

Validation and Comparison of the Demirjian Method and Alqahtani Method in Pediatric Population of Sahibabad Region

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Abstract: Introduction: Age estimation plays a significant role in crime investigation, genetic research, and human identification. It is a vital technique in the field of forensic sciences. Most widely used, Demirjian's technique is a scoring standard based on maturation stages of seven permanent teeth in the lower left quadrant. Alqahtani's approach uses panoramic or lateral oblique radiographs for age estimation. Both these methods have various advantages and disadvantages. In order to reduce the bias amongst different modalities of age assessment our study compares the accuracy of dental age assessment by using these two systems.

Materials and methods: This retrospective, cross-sectional study was conducted on selected 100 Orthopantomogram (OPG) radiographs of children between 3 and 13 years of age of Sahibabad region. The same set of radiographs were used in the calculation of age using the two methods (Demirjian's method and Alqahtani's method) and the child's chronological age was also calculated.

Statistical analysis: Paired t-test was applied to find out the mean difference between chronological age and Alqahtani age and also between the chronological and Demirjian age. One way ANOVA test was applied to know the difference between the chronological age, Demirjian age and Alqahtani age.

Results: The mean difference between the chronological age and Alqahtani age and between the chronological and Demirjian age was statistically significant among males ($P=0.0001$). The mean difference between chronological and Alqahtani age was statistically significant ($P=0.003$). While between the chronological and Demirjian age, it was not found to be statistically significant among females ($P=0.252$). When the three age estimation methods were compared, there was no significant difference ($P=0.100$).

Conclusion: The Demirjian's method and the Al-Qahtani could accurately estimate the actual age of the patient. Instead of only using Demirjian method for age estimation, Alqahtani's method must also be given equal importance since it is equally efficient.

Keywords: Demirjian's Method, Dental Age Estimation, Al-Qahtani's Method, Chronological Age.

1. Introduction

Personal identification, now-a-days has its role not only for the purpose of legal medicine but also in cases of crime investigation, genetic research, and human identification. [1] It plays a significant role in differentiation of guilty from innocent ones for ethical problems, in legal matters, for declaring death records, and the base for penetrating in the criminal cases, mass disasters or war sufferers. [2]

The old school modalities for personal identification may include anthropometry, age estimation, finger prints, sex discrimination, identification of a particular person, height measurement, and gender distinction through blood groups. [3] The exact age estimation during the hour of death with the assistance of remains of dental tissues is a

significant parameter for personal identification. [2] Identification of the age of any person is an imperative technique in the field of forensic sciences. [4] The requirement for positive determination of the age of any person has various uses in the legal and medical arenas. [5]

There are a large number of indicators for assessment of age. Few among them include skeletal maturity, sexual development, body weight and height, and tooth eruption and development. [6] Dental age calculation can be achieved by various approaches, which include: visual, radiological, bio-chemical, morphological, and histological.

The visual methods assess: 1. The sequences of eruption of teeth: this might deliver dental age calculation for children till age of 12 to 13 years. This modality is not so dependable as it is predisposed by various local and systemic influences. 2. Teeth structure: wear and attrition, tooth colour and stains. This way is too considered less dependable. [5]

The radiographic approaches are dependent upon the assessment of tooth development on the different radiographic pictures for evaluating the amount of tooth mineralization from the instant when the radiopaque spots become noticeable far before the calcification of tooth till the time the apex of the tooth is closed. This technique permits continual evaluation of tooth development from birth up to the complete development of the wisdom tooth. This technique evaluates the different stages of formation of the tooth from the early tooth mineralization, the crown development, growth of root, tooth eruption into the oral cavity, and maturation of the root apex. It is largely appropriate for the adolescents. It is a simple, non-invasive, and reproducible way that can be used for both living and unidentified dead persons. [5] Dental age estimation is one of the highly rapid and reliable scientific approaches, as the teeth are more resilient to nutritional, hormonal, and pathological variations, especially in the adolescents. [7]

