Dental Age in Children With a Complete Unilateral Cleft Lip and Palate

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Objective: **To assess dental age in children with a complete unilateral cleft lip and palate and to compare this with a noncleft control group.**

Design: **Two-group, mixed-longitudinal cohort study.**

Setting: **Cleft group from an academic center for cleft lip and palate treatment. Noncleft control group from the same population.**

Patients: **Participants included 70 Caucasian children with a full complement of teeth and a complete unilateral cleft lip and palate (45 boys and 25 girls) from the Cleft Palate Craniofacial Center at the Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands. The control group (90 boys and 91 girls) was taken from the Nijmegen Growth Study.**

Main outcome measure: **Dental age was assessed on orthopantomograms. In the unilateral cleft lip and palate group, linear interpolation in individual age curves was applied to obtain the dental age at 5, 9.5, and 14 years of age. For these ages, a comparison was made with the noncleft control group.**

Results: **Boys and girls with a unilateral cleft lip and palate showed a significant delay in dental age, as compared with their noncleft peers at all three ages. This delay was more pronounced in boys than in girls. The gender effect was significant at chronological ages 5 and 14 years.**

Conclusions: **Children with a complete unilateral cleft lip and palate have a delay in dental age, compared with noncleft children.**

KEY WORDS: *age determination by teeth, cleft palate, cohort studies, dental, dentition, radiography*

In a growing child, the chronological age is not a very reliable guide to assess the stage of physical development. The degree of maturation is better estimated from developmental stages of the skeleton, secondary sex characteristics, and the dentition. Dental age can supplement bone age in the estimation of maturity, because the developmental stages of an individual tooth always occur in the same sequence from the formation of a follicle to the development of the crown and the root formation, after which the process ends with the closure of the apex.

There are few studies on tooth development in bilateral cleft lip and palate children (BCLP). Heidbüchel et al. (2002) showed a significant delay in dental age of boys at 5 years of age with a complete BCLP, compared with noncleft boys. However, such a difference could not be found at 9.5 and 14 years of age. For girls with a complete BCLP versus noncleft girls, no statistical differences were found.

In children with a unilateral cleft lip and palate (UCLP), contradictory findings have been reported regarding tooth development. Some investigators have found a delay in dental development of permanent teeth by approximately 6 months (Bailit et al., 1968; Ranta, 1983, 1986). The delay was observed to be less in younger than in older individuals when compared with normal, unaffected children (Ranta, 1986). Significant gender differences in tooth length development have been observed in the unilateral cleft population (Brouwers and Kuijpers-Jagtman, 1991). At almost every age, a significant delay in tooth length development was present in boys with a cleft, in both the upper and lower jaw, whereas in girls, a delay was found at a few ages only.

Prahl-Andersen (1976) found in a mixed sample of 91 children, 5 to 14 years of age, with various types of clefts, a significant delay in dental development in boys until the age of 9 years. After that age, there was no further evidence of delayed dental development. Girls with a cleft showed a ten-

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dency to delay, although not significantly in comparison with noncleft children. Other investigators, however, report an advanced dental development in males (Loevy and Aduss, 1988).

The conflicting results reported from earlier studies might be attributed to the lack of strict inclusion criteria or to the inclusion of mixed types of clefts, with control groups often missing. Therefore conclusive findings with respect to dental age in children with clefts are not available. It was, therefore, the aim of the present study to assess the possible differences in dental age between children with a complete UCLP and noncleft children.

Subjects and Methods

Subjects

We used records of 70 consecutive children (45 boys and 25 girls), born between 1976 and 1988 with a complete UCLP, with or without a Simonart's band. The diagnosis was confirmed by two experienced CLP-orthodontists. All patients were treated in the Cleft Palate Craniofacial Center of the Radboud University Nijmegen Medical Center, the Netherlands. Patients with syndromes and other congenital malformations or diseases were excluded. Non-Caucasian patients, as well as patients with missing teeth either in the maxilla or mandible, other than the third molars, were excluded also. For each patient, 1 to 9 orthopantomograms were available, with a total of 373 radiographs. The orthopantomograms were taken between 5 and 14 years of age.

Methods

Dental age was assessed on orthopantomograms according to the method of Demirjian et al. (1973) and Demirjian (1978). According to this method, the developmental stages of seven left mandibular teeth (except the third molars) are rated on a scale from A to H (eight stages), based on crown calcification and root development (Table 1).

To assess the developmental stage, each tooth is compared with diagrams and x-ray pictures for that type of tooth as described by Demirjian (1978). The scores for all seven teeth are added together to calculate the maturity score from 0 to 100. This score is converted into a dental age using a table for boys or girls. By means of these data, mean curves of dental age were constructed for boys and girls as appropriate.

