Timing of dental development in Saudi cleft lip and palate patients

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ABSTRACT

الأهداف : تقييم توقيت التطوّر السني لمرضى الشفة الأرنبية وشق الحنك السعوديين، بالإضافة إلى تحليل بعض العوامل الثانوية كالجنس والفئة العمرية .

الطريقة : تم فحص الأشعة البانورامية لـ51 مريض بالشفة الأرنبية وشق الحنك تتراوح أعمارهم بين الخمس و 14 عام. من خلال طريقة ديميرجيان)وذلك لحساب العمر السني والتي تعتمد على تقييم مراحل نمو الجذر والتاج للأسنان الدائمة السفلية اليسرى . حيث تم تحصيل العمر الزمني للمرضى وفقاً لما هو موضح في سجلاتهم الطبية بتقسيمهم إلى 3 مجموعات عمرية . ولقد قام بجمع كافة البيانات باحث واحد وأظهر اختبار معامل العلاقة نتائج ذات دقة عالية)0.984(. ثم تم استخدام إختبار- تي الزوجي لبحث أي فروق ذات دلالة إحصائية بين متوسط العمرين الزمني والسني في العينة التي شملتها الدراسة .

النتائج : أظهرت النتائج تأخر ذو دلالة إحصائية في العمر السني عند مقارنته مع العمر الزمني ،وذلك بمعدل 8.4 أشهر . وكان هذا التأخر واضح للذكور والإناث . كما أن المرضى في عمر 8 إلى 11 عام يميلون لإظهار نزعة متزايدة نحو التأخر في عمر الأسنان مقارنة بالفئات العمرية الأخرى .

خاتمة : مرضى الشفة الأرنبية وشق الحنك السعوديين لديهم تأخر في التطوّر السني وفقاً للعمر السني، بحسب طريقة ديميرجيان، مقارنةً بالعمر الزمني .

Objectives: To assess the timing of dental development in Saudi patients affected with non-syndromic cleft lip and palate (CLP), and further investigate patients' demographics.

Methods: The panoramic radiographs of 51 Saudi subjects (5-14 years) with CLP were assessed cross-sectionally in January 2012. The data were collected at King Abdulaziz Medical City, Riyadh, Saudi Arabia, and the study was completed in February 2013. Demirjian's method was used to evaluate the crown and root developmental stages of mandibular permanent teeth to quantify the dental age. Patients' medical records were used to specify the chronological age, and utilized to divide all participating subjects into 3 groups. All data were collected by one investigator, and the intra-class correlation coefficient test showed a good reliability (0.984). The mean dental and chronological ages were then compared using paired t-test.

Results: Dental age was found to be delayed when compared with chronological age by 8.4 months (p=0.002) for the studied sample. Both gender groups expressed such delay (p=0.022 [male], p=0.020 [female]). The age subgroup 8-11 years displayed significantly (p=0.002) delayed dental development when compared with younger and older age groups. The present findings are consistent with previous reports in the literature.

Conclusion: Compared with their chronological age, Saudi patients with CLP have delayed dental development as defined by dental age using Demirjian's method.

Dental age is one of the available 3 physiological maturity assessment methods beside skeletal and somatic ages. Dental and skeletal ages are 2 important tools that are considered as biological age indictors. Skeletal age, which represents the bone maturity stage, is not well correlated with the chronological age because they are known to be more influenced by external,

