third Molar Development for Age Estimation in A Gujarati Population Using Modified Demirjian's Method

Phulari Rashmi G.S.*, Rathore R.S., Patel Anubhooti I*****

*Professor, **Professor and Head, ***Postgraduate Student, Department of Oral and Maxillofacial Pathology and Microbiology, MP Dental College & Hospital, Vadodara, Gujarat.

Abstract

Background: Multiple teeth in varied stage of dental development provide sufficient data source for accurate age estimation, but only till the age of 14 years. The difficulty in human age estimation after 14 years of age has greatly shifted the focus on third molar which offers a unique advantage over other teeth because its development tends to continue over a longer period and until a later age. *Aim:* Aim of this study was to estimate the age of adolescents and young adults based on Demirjian's method for the development of mandibular 3rd molars using panoramic radiographs. *Material and Methods:* The retrospective study was carried out on 150 digital orthopantomograms of patients in the age group of 13-23 years obtained from the archives at our institution, MP dental college, Vadodara, Gujarat. Demirjian's tooth development method was used. Mandibular right third molar was used, if missing, contralateral molar was used. Data was analysed by using SPSS software (STAT IC-13). *Results:* The linear regression formula was applied which revealed age predilection with mean error of 1.83 year in which 60% cases were estimated within 1 year of actual age, while 40% cases were estimated to be >±1 years from actual age. There was a significant correlation between dental age and chronological age. The predicted age for male was 18.56 ± 1.69 and for female were 18.64 ± 2.21. *Conclusion:* Assessment of third molar using Demirjian's method can be used in estimating age for medico-legal purposes. As the Demirjian's method was based on French population, derivation of population specific formula is recommended.

Keywords: Age Estimation; Demirjian's Method; Third Molar; Dental Radiography; Population Specific Formula.

Introduction

Estimation of age is one of the vital criteria in establishing the identification of living or dead person. As crimes of varied nature are increasing in recent times age estimation becomes one of the important duties of the medico legal officers since age constitutes an important factor in assessing these instances [1]. Determination of age is important for chronological age estimation in relation to school attendance, birth certificate, social benefits, employment, retirement and marriage, determination of the emotional support needed for the victim of a sexual assault [2]. Age estimation also has a vital role in differentiating the juvenile from the adult status in criminal law cases because legal consequences can be quite different if a subject of unknown age is judged to be juvenile or an adult.

There are several indicators of maturity that can be observed as one ages, such as gain in height and weight, ossification of bone, teeth formation and appearance of secondary sex characters. Many of these changes are too variable to be of any reliable use for the estimation of age, but others are fairly constant, and these have been employed by medico-legal workers for the estimation of age [3]. Among these, developing teeth are generally considered to be the most useful and reliable indicators of maturation of biological and chronological age as they are less affected than other body tissues by endocrinopathies and environmental insults, exogenic factors such as malnutrition or disease. Tooth formation is a complex sequence of events from the first evidence of calcification to crown formation, root growth, eruption of tooth in to the mouth and root apex

Corresponding Author: RashmiG.S. Phulari, Professor, Department of Oral and Maxillofacial Pathology and Microbiology, ManubhaiPatel Dental College, Vishvajyoti Ashram, Munjmahuda, Vadodara, Gujarat- 390011.
E-mail: rashugs@rediff.com

maturation. Furthermore, tooth formation is a continuous and progressive process with a set sequence of events that it can be efficiently used for assessing dental maturation [4].

Dental radiography is a non-invasive yet simple technique which has been increasingly used of late for estimating age and it is considered to be an essential tool for identification in forensic science.

Dental age can be evaluated in young children with higher accuracy as many teeth are undergoing development and mineralization simultaneously. However, most of teeth would be completely developed by approximately 14 years of age, leaving only the third molars to continue maturing until a later age. The root of third molar is completed at the age of 18-25 years hence providing a unique advantage over other teeth to estimate age after 14 years[4].

Demirjian was the first to use Orthopantomography for estimating chronological age based on tooth formation on a French population[5]. By far it is the most common method which has been applied in various population groups. It has been advised that population specific formula is much more reliable for estimating age in different ethnic groups than Demirjian's original formula.

