Asymmetrical root resorption in primary mandibular molars: Prevalence and determinants factors

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Abstract

Objective: This study was designed to determine the prevalence of asymmetrical root resorption and associated factors in primary mandibular molars in children aged 3-12 years.

Design: A cross-sectional study was carried out with a representative sample of 1068 molars evaluated using 671 radiographs from 453 children. Age, dental history, and medical history were recorded using a questionnaire administered to the children’s parents/caregivers. Asymmetrical root resorption, dental crown status (sound, caries without pulp involvement, caries with pulp involvement, and evidence of restoration), periradicular lesion, and pulpotomy or pulpectomy were determined. Data analysis involved descriptive statistics, the Chi-square test and a multivariate logistic regression (P < 0.05).

Results: The prevalence rate of asymmetrical root resorption was 3.8%. The 8-12 years age bracket (odds ratio [OR]: 5.8; 95% confidence interval [CI]: 2.3-15.1; P < 0.001) and presence of pulpotomy (OR: 2.8; 95% CI: 1.1-7.4; P < 0.05) were predictors of the occurrence of asymmetrical root resorption in primary mandibular molars. In conclusion, the prevalence of asymmetrical root resorption was low.

Conclusion: Child’s age and the presence of pulpotomy were associated with a greater occurrence of this type of resorption.

Keywords
Child, epidemiology, molar, root resorption, tooth

Introduction

Physiological root resorption of primary molars involves all roots simultaneously.¹ Asymmetrical root resorption, also known as ectopic or atypical resorption, is advanced resorption in a single root; the origin of which may be physiological or pathological.²,³ The main predictors of root resorption in primary molars are occlusal trauma, necrotic pulp, tumor, child’s age, caries with pulp involvement, the absence of restoration, presence of pulpotomy or pulpectomy.⁴,⁵ Other aspects, such as the separation of primary roots and the position and size of follicles of the permanent successor crowns, may also be related factors.⁶,⁷,⁸

Asymmetric resorption can cause a delay in exfoliation due to an extended retention of the primary tooth in the oral cavity, which could consequently lead to occlusal problems.⁹ Another consequence is the presence of root fragments in the dental alveolar tissue as a result of incomplete root resorption.¹⁰ Root remnants may be reabsorbed or, to a lesser extent, serve as potential sites for residual radicular cysts.¹¹,¹²

Most studies on asymmetrical root resorption in the primary dentition are not recent and use case reports and case series, especially in incisors.¹³,¹⁴ There are no studies with substantial scientific evidence that have analyzed the prevalence and associated factors with asymmetrical root resorption in primary molars. Understanding these issues are important to establishing an accurate diagnosis and planning dental care for children as well as allowing the establishment of appropriate preventive measures and efficient treatment to avoid damage in the future.

The aim of this study was to determine the prevalence of asymmetrical root resorption and associated factors in the primary mandibular molars of children aged 3-12 years based on radiographic images and clinical records.
Asymmetrical root resorption in primary mandibular molar

Vieira-Andrade, et al.

Materials and Methods

This study received approval from the Human Research Ethics Committee of the Federal University of the Jequitinhonha and Mucuri Valleys (Brazil) with protocol number 135/10. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Study design and sample

A cross-sectional study was carried out on a representative sample of 1068 primary mandibular molars using 671 periapical radiographs taken from 453 children of both genders aged 3-12 years retrieved from the radiographic files of the pediatric clinic of the Federal University of the Jequitinhonha and Mucuri Valleys (Brazil). The radiographic images were generated by four identical X-ray devices (Spectro 70X, Dabi Atlante, Ribeirão Preto, Brazil) with a potential voltage of 70 kVp and amperage of 8 mA. The radiographs were processed manually. The following were the inclusion criteria: High-quality periapical radiographs (selection was based on the degree of detail, lack of distortion, clarity, adequate density, and adequate image contrast) and with tooth with the visible presence of the root apex and germ of the permanent successor teeth. The exclusion criteria were the absence of information in questionnaires.