environmental, hormonal, and nutritional factors.[1] Different methods have been used to estimate dental age from radiographs.[2,3] Nolla's method is based on 10 stages of tooth calcification for each tooth.[4] Haavikko[5] suggested to estimate dental age by the determination of one of 12 radiographic stages of 4 permanent teeth. Cameriere et al[2] introduced a new method of dental age estimation by measuring the open apices in 7 mandibular teeth. Demirjian'and Tanner's method[3] depends on the identification of 8 radiographic stages (A to H) of the crown, and root development on mandibular permanent teeth, excluding the third molar. The method described by Demirjian has been extensively used in the literature to assess dental maturation, and determine the dental age in Saudi subjects[6] along other ethnicities.[7-9] Several studies have evaluated the correlation between dental age and chronological age. It has been shown that the variability of dental development exists in different populations, such as between the French-Canadian Demirjian's standards and Dutch,[9] Polish,[10] Korean children,[11] and Kuwaiti children.[12] In assessing panoramic and hand-wrist radiographs of 148 Saudi male children, Al-Hadlaq et al[13] reported no statistical significant difference between the mean chronological, skeletal, and dental ages. However, Al-Emran[14] conducted a study on 430 panoramic radiographs of Saudi boys and girls, and found advanced dental age compared with their chronological age ($p>0.05$). Another study demonstrated a much higher mean increase of dental ages of Saudi children.[15] Prior studies have attempted to investigate the timing of dental development for the cleft lip and palate (CLP) population. Several authors have reported a significant delay in the development of permanent teeth ranging from 0.3-0.7 year.[16,17] Many variables have shown to affect the amount of dental delay, such as dental development stage (age group), location type of the jaw, and the severity of the cleft (bilateral versus unilateral).[18] Investigating developmental disorders and gaining additional insight into the nature and pathogenesis would render effective, and more efficient therapeutic approaches. Surgical interventions are usually required to repair oral clefts, and the timing for these interventions depends mainly on the child's stage of dental development. Variability

between dental and chronological age in CLP patients from different populations is well established in the literature. However, there have been no previous studies pertaining to the timing of dental development in Saudi CLP patients. Therefore, the present study was conducted to assess the timing of dental development in Saudi patients with non-syndromic CLP by utilizing chronological and dental age comparison.

Methods. A literature search was carried out before conducting the study. Topics in reference to assessment of the dental development and related findings in CLP patients were investigated utilizing the National Library of Medicine (PubMed) search engine. The sample for this pilot study consisted of 51 (34 male and 17 female) diagnostic panoramic radiographs of non-syndromic CLP Saudi individuals aged 5-14 years old. All subjects presented with a unilateral type of CLP, except 4 who had bilateral CLP. The current records do not indicate the extent and severity of CLP, therefore, sub-classifications were not collected. The required variables were collected cross-sectionally, and the data collection phase was started in January 2012 with the study being completed in February 2013 at the King Abdulaziz Medical City, Riyadh, Saudi Arabia. Subjects with full dental development (18 years and above), inadequate dental records, and associated syndromes, and medical diseases were excluded from the study. All subjects enrolled completed a medical/dental history questionnaire, and panoramic radiographs, as part of their medical records to aid in the exclusion and evaluation processes. The study was ethically approved by the King Abdulaziz Medical City.

The chronological ages of the children involved in this study were collected utilizing the date of birth shown in their medical records, and the registry date fixed on the panoramic radiographs. Both dates were accurate and without discrepancies as the hospital uses electronic health records. Subjects were segregated into 3 groups according to their chorological age (5-7, 8-11, and 12-14 years). For each subject, the dental age was determined using Demirjian's method by one investigator.[3] The method is based on the developmental stages of 7 left permanent mandibular teeth. It divides the tooth formation into 8 stages (A-H) where the criteria for each developmental stage is described for each specified tooth. Each stage of the individual 7 teeth is assigned a score according to a statistical model in a range of 3-16 years old. The sum of the scores of the 7 teeth represents the obtained dental maturity that can then be converted into dental age using a conversion table. Ten randomly selected panoramic radiographs were analyzed twice by

the same investigator (with a one week interval), using Demerjan's method before the initiation of the data collection phase. Intra-class correlation (ICC) test was applied to investigate intra-examiner reliability. An ICC of 0.984 resulted indicating a high level of the reliability of the applied method.

