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Original Article

Comparison of Dental Age in Patients with and without Cleft Lip and Palate: A CBCT Study

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Abstract

Background: This study was designed to estimate the dental age of patients with Cleft Lip and Palate (CLP) and compare it with the control group using the Demirjian's method based on Cone Beam Computed Tomography (CBCT) technique.

Methods: The CBCT images of 46 patients with CLP aged 5–16 years and 46 age-gender matched patients without CLP were evaluated. The dental age was determined using Demirjian's method compared between the two groups (control, experimental) using independent t-test. Significant level was considered at $p<0.05$.

Results: The dental age was overestimated in relation to the chronological age in both groups $p < 0.001$. The mean of dental age in patients with CLP was lower in comparison to control group; however, no statistically significant difference was found ($p=0.706$).

Conclusion: The findings revealed that both groups exhibited a significantly higher mean dental age compared to their chronological age, indicating advanced dental development relative to their actual age. However, no significant difference was observed between the CLP and control groups regarding this advancement in dental age, suggesting that CLP may not have a substantial impact on the overall timing of dental development. These results suggest that while dental age may advance beyond chronological age in children with and without CLP, CLP itself is not a determining factor in this developmental difference.

Keywords: Cleft lip, Cleft palate, Cone beam computed tomography, Dental age

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Introduction

With a prevalence of one in 500-1000 births worldwide, Cleft Lip and Palates (CLP) are the most common craniofacial birth defect (1). The frequency of CLP is illustrated to be the most noteworthy among the Asian population (2). Treatment planning for patients with CLP in the dentofacial area should begin at the earliest stages of their disease and involve a multidisciplinary approach (3). It is very important in forensic medicine, pediatric endocrinology, and clinical dentistry to determine age scientifically as it plays a crucial role in diagnosis and treatment planning (4). In these patients, establishing the dental age is significant in determining the course of treatment. The orthodontic treatment of malocclusions related to maxillofacial growth depends heavily on determining the dental development. In pedodontics treatment, it is important to be able to accurately estimate the phases and stages of tooth development (5-7). Orthodontic and pedodontics treatments for children with CLP commonly begin at the early stages of childhood. This means that knowing the estimated eruption time and the tooth development time is important (8). The dental age is determined by evaluating tooth eruption or tooth formation (5-7). In spite of this, tooth eruption cannot be used as a reliable method for determining dental age, since it is influenced by local factors (8).

Various methods have been used to assessment the dental age using radiographs (5-8). The method developed by Demirjian has been extensively applied in research for measuring dental maturity and estimating dental age (7,9-13). Based on the Demirjian's method, roots and crown in permanent mandibular dentition excluding the third molar, are described in eight radiographic stages (A-H) (5).

During the embryological development, CLP and tooth germ formation are closely related in timing and anatomical location (14-16). CLP and developmental problems have been the subject of recent studies by researchers (17-23). Conflicting results have been reported in previous studies regarding the effect of CLP on dental age (8,18-24). The developments of dental asymmetry, delayed dental maturation, and dental age retardation have all been reported in previous studies of patients with CLP (25-29). In a study of Brazilian children carried out by Topolski *et al* (22), there was a marked incompatibility between chronological and dental ages in both CLP and control groups, while no significant difference was observed in dental ages between the two groups. Children with CLP tend to have asymmetric and delayed dental development, according to Lai *et al* (30) also found that dental development delays may increase in children with CLP as the number of missing teeth increases.

To the best of our knowledge, all previous studies used 2D imaging for dental age estimation in patients with CLP (8,18-24,31-33). Therefore, due to the controversy results in different studies and more up-to-date and accurate Cone Beam Computed Tomography (CBCT) technology, this study was conducted to evaluate and compare the dental age using the Demirjian's method in patients with and without CLP.

Materials and Methods

This study was approved by the institutional Research Ethics Committee of School of Dentistry-Shiraz University of Medical Sciences with the registration number of IR.SUMS.DENTAL.REC. 1401.027. The study sample consisted of 46 non-syndromic patients with CLP (22 girls and 24 boys) aged 5-16 years (mean age 10.85±2.61 years). Additionally, 46 age- and gender-matched patients without CLP, who were referred to the radiology department of Shiraz Dental School and a private maxillofacial radiology center, were included in the study.

