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Research Article

Dental Age Assessment in South Indian Children using Demirijian's Method

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Abstract: Aims and objective of the study was to assess age of children by using Demirijian's method and also to estimate the efficacy of Demirijian's method in South Indian Children. The present study comprised of 25 subjects 3-16 years from Mangalore, South India. Dental age was assessed by using the Demirijian's method. Panoramic radiographs were taken for the same. The obtained data were analysed by using paired t test, intra class correlation coefficient and regression analysis using SPSS 13 software for statistical analysis. Average chronological age was 10.125 ±2.3492. Average age estimated by Demirijian's method was 10.244 ±2.3815. The intraclass correlation coefficient between the two methods showed (ICC > 0.85) excellent agreement between the two. Statistical analysis indicated that there is no significant difference between chronological age and age obtained by Demirijian's method. Demirijian's method has been employed by many authors mainly in the Western population. Few studies have been done in Indian population. The present study indicated that,Demirijian's method was reliable for age estimation in our 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, Demirijian's method.

INTRODUCTION

Forensic age estimation for identifying the unidentified human bodies has been a tradition in forensic science. Application of radiology in forensic science was first introduced in 1896 by Prof. Arthur Schuster [1]. As dental tissues are most durable and also resistant to chemical, mechanical and thermal changes it has been widely used. Histo-pathological investigation especially aspartic acid racemization [2] was supposed to be the best. But as it was not ethical to extract a tooth in a person just to know the age, radiology has gained a greater importance.

There are various methods from which dental age can be estimated. Developmental stages of teeth using radiographs are widely used of which Demirijian's method is simple, less time consuming and easy to apply. Demirijian and his co-workers in 1973 gave scoring criteria [3, 4] which was based on maturation stages of seven teeth that is from mandibular left central incisor up to second molar. Scores were summed up and compared with centile charts to arrive at the age.

In 1998, Koshy S *et al*. had applied Demirijian's method on South Indian population and noticed that there was overestimation by 3 years [5].

With this background the present study was done with an objective to assess age of children by using Demirijian's method & to estimate the efficacy of Demirijian's method in Indian Population.

MATERIALS AND METHOD

The present study was conducted in the Department OPD, Mangalore South India. 25 co-operative patients (10 females, 15 males) with age group of 3-16 years in whom the left mandibular teeth were present & who were advised for panoramic radiograph were selected for the study. In case of missing left tooth, its counterpart on right side tooth was selected for scoring. Patients with developmental anomalies were excluded.

Nature of the study was explained to the patient. Brief clinical findings along with personal details of the patient were recorded using a standard format. Chronological age was calculated from date of birth to date of radiograph being taken.

Patients were subjected to panoramic radiograph (PlanmecaPromax, Finland) using phosphor plates which was later digitized on a laser scanner (Agfa-nx) and images were recorded by a computer-aided Agfa-nx drafting program.

Mandibular right and left teeth were examined and Demirijian's method was applied. The teeth on the mandibular left side from the mandibular central incisor to mandibular 2nd molar in 25 patients were scored based on Demirijian's criteria which included 8 stages of tooth development. Stages were entered into a separate scoring proforma following which sex-specific maturity score for each tooth was entered (Table 1, 2) [3, 4]. Scores were summed up & compared to master chart of the Demirijian's table (Table 3) [3, 4] and the age were estimated. Estimated age was then compared with the chronological age.

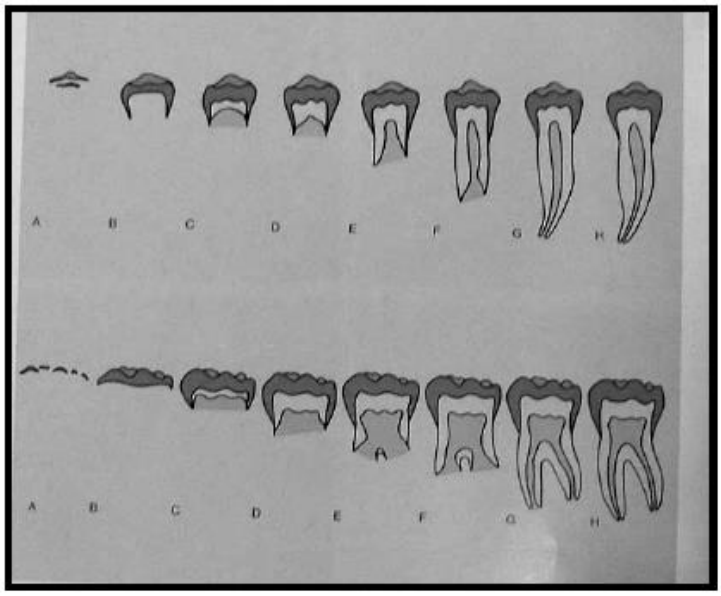

Fig. 1: A: Calcified cusp tips that are not fused, B: Calcified cusp tips that are fused with well-defined occlusal surface outline, C: Complete formation of enamel at occlusal surface. Commencement of dentinal deposition, D: Completion of crown formation upto cement enamel junction. Root formation is 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.

