Development of the Permanent Dentition and Validity of Demirjian and Goldstein Method for Dental Age Estimation in Sample of Saudi Arabian Children (Qassim Region)

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Abstract

Objectives: To determine dental maturity (dental age) in cross-sectional sample of Saudi Arabian children by applying the standards established by Demirjian and Golstein and to examine the applicability of these standards in determination of dental maturity among Saudi Arabian children (Qassim region).

Materials & Methods: Dental maturity was assessed from panoramic radiographs of 400 Saudi Arabian children, 222 boys, and 198 girls ranging in age from 4 to 14 years by using these standards. The difference between the dental and chronological age in different age groups in both sexes was statistically compared using ANOVA testat 0.05 level of significance.

Results: The Saudi Arabian children were generally somewhat advanced in dental maturity compared with the French Canadian reference sample with an overall mean difference between the dental and chronological age of 0.279 years in boys and 0.385 years in girls.

Conclusion: The applied standards appear to be adequate for studying dental age in groups of children among Saudi Arabian population.

Key words: Dental age, chronological age, Demirjian & Goldstein method.

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Introduction

Dental eruption and dental development are two separate processes. Dental eruption limits itself to a very short period, determined by the time of appearance of a tooth [1] and is influenced by several local factors: ankylosis, early or delayed extraction of deciduous teeth, and impaction or crowding of the permanent teeth. [2, 3, 4, 5] By contrast, the development of the permanent teeth is not affected by the status of the deciduous teeth [2, 6, 7] and can be followed longitudinally and assessed from x-rays for a period of several years, even in periods where no eruption takes place, as between 2.5 – 6 years of age and after the 12th years, if we exclude the third molar. [1] Therefore, dental development is a more reliable indicator of the biological maturity of growing children than dental eruption. [2]

Dental age (DA) estimation has an important field of application in legal and forensic dentistry; it is one of the procedures recommended for forensic age estimation, which carries with it a number of legal implications. This dental age estimation will be useful in those cases where no documentation is available evidencing the age of a person. This would apply both in civil matters (registration of birth out of time or adoptions) as in criminal matters, such as the implementation of specific legislation for minors or modification of sentences based on the victim (for example in case of violations) or the accused(as a mitigating).[8, 9, 10, 11, 12]

Likewise, from a clinical perspective, estimating (DA) in patients of known chronological age(CA) allows us to establish the similarity between (DA) and (CA), an important piece of information when planning certain treatments, determination of dental age is important to orthodontist in planning the treatment of malocclusions relative to maxillofacial growth. It is also important to paediatric dentists who may be concerned about the stage of dental development and possible timing of eruption. DA may be of interest to molecular biologists, because genetic mutation may alter dental morphogenesis. [13] Clinicians also have studied dental development as an index of chronological age, and regarded this as superior to other developing organs or structures in children with unknown or uncertain birth records. [14, 15, 16]

Several methods exist for determining DA using dental radiographs, [16,17,18,19] the best internationally known method is that of Demirjian et al. [20] that later revised by Demirjian and Golstein [21] for estimating overall dental maturity based on a sample comprising 4756 normal French – Canadian children. The method has been widely used in studies of dental maturity and comparisons between various population groups. [3,22,23,24,25,26] Furthermore, this method is the method proposed by Swedish Board for Health and Welfare for age estimation in adopted children of unknown age. [25]

Considerable differences in relation to dental development and eruption of permanent teeth have been reported between populations, so the purpose of the present study was to determine dental maturity (dental age) in cross-sectional sample of Saudi Arabian children by applying the standards established by Demirjian and Golstein [21] and to examine the applicability of these standards for use as reference for dental maturity among Saudi Arabian children.

Subjects and Methods

Panoramic radiographic records of 400 children (222 boys, 189 girls), without any history of systemic diseases,were taken from the records of Faculty of Dentistry, Qassim University, Saudi Arabia after acceptance of the college. They were used for determination of dental maturity (DA). The sample ranged in age from 4.37 to 13.94 years for boys (mean age 9.15 years) and between 4.85 to 13.83 years for girls (average age 9.20 years). The included panoramic radiographs were clear without artefacts in the regions of the roots of the teeth.

