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ORIGINAL ARTICLE

# Radiographic evaluation of the chronological development of permanent dentition in children infected with HIV

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**Abstract** The objective of this study is to determine if there is an association between HIV infection in children and alterations in the chronological development of permanent dentition detectable by radiographic examination. The sample comprised two groups of children: (1) 50 children infected with HIV by vertical transmission and (2) 50 healthy children. The groups were paired according to age, sex, race, and socioeconomic level. After obtaining a panoramic radiograph, the stages of tooth calcification and the frequency of subjects showing alveolar eruption of the first and second mandibular permanent molars were determined. There was no significant difference in stages of tooth calcification and frequency of subjects showing alveolar eruption of the permanent molars between the groups ($P>0.05$). Children infected with HIV by the vertical route showed upon radiographic examination stages of tooth calcification and alveolar eruption compatible with normal patterns. There is no association between HIV infection and alterations in the chronological development of the permanent teeth, detectable radiographically, in children infected by vertical transmission.

**Keywords** Children · AIDS · HIV infection · Dental development

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## Introduction

The first cases of acquired immunodeficiency syndrome (AIDS) were identified in 1981 [3, 4], and diagnoses in children have been reported since 1983 [12, 22, 25]. Pediatric AIDS constitutes a universal problem not only because of the high level of mortality but also because of the dramatic course and physical and psychological involvement that it implies [5]. The increased incidence of infection by HIV in children is of interest from an odontologic view. With the development of anti-retroviral therapy, the life expectancy in children infected with HIV increased significantly, which emphasized the need to optimize their odontologic care [1].

Patients infected with HIV exhibit alterations in bone and mineral metabolism, whose principal causes are chronic viral infection, immunologic dysfunction, abnormal production of cytokines, opportunistic infections, neoplasias associated with HIV, and drug use [10]. Children infected with HIV can show a deficiency in general development

[16] and diminution of the mineral density of bone tissue [24]. Studies have examined the importance of oral lesions in pediatric AIDS [12, 23], but the literature lacks investigations on dental development in this population. Considering the delay in general development exhibited by HIV-infected children, as well as the positive correlation between general development and dental development [14], the aim of the present study was to determine the possible association between HIV infection and alterations in dental development in children. Therefore, the stages of tooth calcification and tooth eruption of the permanent dentition were determined in children infected with HIV by vertical transmission.

## Materials and methods

The sample comprised 100 children of both sexes, with ages varying from 4 years and 2 months to 12 years and 2 months distributed into two groups: (1) 50 children infected with HIV through the vertical route, who were under ambulatory care at the Pediatric AIDS Service of the Hospital de Clínicas de Porto Alegre, including 26 females and 24 males all receiving anti-retroviral drug treatment; and (2) 50 healthy children not infected with HIV, who were under ambulatory care of the services of the Pediatric Dentistry and Clinic for Children and Adolescents of the Odontology Faculty of PUCRS, including 26 females and 24 males. The groups were paired according to age, socioeconomic level, sex, and race. That is, each child infected with HIV was paired with a noninfected child of the same age, sex, race, and socioeconomic level. The following criteria were considered for exclusion: (a) children less than four years old because of the difficulty in obtaining a panoramic radiograph; (b) children infected with HIV and hospitalized because of their debilitated physical condition; and (c) children who presented with systemic illnesses were excluded from the control group.

The parents or legal guardians of the children signed an informed consent form. The present investigation was approved by the Ethics Committee in Research of PUCRS and by the Ethics Committee in Research of the Hospital de Clínicas de Porto Alegre.

A panoramic radiograph was obtained for each individual of the sample, where the same X-ray apparatus was used throughout the study (Orthophos Plus, Siemens AG, Bensheim, Germany), and radiographs were processed using an automatic film processor (A/T 2000, Air Techniques, Hicksville, NY).

The radiographs were evaluated by a certified dental radiologist who was calibrated and blinded. That is, the information on name, age, sex, and group of the children was blinded to the examiner to eliminate information bias. Furthermore, it was made an intraobserver calibration with five panoramic radiographs.

Analyses were made three times, with 7 days of interval, by the same observer in a dark room using a magnifying glass (×3) and an X-ray film viewer (Mediltec, São Paulo, SP, Brazil) with collimation. The stages of tooth calcification were determined considering the mandibular permanent teeth on the left side [9, 14], where the third molar was excluded from the evaluations. Each tooth was classified at a stage of calcification according to Nolla [21]: stage 0 (absence of crypt), stage 1 (presence of crypt), stage 2 (initial calcification), stage 3 (one third of the crown completed), stage 4 (two thirds of the crown completed), stage 5 (crown almost completed), stage 6 (crown completed), stage 7 (one third of the root completed), stage 8 (two thirds of the root completed), stage 9 (root almost completed, open apex), and stage 10 (apical end of the root completed). When a tooth was found to be between two stages, an average value was assigned.