There are numerous radiographic pictures that could be used for the purpose of dental age estimation, counting intraoral periapical radiographs, lateral oblique radiographs, cephalometric radiographs, panoramic radiographs, digital radiographs, and advanced imaging techniques. The radiographic pictures should comprise developing teeth which have relevancy, and all the steps of dental growth can be appraised [7]. These days, the most widely accessible, immediately available, and manageable tool on proposition is the panoramic radiograph. This imaging modality necessitates fewer X-ray radiation when associated to status imaging, is informal to perform, and doesn't include any uneasiness to the patient. [5]

The previous approaches of age determination majorly concentrated on derivation of a uniform applicable scale for estimation of age dependent on the score assessed from the different stages of growth that were envisaged radiographically. These were established on populations that weren't heterogeneous in configuration and so often caused in note-worthy changes when using the data-set implications directly. [8]

Further reliable age estimation outcomes are gained from dental constraints when linked to the skeletal development assessment methods. This is particularly appropriate in children and adolescents, where the expansion is continuously taking place. [9] Approximation of age in the pre-adult phase is of dynamic implication in defining the responsible age in lawful proceedings. Therefore, the necessity for dependable approaches that validate the presumed chronological age is vital. [8]

The Demirjian's technique of age calculation in 1973, formed a scoring standard based on maturation stages of seven permanent teeth. [10] Though, using this technique many studies have demonstrated over-estimated chronological age by over a year, various studies use it till date for assessment and judgement with other dental age approximation approaches. Demirjian's technique has a wider application as it uses maturity scores. [11]

Al Qahtani et al. in 2010, stated about The London atlas of Human Tooth Development and Eruption which is an all-inclusive, evidence-based atlas to overcome few of the limits of earlier atlas and is worldwide accessible. [12] This is a basic atlas based comparable assessment of the stages of development and is the newest of the approaches that was chosen for our study. Age approximation by means of Al-Qahtani approach uses panoramic or lateral oblique radiographs, in patients who are older than age of 14 years, it necessitates third molar's presence [13].

The published approaches report a bias while using a single technique on few samples of different ages. In order to reduce the bias amongst different modalities of age assessment our study compares the accuracy of dental age assessment by using two systems called the London atlas and the Demirjian's method. It intends to evaluate the age of people with two different methods (London Atlas and Demirjian's) in a sample population of Sahibabad region and to compare relative accuracy of the techniques in estimation of the chronologic age of a person. This will allow us to propose the most appropriate method that can be applicable in the population of Sahibabad region.

2. Materials and methods

This retrospective, cross-sectional study was reviewed and approved by the Institutional Ethics Committee, Inderprastha Dental College and Hospital, Ghaziabad, Uttar Pradesh (Ref no. IPDC/SS/2022/7638C). This study was conducted on selected radiographs who fulfilled the following inclusion and exclusion criteria:

Inclusion criteria:

- Orthopantomogram (OPG) radiographs of children between 3 and 13 years of age, with gender, place and date of birth of the child.

Exclusion criteria:

- radiographs where the date of birth is not determined
- Name of the child is not present;
- Poor-quality radiographs that did not allow proper visualization of the degree of dental development;
- Radiographs from children with systematic diseases, syndromes or alterations in dental development, permanent tooth extraction (except for the third molar)
- Radiographs of children with proven hereditary or systematic illnesses, malnutrition, or hypodontia of permanent teeth.

100 OPG radiographs of the population of the Sahibabad region of patients aged between 3 to 13 years were taken from the patients coming to Inderprastha Dental College and Hospital, Ghaziabad, Uttar Pradesh between January 2019 to June 2022. Lottery method was used to select the radiographs.

The same set of radiographs were used in the two methods and the child's chronological age was calculated in months by subtraction of the birth date of the subject from the date on which the radiograph was exposed. Then, the dental age approximation was de-identified and evaluated by trained examiner. The examiner evaluated and scored the stages of tooth development and eruption together. All the scores were later subjected to descriptive statistical analysis.

1. Demirjian's Method: [14]

Dependent on tooth mineralization, the development phases of each one of the seven left permanent mandibular teeth, (starting from central incisors to second molar), was evaluated on an 8-stage scale beginning from A to H, and the criterion for the different stages were given individualistically for each tooth. Every phase of the seven teeth were scored, and the amount of the scores brought about an evaluation of the individual's dental 'maturity score' which was projected on a scale from 0 - 100. The 'maturity score' of each patient was then changed to 'dental age' using standard tables exact for every gender.