The UCLP scores were compared with existing scores obtained in the past by two observers from records of noncleft children of the Nijmegen Growth Study (Prahl-Andersen et al., 1979). This mixed longitudinal study comprised 482 children, 4 to 14 years of age. Each child was followed for a period of 5 years. From this database, records of 90 boys and 91 girls without a cleft were used to determine dental age. In case of agenesis or extraction of teeth on the left side of the mandible, the score for the corresponding tooth on the right side of the mandible was recorded. In case of bilateral agenesis or extractions, the child was scored as having missing data. The orthopantomograms were divided over three age groups (5, 9.5, and 14 years of age). At these three ages, the differences in dental age between the UCLP group and the noncleft group were assessed. To test the interobserver agreement between the observer who scored the UCLP group and the ones who scored the Nijmegen Growth Study, a random sample (n = 42) from the Nijmegen Growth Study was taken at the age of 9.5 years and rescored by the observer of the UCLP group.

TABLE 1 Developmental Stages of Seven Left Mandibular Teeth to be Rated on Orthopantomograms 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 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 redicular 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.

Statistical Methods

The differences in dental age of the UCLP and the noncleft group were tested at three different ages (5, 9.5, and 14 years), using a Student's *t* test. The ages of measurement in the UCLP group do not exactly coincide with those in the noncleft control group. To enable a valid comparison at the ages of 5 and 9.5, the dental ages for the sample group were interpolated from the individual age curves. At the age of 14 years, measurements were performed in both groups. Therefore, no interpolation was necessary at this age.

Results

No significant differences were found (n = 42) between the existing scores of the last century from the Nijmegen Growth Study as measured in the '70s and the present scores (2004) of the control sample (paired *t* test, $p = .48$, difference = 0.09 years, SE = 0.13 years, $r = .77$).

TABLE 2 Mean Dental Ages (with SD) and Differences Between Unilateral Cleft Lip and Palate and the Nijmegen Growth Study (± SE) at Three Chronological Ages for Boys and Girls Separately, Together with the Gender Effect in the Delay

Chronological Age (y)	*Boys*			*Girls*			*Gender Effect in Delay ± SE (p value)*
	*NGS**	*UCLP*	*Delay*	*NGS*	*UCLP*	*Delay*	
5	Mean (*SD*)	Mean (*SD*)	Mean (*SE*)	Mean (*SD*)	Mean (*SD*)	Mean (*SE*)	
	6.37 (0.52)	5.05 (0.46)	1.31 ± 0.13	5.81 (0.51)	5.08 (0.38)	0.73 ± 0.14	0.58 ± 0.19
	(n = 33)	(n = 24)	($p < .001$)	(n = 24)	(n = 17)	($p < .001$)	($p = .003$)
9.5	10.18 (1.50)	9.17 (0.61)	1.01 ± 0.29	9.86 (1.05)	9.33 (0.62)	0.53 ± 0.22	0.48 ± 0.36
	(n = 29)	(n = 43)	($p < .001$)	(n = 33)	(n = 23)	($p = .02$)	($p = .20$)
14	16.66 (1.12)	14.92 (0.95)	1.74 ± 0.28	15.32 (0.8)	14.66 (0.76)	0.67 ± 0.28	1.07 ± 0.40
	(n = 28)	(n = 28)	($p < .001$)	(n = 34)	(n = 16)	($p = .02$)	($p = 0.007$)

* NGS = Nijmegen Growth Study; Mean = mean dental age.

Table 2 shows the dental ages of the UCLP group at chronological ages of 5, 9.5, and 14 years, together with the standard deviation. A statistically significant delay in dental age was found for the UCLP group compared with the noncleft group at all three ages, for boys as well as for girls (all $p <$ .02). The delay in dental development was more pronounced in boys with UCLP than in girls with UCLP. The gender effect in this delay was significant at the chronological ages 5 and 14 years.

Figure 1 shows the dental ages of UCLP for boys (a) and girls (b), as well as the significance level of the difference between UCLP and controls.

