Age Estimation Using Third Molar Development–A Radiological Retrospective Study

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Abstract

Introduction: Age estimation using dental findings has an important role in identification of an individual in forensics but its utilization is not well established. This study has been done to estimate the age using third molar in dental radiographs.

Aim: To estimate the chronological age based on the eight stages of third molar development method by Demirjian et al. in Indian population and compare third molar development with age and between sex.

Materials and Method: 294 digital panoramic radiographs of Indian population aged 7 to 25 years are retrospectively enroled and their Demirjian's stages are recorded. Statistical analysis to determine comparison between the chronological age and age estimated using demirjian method are done.

Results: Statistically significant difference were obtained in maxilla and mandible on both the sides in all the age groups which was revealing a decreasing trend as the age progresses. The age estimation using Demirjian method was almost same as the chronological age in group 16 to 20 years.

Conclusion: Third molar development can be a useful tool in age estimation of an individual in disasters, catastrophes and for medico-legal purposes.

Keywords: Third molar; Age estimation; Demirjian's method.

Introduction

Age estimation has played a significant part in determining the identity of an individual in dead as well as living individuals for medico-legal cases, criminal issues and in huge catastrophic disasters. Estimation of age has been useful for the judiciary in unknown victim identification in mass disasters such as earthquakes, floods, bomb blast, airplane crash and recognition of undocumented illegal immigrants. [1,2]

The various methods for determining the age of an individual includes bones, teeth or both structures. In the field of forensics, age estimation is carried out with the help of skeletal maturity indicators such as hand-wrist radiographs, fusion of diaphysis and epiphysis, fusion of cranial sutures, secondary sexual characteristics and so on. [3,4] For the past many years, bones have been used extensively for age estimation but as time passes bones undergoes disintegration process. So, teeth can be beneficial for age estimation as they are preserved for a long-time in alive and dead people. Age estimation using dental records include developmental changes such as dental eruption, third molar development, dental measurement and degenerative changes in the teeth.[5]

Age estimation can be easily done during the developing years of an individual. The primary and permanent teeth can be used for determining the age since they are undergoing crown and root calcification till 14 years. Since, the third molar are the last tooth to initiate and complete crown and tooth development therefore, they are the last dental indicator for age estimation.[4] Development of wisdom teeth may begin as early as 5 years or as late as 6 years. Calcification can start at age 7 years

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in some children and as late as 16 years in others

and root formation is normally completed between 18 and 25 years.[5] So, third molar calcification can be evaluated using dental radiographs and can be an aid in determining the age of an individual

Aim and Objective

The primary aim is to estimate the chronological age based on the eight stages of third molar development method by Demirjian et al. in south Indian population. The objective is to compare third molar development between various age groups and sexes.

Materials and Methods

In this study, 294 panoramic dental radiographs of South Indian population who visited the Oral Medicine & Radiology Department of the institution was enroled. The age group of 7 to 25 years were chosen for the study retrospectively. They were subclassified into four groups - Age less than 10 years (N=61), age 10–15 years (N=70), age 16–20 years (N=79) and age 21–25 years (N=83). All the radiographs were of digital type, i.e. stored and seen on the computer. Radiographs were examined using the Demirjian's method for age determination based on eight calcification stages which spans from the first sign of tooth calcification to apex closure for permanent teeth. Tooth calcification was rated according to the method described by Demirjian et al. in which one of the eight stages of calcification, A–H was assigned to the third molar tooth. Table 1 depicts the stages of third molar development according to Demirjian at al.

Inclusion Criteria

• Age group of 7 to 25 years

• Only South Indian people (images) were included in the study.