All data were then analyzed using the Statistical Package for Social Sciences version 20 (SPSS Inc, Chicago, IL, USA).[19] The distribution of the participating subjects was examined, and the mean value was presented for the sample's dental age and chronological age. They were also calculated for the age and gender subgroups. Standard deviations and confidence intervals were then listed as measures of dispersion. Paired t-test was used then to test for any statistical significant differences between the dental and chronological age means. The use of paired t-test matches the nature of the collected data, where the observations (dental and chronological age) correspond to each other for each subject.[20]

Results. All investigated subjects had a combined CLP. **Table 1** shows the distribution of subjects in the age subgroups according to their chronological age. Most of the studied sample was of 8-11 years of age (n=25), with less representation for the other 2 age groups (16 subjects for the 5-7 age group, and 10 subjects in the 12-14 years age group). When the chronological and dental age means were compared using a paired t-test (**Table 2**), the dental age mean was shown to be delayed by 8.4 months (*p*=0.002). The effect of gender on the dental development was also investigated. Male (*p*=0.022) and female subjects (*p*=0.02) both displayed delayed dental development (**Table 2**). **Table 3** shows the distribution of the 3 segregated groups according to their chronological age. When the mean difference between the chronological and dental age for the age sub-groups was compared, only the middle age group (mixed dentition 8-11 years) showed a statistical significant difference. This age group demonstrated a significantly delayed dental development when compared with other age groups (*p*=0.002). The differences between the chronological and dental age for the younger (*p*=0.165), and older groups (*p*=0.455) were not statistically significant.

Discussion. Dental age is one of the most common ways of assessing dental development timing in relation to the chronological age. The literature shows many methods that were proposed earlier, many of which have their own limitations. In the Nolla method, the increased number of stages has been shown to reduce

the precision and complicate the assessment.[21] The present study utilized Dermerjian's method for dental age assessment.[3] This method was shown to be highly valid[22] and reliable,[11,23] which rendered the method the most practical and widely used one to calculate the dental age[6-9] with some deviations being shown when the method is applied to different ethnicities and populations. An advancement of the dental age when compared with the chronological age is a frequently reported finding with Demirjian's method on normal (non-CLP) subjects.[10,11] A significant difference was found in a sample of Dutch children, where the boys were 0.4 years, and the girls were 0.6 years, ahead of the French-Canadian reference.[9] Similar findings were shown in Korean children.[11]

Table 1 - The distribution of male and female cleft lip and palette subjects within the age subgroups according to their chronological age.

Gender	Age groups (years)			Total
	5-7	8-11	12-14	
Male	10	15	9	34
Female	6	10	1	17
Total	**16**	**25**	**10**	**51**

Table 2 - Comparison of chronological age (CA) and dental age (DA) means (in years) showing the standard deviation (SD) and confidence interval (CI) of the studied cleft lip and palette subjects.

Gender	Mean CA	Mean DA	Mean difference	*P*-value*
	(95% CI)			
Male (n=34)	9.9 ± 2.4 (9.1-10.8)	9.3 ± 2.7 (8.3-10.2)	0.6	0.022
Female (n=17)	8.8 ± 2.0 (7.8-9.9)	8.2 ± 2.1 (7.1-9.2)	0.6	0.02
Combined (n=51)	9.6 ± 2.4 (8.9-10.2)	8.9 ± 2.6 (8.2-9.6)	0.7	0.002
*paired t-test. Values are expressed as mean ± SD				

Table 3 - Comparison between chronological age (CA) and dental age (DA) means (in years) within different age groups showing standard deviation (SD) and confidence interval (CI) of the studied cleft lip and palette subjects.