About 50% of prevalence rate (PR) of asymmetrical root resorption was used in the calculation of the sample size, although this information is not available in previously published studies. Employing a 95% confidence interval (CI) and 3% margin of error, the minimum sample was determined to be 854 primary mandibular molars, to which 214 molars (20%) were added to compensate for possible losses, totaling 1068 primary mandibular molars.

Data collection

The research team was composed of four examiners (general dentists) who underwent a training and calibration exercise. The training exercise involved a discussion of the criteria for the diagnosis of asymmetrical root resorption, which was radiographically defined by the presence of complete resorption in only one of the roots (mesial or distal) [Figure 1] with or without the presence of periapical lesion [Figure 2]. Disagreements in the diagnosis were discussed and resolved by consensus. For the calibration exercise, 80 radiographs not included in the main study were randomly selected for the analysis of images of primary mandibular molars. Inter-examiner agreement was tested by comparing the response of each examiner with the gold standard (a Ph.D. student with expertise in the subject matter). After 7 days, the same radiographs were reevaluated by the same examiners to determine intra-examiner agreement. Data analysis involved the calculation of Cohen’s Kappa coefficients on a tooth-by-tooth basis, which ranged from 0.82 to 0.91 for intra-examiner agreement and 0.85 to 0.90 for inter-examiner agreement, demonstrating that the examiners were capable of performing the exams in the main study. A pilot study was conducted with a sample of 214 (20%) teeth and its respective questionnaires to test the applicability of data collection method. The questionnaires had been pretested in 13 parents/caregivers not included in the main sample of the study. The minimum Kappa value in this step was 0.81.

The periapical radiographs were analyzed through direct observation with the aid of a viewing box (CARP, Ribeirão Preto Brazil). This assessment was divided into three steps. The researchers first determined the presence/absence of asymmetrical root resorption with or without the presence of periapical lesion. The second step was the determination of crown status (sound, caries without pulp involvement, caries with pulp involvement, and presence of restoration). In addition to these variables, the researchers also checked whether the primary molar

Figure 1: Periapical radiograph of primary mandibular molar with presence of asymmetrical root resorption

Figure 2: Asymmetrical root resorption in primary mandibular molars, (a) asymmetrical root resorption without periradicular lesion, (b) asymmetrical root resorption with periradicular lesion
showed any evidence of pulpotomy and pulpectomy, which were confirmed by the children’s clinical records.

A questionnaire was previously administered to the children’s parents/guardians to obtain information on age, gender, dental and medical history. Medical history investigated the presence/absence of general health problems such as chronic and systemic diseases. Dental history involved information related to previous treatments performed on the teeth under study.

**Statistical analysis**

The data were tabulated and analyzed using the Statistical Package for the Social Sciences (SPSS for Windows, version 17.0, SPSS Inc., Chicago, USA). Initially, absolute and relative frequencies were determined for all variables studied. The Chi-square test was then employed to investigate associations between asymmetrical root resorption and each independent variable (gender, age, general health problem, sound tooth, caries without pulp involvement, caries with pulp involvement, presence of restoration, pulpotomy, pulpectomy, and periradicular lesion). A $P < 0.05$ demonstrated a statistically significant association.

Multivariate logistic regression was performed for the analysis of factors associated with the presence/absence of asymmetrical root resorption. The association magnitude of each factor with the presence of asymmetrical root resorption was assessed using unadjusted and adjusted odds ratio (OR), respective CIs (CI = 95%) and $P$ values (Wald test). Explanatory variables with a $P$ value $\leq 0.20$ in the bivariate analysis and those with theoretical relevance (regardless of the $P$ value) were incorporated into the model.

**Results**

The mean age of the children was 7.9 years (standard deviation: 2.12 years). Males accounted for 53.4% ($n = 242$) and females accounted for 46.6% ($n = 211$) of the children. The PR of asymmetrical root resorption was 3.8% ($n = 41$).