Evaluation of dental maturity

Dental age was assessed twice from the panoramic radiographs using the method of Demirjian and Goldstein. [21] In this method, the individual radiological appearance of the seven permanent teeth (second molar to central incisor) on the left side of the mandible were evaluated according to the developmental criteria to score different stages of a permanent tooth calcification. Eight stages of mineralization (A through H) for each tooth are described by written criteria, which are accompanied by photographic illustrations and

schematic drawings. The stage of each tooth was converted to corresponding numeric value, and then all seven values were added to obtain a dental maturity score, which correspond to (DA) by using available tables (Fig: 1A, B & C). The standards are given for boys and girls separately.

Using the above described method, a dental maturity score was obtained and the (DA) was determined for each subject in both groups and the differences between the chronological age (CA) and DA demonstrated the delay or acceleration in dental maturity.

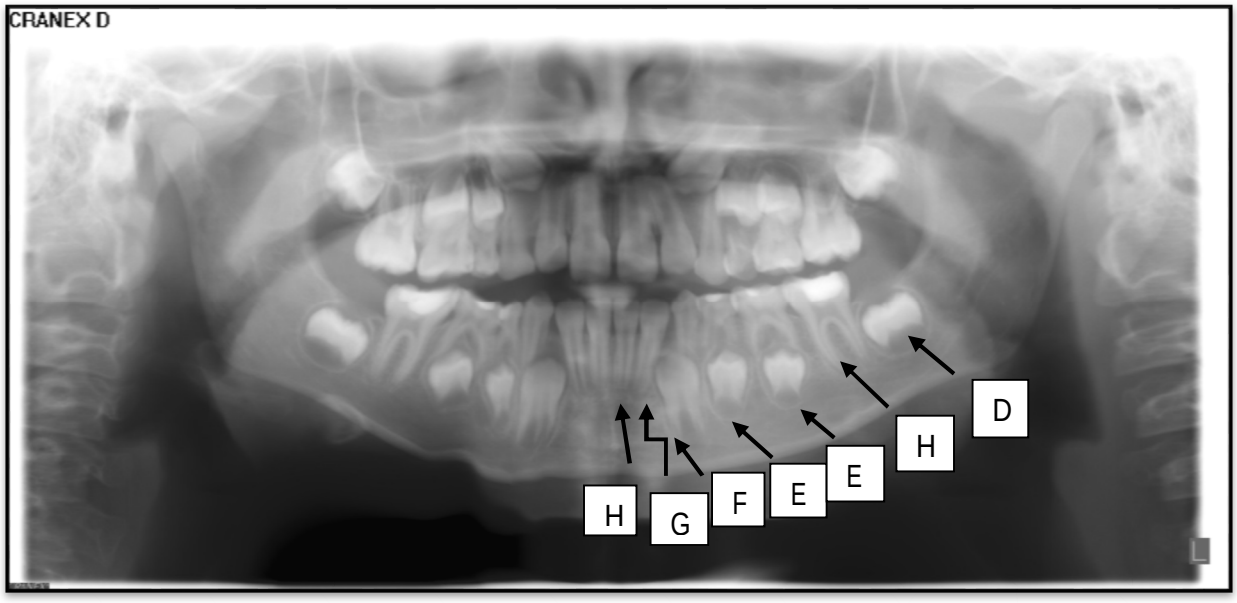
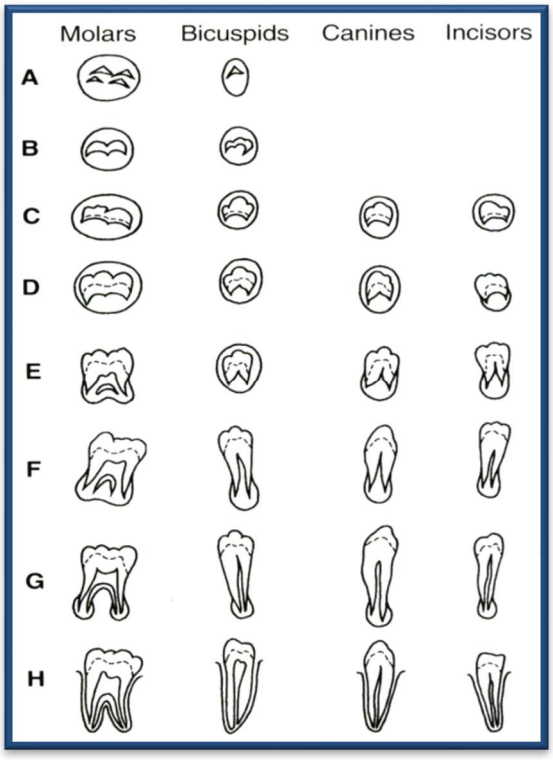