Exclusion Criteria

• Presence of orthodontic wires and appliances in jaws

• Presence of fracture plates in jaws

• Absence of more than 2 third molar

Statistics

Regression formula (y=mx+c)   was used to determine the age where y=age, m=1.5(constant), c=10.431 (constant) and x=developmental stage of third molar expressed by numbers as follows: A=1, B=2, C=3, D=4, E=5,F=6, G=7, H=8. Statistical analysis was done using SPSS Software to determine the difference in age estimated using Demirjians's method using above formula and chronological age of the patient. Comparison of the difference between the age estimated using Demirjian's method using above formula and chronological age and comparison of age within gender was done using Kruskal-Wallis test and Mann-Whitney test. Descriptive statistics and regression analysis was carried out for each age group and constants were derived for each age group.

Results

The third molar calcification process was examined in all the age groups in both sexes. The mean difference in chronological age and age estimated using Demirjian's method and standard deviation for each age group in maxilla and mandible both left and right side are calculated. Table 2 shows the mean and standard deviation of each age group in maxilla and mandible for both the sides. Bar graph -1 shows mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in maxilla and mandible.

Statistically significant difference were obtained in maxilla and mandible on both the sides in all the age groups which was revealing a decreasing trend as the age progresses. The age calculated using Demirjian's method was five years more than the chronological age in age group less than 10years, two years more than the chronological age in age group 10 to 15 years, almost same as the chronological age in age group 16 to 20 years and five months less than the chronological age in age group 21 to 25 years. Table 3 depicts the mean and standard deviation of the difference between the actual chronological age and age estimated using Demirjian method for each age group in male as well as females in both the dentition.

Statistically no significant difference was obtained between males and females in all age groups in both maxilla and mandible both the sides. Bar graph 2 shows mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in males and females in both the dentition (maxilla and mandible) in age group less than 10 and age group 10 to 15 years. Bar

graph 3 shows mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in males and females in both the dentition (maxilla and mandible) in age group 16 to 20 years and 21 to 25 years.

Table 1 : Stages of third molar development according to Demirjian et al.

Stage	Description	Picture	Radiograph
Stage A	Cusp tips are mineralized, but have not yet coalesced		
Stage B:	Mineralized cusps have united, so mature coronal morphology is well defined		
Stage C	The crown is about half formed, the pulp chamber is evident and dentinal deposition is occurring		
Stage D	Crown formation is complete to the dentinoenamel junction. The pulp chamber has trapezoidal form		
Stage E	Formation of inter-radicular bifurcation has begun. Root length is less than crown length		
Stage F	Formation of inter-radicular bifurcation has begun. Root length is less than crown length		
Stage G	Root walls are parallel, but apices remain open		
Stage H	Apical ends of the roots are completely closed and the periodontal membrane has a uniform width around the root		

Discussion

When the growth and development of an individual is nearing completion the third molar is only tool to determine the age. During the teenage and adolescence period most of the skeletal and dental maturity indicators are not available for age estimation in forensics.[6] The correlation between radiologically detected developmental stages of third molars and the actual chronological age help to estimate age in the transition zone between juvenile and adult status.[7] So, third molar development stage is the only valuable parameter to determine the age of an individual.

There are numerous dental maturity systems developed and described in the past. In a study by Olze at al. to assess the validity of common classification systems including: Gleiser and Hunt, Demirjian, Gustafson and Koch, Harris and Nortje and Kullman. Demirjian et al. presented a classification distinguishing four stages of crown development (stages A–D) and four stages of root development (stages E–H). The stages proposed by Demirjian et al. are defined by changes in shape and calcification of tooth. The classification of third molar stages are simple and easily applicable. Therefore, Demirjian's method can be regarded as the best method.[10] There are various modified systems such as Solari and Abramovitch added

Table 2: Mean and standard deviation of the difference between the actual chronological age and age estimated using Demirjian method for each age group (less than 10 years, age group 10–15 years, age group 15–20 years and age group 21–25 years) in maxilla and mandible.

