Relationship between pulpal involvement of primary molars and eruption pattern of premolars

G. P. PINI PRATO, T. BACCETTI, L. FRANCHI, R. GIORGETTI* A. MARINELLI

SUMMARY. Aim This study’s aim was to investigate the relationship between deep caries, with pulp necrosis of primary molars, and the pattern of eruption of the corresponding premolars. Methods A total of 126 children were followed up to the completion of premolar eruption over an 8-year period. Criteria for case selection included arch length adequacy and absence of abnormally large teeth. Primary molars were classified as test teeth if affected by deep caries; otherwise they were classified as control teeth. Eruption of corresponding premolars was classified as either centric or ectopic in relation to the area of eruption on the alveolar ridge. Results A total of 682 premolar eruptions were examined. Of these 73 (10.7%) eruptions of premolars were ectopic; 308 (45.2%) primary molars presented with deep caries and pulp necrosis. Some 61 (83.6%) out of the 73 ectopic eruptions occurred in association with pulp necrosis of the primary molars. A chi-square test was used to study the relationship between deep caries of primary molars and ectopic eruption of premolars, separately for upper and lower arches and for first and second premolars. A significant association was found for both first (p<0.01) and second (p<0.05) mandibular premolars, and for maxillary first premolars (p<0.0001). No significant association was assessed for maxillary second premolars. Conclusion Deep caries with pulp involvement of primary molars appears to be a factor associated with deviations of the eruption pattern for corresponding premolars. Clinical consequences may include the need for orthodontic treatment and periodontal concerns regarding the amount of keratinized gingiva of ectopically erupting premolars.

KEY WORDS. Pulp necrosis; Primary molars; Ectopic eruption, Mucogingival defects.

Introduction

The physiological site of tooth eruption is the centre of the alveolar ridge. This pattern of eruption usually results in an ideal soft tissue and osseous anatomy [Hall, 1977]. When the permanent tooth erupts on the buccal or the lingual aspect of the alveolar ridge (ectopic eruption), it entraps and destroys the keratinized tissue between its cusps and the corresponding primary tooth (Fig. 1). Some modifications of the periodontium may be observed after completion of the eruption. There is often a reduction in the height and the width of the cortical alveolar bone and in the amount of keratinized tissue on the side of the deviation [Bowers, 1963; Maynard and Ochsenbein, 1975; Hall, 1977; Årtun et al., 1986]. Bone dehiscence can be observed as well [Parfitt and Mjör, 1964]. These alterations in the periodontium of the permanent tooth may facilitate gingival recession during subsequent orthodontic treatment to align the ectopically-erupted tooth, when tooth-brushing is often either impaired or traumatic [Pini Prato et al., 2000a; Pini Prato et al., 2000b].

Several clinical conditions have been considered as causes of ectopic eruption of permanent teeth [McDonald and Avery, 1983]. These may be abnormal tooth size or shape; arch length inadequacy; arch length loss due to interproximal caries of primary molars, ectopic eruption of first permanent molars, delayed eruption after loss of primary teeth, or premature loss of primary teeth; overretained primary teeth; ankylosed primary molars; presence of supernumerary teeth; premature occlusal contacts.

Besides these acknowledged conditions, there is
experimental evidence that the deep caries in primary molars alters the timing and pattern of eruption of the corresponding permanent teeth in dogs [Aida, 1984]. A few studies [Lauterstein et al., 1962; McCormick and Filostrat, 1967; Valderhaug, 1974] suggest that also in human subjects aberrant or accelerated eruption of the permanent teeth, tooth deflections, impactions, and rotations may result from infected primary teeth. Therefore, deep caries with pulpal involvement could be a factor associated with deviations of the eruption pattern.

The aim of the present study was to ascertain if a relationship exists between the deep caries with pulpal necrosis of the primary molars and the pattern of eruption of the corresponding premolars in humans.

**Materials and methods**

A prospective study was carried out on a sample of patients seeking orthodontic care at the Dental School of the University of Siena. In total, 126 children were followed up to the completion of their premolar eruption over an eight year period. Caries of the primary molars was treated when indicated. The children were 67 females and 59 males, aged 8 to 13 years (mean: 9.6 years) at the time of first observation. Each patient had one to eight primary molars in the arches (mean: 6.0 primary teeth/patient) at the first visit.

