Dental Age Assessment in a South Indian population using Demirjian's Method– A Radiographic study

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Abstract
AIM AND OBJECTIVE:
To check the validity of Demirjian's method by comparing the chronological age to dental age estimated by Demirjian's method in Mangalore population.
MATERIALS AND METHODS:
This retrospective study was done using 62 panoramic radiographs which were collected in the age group of 3-16 years from the archives. Dental age was calculated using Demirjian's method, and it was then compared with the chronological age of the study population. The obtained data were statistically analysed using paired t test, intra class correlation coefficient and a regression analysis was done using SPSS 13 software.
RESULTS:
Average chronological age obtained was 11.3081 ±2.57308. Average dental age estimated by Demirjian's method was 11.2210 ±2.45115. The intraclass correlation coefficient showed excellent agreement between the two. Statistical analysis indicated no significant difference between chronological age and age obtained by Demirjian's method. The present study indicated that Demirjian's method is reliable for age estimation in Mangalorean population. Age of subjects can be estimated with a good degree of accuracy using regression equation which was obtained after statistical analysis
Keywords: Panoramic radiograph, Forensic odontology, Regression equation, Demirjian's method.

I. Introduction

The concept of physiological age is based on the degree of maturation of different tissue systems. Different categories of biological age have been established: skeletal age, morphological age, secondary sexual character age and dental age [1]. Correct age estimation based on dental records has been found to play a crucial role in a broad range of fields, including paediatric dentistry, orthodontics, forensic medicine, paediatric endocrinology, orthopaedics, and anthropological studies [2]. In dentistry, it has helped in planning and timing treatment during the optimal growth stage (pubertal growth spurt) and to achieve ideal correction of skeletal discrepancies by selecting the appropriate orthodontic appliance like extra oral tractions and functional appliances, and to correctly schedule orthognathic surgery [3]

Dental age assessment can be done either by observing the timing of eruption of tooth or by assessing the degree of mineralisation of the developing teeth from radiographs [4]. Tooth calcification has been found to be a more reliable indicator of dental maturity than eruption (gingival emergence) as it is not affected by local factors such as loss of primary teeth, lack of space, malnutrition, dental decays, ankylosis, or orthodontic anomalies, and is much more genetically determined [1,5,6]. Many authors have developed different scoring methods to estimate dental age using dental calcification stages of permanent teeth, including Demirjian, Nolla, Goldstein, and Van der Linden . Among these the most widely used and accepted dental maturity scaling system is the method developed by Demirjian in 1973 on a sample of French - Canadian children [1,7], and it has been seen to be accurate in most of the population. So, in order to check the feasibility and accuracy of Demirjian's method in Mangalorean population we chose this method for our study.

II. Aims And Objectives

To determine the dental age of children by using Demirjian's method and compare it with the chronological age to estimate its efficacy in assessing the age of an individual in Mangalore population

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III. Materials And Methods

This retrospective study was done in our department, Mangalore. Panoramic radiographs of 62 patients (31 females, 31 males) within the age group of 3-16 years, in whom all the seven left mandibular teeth were present, were selected for the study. Patients radiographs which showed any developmental anomalies were excluded from the study. The radiographs selected were taken for various other reasons and it was retrieved from the database (archives).

The dental age estimation was done using the Demirjian's radiographic method of age estimation [1]. The teeth assessed were seven left mandibular permanent teeth in the following order: 2nd molar, 1st molar, 2nd bicuspid, 1st bicuspid, canine, lateral incisor, central incisor. All the teeth were rated on a scale A to H. The rating is assigned by following carefully the written criteria for each stage and by comparing the tooth with diagram and radiographic images given by Demirjian (Fig 1). Each tooth is given a score depending on its stage and the scores on all the seven left mandibular teeth are added together to give a total maturity score which can be converted directly into a dental age using an appropriate table of standards given by Demirjian . Girls and boys are given different system of scores. The date of birth which was recorded previously, and the date of radiograph taken was used to calculate the chronological age by using the following format,

Chronological age = (date of radiograph – the date of birth)

IV. Results

This study comprised of 62 radiographs of individuals between the age group of 3-16 years. Demirjian's method was used to determine the dental age. There was no significant difference between the chronological age and the age obtained by Demirjian's method. Frequency in gender distribution is shown in Table 4.