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
Central Incisor						1.9	4.1	8.2	11.8

(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: Demirijian 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: Sexwise distribution of Frequency and Percentage

	Frequency	Percent
Female	10	40.0
Male	15	60.0
Total	25	100.0

Demirijian's method.

The chronological age & dental age obtained using Demirijian's method was later subjected to paired t test, intra class correlation coefficient and regression analysis using SPSS 13 software.

RESULTS

This study comprised of 25 patients between the age group of 3-16 years. Demirijian's method was used to determine the age. There was no significant difference between chronological age and age obtained by

Frequency in gender distribution is shown in Table 4.

Distribution of patients with their chronological age and the estimated age using Demirijian's method are shown in Table 5.

Out of 15 males, 11 patients showed good correlation in estimated age when compared with their respective chronological age with maximum difference in age by 5 months and minimum by 1 month. Remaining 4 male

patients showed difference of more than 6 months. Over estimation was seen in 1 male patient by 1.3 years. Under estimation was seen in 3 patients by 11 months to 2 years.

Out of 10 females, 8 patients showed good correlation between chronological age and estimated age with difference of 1-6 months. 2 patients showed over estimation of age by 1.0 & 1.2 years.

A comparison of chronological age and Demirijian's method is shown in Fig.3. There was no significant difference between chronological age and age with Demirijian's method.

Intraclass correlation was 0.984(C.I: 0.937-0.996) for females and 0.971 (C.I:0.913-0.990) for males both the gender shows excellent agreement (>0.85) as shown in Table 6.

No significant difference between chronological age and age with Demirijian's method (Table 7) both in males and females as in Table 8. 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 age by Demirijian's method was 10.244 and standard deviation of 2.3815 was seen. Average age estimated by Demirijian's method was 10.244 ±2.3815 shows statistically non-significant difference. Average chronological age was 10.125±2.3492 & average age by Demirijian's method was 10.244±2.3815 shows statistically non-significant difference.

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

Regression formula

Chronological age=0.343+0.941*Age by Demirijian Method+0.237*Gender (Substitute 1 for male and 0 for females)

Table 5: Distribution of patients with their chronological age and the estimated age using Demirijian's method

Sl. No	Name	Gender	DOB	DOR	Chronological Age (Years)	Age By Demirijian's Method (Years)
1	Abdul basheer	Male	18/12/2004	29/1/2013	9.1	9.4
2	Mohammed Irfan	Male	14/9/1999	9/2/2013	13.4	14.7
3	Sahal	Male	5/1/2008	9/2/2013	5.1	4.5
4	Abdulla hani	Male	23/5/2001	2/2/2013	11.8	12.0
5	Akther	Male	13/11/2001	7/5/2013	11.6	11.5
6	Abhishek	Male	7/72004	15/6/2013	9.1	9.2
7	Muzamil	Male	20/2/2003	4./5/2013	10.3	10.8
8	Aftab	Male	12/5/2003	15/6/2013	10.1	10.3
9	Ashraf	Male	12/4/2000	29/5/2013	13.1	12.3
10	Ziyad	Male	3/4/2003	28/5/2013	10.1	8.1
11	Nihaal	Male	3/1/2006	25/5/2013	7.4	7.9
12	Thansif	Male	21/2/2001	21/5/2013	11.3	11.5
13	Ameenijaz	Male	2/9/2002	3/8/2013	10.11	9.7
14	AmanIjaz	Male	6/3/2005	3/8/2013	8.5	8.2
15	Shakeeb	Male	19/3/2002	3/4/2013	12.1	12.3
16	Sharmina	Female	7/ 5/2005	11/6/2013	8.5	8.6
17	Riza	Female	28/6/2002	30/5/2013	10.11	11.0
18	Safwana	Female	28/3/2000	16/2/2013	12.1	11.9
19	Ashneefa	Female	4/4/2002	30/5/2013	11.1	11.6
20	Ashida	Female	15/6/1997	15/6/2013	16	15.6
21	Fathimath	Female	12/2/2005	27/5/2013	8.4	9.4
22	Maliha	Female	3/3/3005	28/5/2013	8.2	9.4
23	Mariyam	Female	3/2/2005	14/5/2013	8.2	7.8
24	Murshida	Female	12/11/2002	9/4/2013	11.2	10.9
25	Samzina	Female	28/3/2006	28/5/2013	7.2	7.5