To determine the sample size, the study by Huyskens *et al* (20) was referenced, which provided values of 9.86±1.05 and 9.33±0.62. Considering a significance level of $\alpha=0.05$ and a power of 80% ($\beta=0.80$), the minimum required sample size for each group was estimated to be 42 participants, calculated using the following formula:

All CBCT examinations were performed using standard parameters (120 *kVp*, 15 *mA*, and 9.6 *s*) with a New Tom VGi (QR Srl, Verona, Italy) device, utilizing a field of view. These CBCTs were conducted for various medical reasons, such as maxillofacial trauma, orthodontic treatment, and oncological diseases treated without radiation. It is important to note that these examinations were not conducted specifically for this study. Subjects were excluded if they had insufficient dental records, associated syndromes, medical diseases, agenesis, or tooth extractions outside the cleft region.

An examiner, blinded to the child's gender, birthdate, and radiograph date, evaluated the CBCT images. Only the lower left teeth (excluding third molars) were considered. Frontal and lateral reconstructed views, along with reconstructed panoramic images, were used to assess the development of the permanent dentition based on the Demirjian method.

Demirjian Method

This method is based on the developmental stages of seven left permanent mandibular teeth, with tooth formation divided into eight stages (A-H). Each stage's criterion was described for each tooth (Table 1). A statistical model was used to assign scores for each of the seven teeth within the 5-16 years age range. Using a conversion table, dental maturity scores were converted into dental age by summing the scores of the seven teeth. Chronological age was estimated by subtracting the date of birth from the date of the X-ray examination.

To assess the reliability of measurements, 10 randomly selected CBCT images were re-evaluated by the same operator after two weeks. Intraclass Correlation Coefficients (ICCs) were used to compare the first and second sets of measurements, yielding an average measure ICC of 0.88, indicating high reliability.

Statistical Analysis

Data were analyzed using SPSS software version 20 (SPSS Inc., IBM Corp., Armonk, NY, USA). A paired t-test was used to compare the chronological and dental ages in each group due to the normality of the data distribution. Comparison of dental ages between CLP patient and control group, and comparison of dental ages in relation to sex, was performed based on independent t-tests.

Results

In this study, a comparison was made between dental age and chronological age in two groups: patients with CLP and a control group. The results demonstrated that in both groups, the mean dental age was significantly higher than the mean chronological age ($p<0.001$). This indicates that dental development is ahead of chronological age in both groups. However, the difference in the gap between dental age and chronological age between the CLP and control groups was not statistically significant ($p=0.706$).

Table 1. Developmental Stages of Seven Left Mandibular Teeth According to the Method of Demirjian (1978)

Stage A	Beginning of calcification at the most occlusal part of the crypt
Stage B	Fusion of the calcified points with regularly outlined occlusal surface
Stage C	Enamel formation complete at the occlusal surface. Extension of enamel formation toward the cervical region. Beginning of the dental deposit. The outline of the pulp chamber has a curved shape at the occlusal border.
Stage D	Crown formation is complete down to the cemento-enamel junction. Uniradicular teeth: The superior border of the pulp chamber has a definite curved form, being concave toward the cervical region. Molars: The pulp chamber has a trapezoidal form. Beginning of root formation in the form of a spicule
Stage E	Uniradicular teeth: The walls of the pulp chamber form straight lines. The pulp horn is larger than in the previous stage. Molars: The initial formation of the radicular bifurcation in the form of either a calcified point or a semi-lunar shape. For both uniradicular teeth as well as molars, the root length is still less than the crown length.
Stage F	Uniradicular teeth: The walls of the pulp chamber form a more or less isosceles triangle. The apex ends in a funnel shape. Molars: The calcified region of the bifurcation has developed farther down from its semilunar stage to give the roots a more definite and distinct outline with funnel shaped endings. For both uniradicular teeth as well as molars, the root length is equal to or greater than the crown height.
Stage G	The walls of the root canal are now parallel and its apical end is partially open (distal end in molars).
Stage H	The apex of the tooth is completed and the periodontal membrane around the tooth is uniformly wide around the root and the apex.

Table 2. Comparison of the chronological age and dental age in CLP patients and control groups

Group		Mean	Std. Deviation	Sig.
CLP*	Chronological age	10.85	2.616	p<0.001
	Dental age	11.793	2.4617	
Control	Chronological age	10.85	2.616	p<0.001
	Dental age	12.680	2.5941	

*CLP: Cleft Lip and Palate

Table 3. Sex-based comparison of dental age between the CLP and control groups

Dental age	CLP*(Mean±SD**)	Control(Mean±SD)	p-value
Girl	11.683±2.45	12.225±2.50	0.827
Boy	11.914±2.48	13.177±2.59	0.634
Total	11.793±2.46	12.680±2.59	0.706

*CLP: Cleft Lip and Palate

** SD: Standard deviation

This suggests that the presence of CLP has no significant impact on the difference between dental and chronological ages (Table 2).