Out of 31 males, 25 patients showed good correlation in estimated dental age when compared with their respective chronological age with maximum difference in age by 5 months and minimum by one month. Remaining six male patients showed difference of more than six months. Over estimation was seen in three male patient by 1- 2 years. Under estimation was seen in three patients by 11 months to two years. Out of 31 females, 26 patients showed good correlation between chronological age and estimated dental age with difference of 1-6 months. Two patients showed over estimation of dental age by one year and underestimation was seen in two patients by one year and in one patient by two year. A comparison of chronological age and Demirjian's method is shown in Fig.2. There was no significant difference between chronological age and dental age with Demirjian's method (Fig 3, Table 6). Intraclass correlation coefficient was 0.972(C.I: 0.937-0.996) for females and 0.950 (C.I:0.913-0.990) for males, both the gender showed excellent agreement (>0.85) as shown in Table 5. No significant difference was seen between chronological age and dental age with Demirjian's method (Table 6) both in males and females as in Table 7. It also shows mean and standard deviation in two methods. Mean chronological age was 10.125 and standard deviation of 2.3492 was seen. Average chronological age was 10.125 ±2.3492. The mean dental age by Demirjian's method was 10.244 and standard deviation of 2.3815 was seen. Average dental age estimated by Demirjian's method was 10.244 ±2.3815. Average chronological age was 10.125±2.3492 & average dental age by Demirjian's method was 10.244±2.3815 which showed statistically non-significant difference.

Following statistical analysis a regression formula was obtained which can be applied in future studies by Demirjian's method in our population.

Regression formula
Chronological age=0.114 +1.006*Age by Demirjian Method -0.182*Gender (Substitute 1 for male and 0 for females)

V. Discussion

Radiological method of age estimation is one of the most reliable methods used to calculate the age of an individual. We tried using Demirjian's method in 62 panoramic radiographs from Mangalore population, South India and a good correlation was found between the chronological age and the dental age obtained. It was easy to apply and did not involve many calculations. Demirjian's method was introduced by Demirjian A and Goldstien H in 1973 which was updated in 1976 and the method was developed on French Canadian population. It used eight stages of tooth development. This method not only estimates age in years but also in months of an individual's age. In 1999, Demirjian's method has been widely used on British children of Bangladeshi origin and white Caucasians.

Non-significant difference between the ethnic groups was found. It was also stated that Demirjians method cannot be applied in British population as it showed more advanced in age. In one study this method was applied on Dutch population in 2005 and was considered as the most reliable method for age estimation in

that population. It also stated that this method gives a continuous score to each change taking place in all the seven mandibular teeth which is the basis for age estimation.

The original method of Demirjians was also modified by many authors at later date. Few other authors in 2007 also used Demirjians method on third molars although third molars were not used in original study. It stated that Demirjians method was easy to apply and it can be used in medico legal cases in order to identify if an individual is over 18 years or not. In 2007, a study done on Turkish population showed that no sexual variation was found in dental maturity. There are few studies done on Indian population using Demirjians method. In 1998, a study had applied this method on South Indian population and noticed that there was overestimation in age by three years. With this background a study was conducted in 2011 which used Demirjians eight teeth method and noticed reduction in overestimation by one year in Indian population. The author also found that there were greater errors on incorporating 3rd molars. In 2011, a similar study was done using eight teeth method and carried out a regression analysis and had introduced a formula for Indian population.

A study from Central Poland also did not show any sexual variation in their dental maturity. There was no statistically significant difference found between girls and boys

We used Demirjians method on 62 radiographs of individuals from Mangalore population between the age group of 3-16 years and found good correlation between the chronological age and the estimated dental age. In our study out of 31 males, one male showed dental age overestimation by 1.3 years and under estimation was seen in three males (11 months, 1.4 years and 2 years). In females out of 31, two showed overestimation of 1.0 & 1.2 years. Difference of less than 6 months was considered as normal. However, statistically no significant difference was found in both males and females. The intra class correlation for males and females also showed excellent agreement. We have come up with regression formula which can be applied to estimate more accurate age of an individual in Mangalore population using Demirjians method.

