

# Correlation of Radiographic and Chronological Age in Human by using Demirjian's Method: A Radiographic Study

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## ABSTRACT

The age of the individual can be assessed as skeletal age, morphological age, secondary sex character age and dental age and these may be applied singly or in conjunction to assess the degree of physical maturity of a child. The determination of physiological age is based on the various degree of maturation of the different tissue systems. Dental age is one of the important factor taken into account when formulating treatment plans and having particular relevance to the timing of treatment.

**Aim:** The study was designed to determine dental age from orthopantomograph using Demirjian method and to investigate applicability of Demirjian method for estimation of chronological age in Central Indian (Indore, Madhya Pradesh) population.

**Materials and methods:** The sample for the study consisted of 210 individuals between 72-156 months (6-13 years) of age randomly selected from various schools. Panoramic radiographs of all individuals were studied and dental age was calculated by using Demirjian's method.

**Results and conclusion:** When Demirjian method was applied to Indore children, mean difference between true and assessed age for males showed overestimation of 1.34 months, i.e. overestimation by 40 days and females showed overestimation of 1.97 months, i.e. overestimation by 59 days. The mean difference between true age and assessed age for total sample was 1.66 months, i.e. overestimation by 49 days. Positive correlation showed in total male and female sample along with male and female combined sample.

Age estimation using Demirjian's method was found to be accurate when applied to Central Indian (Indore, Madhya Pradesh) population.

**Keywords:** Dental age, Chronological age, Demirjian method.

## INTRODUCTION

Although various age assessment methods showed high degrees of reliability, ethnic differences between various population groups were found to affect the accuracy resulting in overestimation or underestimation of the dental age. The previous studies for assessing the dental age have been conducted predominantly on the western population.

In 1973 Demirjian et al<sup>4</sup> studied, 1446 boys and 1482 girls of French-Canadian origin and gave new method of age estimation based on the radiological appearance of the seven teeth on the left side of the mandible. Four studies carried out in different regions of India to see the applicability of Demirjian<sup>4</sup> method in Indian population. This method of age estimation was significant in two studies and was insignificant in other two studies. The present study was undertaken to evaluate the correlation between chronological and dental age in central Indian population by using Demirjian<sup>4</sup> method.

## MATERIALS AND METHODS

The study was conducted at Department of Oral Medicine and Radiology, MDCRC, Indore. The sample consisted of 210 panoramic radiographs of 105 boys and girls each, randomly selected from various schools of Indore (MP). The age group consisted of children from 72 to 156 months (6-13 years) of known chronological age. All these individuals were divided into seven groups each of 12 months duration, i.e. 72-84, 85-96, 97-108,

109-120, 121-132, 133-144, 145-156 months respectively. The development of the seven permanent left mandibular teeth was determined. Tooth formation was divided into eight stages, and criteria for the stages were given for each tooth separately. Each stage of the seven teeth were given the scores according to a statistical model, which was used for assessment of skeletal maturity (Tanner et al 1975) for which standards are given separately for each sex. The sum of the scores for the seven teeth was converted into dental age according to the reference values given by Demirjian (1973).<sup>4</sup> Chronologic age of an individual was calculated by subtracting the birth date from the date on which the radiographs were exposed for that particular individual. Decimal age was taken for simplicity of statistical calculation and ages were estimated on yearly basis. Children clinically free from any developmental, endocrine or nutritional disorder and any past prolonged illness were included in the study. This was to avoid any irregularity in the results as abnormal or delayed growth can have a significant effect in the dental as well as the skeletal age as stated by Gulati et al (1990).<sup>5</sup>

## RESULTS

The values were tabulated and evaluated statistically by using t-test with help of statistical package for the social sciences (SPSS) 14 software.

Maximum correlation was found in combined group II (85-96 months) sample (0.30 months) and least correlation was found in combined group I (72-84 months) sample (7.50 months).

It is estimated in 9 days that the lowest value observed in group II in all groups and furthermore over estimation of 225 days observed in group I as highest in all groups (Table 1).

The mean difference between true age and assessed age for total male sample (Table 2) was 1.34 months ( $p = 0.107$ ), i.e. overestimation by 40.2 days and 1.97 months ( $p = 0.049$ ), i.e. overestimation by 59 days for females (Table 3). The mean difference between true age and assessed age for total sample was 1.66 months ( $p = 0.011$ ), i.e. overestimation by 49 days (Table 1).