None of the teeth evaluated had undergone orthodontic movement or exhibited tumors. Asymmetrical root resorption was significantly associated with child’s age ($P < 0.001$) and the presence of pulpotomy ($P < 0.05$). Regarding age, 6% of children between 8 and 12-year-old exhibited asymmetrical root resorption. In those aged 3-7 years, only 1% exhibited this type of resorption. Regarding pulpotomy, 10% of pulpotomized teeth had asymmetrical root resorption, whereas 3.6% of non-pulpotomized teeth had this condition. No statistically significant associations were found between asymmetrical root resorption, and the other independent variables investigated [Table 1].

Table 2 shows the results of the multivariate logistic regression analysis. The following variables were predictors of asymmetrical root resorption in primary mandibular molars: Age 8-12 years ($OR: 5.8; 95\% CI: 2.3-15.1; P < 0.001$) and presence of pulpotomy ($OR: 2.8; 95\% CI: 1.1-7.4; P < 0.05$). These variables were controlled for all variables that remained in the model as well as for child’s gender and age. Multicollinearity test has been checked in the multivariate model and none variables showed multicollinearity ($P = 0.412$).

**Discussion**

In this study, asymmetrical root resorption was associated with child’s age and the presence of pulpotomy. Pulpotomy is a more

<table>
<thead>
<tr>
<th>Variables</th>
<th>Presence of complete asymmetrical root resorption, $n$ (%)</th>
<th>$P^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>565 (96.4)</td>
<td>21 (3.6)</td>
</tr>
<tr>
<td>Female</td>
<td>462 (95.9)</td>
<td>20 (4.1)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-7 years</td>
<td>463 (98.9)</td>
<td>5 (1.1)</td>
</tr>
<tr>
<td>8-12 years</td>
<td>564 (94.0)</td>
<td>36 (6.0)</td>
</tr>
<tr>
<td>Health problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>853 (96.2)</td>
<td>34 (3.8)</td>
</tr>
<tr>
<td>Present</td>
<td>174 (96.1)</td>
<td>7 (3.9)</td>
</tr>
<tr>
<td>Sound tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>814 (96.3)</td>
<td>31 (3.7)</td>
</tr>
<tr>
<td>Present</td>
<td>213 (95.5)</td>
<td>10 (4.5)</td>
</tr>
<tr>
<td>Caries without pulp involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>887 (96.2)</td>
<td>35 (3.8)</td>
</tr>
<tr>
<td>Present</td>
<td>140 (95.9)</td>
<td>6 (4.1)</td>
</tr>
<tr>
<td>Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>866 (96.0)</td>
<td>36 (4.0)</td>
</tr>
<tr>
<td>Present</td>
<td>161 (97.0)</td>
<td>5 (3.0)</td>
</tr>
<tr>
<td>Pulpotomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>991 (96.4)</td>
<td>37 (3.6)</td>
</tr>
<tr>
<td>Present</td>
<td>36 (90.0)</td>
<td>4 (10.0)</td>
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<tr>
<td>Pulpectomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>1012 (96.1)</td>
<td>41 (3.9)</td>
</tr>
<tr>
<td>Present</td>
<td>15 (100.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Periradicular lesion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>863 (96.4)</td>
<td>32 (3.6)</td>
</tr>
<tr>
<td>Present</td>
<td>164 (94.8)</td>
<td>9 (5.2)</td>
</tr>
</tbody>
</table>