Fig 1. A: Panoramic radiograph of 8.8years (CA) old girl, the corresponding DA is 8.9 years.



Tooth formation stages

Stage A: Beginning mineralization of separate cusps.
Stage B: Fusion of cusps.
Stage C: Beginning of dentinal deposits is seen.
Stage D: Crown formation completed down to the cemento-enamel junction.
Stage E: The root length is less than the crown height.
Stage F: The root length is equal to or greater than the crown height.
Stage G: The walls of the root canal are parallel, and its apical end is still partially open.
Stage H: The apical foramen is completed

B. Determining the developmental stage of the seven left permanent mandibular teeth.

C. Conversion of developmental stage to maturity score

TOOTH	STAGE							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
M_2	2.7	3.9	6.9	**11.1**	13.5	14.2	14.5	15.6
M_1	-	-	0.0	4.5	6.2	9.0	14.0	**16.2**
PM_2	1.8	3.4	6.5	10.6	**12.7**	13.5	13.8	14.6
PM_1	-	0.0	3.7	7.5	**11.8**	13.1	13.41	14.1
C	-	-	0.0	3.8	7.3	**10.3**	1.6	12.4
I_2	-	-	0.0	3.2	5.6	8.9	**12.2**	14.2
I_1	-	-	-	0.0	2.4	5.1	9.3	**12.0**

Total dental maturity score= 11.1+ 16.2 + 12.7+11.8+10.3+12.2+ 12.0 = 86.3, converted to a dental age of 8.9 years old by using available tables - which can then be compared to the individual's chronological age.

Reliability was achieved by repeated assessment of all radiographs, the assessments agreed in 94% of the cases and the difference never exceeded one stage.

Statistical Analysis

The difference between DA and CA was tabulated according to sex and age groups, the differences were compared using a one-way ANOVA and post hoc Scheffe's test at 0.05 level of significance. All data were tabulated usingthe SPSS ver.19 (IBM Corp., NY, and USA) data processing software.

Results

Dental maturity of the normal permanent teeth assessed by the method of Demirjian and Goldstein [21] resulted in a consistent over estimation of dental age for the Saudi Arabian sample, the overall mean difference of acceleration of dental development was 0 to 0.5 (mean :0.279;sd: 0.128) in boys and 0.1 to 0.6 (mean :0.385;sd: 0.128) in girls. For almost all the 14 age classes in this sample a significant difference was found between the dental ages determined from French – Canadian standers and the chronological age. Both sexes were advanced in dental maturity compared with the reference sample, girls were always more dentally developed than boys in the different age groups and there was a significant statistical difference in the timing of dental development between boys and girls in the studied sample ($P<0.05$) Table 1.