VI. Conclusion

The results of our study using Demirjians method showed a good correlation between dental age and chronological age in individuals although there are under and overestimation in a few cases. Statistically no significant difference was found between males and females. Demirjians method has not given exact age in every individuals but it can be clinically accepted with regard to accuracy and ease of assessment. New regression formula obtained after the study can give a more accurate age in individuals. Further study will be required with the use of larger sample size to consider this method as specific in Mangalore population.

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Figures
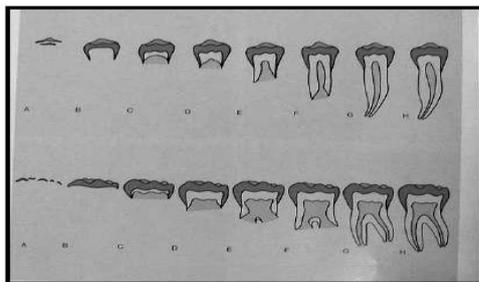
Fig. 1: A: Calcified cusp tips that are not fused, B: Calcified cusp tips that are fused with well-defined occlusal surface outline, C: Complete formation of enamel at occlusal surface. Commencement of dentinal deposition, D: Completion of crown formation upto cement enamel junction. Root formation is seen and pulp horns begin to differentiate, E: Pulp horns and pulp chamber are more differentiated. Root length is less than crown length.

Radicular bifurcation is visible in molars. F: Funnel shaped apex is seen. Crown length is equal and greater than root length, G: Root canal walls are parallel and the apical ends are still open, H: Apical ends are closed and uniform periodontal ligament space is seen around the tooth.
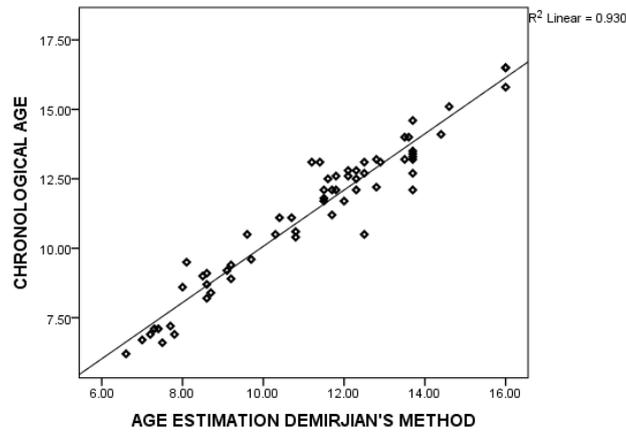
Fig. 2: Comparison of chronological age and Demirijian's method
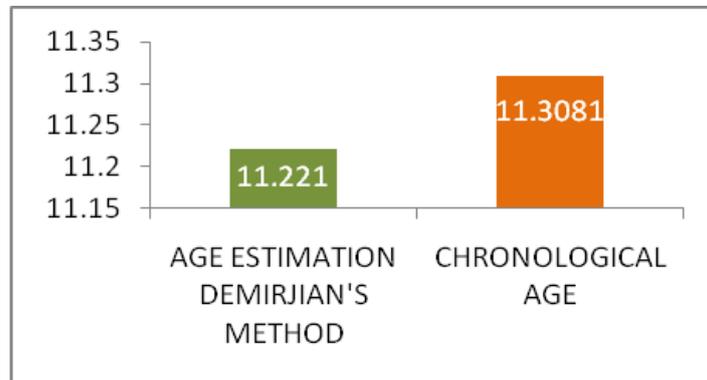
Fig 3. Comparison of chronological age and Demirijian's method
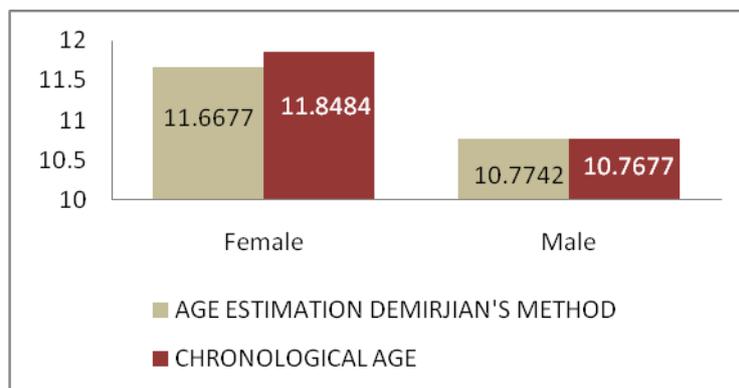
Fig 4 Comparison of chronological age and Demirijian's method in females and males