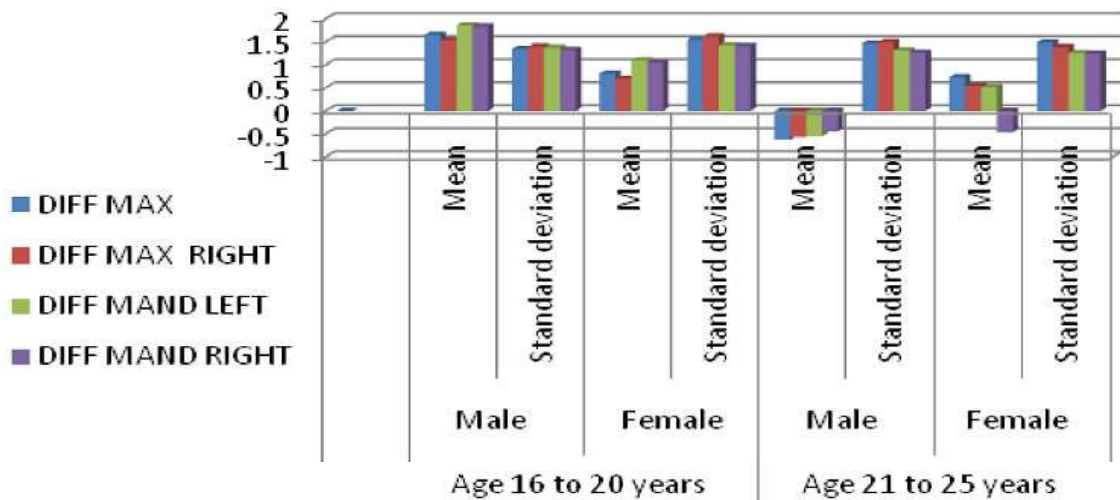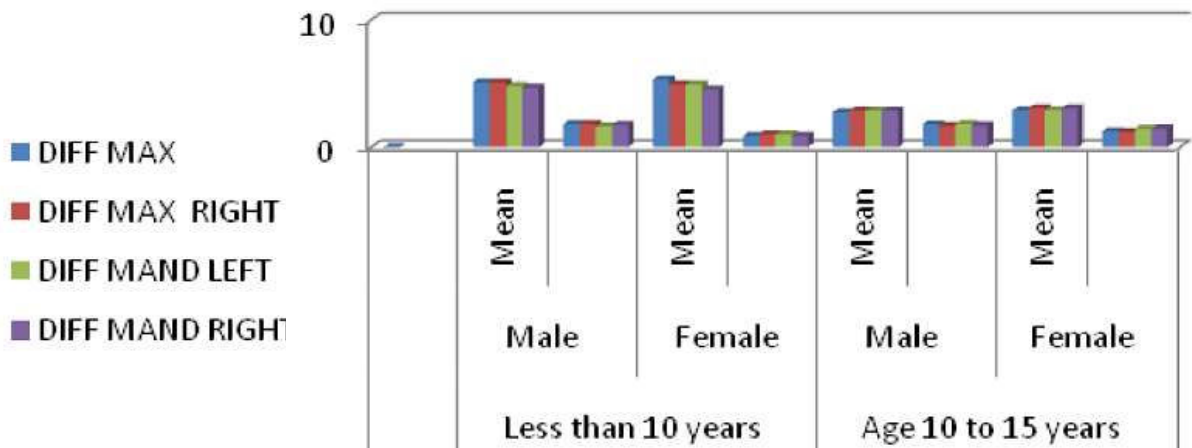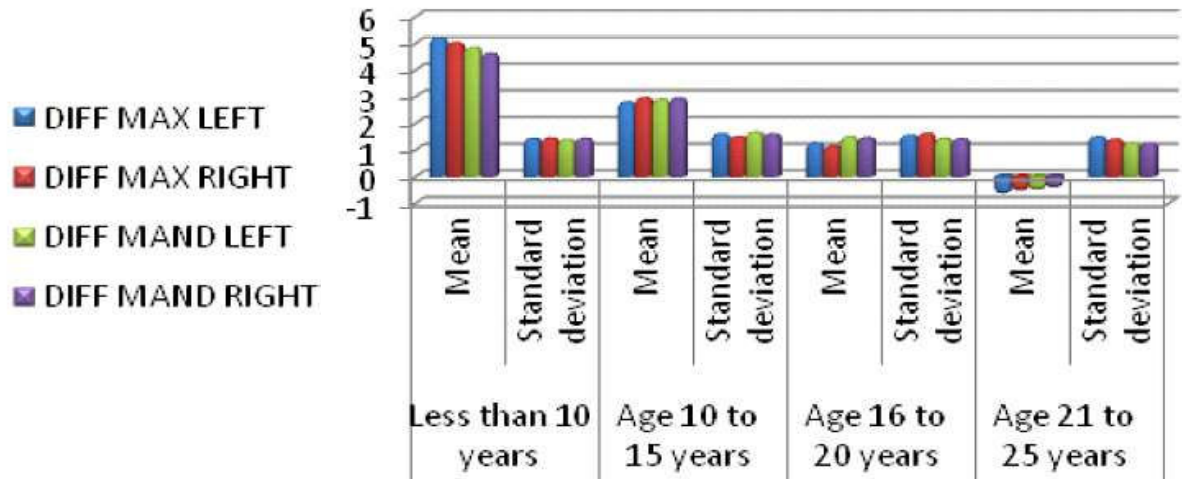| Age Group Left		Difference between Chronological Age And Age Estimated Using Demirjian Method Maxilla		Difference between Chronological Age And Age Estimated Using Demirjian Method Mandibular	
		Right	Left	Right	Left
Less than 10 years	Mean	5.20	5.02	4.85	4.62
	Standard deviation	1.42	1.44	1.38	1.43
Age 10 to 15 years	Mean	2.80	2.95	2.89	2.94
	Standard deviation	1.61	1.49	1.67	1.60
Age 16 to 20 years	Mean	1.26	1.14	1.49	1.46
	Standard deviation	1.55	1.62	1.43	1.41
Age 21 to 25 years	Mean	-0.68	-0.56	-0.53	-0.45
	Standard deviation	1.49	1.39	1.26	1.25