When the sample were categorized into four age groups, in the first group (3-6) years, there was acceleration of dental development amounting (mean: 0.257; sd: 0.047) in boys and (mean: 0.350; sd:51) in girls. In children aged (6 – 9 years) there was an acceleration of dental development amounting (mean: 0.215; sd: 0.095) in boys and (mean: 0.329; sd: 0.113) in girls. In the third age group (9-12 years) the mean differences was (0.296; sd: 0.148) in boys and (mean: 0.396; sd: 0.110) in girls. In the older age group (<12 years), the overestimation was (mean: 0.433; sd: 0.048) in boys and (mean: 0.571; sd: 0.071) in girls (Tables 2&3). The post hoc Schaffer's test showed that when the boys and girls groups were compared, the Saudi children had a significantly accelerated dental development.

The accelerated dental development may be observed qualitatively from bar graphs of paired dental and chronological age data (Figs: 1and 2). The most apparent acceleration was found in the older age group (<12 years) than younger age groups in both sexes, and the least was observed in the age groups (6-9 years) in both sexes.

Table 1: Comparison of differences between CA and DA in relation to sex

Males (N1=222)		Females (N2=198)		Test of Sig		95% Conf. Interval	
Mean	**SD**	**Mean**	**SD**	**t-test**	**p**	**Lower**	**Upper**
0.279	0.128	0.385	0.128	8.520	P<0.001*	-0.131	-0.082

*: statistically significant at p<0.05.

Table 2: Comparison of differences between CA and DA in different age groups for boys

3-6years (N1=42)		6-9 years (N2=78)		9-12 years (N3= 72)		More than 12 years (N4=30)	
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
0.257	0.074	0.215	0.095	0.296	0.148	0.433	0.048
F= 30.633 , p<0.001							

F: for one way ANOVA between 4 groups
*: statistically significant at p<0.05

Table 3: Post-Hoc test for age groups comparison in boys

	3-6 years	6-9 years	9 – 12 years	More than 12
3-6 years		P=0.183	P=0.255	p<0.001*
6-9 years			P<0.01*	p<0.001*
9-12 years				p<0.001*

Post Hoc for multiple comparisons Turkey HSD
*: statistically significant at p<0.005

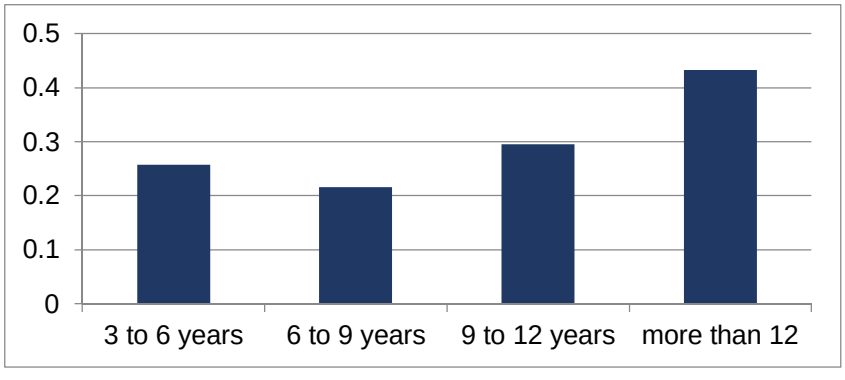


Fig 2: Comparison of differences between CA and DA at different age groups for boys indicating acceleration of dental development

Table 4: Comparison of differences between CA and DA in different age groups for girls

3-6years (N1=30)		6-9 years (N2=85)		9-12 years (N3= 55)		More than 12 years (N4=28)	
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
0.350	0.051	0.329	0.113	0.396	0.110	0.571	0.071
F=							

F: for one way ANOVA between 4 groups
*: statistically significant at p<0.05

Table 5: Post-Hoc test for age groups comparison in girls

	3-6 years	**6-9 years**	**9 – 12 years**	**More than 12**
3-6 years		P=0.768	P=0.178	p<0.001*
6-9 years			P=0.01*	p<0.001*
9-12 years				p<0.001*

Post Hoc for multiple comparisons Turkey HSD
*: statistically significant at p<0.005

