## Scientific Article

# Radiographic Evaluation of Alveolar Bone Height in the Primary Dentition: A Retrospective Follow-up Study

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**Abstract:** *Purpose:* The aim of this retrospective follow-up study was to verify the distance between the cementoenamel junction (CEJ) and the alveolar bone crest (ABC) in bitewing radiographs. **Methods:** Radiographs were digitized and divided into groups by: age, proximal crown surface status (sound  $\rightarrow$  sound and unsound  $\rightarrow$ unsound), tooth, and timing of radiograph. The CEJ-ABC distances were measured on the distal surface of the first primary molar and/or the mesial surface of the second lower primary molar, using the Image Tool software. **Results:** The results revealed interactions between the following variables: timing of radiograph-age, age-tooth, timing of radiograph - proximal crown surface status and age- proximal crown surface status. It has been detected that CEJ-ABC distances have significantly increased with time, particularly in terms of assessment of primary lower first molars. However, this increase is greater in unsound when compared to sound surfaces. **Conclusion:** This study suggests that an increase in the CEJ-ABC distance is directly associated with aging in a normal periodontium in the primary dentition and that the presence of unsound surfaces can be a risk indicator for the development of alveolar bone loss. (Pediatr Dent 2011;33:312-5) Received December 3, 2009 | Last Revision August 17, 2010 | Accepted August 25, 2010

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Periodontitis is a disease caused by micro-organisms that colonize the tooth surfaces as the result of an imbalance between the external aggression and the immune response. The inflammatory process may promote the loss of the tooth's supporting tissues.<sup>1.4</sup>

Several studies have been conducted to correlate periodontal changes with pathological and normal events in adults. The diagnosis and treatment of periodontal problems in the primary and mixed dentition, however, have been neglected. It may be justified by the short time of maintenance of the primary teeth in the oral cavity (progression of periodontal disease is slow and often does not produce substantial bone loss in children) and the limited cooperation during the intraoral examination. Moreover, additional factors such as eruptive movements and the influence of systemic factors might be considered.<sup>5-9</sup>

Besides changes due to facial growth and the tooth eruption process, the alveolar bone loss may be influenced by caries and proximal restorations. They can contribute to food retention, thus favoring bacterial biofilm organization. The ideal environment for the development of periodontal disease is thereby formed.<sup>10-15</sup>

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Radiographic parameters have been used to estimate alveolar bone loss in the primary and mixed dentition as a complementary approach to the clinical and microbiological findings. The alveolar bone loss evaluation has been currently assessed by the distance between the cementoenamel junction (CEJ) and the alveolar bone crest (ABC) on bitewing radiographs.<sup>7,9,11,15-17</sup>

The current literature has not provided strict radiographic parameters for the diagnosis of alveolar bone loss in the primary dentition, and the influence of normal/pathological factors has not been depicted yet. The accepted CEJ-ABC radiographic distance that corresponds to a normal alveolar bone height is around 1 mm.<sup>7,18,19</sup> Most authors suggest, however, that alveolar bone loss is associated with CEJ-ACB distances greater than 2 mm with the presence or absence of lamina dura.<sup>14,16,19-24</sup>

The correlation between the increased CEJ-ABC distance, local modulating factors, and alterations in bone crest has not yet been assessed. Therefore, the purpose of this study was to determine the cementoenamel junction-ABC distance considering the patient's age and the radiographic characteristics of the proximal surfaces through bitewing radiographs.

#### Methods

The present study was approved by the Institutional Review Board of Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil. A total of 302 bitewing radiographs from 3- to 10-year-old subjects were provided by 2 heath institutes. Subjects who reported any systemic disease or previous

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orthodontic or periodontal treatment were excluded from the study. Subjects presenting a CEJ-ABC distance of 2.5 mm or more in any examined tooth were not included. The initial and follow-up radiographs (taken at least 1 year after the beginning of the experiment) were evaluated. They should display minimum distortion, no overlapping of the proximal surfaces, and a clear image of the CEJ. A total of 178 fully erupted and non-exfoliating teeth in occlusion were included in this study.

Radiographs were digitalized (Scanjet 3800, Hewlett-Packard, Palo Alto, Calif) and stored as a jpg file. The scanning parameters were 300-dpi resolution and original size kept intact. Brightness and contrast were manually adjusted. Each tooth received a code to guarantee a random and blinded evaluation. The examiner was previously calibrated (Intraclass correlation coeficient – ICC>0.80). No information regarding the timing of each radiograph (initial or follow-up examination) was provided.

The CEJ-ABC distance was measured with Image Tool 3.0 software (The University of Texas Health Science Center, San Antonio, Texas). The standard length of the radiographic film was set as the initial calibration.

The distal surface of the primary mandibular first molar and/or the mesial surface of the primary mandibular second molar were analyzed. The measurement comprised the distance from the CEJ to the most cervical point of the ABC corresponding to the same proximal surface in the crown, perpendicular to the occlusal surface.