The aim of current study was to assess age accuracy using third molar development for age estimation using Demirjian's method in a Gujarati population of India.

Material and Methods

The study was approved by the ethical committee of the institution. The study was carried out on 150 digital orthopantomograms (OPG) of patients in the age group of 13 to 23 years, at Manubhai Patel Dental College, Gujarat state, India. These radiographs were of the patients who underwent OPG for varying diagnostic purposes.

The softcopy of these radiographs were retrieved from the computer attached to the digital OPG machine and were exported to JPEG format and the digital images were then analysed with Adobe Photoshop 7.0.

Mandibular right third molar was used for the entire study, if missing then contralateral molar was used. Dental development in each radiograph was assessed based on Demirjian et al.'s description and its subsequent modifications[6].

For statistical computations, stages were assigned a numeric value where stage 0 = 1, stage A = 2, stage B = 3, stage C = 4, stage D = 5, stage E = 6, stage F = 7, stage G = 8and stage H = 9. All the scores were then subjected to descriptive statistical analysis using SPSS (Statistical Package for Social Science) software.

Each orthopantomogram was studied for different stages of development of the third molars [Figure 1] by methods adapted by Demirjian as follows[6]:

Stage 0: Dental calcification has not yet begun.

Stage 1: The bone crypt has formed, but no sign of tooth germ.

Stage 2: In both single rooted and multi-rooted teeth, a beginning of calcification is seen at the superior level of the crypt, in the form of inverted cone or cones. There is no fusion of these calcified points.

Stage 3: Fusion of the calcified points forms one or several cusps, which unite to give a regularly outlined occlusal outline.

Stage 4: Enamel formation is complete at the occlusal surface. Its extension and convergence towards the cervical region is seen. The beginning of dentinal deposit is seen. The outline of the pulp chamber has a curved shape at the occlusal border.

Stage 5: The crown formation is completed down to the cemento-enamel junction. The superior border of the pulp chamber in single rooted teeth has definite curved form, being concave towards the cervical region. The projection of the pulp horns, if present, gives an outline like an umbrella top. In molars, the pulp chamber has a trapezoidal form. Beginning of root formation is seen in the form of a spicule.

Stage 6: In single rooted teeth, 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. The root length reaches at least 1/3rd of the crown height. In multi-rooted teeth, initial formation of the radicular bifurcation is seen in the form of either a calcified point or semi-lunar shape.The root length reaches at least 1/3rd of the crown height.

Stage 7: In single rooted teeth, the walls of the pulp chamber now form a more or less isosceles triangle. The apex ends in a funnel shape. The root length is equal to or greater than the crown height. In multi-rooted teeth, the calcified region of the bifurcation has developed further down from its semi-lunar stage to give roots a more definite and distinct outline, with funnel shaped endings. The root length is equal to or greater than the crown height.

Stage 8: The walls of the root canal are now parallel (distal root in molars). The apical ends of the root canals are still partially open (distal root in molars).

Stage 9: The apical end of the root canal is completely closed (distal root in molars). The periodontal membrane has a uniform width around the root and apex.

Inclusion Criteria

- Patients free of obvious developmental anomalies
- OPGs without any distortions
- OPGs of patients having age proof in the form of Birth certificate or School/College register or I.D. card/Driving license.
- OPGs having atleast one mandibular third molar

Exclusion Criteria

- Any congenital anomalies.
- Malnutrition or other diseases that would affect the skeletal growth and general development of the individual.
- Subjects with history of third molar extraction

Results

Age and gender distribution of 150 samples are given in [Table 1]. Mean ages at attainment of various Demirjian stages of 3rd molar development are described in [Table 2]. In the present study, it was observed that none of the cases showed Demirjian stages 0-4. A significant Pearson correlation 0.734 (r = > 0.6) was found between age and 3rd molar score with an increased 3rd molar score as the age increased [Table 3]. The linear regression coefficients are provided to assess the correlation of third molar development and chronologic age. Regression analysis revealed accuracy of the formula [Table 4].The scores were summed up and substituted in the regression formula shown below:

Age = 0.729 + 1.286 * 3rd Molar Score

Anova evaluation suggested that mean ages were different significantly from each other [Table 5].Age prediction of these 150 cases revealed a Mean absolute error of 1.83 years [Table 6]. The graphical representation of diagram indicated that the efficiency of age prediction was accurate [Graph 1].91 of the 150 cases (60%) were estimated to within 1 year of actual age, while 59 of the 150 (40%) of the estimated were >±1 years from actual age [Table 6]. The predicted age for males was 18.56 +/- 1.69 and for females was 18.64 +/- 2.21, which suggested that there was no gender bias when the formula is applied [Table 7], eliminating the need of separate formula for male and female. Both male and female groups showed high correlation between actual age and 3rd molar score with Pearson correlation value 0.750 and 0.728 respectively with p-value of 0.00.

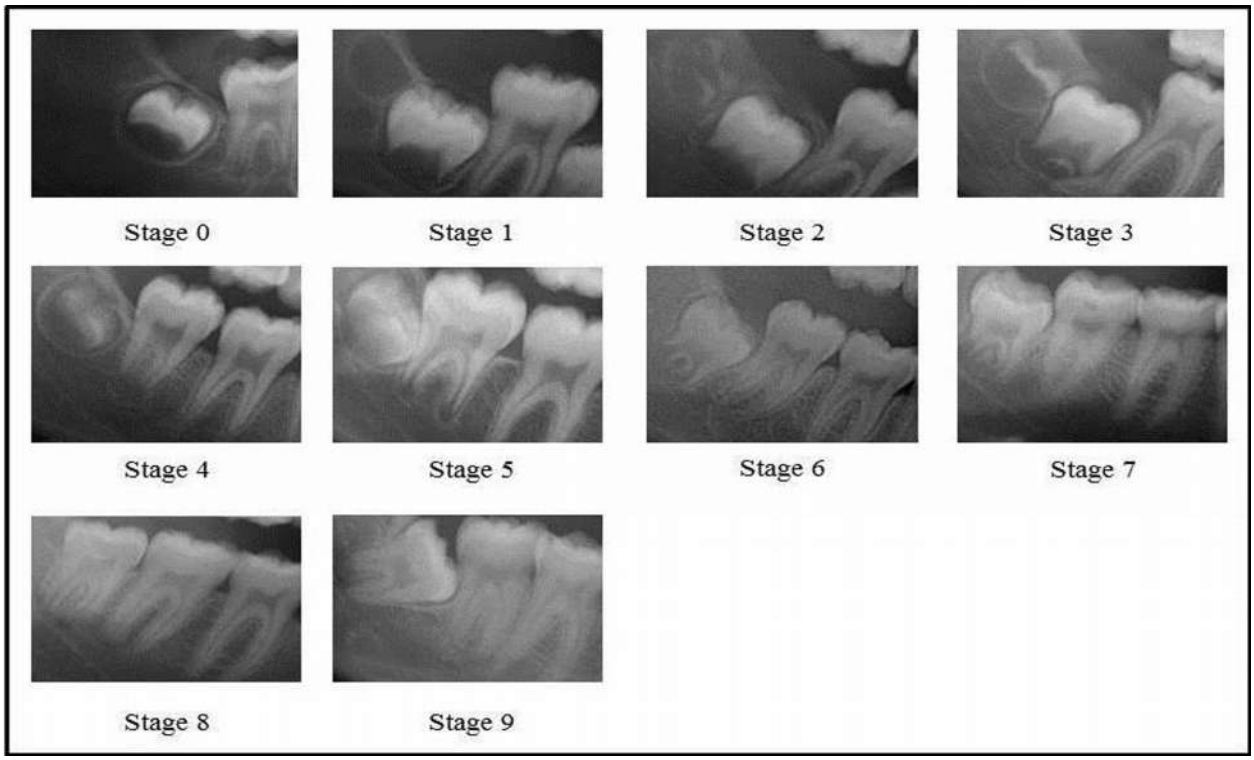


Fig. 1: Radiographs showing stages of development of mandibular third molar

Table 1: Sample distribution across age and gender

Age (completed years)	Female	Male	Total
13	6	1	7
14	2	4	6
15	5	7	12
16	4	3	7
17	6	8	14
18	11	12	23
19	8	11	19
20	15	9	24
21	9	9	18
22	5	2	7
23	6	7	13
Total	77	73	150