2. Al Qahtani's Method (The London Atlas Method): [13,15]

A pair of London Atlas illustrations for tooth eruption and development was used for comparison of the relative crown or root length of all the eight right teeth in the upper and lower quadrants.

Statistical analysis:

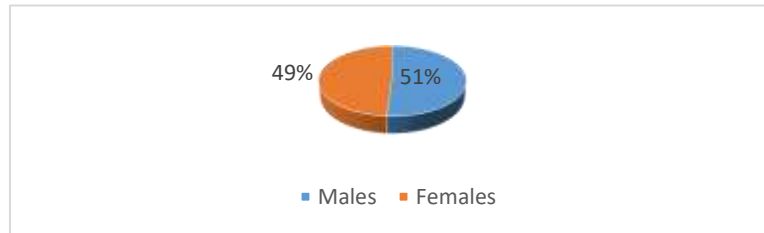
Data was analyzed using SPSS statistical package for social sciences version 27.0. Paired t-test was applied to find out the mean difference between chronological age and Alqahtani age and also between the chronological and Demirjian age. The mean chronological age of males and females was compared with the mean Alqahtani age and Demirjian age. One-way ANOVA test was applied to know the difference between the chronological age, Demirjian age and Alqahtani age. P value of ≤ 0.05 was considered to be statistically significant.

3. Results

Table 1 and graph 1 represents the Sex distribution of study population. It was seen that among the 100 samples studied, 51 were males and 49 were females.

Table 1: Sex distribution of study population

Gender	N
Males	51 (51%)
Females	49 (49%)
Total	100



Graph 1: Sex distribution of study population

Table 2, Graph 2 and table 3, graph 3 represent the comparison of chronological and dental age using different methods among males and females respectively. The mean chronological age of males was compared with the mean Alqhatani age and Demirjian age. The mean Alqhatani and Demirjian age were found to be more than the chronological age among both males and females.

Table 2: Comparison of chronological and dental age using different methods among males

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	CHRONOLOGICAL AGE	11.45	51	2.564	.359
	ALQAHTANI AGE	12.412	51	2.8689	.4017
Pair 2	CHRONOLOGICAL AGE	11.45	51	2.564	.359
	DEMIRJIAN AGE	12.353	51	3.1268	.4378

Graph 2: Comparison of chronological and dental age using different methods among males

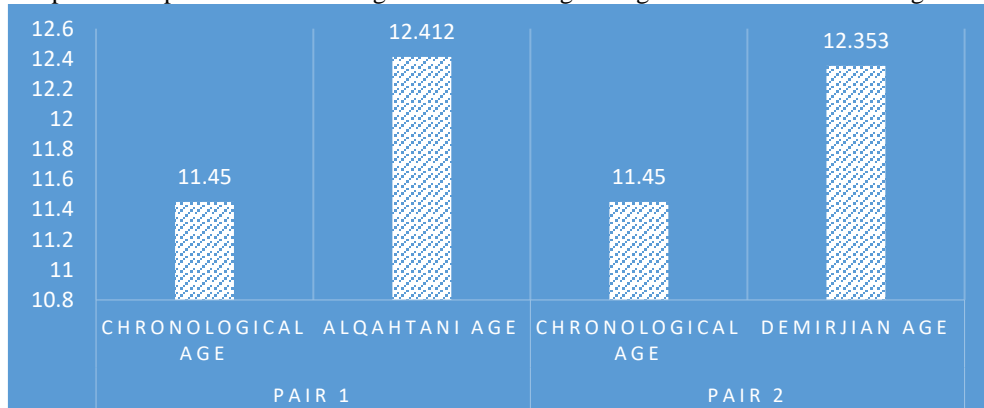


Table 3: Comparison of chronological and dental age among females

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	CHRONOLOGICAL AGE	11.8571	49	2.29129	.32733
	ALQAHTANI AGE	12.4551	49	2.59624	.37089
Pair 2	CHRONOLOGICAL AGE	11.8571	49	2.29129	.32733