Clinical and radiographic variables were considered for data analysis, such as subject age ( $\leq 6$  or  $\geq 7$  years old), timing of radiograph (initial or follow-up examination), tooth (primary mandibular first or second molar), and proximal crown surface status (sound—sound or unsound—unsound). Unsound surfaces presented proximal caries or restorations, as detected through the radiographic examination.

Data were analyzed with SPSS 13.0 software (SPSS Inc, Chicago, Ill) and SAS/STAT software (SAS Institute Inc, Cary, NC). Analysis of variance and Tukey's test were used to assess the CEJ-ABC distance after considering the different variables ( $P \le .05$ ).

#### Results

The only interaction between variables, was for timing of radiograph/subject age, subject age/tooth, timing of radiograph/proximal crown surface condition, and subject age/ proximal crown surface status (*P*>.05; Table 1).

Considering the parameters, it was observed that the mean for the CEJ-ABC distance increased significantly from the initial to the follow-up radiographs for both age groups (Table 2).

The mean of the CEJ-ABC distance increased significantly with aging only for the primary first molar. Subjects who were at least 7-years-old had a higher CEJ-ABC mean in their primary mandibular first molars than in their primary mandibular second molars (P<.05). Data are shown in Table 3.

Table 4 shows data related to the interaction between timing of radiograph /proximal crown surface status. For both initial and follow-up radiographs, the mean CEJ-ABC distance in teeth with sound—sound surfaces was lower than in teeth

able 1.	RELATIONSHIP BETWEEN DIFFERENT VARIABLES:
	SUBJECT AGE, PROXIMAL CROWN SURFACE STATUS
	(PCSS), TOOTH, AND TIMING OF RADIOGRAPH

Effect	F-value	P-value
Subject's age,* PCSS	3.93	.04
PCSS,* tooth	0.16	.69
Timing of radiograph,* PCSS	6.12	.01
Subject's age,* tooth	4.60	.03
Timing of radiograph,* subject's age	4.11	.04
Timing of radiograph,* tooth	0.86	.35
Subject's age,* PCSS,* tooth	1.25	.26
Timing of radiograph,* subject's age,* PCSS	0.57	.45
Timing of radiograph,* PCSS,* tooth	0.02	.88
Timing of radiograph,* subject's age,* tooth	·0.24	.62
Timing of radiograph,* subject's age,* PCSS,* tooth	0.00	.94

\* P<.05 values reveal the interaction between the variables analyzed by repeated measures/analysis of variance.

Table 2. INTERACTION BETWEEN SUBJECT AGE GROUPS AND TIMING OF RADIOGRAPH*			
≤6 ys old group	≥7 ys-old group		
Mean (range)±SD	Mean (range)±SD		
1.08 (043-2.13)±0.29 <sup>B</sup>	1.24 (0.43-2.14)±0.32 <sup>B</sup>		
1.22 (0.62-2.27)±0.33 <sup>A</sup>	1.32 (0.54-2.14)±0.32 <sup>A</sup>		
	TERACTION BETWEEN S ROUPS AND TIMING OF ≤6 ys old group Mean (range)±SD 1.08 (043-2.13)±0.29 <sup>B</sup> 1.22 (0.62-2.27)±0.33 <sup>A</sup>		

\* Means followed by different uppercase letters in the same column indicate a statistical difference in the repeated measures analysis of variance, complemented by Tukey's test (5% significance level).

Table 3.	INTERACTION BETWEEN T SUBJECT AGE GROUPS*	OOTH AND
Subject's age (ys)	Primary mandibular first molar	Primary mandibular second molar
	Mean (range)±SD	Mean (range)±SD
≤6	1.21 (0.52-2.27)±0.33 <sup>Ba</sup>	1.10 (0.43-2.04)±0.30 <sup>Aa</sup>

\* Means followed by different uppercase letters in one same column indicate a statistically significant difference, while means followed by lowercase letters in the same line indicate a statistically significant difference in the repeated measures analysis of variance, complemented by Tukey's test (5% significance level).

Table 4.	INTERACTION BETWEEN PROXIMAL CROWN
	SURFACE STATUS AND RADIOGRAPHIC SEQUENCE*

Radiographic	Proximal crown surface status		
sequence	Sound → sound Mean (range)±SD	Unsound→ unsound Mean (range)±SD	
Initial Follow-up	1.08 (0.43-2.13)±0.27 <sup>вь</sup> 1.17 (0.55-1.92)±0.27 <sup>Аь</sup>	1.28 (0.43-2.14)±0.35 <sup>Ba</sup> 1.46 (0.52-2.27)±0.38 <sup>Aa</sup>	

\* Means followed by different uppercase letters in the same column and means followed by lowercase letters in the same line indicate a statistically significant difference in the repeated measures analysis of variance, complemented by Tukey's test (5% significance level). with unsound  $\rightarrow$  unsound surfaces. Lower CEJ-ABC distances were detected in the initial radiographs when compared to the follow-up ones (*P*<.05).

The interaction between proximal crown surface status and subject age is shown in Table 5. Subjects 6-years-old and younger had the lowest CEJ-ABC distances in the sound $\rightarrow$ sound group when compared to the unsound $\rightarrow$ unsound group. The CEJ-ABC distance increased in the sound $\rightarrow$ sound group, regardless of the subject's age.