Trend line graphic representation (data not shown) indicated that as chronological age advances, the dental age also increases accordingly.

Positive correlation showed in total male and female sample with a correlation coefficient of 0.938 ( $p < 0.01$ ) and 0.922 ( $p < 0.01$ ) respectively. And, positive correlation in male and female combined sample showed correlation coefficient of 0.929 ( $p < 0.01$ ).

**DISCUSSION**

Although various methods for the age determination do exist, a universal system has not been achieved due to the varying differences in different ethnic population groups. Moreover, determination of growth and development of a child is of great value in medical and dental field.

Tooth formation is superior to tooth emergence in age determination because emergence is a fleeting event disturbed by different exogenous factors, such as infection or premature extraction, crowding, ankylosis and determination of precise time

in emergence is very difficult. It can only be applied up to the age of 30 months (completion of the deciduous dentition) and after the age of 6 years (eruption of the first molar) till approximately 12 years of age (last permanent tooth emergence), excluding third molars.<sup>6</sup> Whereas calcification in developing tooth is a continuous process which can be assessed by using radiographic study as a permanent record.

Demirjian system utilizes panoramic radiographic technique as it is easier to take than intraoral radiographs in young or nervous children and use less radiation dose than a full mouth radiograph (McDonald, 1969). Although there is 3 to 10 % enlargement of left side of mandible on the panoramic radiographs (Sapoka, 1971), this is not a serious drawback as the rating of Demirjian system is based on shape criteria and relative values rather than on absolute length.<sup>4,6</sup>

The obtained dental age in this study in different groups was found to be higher than the chronologic age in both males and females. Therefore, the obtained dental age of the children from Indore was observed to be at a little higher level than the French-Canadian population on whose dental development, Demirjian values are based.

An average overestimation of 1.34 months (40 days) in males and 1.97 months (59 days) in females was found. Koshi (1998) reported an overestimation of 3.04 and 2.82 years in males and females respectively in South Indian children.<sup>7</sup> Prabhakar (2002) reported an overestimation of 1.20 and 0.90 years in males and females respectively in Davangere children (South India).<sup>8</sup>

**Table 1:** Comparison of true and assessed age for combined sample

Age group (In months)	Mean ± Standard deviation		Difference between means	t value	p value
	Chronological age	Dental age			
72-84	81.56 ± 2.18	89.06 ± 8.06	7.50	5.40	0.000
85-96	89.90 ± 3.39	89.60 ± 4.56	- 0.30	0.42	0.674
97-108	100.70 ± 3.08	98.43 ± 5.87	- 2.27	3.26	0.003
109-120	115.00 ± 2.79	118.46 ± 11.39	3.46	1.73	0.093
121-132	126.46 ± 3.70	128.10 ± 11.69	1.64	0.76	0.450
133-144	139.40 ± 3.20	139.20 ± 11.18	- 0.20	0.09	0.925
145-156	150.80 ± 3.65	152.56 ± 10.95	1.76	1.04	0.303

**Table 2:** Comparison of true and assessed age for males

Age group (In months)	Mean ± Standard deviation		Difference between means	t value	p value
	Chronological age	Dental age			
72-84	81.13 ± 2.32	88.73 ± 7.33	7.60	4.38	0.000
85-96	89.53 ± 3.27	89.46 ± 3.70	- 0.07	0.07	0.946
97-108	101.80 ± 3.09	101.40 ± 3.85	- 0.40	0.62	0.545
109-120	114.80 ± 3.00	116.26 ± 9.66	1.46	0.63	0.534
121-132	126.53 ± 3.20	130.80 ± 11.91	4.27	1.37	0.189
133-144	140.73 ± 2.66	137.86 ± 11.55	- 2.87	1.07	0.300
145-156	150.06 ± 3.49	149.46 ± 7.60	- 0.60	0.30	0.766

**Table 3:** Comparison of true and assessed age for females

Age group (In months)	Mean ± Standard deviation		Difference between means	t value	p value
	Chronological age	Dental age			
72-84	82.00 ± 1.89	89.40 ± 8.98	7.40	3.31	0.005
85-96	90.26 ± 3.59	89.73 ± 5.43	- 0.53	0.50	0.621
97-108	99.60 ± 2.74	95.46 ± 6.15	- 4.14	3.96	0.001
109-120	115.20 ± 2.65	120.66 ± 12.84	5.46	1.67	0.116
121-132	126.40 ± 4.25	125.40 ± 11.21	- 1.00	0.34	0.733
133-144	138.07 ± 3.22	140.53 ± 11.05	2.46	0.75	0.463
145-156	151.53 ± 3.77	155.66 ± 13.04	4.13	1.56	0.141

A possible explanation for the difference in the estimated dental age between the French-Canadian children and the Indore children (Indian) can be attributed to the difference in ethnicity and/or considerable time gap between two studies on the dental development of these children.