Tables

Table 1: Stages and Scores (Boys)

Tooth	Stages and Scores								
	0	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
2nd molar	0.0	2.1	3.5	5.9	10.1	12.5	13.2	13.6	15.4
1st molar				0.0	8.0	9.6	12.3	17.0	19.3
2nd premolar	0.0	1.7	3.1	5.4	9.7	12.0	12.8	13.2	14.4
1st premolar			0.0	3.5	7.0	11.0	12.3	12.7	13.5
Canine				0.0	3.5	1.9	10.0	11.0	11.9
Lateral Incisor					3.2	5.2	7.8	11.7	13.7

							1.9	4.1	8.2	11.8
Central Incisor										

(0= No   mineralization)

Table 2: Stages and Scores (Girls)

Tooth	Stages and Scores								
	0	A	B	C	D	E	F	G	H
2nd molar	0.0	2.7	3.9	6.9	11.1	13.5	14.2	14.5	15.6
1st molar				0.0	4.5	6.2	13.5	14.0	16.2
1st premolar	0.0	1.8	3.4	6.5	10.6	12.7	13.5	13.8	14.6
2nd premolar			0.0	3.7	7.5	11.8	13.1	13.4	14.1
Canine				0.0	3.2	5.6	10.3	11.6	12.4
Lateral Incisor				0.0	3.2	5.6	8.0	12.2	14.2
Central Incisor					0.0	5.4	5.1	9.3	12.9