### Discussion

The shift from a healthy to a diseased status in the periodontal tissues in children is similar to adults. Normal changes associated with a patient's growth, such as tooth exfoliation and eruption, may modulate the host response and tissue breakdown.<sup>7-9,19</sup>

Bitewing radiographs are considered the most efficient technique to assess incipient marginal bone loss because of their ability to detect details in the sharpness of the structures.<sup>25,26</sup> They become an important tool to evaluate primary and mixed dentition due to the limitations associated with a proper clinical examination in children.<sup>27</sup> The bitewing technique is adopted as a routine for clinical diagnosis in the health institutes that provided the material for the present study. The angulation of the cone beam can promote image alterations.<sup>26</sup> Radiographs with clear distortion were excluded from the study. Several protocols have been suggested to avoid radiographic distortions, especially in follow-up studies such as aligning systems. A child's continuous growth, however, may promote bone remodeling and alteration in tooth position, limiting the use of aligning systems. In the present study, a group comprising only sound teeth was added to assess the influence of aging in the CEJ-ABC measures.

In the present study, the mean CEJ-ABC distance was 1.22 mm for sound surfaces and less than 2 mm even for unsound surfaces, indicating no clinically significant bone loss. Several studies divided the CEJ-ABC values in groups and determined one of the them as a threshold to indicate the presence or absence of bone loss.<sup>14,16,19-23</sup> This grouping method did not seem to be appropriate, however, because there is no consensus regarding the exact CEJ-ABC distance for healthy/ diseased sites in the primary dentition.

Several studies have correlated the CEJ-ABC distance to the subject age.<sup>7,9,11,18</sup> It could result from facial growth, continuous eruption of teeth, tooth wear due to attrition, and frequent episodes of biofilm formation that may affect the periodontal tissue.<sup>25</sup>

According to the literature, different CEJ-ABC distances can be observed for the primary mandibular first and second molars.<sup>7,13,14,23</sup> In the present study, the CEJ-ABC distance increased significantly with aging in the primary mandibular first molar. Further studies examining the influence of normal changes, such as tooth eruption/exfoliation on this distance for different age groups are warranted.

Despite the timing of radiographic evaluation (initial or follow-up examination), the sound  $\rightarrow$  sound group had lower mean for the CEJ-ABC distance than the unsound  $\rightarrow$  unsound group, supporting previous literature reports.<sup>9,10,12,15,16,21</sup> This

Table 5. INTERACTION BETWEEN PROXIMAL CROWN SURFACE STATUS AND SUBJECTS AGE GROUPS*			
Evaluation	Proximal crown surface status		
(ys old)	Sound → sound Mean (range)±SD	Unsound → unsound Mean (range)±SD	
≤6	$1.07 (0.43 - 2.13) \pm 0.26^{Bb}$	1.35 (0.52-2.27)±0.37 <sup>Aa</sup>	

\* Means followed by different uppercase letters in the same column indicate a statistically significant difference, while means followed by lowercase letters in the same line indicate a statistically significant difference in the repeated measures analysis of variance, complem.

result indicated that the shift from a sound to an unsound condition may increase the CEJ-ABC distance. The same behavior was observed for children who were 6-years-old or younger and at least 7-years-old, suggesting that the increase in the CEJ-ABC distance is physiological and associated with aging, regardless of the proximal condition (sound or unsound).

In the unsound  $\rightarrow$  unsound group, there was an increase in the CEJ-ABC distance. The plaque-retentive characteristics of proximal cavities and dental restorations may be associated with the bone level.<sup>10,14,16,29</sup> Therefore, patient follow-up should be warranted in this particular situation.

Children 6 years old and younger had an increased CEJ-ABC distance in the unsound  $\rightarrow$  unsound group regarding the proximal crown surface condition and subject age. This behavior was not detected in children who were at least 7years-old due to high values in the initial measurement caused by the children's physiological growth.<sup>7,11,21,23</sup>

Lower CEJ-ABC distances were observed for the sound  $\rightarrow$  sound group in the 6 years old and younger group. This result supports the hypothesis that there is an increase in the CEJ-ABC distance with aging, especially in the first molar, which could be justified by its continuous eruptive movement. In the unsound  $\rightarrow$ unsound group, this difference was not observed, possibly because the CEJ-ABC distance was greater in the measurements for the 6-years-old and younger group, due to the unsound proximal surface condition.

The present study found CEJ-ABC measures that were consistent with the normal pattern, as suggested by the current literature, despite the evaluated variables. The follow-up period and the nature of the primary dentition, however, may have strongly influenced these findings. The existence of statistically significant differences pointed to the association between bone resorption and unsound proximal crown surfaces.

#### Conclusions

- 1. This study suggests that an increase in the CEJ-ABC distance is directly associated with aging in a normal periodontium in the primary dentition.
- Greater distances are found when considering unsound proximal surfaces, then these CEJ-ABC values can be a risk indicator for the development of alveolar bone loss.
- 3. Further research is needed to correlate the association between the presence of periodontal disease in the primary dentition and widened CEJ-ABC distances in the permanent dentition.

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