Age group, years	Mean CA	Mean DA	Mean difference	*P*-value*
	(95% CI)			
5-7 (n=16)	7.0 ± 0.7 (6.6-7.3)	6.7 ± 1.1 (6.1-7.3)	0.3	0.165
8-11 (n=25)	9.9 ± 1.3 (9.4-10.4)	8.9 ± 1.4 (8.3-9.5)	1.0	0.002
12-14 (n=10)	12.9 ± 0.6 (12.5-13.4)	12.3 ± 2.6 (10.5-14.2)	0.6	0.455
*paired t-test. Values are expressed as mean ± SD				

The CLP subjects demonstrated a statistical significant difference when the chorological and dental age means were compared (**Table 2**). The dental age was delayed by 8.4 months. This is contrary to the general pattern (shown above) of the dental age advancement found in normal non-CLP subjects. Al-Emran[14] investigated 430 panoramic radiographs of Saudi healthy (non-CLP) male and female aged from 8.5-17 years. He showed an advancement in Saudi controls by 4.2 months. Another study documented the same range of advancement.[13]

Furthermore, the present finding is consistent with the literature documenting a delayed dental age compared with the chronological one. Pham et al[24] demonstrated in a group of 182 CLP children in the United States, a delay of 7.2 months in dental ages compared with their respective chronological ages. This is also in agreement with the general clinical observation of delayed dental age by 1-2 years within the studied CLP population. Moreover, most of literature indicated a similar amount of delayed dental development for CLP, ranging from 0.3-0.7 years.[16,17]

The CLP males and females showed a similar magnitude of delayed dental development. However, the literature has identified males as having an increased delayed dental development compared with females.[17,25,26] Borodkin et al[26] stated that males are more dentally delayed than girls with an average difference of 0.96 years. The present study did not investigate the impact of gender demographics as a primary aim. The over presentation of male subjects as opposed to females (34 versus 17) in the sample could be a reason behind not expressing any statistical differences between the 2 gender groups. The mean chronological and dental age for the studied group spanned from 8-9 years, ranging from 5-14 years of age. This age period reflects all phases of dental development and emergence stages allowing investigation of any potential discrepancy at different levels of dental maturation.

In order to analyze that aspect further, the sample was segregated earlier into 3 age groups to capture the 3 main dental development domains (primary, mixed, and permanent dentition stages). Other studies have grouped its samples into individual age group for each year of age.[7,11,14] Doing so would result in losing the power needed to identify any statistical significant findings. Nevertheless, the current data was able to highlight an increased tendency toward delayed dental development in the middle age group (8-11 years) when compared with other age groups. This age group represents the

period where most of the posterior segment dentition emerges into the oral cavity. Delayed canines and premolar eruption can be a result of local space loss. Whether or not the available arch space in CLP subjects is compromised or not, is a questionable etiology that the literature has not addressed yet. The Demirjian method excludes all local factors directly related to the presence of the cleft (dilacerations, malformed teeth, ectopic eruptions, supernumerary teeth) enabling it to only highlight dental delay independent of these known factors. Another reason for the significant difference displayed in the middle age group can be due to the increased subjects' quantity in that specific subgroup.

Some of the limitations of the present study include the lack of even presentation of the secondary variables such as chronological age subgrouping, gender, and laterality of the cleft site. Nearly half of the studied sample was composed of subjects aged 8-11 years. That age group reflected the only statistical significant finding at a high level that would influenced the overall results. Further studies are recommended where groups are recruited, and assigned according to these variables of interest. The inclusion of a control group would be of value to revalidate the presented data and overcome any potential variation in relation to ethnicity of the studied population. It would also serve as a standardized reference for Saudi Demirjian values where adjustment for the current measures can be established for CLP subjects. The modified Demirjian method was reported by creating an adapted method in dental age estimation in the Belgian population. This adapted method has resulted in a more accurate dental age estimation when compared with the original method.[27] Finally, the present data was collected from a single regional CLP center where neither the extent, nor the severity of CLP were initially recorded. An extended nationwide study including multiple CLP major centers, with increased sample size and CLP sub-classification identification, is recommended for future studies.

In conclusion, the current study indicates a statistically significant 8.4 months delay in dental development for CLP subjects. The findings support the clinical observation of delayed dental development in patients with CLP, and the current data suggests that such delay is more pronounced in subjects at the late mixed dentition stage (8-11 years). Further study for age subgroups is recommended as the age distribution of current subjects was not evenly presented. These findings can be of diagnostic and treatment planning value for dental, oral, maxillofacial, and/or plastic surgery departments.

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