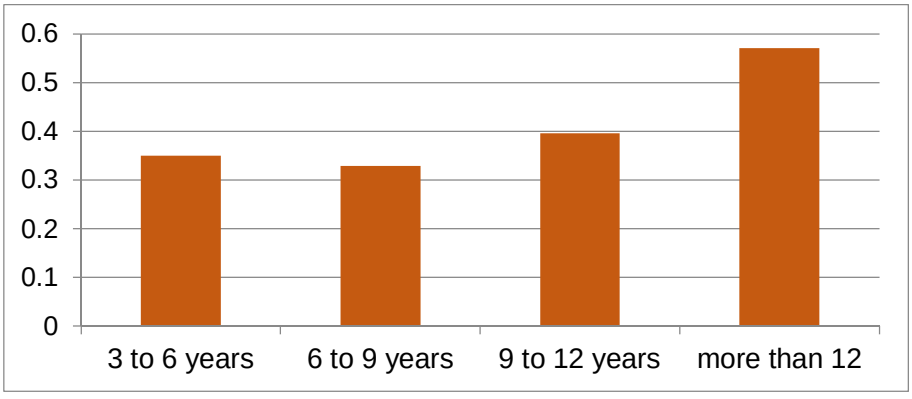


Fig 3: Comparison of differences between CA and DA at different age groups for girls indicating acceleration of dental development

Discussion

The eight stage system of Demirjian and Goldstein [21] for assessing tooth development was convenient to use and seems to be suitable for making population standards and comparing different population groups with each other.

The present results showed that in general the normal Saudi Arabian children in Qassim region were somewhat advanced in dental maturity compared with the reference sample. This finding is in accordance with the previous studies on different ethnic groups [3,22,23,24,25] in which the Demirjian method has been applied indicating rather good correspondence between dental maturity in the Saudi Arabian children and the French Canadian reference sample.

Although the dental maturity standards used in this study were those of French Canadian children provided in the report of Demirjian and Goldstein, [21] the employment of a race, age and sex matched group in this study should have cancelled sampling error from using the published standards derived from a different population and ethnic groups.

In the present sample, the overall mean differences between the DA determined from the French Canadian standards and the CA were 0.279 years in boys and 0.385 years in girls in accordance with Nykanen et al.[25] and Willam G et al. [26] who reported a mean difference 22 years for boys and 0.3 years for girls in Norwegian children ranging in age from 6 to 12 years, whereas Liversidge et al. [24] reported mean difference of 0.51 years and 0.73 years for boys and girls respectively in British children, however, the mean differences observed in the Somali, [22] Brazilian [3,20] Spanish, [27,28] and Swedish [23] populations were generally greater (up to 2.2 years) than reported in the other studies.

In the present investigation, girls were always more advanced in dental development than boys with statistically significant differences, finding that agree well with other reports on different ethnic groups, [3,22,23,24,25] other authors have reported a close similarity in the early stages of formation of individual teeth in boys and girls but pronounced differences at later stages [5,6,23,29,30] were observed.

It is already an accepted fact that girls are generally more advanced than boys in somatic growth and development up to the pre-adolescent years. This holds for the development and eruption of the permanent teeth occurring between the ages of six and 12 years if we exclude the third molar which is too inconsistent. [1]

Demirjian et al. [17] has observed that the mechanisms controlling dental development are independent of somatic and / or gender maturity and seem to be highly influenced by unknown controlling factors.

One of the greatest advantages of the Demirjian and Goldstein [21] method has been the inter-examiner inter reliability of the method, [1, 24] that confirm and underlines the usefulness of the technique in field where reproducibility rather than accuracy is of prime importance.

Conclusions

1. Saudi Arabian children (Qassim region) are generally advanced in dental development compared with the French Canadian reference sample by an average of 0.279 years in the boys and 0.385 vears in the girls. This is basically due to different rates of dental development in different populations.
2. Since the average DA in the Saudi Arabian sample did not differ markedly from the reference sample, the applied standards may be adequate as a reference for studying dental maturity in groups of children, particularly in the younger age groups.
3. Demirjian method, although limited by its accuracy in different populations, offers great scope in fields that require the study of the pattern of growth rather than the accuracy of age estimation.

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