Table 2: Distribution of mean ages at attainment of stages of third molar development

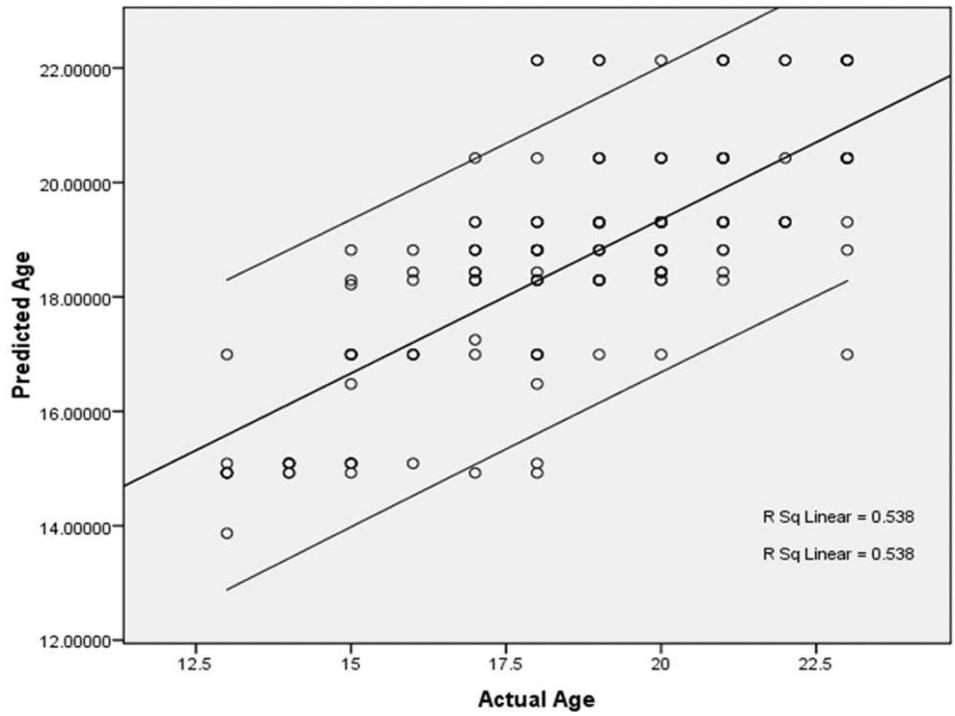
Stage of development	No. of patients (N=150)	Mean age
Stage 5	19	14.63
Stage 6	19	16.94
Stage 7	27	18.37
Stage 8	50	19.44
Stage 9	35	20.88

Table 3: Correlation between age and 3rd molar score

		3rd molar score
Pearson Correlation	Age	.734
P-value (1-tailed)		.000
N		150

Table 4: Regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	*(Constant)*	.729	1.369		.533	.595	-1.976	3.435
	3rd molar score	1.286	.098	.734	13.138	.000	1.092	1.479



Graph 1: Correlation between predicted age and actual age

Table 5: ANOVA

Model		Sum of Squares	DF	Mean Square	F	P-value
1	Regression	581.317	1	581.317	172.596	.000[a]
	Residual	498.476	148	3.368		
	Total	1079.793	149			

*Predictors: (Constant), 3rd molar score
*Dependent Variable: Age

Table 6: Model summery

R	R Square	Adjusted R Square	Mean absolute error	<±1 years age error	>±1 years age error
0.734	0.538	0.535	1.83	91/150 (60%)	59/150 (40%)

Table 7: Group statistics for male and female

	Sex	N	Mean	Std. Deviation	Std. Error Mean
Actual Age	Male	73	18.59	2.586	.303
	Female	77	18.62	2.805	.320
Predicted Age	Male	73	18.56	1.69603949	.19850641
	Female	77	18.64	2.21831197	.25280011

Discussion

Age estimation has become increasingly important to determine the age of living as well as dead individuals. In the recent times, the need for age estimation has increased for important reasons at certain specific age groups in the Indian context such as: children below 12 years of age are not liable for certain offences, a child cannot be employed below 14 years, 18 years of age determines the status of majority and the legally permissible age for marriage in females, the legally permissible age of marriage in males is 21 years and for female it is 18 years.