	DEMIRJIAN AGE	12.1571	49	2.70247	.38607
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Graph 3: Comparison of chronological and dental age among females

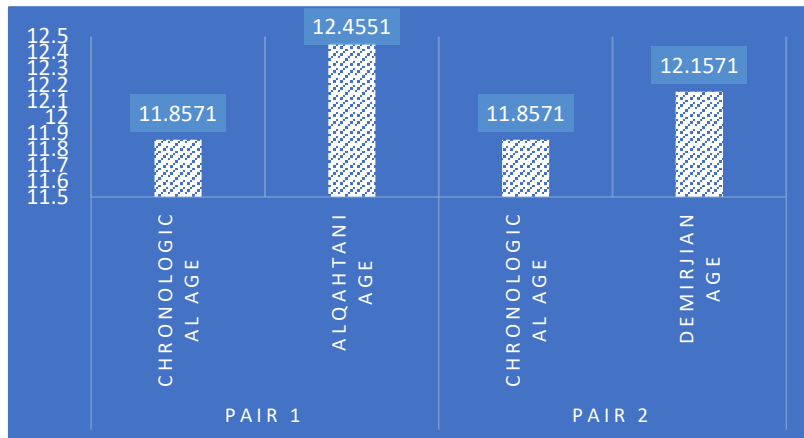


Table 4 represents the Paired sample t- test among males. When paired t-test was applied to find out the difference, the mean difference between chronological and alqahtani was 0.96+1.34 and this mean difference was statistically significant (p=0.0001). When the chronological and demirjian age were compared, the mean difference was 0.90+1.28 and this mean difference was also statistically significant among males (p=0.0001).

Table 4: Males: Paired sample t- test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CHRONOLOGICAL AGE - ALQAHTANI AGE	-.9608	1.3379	.1873	-1.3371	-.5845	-5.128	50	.0001
Pair 2	CHRONOLOGICAL AGE - DEMIRJIAN AGE	-.9020	1.2846	.1799	-1.2633	-.5407	-5.014	50	.0001

Table 5 represents the Paired sample t- test among females. When paired t-test was applied to find out the difference, the mean difference between chronological and alqahtani was 0.59+1.36 and this mean difference was statistically significant (p=0.003). When the chronological and demirjian age were compared, the mean difference was 0.30+1.81 and this mean difference was not found to be statistically significant among females (p=0.252).

Table 5: Females: Paired sample t-test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CHRONOLOGICAL AGE - ALQAHTANI AGE	-.59796	1.36145	.19449	-.98901	-.20691	-3.074	48	.003

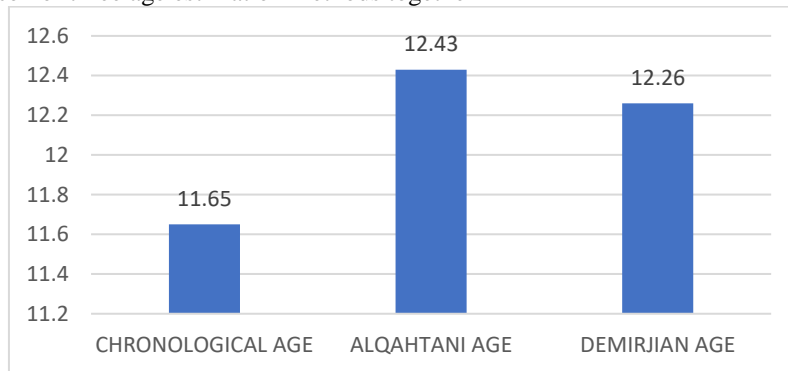
Pair 2	CHRONOLOGICAL AGE - DEMIRJIAN AGE	-.30000	1.81292	.25899	-.82073	.22073	- 1.158	48	.252
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Table 6 and graph 4 represents the Comparison of all three age estimation methods together. One-way ANOVA test was applied to find out the significant difference among the three methods. The mean chronological age was less than that reported by alqhatani and demirjjan method. However, there was no significant difference between the three age estimation methods (p=0.100).