Table 3: Mean and standard deviation of the difference between the actual chronological age and age estimated using Demirjian method for each age group (less than 10 years, age group 10–15 years, age group 16–20 years and age group 21–25 years) in male as well as females in both the dentition (maxilla and mandible).

Age group	Sex	Statistical parameter	Difference between chronological age and age estimated using demirjiamethod Maxilla		Difference between chronological age and age estimated using demirjian method Mandibular	
			Left	Right	Left	Right
Less than 10 years	Male	Mean	5.09	5.09	4.80	4.68
		Standard deviation	1.83	1.83	1.64	1.75
	Female	Mean	5.33	4.93	4.93	4.53
		Standard deviation	0.89	1.00	1.00	0.89
Age 10 to 15 years	Male	Mean	2.74	2.87	2.87	2.87
		Standard deviation	1.79	1.66	1.82	1.70
	Female	Mean	2.90	3.07	2.93	3.06
		Standard deviation	1.25	1.19	1.45	1.46
Age 16 to 20 years	Male	Mean	1.66	1.54	1.86	1.84
		Standard deviation	1.35	1.40	1.38	1.33
	Female	Mean	0.81	0.70	1.10	1.05
		Standard deviation	1.55	1.62	1.43	1.41
Age 21 to 25 years	Male	Mean	-0.62	-0.56	-0.55	-0.44
		Standard deviation	1.47	1.50	1.32	1.27
	Female	Mean	0.74	0.55	0.52	-0.46
		Standard deviation	1.49	1.39	1.26	1.25

Bar graph 1: Mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in maxilla and mandible.