There are innumerable methods like Nolla's method, Moores et al, Kullman et al, Gleiser & hunt et al, Kohler et al for staging the calcification of the teeth. Demirjian et al put forth a method of age prediction. The original method was based on the mandibular left side teeth from the central incisor to the second molar and had assigned eight stages of development which were categorised as A to H. This original method of age estimation enabled the clinicians to know the deviation of the dental maturity for one individual, but it was inappropriate for age determination [5]. Also when the method was applied to the Indian population, it resulted in an average overestimation of about 3 years. Hence subsequently Chaillet and Demirjian modified the method to incorporate the third molar and developed a new maturity score based on a French population and also include two additional stages of non-formation of tooth (Stage "0") and crypt development (Stage "1"); furthermore, the stage of development were assigned numerals which were designated as 0–9 for easier calculation [6]. However, its test in many populations has resulted in relatively wide variations between predicted and actual age, prompting several authors to suggest the use of population-based standards.[7,8,9]

Aacharya had derived Indian specific formula using revised method of Demirjian[10]. In our study, we also used modified Demirjian's method and derived Gujarati population specific formula.

The present study focused on the lower third molars as the maxillary third molars have difficulty in assessing the teeth because of adjacent structures on the orthopantomograms (e.g. floor or posterior wall of maxillary sinus, zygomatic arch)superimpose the maxillary teeth. Many authors such as Darji et al [1], Kasper et al [9],Mincer et al [11], Kanmani et al [12] have analysed 3rd molar on both right and left sides in which Mincer et al [11] had found significant results. In our study we have only analysed right sided third molar (48) and in cases of absence of 48, we have used 38(13 cases out of 150).

Numerous reports have been published on the age estimation issue concerning adolescents and young adults in whom the assessment of third molar development was frequently investigated. An individual having third molars with Demirjian stage ''H'' development had very likely reached the chronologic age of 18, indicating that the use of this technique for determining the legal age of majority is valid. We found the mean age of 20.8 years for stage H which were in accordance with Solari and Abramovitch study [13], who stated that the mean age for stage H was 20.5 years. However, the mean age could be lower if the population sample age range was limited to a younger age less than 24 years.

Our study showed a positive correlation between various stages of third molar development and chronologic age which is similar to Darji et al[1], Mincer et al [11] studies. In present study, we found a significant correlation between dental age and

chronological age in both males and females similar to Mohammed et al[8] study. According to Mincer et al., the examination of third molars may provide reasonable accuracy for the likelihood that a person is at least, e.g., 18 years old, instead of the estimation of exact chronological age [11]. In our study, the standard error of age estimation was 1.83 years, and 60% of cases were predicted to be within +/-1 year of actual age while 40% of cases had errors > +/-1 years.

Darji et al found slight early development of third molar in males than in females [1]. Similarly, Mincer et al also reported early calcification of teeth in males than in females. This finding was unique for third molar as all other permanent teeth development is earlier in female as compared to males[11]. In our study, development of third molar in all stages was relatively found at the same time in both male and female which were in contradiction to Darji et al[1], Mincer et al.[11].

Conclusion

Objective and practical age estimation of individuals of unknown age requires a reliable method to estimate age that is safe and noninvasive on living subjects. Third molar root development can be reliably used to generate mean age and the estimated age range for an individual of unknown chronological age. The interobserver readings were not considered because we have employed digital radiography, which itself provides a significantly accurate result. Our study yielded acceptable age estimation for a Gujarati population using only third molar with modified Demirjian's method.

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