Additionally, a sex-based analysis of dental age in the CLP and control groups revealed no statistically significant differences between males and females in either group. In the CLP group, the mean dental age for girls was 11.683 and for boys was 11.914, while in the control group, the mean dental age for girls was 12.225 and for boys was 13.177. Although the mean dental age was higher in boys compared to girls in the control group, this difference was not statistically significant (p=0.634 for boys and p=0.827 for girls). Overall, there was no significant difference in dental age between patients with and without CLP in relation to sex (p=0.706) (Table 3).

These findings suggest that although CLP patients may have more advanced dental development compared to their chronological age, the difference is not significant enough to distinguish them from the control group. Additionally, gender appears to have no significant influence on dental age in either CLP patients or the control group. These results demonstrate that CLP, by itself, may not be a major determinant of dental development, and other factors could also play a role in this process.

Discussion

In the current study, the dental age of the cleft group showed a delay, but no statistically significant difference was found between the cleft and control group. Similarly, Eerens *et al* (26) reported a slight delay in the dental development of Belgian CLP children with no statistically significant difference. Also, Cesur *et al* (8) and Topolski *et al* (22) showed that there was no significant difference in dental age between the CLP group and healthy patients. However, most of the previous studies showed a statistically significant delay in dental age between CLP and control groups (20,29-31,34-39).

In some studies, there is not enough information about the methodology used (34,36), and the dental age assessment methods used by other researchers are inconsistent (35,38), making it difficult to interpret and compare the results in an appropriate way. There was no control group in Bindayel *et al*'s study (19), which may compromise the validity of their findings. Thus, this study differs from other studies that evaluated the dental development of patients with CLP due to its methodological design.

Additionally, in contrast to the previous studies (19, 20,29-31,34-39), a blinding methodology was utilized to prevent possible bias during analysis. The blinding methodology plays an important role in ensuring the validity of the results of the study since the method of Demirjian involves a certain level of subjectivity. Age estimation may be hindered by teeth in intermediate stages of development (*e.g.*, between stages D and E). As the literature reports that dental development in these patients is delayed, the operator tends to choose a premature stage if he knows the patient has a CLP, therefore blinding is essential.

Moreover, dental anomalies in CLP patients and the manifestation of the cleft itself are believed to be related to the etiology of delayed dental development in patients with cleft (15,26,34). In the present study, patients with agenesis and a greater chance of dental development changes were excluded, which could explain why no delayed development was observed in the patients with CLP in this study.

CBCT was used in the present study since it is more accurate and up to date. As shown in some studies (40,41), CBCT images illustrate the apical zone in more detail than 2D-generated panoramic images. Consequently, the apical zone of the teeth's achieved detail rank is more accurate, dental age is determined more precisely, and deviation from chronological age is reduced. As in the Zirk *et al*'s study (41), Nolla's and Demirjian's 2D and 3D imaging present significantly different staging results.

The present study demonstrated no statistically significant difference in dental age between the cleft and control groups in relation to sex. These findings are consistent with those of the study carried out by Cesur *et al* (8) and Topolski *et al* (22). Also, similar delays in dental development in the CLP males and females were observed by Bindayel *et al* (19). However, some studies showed that the delay in dental development was more pronounced in boys than in girls (20,42,43). A possible reason for the difference between CLP boys and girls in could be the smaller sample size for girls in the study groups (20). In some previous studies which compared the patients with and without CLP, the groups were not matched by gender and chronological age (20,31,34,35,37) while the present study designed the control group based on gender and chronological age matching, making the present results more appropriate.

In the current study, cleft and control groups' dental ages were advanced in relation to chronological ages with statistically significant differences in both groups using the Demirjian method. Other studies (7,10,11) and systematic reviews (44-46) found similar results of age overestimation with Demirjian's method. According to these results, this method tends to overestimate the dental age in various populations. Although Demirjian *et al* (5) have developed an easy-to-use method for determining dental age, their data comes from French-Canadian children. As a result, there have been discussions about the applicability and reliability of the method in other ethnicities, leading to a great deal of controversy in the literature today (4,10,12,47,48). For highest accuracy of age estimation, population-specific standards, rather than a universal standard or methods developed on other populations, need to be employed.

Despite the fact that the difference in dental age between the CLP group and control group in this study was not statistically significant, this number seems clinically relevant. Accordingly, it would be better to conduct more studies using CBCT with a larger sample size.

Conclusion

The present study showed a similar dental age in children with and without CLP. Therefore, the evaluation of dental development in patients with CLP should be approached in the same way as in patients without clefts, with a focus on the individualization of diagnosis and treatment planning.

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Conflict of Interest

There was no conflict of interest in this manuscript.

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