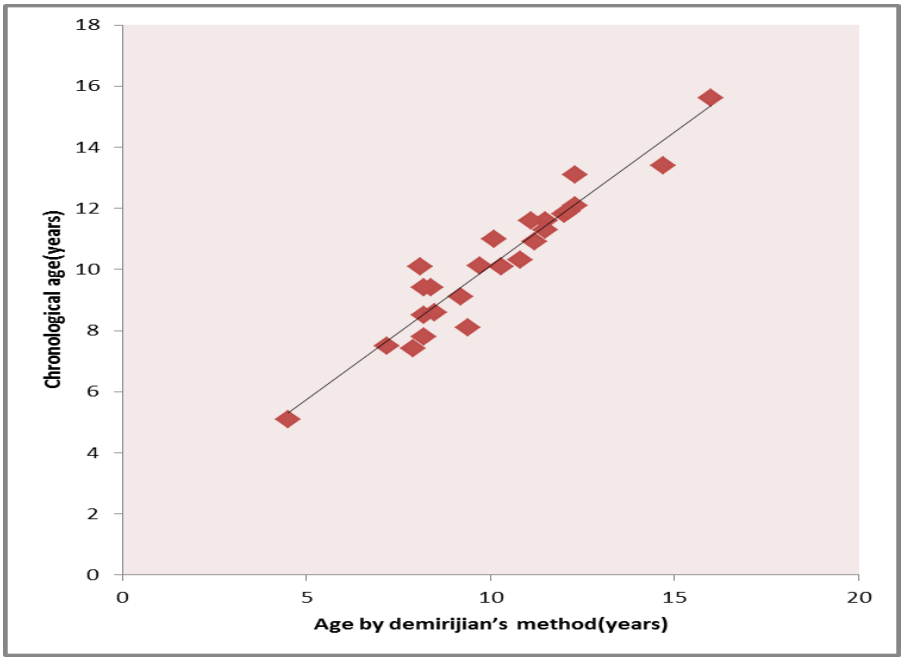

Fig. 2: Comparison of chronological age and Demirijian's method

Table 6: Intraclass Correlation Coefficient

Gender	Intraclass Correlation	95% Confidence Interval		p value	
		Lower bound	Upper bound		
Female	0.984	0.937	0.996	0.000	HS
Male	0.971	0.913	0.990	0.000	HS

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

Table 7: Comparision between chronological age and age with Demirijian's method

	N	Minimum	Maximum	Mean	Std. Dev.	Diff	't' Value	'p' Value
Chronological age (years)	25	5.1	16.0	10.125	2.3492	0.1192	0.810	0.426
Age by Demirijian's method (years)	25	4.5	15.6	10.244	2.3815			NS

Table 8: Comparision 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)	10	7.2	16.0	10.101	2.6268	0.2690	1.403	0.194
	Age by Demirjian's method (years)	10	7.5	15.6	10.370	2.3977			NS
Male	Chronological Age (Years)	15	5.1	13.4	10.141	2.2414	0.0193	0.092	0.928
	Age by Demirjian's method (years)	15	4.5	14.7	10.160	2.4512			NS

DISCUSSION

Radiological method of age estimation is one of the most reliable methods which have been used. We tried using Demirijian's method in 25 individuals from Mangalore, South India and a good correlation was found and was also easy to apply. It was quick method and did not involve many calculations. Demirijian's method was introduced by Demirijian A and Goldstien H [3] in 1973 which was updated in 1976 and the method was used on French Canadian population. It uses eight stages of tooth development. This method not only estimates age in years but also month of an individual's age.

In 1999, Demirijian's method has been widely used on British children of Bangladeshi origin and white Caucasians [6]. Non-significant difference between the ethnic groups was found. It was also stated that Demirijian's 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 [7] and was considered as the most reliable method. It also stated that this method gives a continuous score to each change taking place in all 7 mandibular teeth which is the basis for age estimation. A study in 2007 [8] stated that Demirijian's method was more accurate and also it assess age by maturity pattern of teeth thus deserves special attention.