(0= No mineralization

Table 3: Demirjians conversion chart for age estimation

Age	Maturity Score		Age	Maturity Score		Age	Maturity Score		Age	Maturity Score	
Y	Boys	Girls	Y	Boys	Girls	Y	Boys	Girls	Y	Boys	Girls
3.0	12.4	13.7	6.3	36.9	41.3	9.6	87.2	90.2	12.9	95.4	97.2
3.1	12.9	14.4	6.4	36.9	41.3	9.7	87.7	90.7			
3.2	13.5	15.1	6.5	39.2	43.9	9.8	88.2	91.1	13.0	95.6	97.3
3.3	14.0	15.8	6.6	40.6	45.2	9.9	88.6	91.4	13.1	95.7	97.4
3.4	14.5	16.6	6.7	42.0	46.7				13.2	95.8	97.5
3.5	15.0	17.3	6.8	43.6	48.0	10.0	89.0	91.8	13.3	95.9	97.6
3.6	15.6	18.0	6.9	45.1	49.5	10.1	89.3	92.3	13.4	96.0	97.7
3.7	16.2	18.8				10.2	89.7	92.3	13.5	96.1	97.8
3.8	17.0	19.5	7.0	46.7	51.0	10.3	90.0	92.6	13.6	96.2	98.0
3.9	17.6	20.3	7.1	48.3	52.9	10.4	90.3	92.9	13.7	96.3	98.1
			7.2	50.0	55.5	10.5	90.6	93.2	13.8	96.4	98.2
4.0	18.2	21.0	7.3	52.0	57.8	10.6	91.0	93.5	13.9	96.5	98.3
4.1	18.9	21.8	7.4	54.3	61.0	10.7	91.3	93.7			
4.2	19.7	22.5	7.5	56.8	65.0	10.8	91.6	94.0	14.0	96.6	98.3
4.3	20.4	23.2	7.6	59.6	68.0	10.9	91.8	94.2	14.1	96.7	98.4
4.4	21.0	24.0	7.7	62.5	71.8				14.2	96.8	98.5
4.5	21.7	24.8	7.8	66.0	75.0	11.0	92.0	94.5	14.3	96.9	98.6
4.6	22.4	25.6	7.9	69.0	77.0	11.1	92.2	94.7	14.4	97.0	99.5
4.7	23.1	26.4				11.2	92.5	94.9	14.5	97.1	98.8
4.8	23.8	27.2	8.0	71.6	78.8	11.3	92.7	95.1	14.6	97.2	98.9
4.9	24.6	28.0	8.1	73.5	80.2	11.4	92.9	95.3	14.7	97.3	99.0
			8.2	75.1	81.2	11.5	93.1	95.4	14.8	97.4	99.1
5.0	25.4	28.9	8.3	76.4	82.2	11.6	93.3	95.6	14.9	97.5	99.1
5.1	26.2	29.7	8.4	77.7	83.1	11.7	93.5	95.8			
5.2	27.0	20.0	8.5	79.0	84.0	11.8	93.7	96.0	15.0	97.6	99.2
5.3	27.8	31.3	8.6	80.2	84.8	11.9	93.9	96.2	15.1	97.7	99.3
5.4	28.6	32.1	8.7	81.2	85.3				15.2	97.8	99.4
5.5	29.5	33.0	8.8	82.0	86.1	12.0	94.0	96.3	15.3	97.8	99.5
5.6	30.3	34.0	8.9	82.8	86.7	12.1	94.2	96.4	15.4	97.9	99.3
5.7	31.1	35.0				12.2	94.4	96.5	15.5	98.0	99.6
5.8	31.8	36.0	9.0	83.6	87.2	12.3	94.5	96.6	15.6	98.1	99.6
5.9	32.6	37.0	9.1	84.3	87.8	12.4	94.6	96.7	15.7	98.2	99.7
			9.2	85.0	88.3	12.5	94.8	96.8	15.8	98.2	99.2
6.0	33.6	38.0	9.3	85.6	88.8	12.6	95.0	96.9	15.9	98.3	99.9
6.1	34.7	39.1	9.4	86.2	89.3	12.7	95.1	97.0			
6.2	35.8	40.2	9.5	86.7	89.8	12.8	95.2	97.1	16.0	98.4	100.0

Table 4: Genderwise distribution of Frequency and Percentage

	Frequency	Percent
Female	31	50
Male	31	50
Total	62	100

Table 5 : Intraclass Correlation Coefficient[a]

	Intraclass Correlation[c]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Female	.972[b]	.943	.986	70.493	30	30	.000
Male	.950[b]	.899	.976	38.910	30	30	.000

Interpretation of ICC	
< 0.40	Poor agreement
.4 -- .75	Fair agreement
.75 - .85	Good agreement
> 0.85	Excellent agreement

Table 6: Comparison between chronological age and age with Demirijian's method

	N	Minimum	Maximum	Mean	Std. Dev.	Diff	't' Value	'p' Value
Chronological age (years)	62	5.1	16.0	11.3081	2.57308	0.1192	-1.010	0.317
Age by Demirijian's method (years)	62	4.5	15.6	11.2210	2.45117			NS

Table 7: Comparison between chronological age and age with Demirijian's method both in males and females

Gender		N	Minimum	Maximum	Mean	Std. Dev.	Diff	'T'value	'P'value
Female	Chronological Age (Years)	31	7.2	16.0	11.8484	2.68165	0.2690	1.403	0.122
	Age by Demirjian's method (years)	31	7.5	15.6	11.6677	2.65887			NS
Male	Chronological Age (Years)	31	5.1	13.4	10.7677	2.38067	0.0193	0.050	0.961
	Age by Demirjian's method (years)	31	4.5	14.7	10.7742	2.17592			NS