The analysis of calcification stages was made per group of teeth, that is, the means of values obtained for each group of teeth (central incisor, lateral incisor, canine, first premolar, second premolar, first molar, and second molar) in the HIV-infected children were compared to those values obtained in the control group. In addition, the stages of tooth calcification obtained for each tooth evaluated were summed (total value, without discrimination per group of teeth), resulting in a single value for each child [21], and the mean values obtained for HIV-infected children were compared to those obtained for the control group.

The frequency of subjects showing alveolar eruption of the first and second mandibular permanent molars was also evaluated and compared between both groups, test


**Fig. 1** Panoramic radiograph of a 4-year-old female child infected by HIV. Considering the left mandibular permanent teeth, the first molar is not erupted (alveolar eruption), and the central incisor, first premolar, and first molar are, respectively, in the 6.5, 5, and 7 calcification stages of Nolla


**Fig. 2** Panoramic radiograph of a 4-year-old female child of the control group. Considering the left mandibular permanent teeth, the first molar is erupted (alveolar eruption), and the central incisor, first premolar, and first molar are, respectively, in the 7, 6, and 8 calcification stages of Nolla

and control. The alveolar eruption of the permanent molars was determined on the left side. The criterion for tooth eruption employed was that proposed by Lewis and Garn [13], classifying a tooth as erupted when radiographic examination indicated no alveolar bone above the crown. Alveolar eruption of the first molar was determined in children who ranged in age from 4 years and 1 month to 8 years, with a mean age of 6 years, and included 32 males and 32 females ($n$=64). Alveolar eruption of the second molar was determined in children who ranged in age from 8 years and 1 month to 12 years and 2 months, with a mean age of 9 years and 9 months, and included 16 males and 20 females ($n$=36).

The results obtained were evaluated by descriptive statistics and by analysis of variance, Student's $t$ test, and chi-square test, considering the level of significance at 5%. Figs. 1 and 2 show panoramic radiographs exemplifying the analysis of alveolar eruption of the first molar and the calcification stages for central incisor, first premolar, and first molar.

## Results

### Stages of tooth calcification

#### *Tooth by tooth evaluation*

The mean values for stages of calcification obtained, per tooth evaluated, are presented in Table 1. Although the values obtained for the central incisor, lateral incisor, canine, first premolar, first molar, and second molar were slightly lower in the group of children infected with HIV than in the control group, such difference was not significant (ANOVA, $P$>0.05).

**Table 1** Stages of calcification, per tooth evaluated, in HIV-infected children and control group

| Tooth (left mandible) | HIV-infected children | | Control group | | $P$ (ANOVA) |
|---|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation | |
| Central incisor | 8.45 | 1.18 | 8.60 | 1.26 | 0.57 |
| Lateral incisor | 8.20 | 1.29 | 8.34 | 1.37 | 0.59 |
| Canine | 7.41 | 1.06 | 7.47 | 1.07 | 0.78 |
| First premolar | 6.84 | 1.22 | 6.89 | 1.15 | 0.83 |
| Second premolar | 6.53 | 1.46 | 6.36 | 1.31 | 0.57 |
| First molar | 8.58 | 1.14 | 8.67 | 1.00 | 0.67 |
| Second molar | 6.18 | 1.22 | 6.30 | 1.26 | 0.63 |

#### *Sum of the stages of calcification*

Table 2 shows the means for the sum of the stages of calcification obtained for each group of children evaluated. The mean values were found to be similar, and when submitted to statistical analysis, there was no evidence of a significant difference between the group of HIV-infected children and the control group ($t$ test, $P$>0.05).

### Alveolar eruption

The frequency of subjects showing alveolar eruption of the first and second mandibular permanent molars did not exhibit a significant difference between children infected with HIV and the control group (Tables 3 and 4, chi-square test, $P$>0.05).