The original method of Demirijian was also modified by many authors at later date. One among them was in 2003 [9]. Few other authors in 2007 [10, 11] also used Demirijian's method on third molars although third molars were not used in original study. It [10] stated that Demirijian's method was easy to apply and it can be used in medicolegal cases in order to identify an individual is over 18 years or not. In 2007 [11], no sexual variation was found in dental maturity. It was done on a Turkish population. There are few studies done on Indian population using Demirijian's method. In 1998, a study [5] had applied this method on South Indian population and noticed that there was overestimation by 3 years. With this background a study [12] in 2011 used Demirijian's 8 teeth method and noticed reduction in overestimation by 1 year in Indian population. The author also found that there were greater errors on incorporating 3rd molars. In 2011, [13] had done similar study using 8 teeth method and carried out a regression analysis and had introduced a formula for Indian population.

We used Demirigian's method on 25 patients in South Indian children between age group of 3-16 years and found good correlation between chronological age and the estimated age.

In our study out of 15males, one male showed dental age overestimation by 1.3 years and under estimation in 3 males (11 months, 1.4 years and 2 years). In females out of 10, 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 males and females.

Study in 2007 [14] also have shown high correlation between the chronologic ages, dental age which also used Demirijian's method. A study from Central Poland [8] also did not show any sexual variation in their dental maturity. There was no statistically significant difference found between girls and boys which were similar to our results.

In the year 2001, [15] was carried out a study in Belgian Caucasian population. Demirijian's method was applied on 355 orthopantamograms. The over estimation of chronological age was confirmed. The adapted scoring system resulted in new age scores and was highly accurate in comparison with the original method.

The inter 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 using Demirijian's method.

CONCLUSION

The results of our study using Demirijian's method showed a good assessment of dental age in South Indian children although there are under and overestimation in literature. Statistically no significant difference was found between males and females. Demirijian's 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 accurate age in children. Further study will be required with the use of larger sample size to consider this method as specific in our population.

REFERENCES

1. Shahin KA, Chatra L, Shena P; Dental and craniofacial imaging in forensics. Journal of Forensic Radiology and Imaging 2013; 1(2): 56-62.
2. Shafer, Hine & Levy; Shafer's textbook of oral pathology. 5th edition, 1999.
3. Demirijian A, Goldstein H, Tanner JM; A new system of dental age assessment. Hum Biol., 1973; 45(2): 211-227.
4. Demirijian A, Goldstein H; A new system of dental maturity based on seven and four teeth. Annals of Human Biol., 1976; 3(5): 411-421.
5. Koshy S, Tandon S; Dental age assessment: the applicability of the assessment in South Indian children. Forensic Sci Int., 1998; 94(1-2): 73-85.
6. Liversidge HM, Speechly T, Hector MP; Dental maturity in British children: Are Demirijian's standard applicable? Int Journal Paediatric Dent., 1999; 9: 263-269.

7. Leurs IH, Wattel E, Aartman I, Etty E, Prahl Andersen BP; Dental age in Dutch children. European J of Orthod., 2005; 27(3): 309-314.
8. Kalinowska IR, Czkowska EKR, Kalinowski P; Dental age in Central Poland. Forensic Sci Int., 2008; 174(2-3): 207-216.
9. Foti B, Lalys L, Adalian P, GiustinianiJ, Maczel M, Signoli M; New forensic approach to age determination in children based on tooth eruption. Forensic Sci Int., 2003; 132(1): 49-56.
10. Meinl A, Tangl S, Huber C, Maurer B, Watzek G; The chronology of third molar mineralization in the Austrian Population- A contribution to forensic age estimation. Forensic Sci Int., 2007; 169(2-3): 161-167.
11. Orhan K, Ozer L, Orhan AI, Dogan S, Paksoy CS; Radiographic evaluation of third molar development in relation to chronological age among Turkish children & youth. Forensic Sci Int., 2007; 165(1): 46-51.
12. Kumar V J, Gopal KS; Reliability of age estimation using Demirijian's 8 teeth method and India Specific Formula. J Forensic Dent Sci., 2011; 3(1): 19-22.
13. Acharya AB; Age estimation in Indians using Demirijian's 8 teeth method. J Forensic Sci., 2011; 56(1): 124-127.
14. Krailassiri S, Anuwongnukroh N, Dechkunakorn S; Relationship between dental calcification stages & skeletal maturity indicators in Thai individuals. Angle Orthod., 2002; 72(2): 155-166.
15. Willems G, Van Olmen A, Spiessens B, Carels C; Dental age estimation in Belgian children: Demirijian's method revisited. J Forensic Sci., 2001; 46(4): 893-895.