Other probable causes of difference are the environmental factors, such as the socioeconomic status, nutrition and dietary habits that vary in different population groups.<sup>6-8</sup> Gulati et al (1990) stated that malnutrition can have an adverse effect on the dental and skeletal maturation.<sup>5</sup>

In the present study, obtained dental age and chronologic age was correlating and statistically significant ( $p < 0.001$ ,  $r = 0.938$  in males and  $r = 0.922$  in females). This is in agreement and support with Cheraskin (1972) and Hagg et al (1985, Swedish children) who found a high correlation level ( $r = 0.7-0.9$ ) between true and estimated age in children between 3.5 and 6.5 years, regardless of the methods used.<sup>9,10</sup> Statistically significant correlation between chronological age and dental age assessed by Demirjian method was found in different populations,<sup>11</sup> as in Finnish,<sup>12</sup> Jenian,<sup>13</sup> Brazillian,<sup>14</sup> South-Australian<sup>15</sup> and South-Indian children.<sup>6</sup> Many other studies also showed overestimation of age by Demirjian method in different population worldwide like in India,<sup>7,8,16</sup> South Australia,<sup>17</sup> Thailand,<sup>18</sup> Brazil,<sup>19</sup> South France,<sup>20</sup> Poland,<sup>21,22</sup> London,<sup>23</sup> Cortica,<sup>24</sup> Turkey<sup>25</sup> and in Spanish-Italin-Cortian children.<sup>26</sup>

Male and females of younger age group showed less correlation and maximum difference between true and assessed age (72-84 months of age group,  $r = 0.389$ ) as compared to older age group (85-156 months).

Demirjian system utilizes eight stages of development for each of the seven left mandibular teeth, altogether 56 stages of which only the late 26 stages are given separate scores, specific for sex. According to the figures on median age of attainment, 16 out of 26 stages are attained within the younger group of present study (6-9 years), and 12 to 13 stages within the older age group (10-13 years).

In 85 to 156 months of age group, the difference between true and assessed age of combined sample decreased with mean of 0.65 months. The females ( $n = 105$ ) were ahead of the boys ( $n = 105$ ) in dental development while comparing with all groups with a difference of 0.67 months. This is in accordance and compatible with the findings of other studies.<sup>16,17,21,25,26,27-33</sup> This is because of earlier maturation of other parameters of development in females, such as height, sexual development and skeletal development.<sup>21, 33</sup>

Staaf Vera et al (1991) studied precision and accuracy of three different methods; Haavikko, Lilliequist-Lundberg and Demirjian. The outcome of the study showed that when Demirjian method was applied, age estimated was too high, and it was found that charts made from Scandinavian population gave good precision while one from Canadian population gave consistent overestimate.<sup>29</sup>

Furthermore, Davis and Hagg (1994) suggested the accuracy and precision of Demirjian method for estimation of chronological age based on tooth formation in Chinese children of 5 to 7 years of age group. This indicated that Demirjian method cannot be used accurately to estimate chronologic age of 5 to 7 years age group. An explanation to this could be relatively less sample size which cannot be fully comparable to the subjective index in the reference study of French-Canadian population. No two individuals grow and develop at the same rate.<sup>34</sup> Nystrom et al (1988) emphasized that differences in overall dental maturity do exist not only in group

of nations but also amongst the groups of children in a nation with a relatively homogeneous population.<sup>35</sup>

The applicability and reliability of Demirjian method shows variation in different regions of the country and out side the country. In the present study estimated dental age was found within the range of 0 to 2 months of the chronologic age.

This variation of 2 months in age estimation is not much and the method can be applied reliably in central indian population.

## CONCLUSION

The assessment of dental age, stage of calcification can be reliable indicator as the teeth progressively calcify with the definite age. It is independent of somatic growth and is the least susceptible of these systems to change, both over the centuries and to environmental influences. In the present study, we evaluated the interrelationship between chronological and dental age using Demirjian method. Age estimation using Demirjian method was found to be accurate when applied to Central India (Indore, Madhya Pradesh) population.

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