*Chi-square test
conservative treatment option commonly used on teeth with deep carious lesions without fistula or swelling as well as lesions in the periapical or furcation region.\[13,14\] Regarding chemical trauma, it was noted that the chemical compound formocresol was used in all pulpotomies. A number of histological studies have shown that formocresol may alter the pattern of root resorption, since this agent can cause internal and external root resorptions as well as abscess formation.\[15,16\] This may explain the prevalence of asymmetrical root resorption in pulpotomized teeth treated with formocresol. Thus, the use of a biocompatible pulp-capping agent is advisable. Studies have shown that mineral trioxide aggregate (MTA) is highly biocompatible and induces a better response in the vital pulp of primary teeth. MTA appears to be superior to formocresol and could serve as a suitable replacement, but generally costs more than formocresol.\[17-19\] Although the use of formocresol has been questioned, a recent study showed that the clinical and radiographic success rates for the formocresol at 12 months were 97% and 87%, respectively. These rates were higher than alternatives methods for pulpotomy (diode laser and ferric sulfate).\[20\] Thus, formocresol still can be regarded for pulpotomy in primary teeth.

Regardless of the pulp-capping agent used, pulpotomies can affect normal root resorption in primary teeth.\[13\] A number of factors have been seen in pulpotomized teeth such as purulent exudate, pulp abscess, inadvisable pulpotomy treatment of teeth with irreversibly inflamed pulp, and bacterial contamination.\[15\] These factors result from the incomplete sealing of the tooth after pulpotomy and may have been responsible for asymmetrical root resorption in the pulpotomized primary molars in the present study. A histological analysis of pulpotomized primary teeth with asymmetrical root resorption should be performed in future studies to test this hypothesis.

The association between asymmetrical root resorption in primary molars and the presence of pulpotomy found in this study suggests the importance of clinical and radiographic follow-up after this procedure throughout childhood. Indeed, follow-up gives the dentist a greater understanding of the management and control of pulpotomy, allowing the identification of the incidence of possible defects in the seal or failure over time. Follow-up also allows the determination as to whether pulpotomy indeed constitutes a causal factor of asymmetrical root resorption. Moreover, the monitoring of root resorption allows predicting the occurrence of prolonged retention and the better planning of care to avoid future occlusal problems.\[10\]

Studies have reported that root resorption in primary teeth depends on the germ of permanent successor as well as other factors.\[1,5-4\] Furthermore, the morphological relationship between the roots of the primary teeth and the crowns of the permanent successors should be considered.\[2] In this study, a situation in which the germ of the permanent successor completely occupied only one of the roots of the primary tooth was considered atypical resorption, which may explain the greater prevalence of asymmetrical root resorption in the primary molars of children aged 8-12 years, as primary molars undergo a natural exfoliation process in this period, in comparison to those aged 3-7 years. On the other hand, cases of root resorption were observed during the data collection process involving only one of the primary molar roots without the presence of the permanent successor. These situations of root resorption were associated with areas of periradicular bone rarefactions and tooth decay with pulp involvement, which is in agreement with findings described in previous studies.\[1,6,7\]

It is not possible to identify the initial moment of root resorption clinically or through radiographs. Only advanced stages of root resorption are seen in radiographic exams. Periapical radiographs are most commonly used in this situation.\[21,22\] In this study, periapical radiographs were used in the evaluation of the type of root resorption in the teeth investigated. It should be stressed that the periapical radiographic images were taken by different X-ray operators. However, bias was minimized due to the high quality of the radiographs selected. Other accurate diagnostic methods are currently used to evaluate root resorption, such as cone beam tomography.\[23\]

The main limitation of the present study is related to the cross-sectional design. In this type of study, exposure and outcome are collected at a single moment in time, making it difficult to determine cause-and-effect relationships among the variables investigated. Therefore, the results should, therefore, be interpreted with caution and longitudinal studies, including the use of new diagnostic methods, should be conducted to establish a better understanding of the factors that influence the occurrence of asymmetrical root resorption. Furthermore, some information was obtained from a questionnaire filled out by the children’s parents or guardians. Memory bias related to medical history should be taken into account in this situation.

**Conclusion**

Based on this study’s results, the following conclusion can be made: The PR of asymmetrical root resorption was low and child’s age (8-12 years) and the presence of pulpotomy were associated with a greater occurrence of asymmetrical root resorption.
References