**Table 2** Sum of stages of tooth calcification for seven mandibular teeth in HIV-infected children and control group

| Group | Stages of calcification (sum for seven mandibular teeth) | | $P$ ($t$ test) |
|---|---|---|---|
| | Mean | Standard deviation | |
| HIV-infected children | 50.27 | 7.38 | |
| Control | 50.54 | 7.30 | 0.83 |

## Discussion

The stages of tooth calcification did not differ significantly between the group of children infected with HIV and the control group. This indicates that the children infected with HIV examined in the present study showed stages of tooth calcification of the permanent teeth within the normal range. On the other hand, Valdez et al. [28], who examined the panoramic radiographs of 29 children infected with HIV, found a delay in tooth calcification in nine cases (31%). Although they examined a sample with an age range similar to that in the present study, the authors failed to include a control group, which makes it difficult to conclude that such condition is characteristic of HIV-seropositive children.

Although the toxicity of anti-retroviral drug therapy has already been associated with alterations in bone metabolism, the usual risk factors and advanced HIV infection are more strongly related to the processes of osteopenia and osteoporosis [10, 18]. In the present study, the finding that the infected children showed values for stages of tooth calcification very close to those of the control group can be explained by their regular follow-up by the medical team who made sure that factors such as malnutrition and serious infections were controlled as well by their treatment with anti-retroviral drugs, which are considered a risk factor for bone metabolism but less than advanced HIV infection [10, 18]. The latter clinical care may have a positive influence in the growth of HIV-infected children [15, 16, 20]. It should also be noted that dental tissues are less susceptible to factors that interfere with development [17].

There was no significant difference observed in the frequency of subjects showing alveolar eruption of the mandibular molars between the groups evaluated. Such finding suggests that the children infected with HIV showed alveolar eruption within the normal pattern. Meanwhile, Leggott et al. [11] observed a tendency for a delay in tooth eruption in children infected with HIV, suggesting that this delay is characteristic of the infection. The difference in results between this study and the present work can perhaps be explained by the fact that the latter consisted of clinical observations in a smaller sample and mainly of younger age, that is, evaluating deciduous dentition.

**Table 3** Alveolar eruption of the first permanent molar in the group of HIV-infected children and control group

| Group | Alveolar eruption of the first molar (no. of subjects) | | |
|---|---|---|---|
| | Erupted | Not erupted | Total |
| HIV-infected children | 25 (78.1%) | 7 (21.9%) | 32 |
| Control | 23 (71.9%) | 9 (28.1%) | 32 |
| Total | 48 (75%) | 16 (25%) | 64 |

Included only children in the age range from 4 years and 1 month to 8 years. Chi-square test, $P>0.05$

**Table 4** Alveolar eruption of the second permanent molar in the group of HIV-infected children and control group

| Group | Alveolar eruption of the second molar (no. of subjects) | | |
|---|---|---|---|
| | Erupted | Not erupted | Total |
| HIV-infected children | 10 (55.6%) | 8 (44.4%) | 18 |
| Control | 9 (50%) | 9 (50%) | 18 |
| Total | 19 (52.8%) | 17 (47.2%) | 36 |

Included only children in the age range from 8 years and 1 month to 12 years and 2 months. Chi-square test, $P>0.05$.

The delay of tooth eruption in HIV-infected children, cited in the literature, was seen in the majority of cases as a result of clinical evaluations and at a young age [6–8, 27]. It should be noted that the process from alveolar eruption up to clinical tooth eruption takes 1 year and 4 months [19]. Local factors can interfere in this process, such as gingival fibromatosis, a condition in which the dense conjunctive tissue does not allow clinical tooth eruption, and the presence of supernumerary or impacted teeth [26], which is detectable initially by radiographic examination. Such factors demonstrate the importance of radiographic evaluation and explain the divergence in results between the present study and other investigations employing clinical evaluation of tooth eruption. The pairing of the test and control groups reinforced the reliability of the results obtained in the present study; however, measurements were not taken of the proportion of the crown breaking through, as tooth eruption was determined according to the alveolar eruption criteria of Lewis and Garn [13]. Quantitative data obtained from these measurements could have provided more precise information on the degree of tooth eruption in the groups studied.

Growth deficiency associated with HIV infection in children infected by vertical transmission is identified at an early stage, just after birth, after which it is stabilized with the use of anti-retroviral drugs [2]. Therefore, it is probable that the effects of HIV infection on deciduous and permanent teeth differ. It is thereby necessary to conduct longitudinal studies on the development of both dentitions in children infected with HIV, which means preferably evaluations of the same children during distinct periods. Also needed are clinical radiographic studies comparing the dental development of these children with skeletal development and systemic conditions.

## Conclusion

Children infected with HIV by the vertical route showed upon radiographic examination, stages of tooth calcification and alveolar eruption compatible with normal patterns. There is no association between HIV infection and alterations in the chronological development of the permanent teeth, detectable radiographically, in children infected by vertical transmission.

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