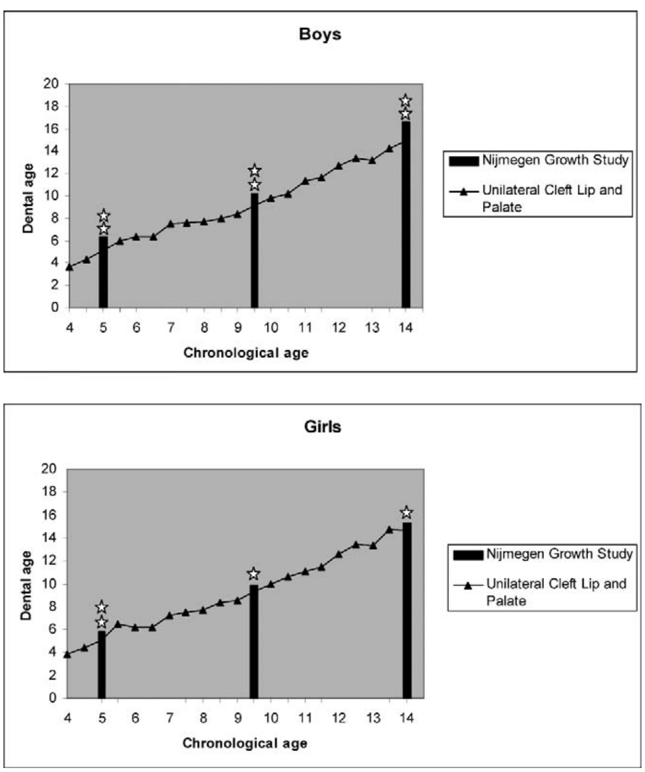

FIGURE 1 Mean dental age (obtained by interpolation) at chronological ages of 4 to 14 years (at a distance of 0.5 year) in the UCLP group, for boys and girls separately. Asterisk indicates the level of significance of the difference between UCLP and controls (* .01 < p < .05; ** p < .01).

Discussion

The method of Demirjian et al. (1973) and Demirjian (1978) was chosen for the present study because it is a reliable and convenient method to determine the dental age for the selected group. The method of Demirjian uses the stages of tooth formation of the seven left mandibular teeth. Environmental factors such as the presence of the cleft, therefore, are excluded. According to the method, the dental age was assessed on orthopantomograms.

The Demirjian method was tested in the past for accuracy and precision for estimation of chronological age in Swedish children from 3.5 to 12.5 years of age (Hägg and Matsson, 1985). A high degree of accuracy was found for the younger age group (3.5 to 6.5 years of age). For this age group, the mean difference between dental age and chronological age was 0.3 months, with a standard deviation of the difference of 7.6. The accuracy of the Demirjian method decreased in children 9.5 to 12.5 years of age. The mean difference for this group was 10.3 months, with a standard deviation of the difference of 12.6. The reason for the difference in accuracy might be that the differences between the developmental stages are clearer at younger ages.

The maturity standards of Demirjian are based on a sample of French Canadian children. Because the timing of dental development might be different between various population groups, the standards of dental age determination may need to be adjusted. Therefore, the validity of the Demirjian method for dental age determination was studied in Norwegian children (Nykänen et al., 1998). These children were found to be generally advanced in dental maturity compared with the French Canadian sample. The variability in individual dental age was marked and increased with age. Despite this, the standards appear to be adequate for dental age determination in the Norwegian population. More recently, Demirjian standards of dental maturation also were compared with data of British children (Liversidge et al., 1999). British children between ages 4 and 9 years were dentally advanced compared with the Canadian standards. The mean advancement in girls was 0.51 years, whereas in boys it was 0.73. We conclude from the results of the Norwegian and British children that it is impossible to perform a study on dental age in UCLP without a control group of the same population.

As mentioned previously, earlier studies on dental development in UCLP gave conflicting results (Bailit et al., 1968; Prahl-Andersen, 1976; Ranta, 1983, 1986). The main finding in the present study was a delay in dental age for both sexes at 5, 9.5, and 14 years of age. Earlier studies also are contradictory regarding gender differences, because Loevy and Aduss (1988) reported an advanced dental development in males.

In the present study, the delay in dental development was more pronounced in boys than in girls. A possible reason for the difference between UCLP boys and girls could be the smaller sample size for girls in the study group. The UCLP effect on dental development, therefore, might be suppressed. Ranta (1986) published a review on tooth formation in children with different types of cleft lip/palate. The tooth formation of permanent teeth was delayed in children of all cleft groups, compared with noncleft children. The delay increased in both jaws from 0.3 to 0.7 years with increasing severity of the cleft. In children with hypodontia, the delay in tooth formation was even more severe and increased with age (Ranta, 1984). To anticipate the effect of hypodontia, we excluded children with agenetic teeth from our cleft groups.

The genetic background of clefts and tooth development seem to have some similarities. Much research has been done on the involvement of genes such as *TFG*α, *TGF*β*3*, and *MSX1* in clefts and the etiology of their interactions with environmental factors (Carinci et al., 2003). Deficiency of the homeobox gene *MSX1* in mice leads to abnormalities in craniofacial and dental development (Satokata and Maas, 1994). Moreover, *MSX1*-deficiency leads to cleft palate and tooth agenesis in mice (Zhang et al., 2002). Recently, a specific *MSX1* mutation was described in a human family with orofacial clefting and tooth agenesis (Van den Boogaard et al., 2000). These results indicate that the development of the teeth and the secondary palate is partly regulated by the same genes. Defects in these genes that lead to a cleft palate also may give a delay in tooth development. According to Ranta (1984), it is to be expected that the delay in tooth development in the BCLP group would be more than in the UCLP group, because of the severity of the cleft. Comparing the results of Heidbüchel et al. (2002) with the results of the present study, we may preliminarily conclude that it is not necessarily the case.

In conclusion, the results of the present study show a delay in dental age for boys and girls with a UCLP at the age of 5, 9.5, and 14 years, compared with noncleft children. The cause for this delay in tooth development might be that both secondary palate development and tooth development are partly regulated by the same genes.

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