Table 6: Comparison of three age estimation methods together

Method	N	Mean	S.D.	Std. error mean	p-value
Chronological age	49	11.65	2.43	0.24	0.100
Alqhatani age	49	12.43	2.72	0.27	
Demirjjan age	49	12.26	2.91	0.29	

Graph 4: Comparison of three age estimation methods together



4. Discussion

Dental age calculation techniques are of countless importance, as the teeth are unusually resistant to mechanical, chemical, or physical insults and duration. Additionally, dental age is slightly affected by nutritional, medical, environmental, and living circumstances. The different methods used for dental age estimation in persons include: radiological, histological and bio-chemical methods. The histological and bio-chemical modalities involve either extraction or preparation of microscopic sections of at least single tooth from a given patient so as to obtain the chronological age. [16]

To the best of our knowledge, no such study has taken place till date in the Indian subjects evaluating the alteration in the accurateness of age assessment using these two non-invasive radiographic modalities. Therefore, we compared the correctness of both these approaches in an Indian population in the Sahibabad region.

The results of this study presented that there was no substantial difference between age approximation using the Demirjjan’s technique, and the Al-Qahtani technique (P > 0.05), suggesting that both the approaches evaluate age that is near to the actual age. Nevertheless, there are various advantages and disadvantages to both the modalities. The advantages of Al-Qahtani approach are that it is easier and quicker with less charges of evaluation. Prominently, these results demonstrate that the Al-Qahtani technique can be useful on the Indian population. Significant difference was seen in our study when the Alqahtani’s age and the Chronological age were compared in both males and females. The results were similar to the study conducted in Indonesia. [17] While in another study conducted in India, no significant difference was seen between the Alqahtani’s age and the Chronological age. [18] However, the Al-Qahtani technique also has its disadvantages. Age evaluation using Al-Qahtani modality uses panoramic or lateral oblique radiographs, in subjects older than age of 14 years, it needs third molars presence [13,15]. Though, not all the subjects have presence of third molars, which might be absent or non-existent. Additionally, the size and shape of third molars is inconstant, which can disturb age evaluation, separately from the difficulties rising from influential age utilizing the atlas, such as abnormalities or delayed tooth eruption.

Demirjian's Method was established for evaluation of the age of the person dependent on the stages observed in teeth. [14] This chart was established on a French-Canadian individual and so has restrictions that it desires improvements to be validated to other ethnic populations. Earlier studies in 2015 on Western Saudi population presented the mean difference of 1.44 to 0.64 in girls and from 0.66 to 0.77 in boys. [12] Similarly, in our study we found that the Demirjian's Method presented a statistically significant difference from the chronologic age in males but not in females. We accept that the differences in the Demirjian's method is due to the age group range that is evaluated.

When the chronological mean age was compared to mean Alqahtani's age and to mean Demirjian age, the calculated age was found to be slightly over-estimated in both the methods (Table 3). The findings were similar to a study conducted in Indonesia, who evaluated the age difference using the London Atlas of tooth development method. [17] Also, in another study in the Spanish population, Demirjian method estimated an age 0.853 years older than the chronological age. [19]

In the present study, there was no statistically significant difference found between estimated age by the Demirjian's method and the Alqahtani's method and the actual chronological age. This finding is similar to that previously reported in Portuguese and Brazilian children. [9,20]

There are various advantages and disadvantages of these approaches that must be measured before selecting a suitable age evaluation modality. This study has a few draw-backs that are implied with the restrictions of sample size and the association of the alterations seen in age evaluation with an apparent alteration in demographic nutritional exposure. Additional study for quantification of variations in diet and consequence on dental tooth development is necessary in this population to overwhelmingly decide on its effect.

5. Conclusion

The Demirjian's method and the Al-Qahtani could accurately estimate the actual age of the patient. Age approximation using the Al-Qahtani and Demirjian's methods both can be applied on the population of Sahibabad region. Instead of only using Demirjian method for age estimation, Alqahtani's method must also be given equal importance for the same.

Altering diet and socio-economic factors impact the growth and development of the children and this can modify the expected consequences of age estimation by the mathematical techniques. We also conclude that periodic studies for the assessment of the variations in growth among different populations and re-evaluation of pre-determined correction values for age estimation modalities are vital in today's fluctuating culture.

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