Bar graph 2: Mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in males and females in both the dentition (maxilla and mandible) in age group less than 10 and age group 10 to 15years.

Bar graph 3: Mean and standard deviation of the difference between actual chronological age and age estimated using Demirjian method for left and right side in males and females in both the dentition (maxilla and mandible) in age group 16 to 20years and 21 to 25 years.

intermediate substages to the latter stages of development.[11] Kasper's modification maintains the same letter classification system and descriptors, but adds useful radiographic examples of each stage.[6]

In the present study, the third molar development in all stages in maxilla and mandible left and right sides in all the age groups are statistically non significant at P value >0.05. No differences in the mineralization rate between the upper and lower, left and right third molars were observed.[9] In the present study there was no significant difference between development of third molars between males and females.[12] Olze et al. also evaluated the chronological age with third molar mineralization of 1,615 Japanese and revealed results consistent with the present study.[13]

Various similar studies have been carried out by Mincer et al, Darji and Govekar et al, Lewis et al, Priyadarshini et al and Ajmal et al. on age estimation using third molar development by demirjian method. The mean age estimation in the present study is similar to the study done by Darji and Govekar at al.[1] But in the present study, there was no difference in the development of third molar in maxilla and mandible which is in contraindication to Darji and Govekar et al. study in which maxillary third molar tended to develop earlier than mandibular third molar. The difference in the results obtained in the present study can be attributed to inclusion of wider age group i.e. 7 to 25 years in comparison to Darji and Govekar at al study which included only 15 to 25 years age group.

According to the previous studies on chronological age estimation and third molar mineralization by Zeng et al. and Lewis et al, no significant differences were found in third molar development between males and females.[4,8] On the contrary, females attained demirjian formation stages 6–21 months earlier than males in the study by by Rai et al. in age group of 7 to 26 years north Indian patients. Although the developmental stages of all the third molar teeth were assessed

by a modified Demirjian's chart as proposed by Kasper et al in the study by Ravi et al. no significant differences were found when the development of each wisdom tooth was calculated between the males and females.[14]

Earlier studies have described mean age and standard deviation for demirjian's stages but difference in chronological age and age estimated using demirjian's method was not assessed till date. Ajmal et al. evaluated the third molars of only Saudi male patents of age 13 to 23 years in 360 panoramic dental radiographs. The study predicted the age with the average standard deviation of 1.47 years with minimum standard deviation of 0.76 years and a maximum of 2 years for the third molar development stages. The present study has this peculiarity of assessing and evaluating the differences encountered in age estimation.

Linear regression coefficients were calculated by statistical analysis to assess the correlation between the third molar development and chronological age. This revealed a strong positive correlation between various stages of third molar development and chronological age. Regression formulas for each age group were estimated and following equations derived:

For age group less than 10 years maxillary right third molar, $y=mx+c$

Where y=chronological age in years, m=0.00, c=10.98, x=age using demirjian method

For age group 10-15years maxillary right third molar, $y=mx+c$

Where y=chronological age in years, m=0.64, c=3.59, x=age using demirjian method

For age group 16-20 years maxillary left third molar, $y=mx+c$

Where y=chronological age in years, m=0.4561, c=7.11, x=age using demirjian method

For age group 21-25years maxillary left third molar, $y=mx+c$

Where y=chronological age in years, m=0.30, c=15.13, x=age using demirjian method

The various limitations of the study include: great variation in position, morphology, and time of formation of third molar, only one observer to interpret the OPG's and south Indian population was evaluated. Rather, multiple observers to interpret the OPG's and various other ethnic group population must be taken into account.

Conclusion

The Demirjian's method of third molar development can be used for chronological age estimation using the regression formula in the present study. There is no variation in third molar development regarding the dental arch i.e. maxilla and mandible both the sides and gender. The scope for future research includes: Incorporating larger sample size, more than one observer for interpretation of OPG and various other ethnic group population incorporated in the study.

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