The entry criteria were the following.
- Presence of at least one primary molar in situ.
- Arch length adequacy, evaluated on plaster models: at least 22 mm from the mesial aspect of the first permanent molar to the distal aspect of the lateral incisor. If the lateral incisor was missing, at least 29 mm at the upper arch and 28 mm at the lower arch, between the first molar and the central incisor [Moyers, 1988].
- Absence of teeth abnormally large mesiodistally: patients were excluded from the study if any tooth present at the time of the initial examination was found to exceed a maximum reference value.

The maximum reference value was set at two standard deviations above the mean size for each type of tooth based on the values determined by Moorrees [1959]. Separate maximum reference values were used for males and females. The inter-examiner reliability was tested by replicating linear measurements of 112 teeth on plaster models. The 95% confidence interval for average discrepancy was from 0.004 mm to 0.047 mm. The maximum discrepancy in this sample was 0.4 mm.

The classification criteria for the primary molars and for the erupting premolars were as follows.
- Caries of primary molars: each primary molar still in situ was classified as a test tooth if caries could be detected that involved the endodontic space either clinically or radiographically (Fig. 2), even when the caries had been adequately treated. Otherwise, it was classified as a control tooth.
- Eruption pattern of premolars: the eruption of each premolar was classified as centric if the tooth was erupting at the centre of the alveolar ridge, with a direct contact of its emerging crown with the corresponding primary molar (Fig. 3a). The eruption was classified as centric even when the tooth was rotated, provided its vertical axis was correct. The eruption was recorded as ectopic if the premolar was erupting on the buccal or lingual aspect of the alveolar ridge, with interposed...
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The gingiva between the cusp of the premolar itself and the corresponding exfoliating primary tooth (Fig. 3b).

The assignment of the teeth to the different categories was performed by two examiners independently. If they did not agree, a joint examination was made. If an assignment remained in doubt (e.g. because the primary molar was missing at the time), the premolar and the corresponding primary molar were excluded from the study.

The patients were recalled at two monthly intervals until all of the primary molars exfoliated, or up to the end of the study. Each primary molar and its corresponding premolar were considered as a unit for data analysis. The statistical analysis aimed to study a possible relationship between deep caries in the primary molars and ectopic eruption of the corresponding premolars. The chi-square test was used as a test for independence of two classification criteria (deep caries of the primary molars and pattern of eruption of the corresponding premolars). Yates’ correction was applied to face the low expected incidences in 2 x 2 contingency tables with n<40. The null hypothesis stated that the ectopic eruption of premolars and the deep caries of the corresponding primary molars were independent from each other. The p=<0.05 significance level was chosen.

Results
A total of 761 primary molars were followed during the observation period. Most of the caries had been treated by endodontic treatment (pulpectomies) and restorations (either amalgams or stainless steel crowns). A total of 695 eruptions of premolars occurred during the eight years of which 13 eruptions could not be classified because the primary tooth was already missing when the premolar erupted. Of the remaining 682, that were included in the analysis (Table 1), 609 (89.3%) were centric eruptions and 73 (10.7%) were ectopic. Deep caries had been detected in 308 primary molars (45.2% of the total sample), and 61
out of the 73 eccentric eruptions (83.6%) occurred in association with deep caries of the primary molars.

The data relating to each tooth type (maxillary first and second premolar, mandibular first and second premolar) is reported in Tables 2 to 5. The frequencies of centric and ectopic eruption and of deep caries of the corresponding primary molars are reported as contingency tables, along with the results of the chi-square test.

A highly significant association ($p<0.0001$) between deep caries of primary molars and ectopic eruption of the corresponding premolars is apparent in the maxillary first premolars (Table 2).

### Table 1 - Occurrence of centric and ectopic eruption of the premolars in cases of presence or absence of deep caries of the corresponding primary molar.

<table>
<thead>
<tr>
<th>Eruption pattern of the permanent tooth</th>
<th>Centric</th>
<th>Ectopic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary molar</td>
<td>N %</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>No deep caries</td>
<td>362 (96.8)</td>
<td>12 (3.2)</td>
<td>374</td>
</tr>
<tr>
<td>Deep caries</td>
<td>247 (80.2)</td>
<td>61 (19.8)</td>
<td>308</td>
</tr>
<tr>
<td>Total</td>
<td>609</td>
<td>73</td>
<td>682</td>
</tr>
</tbody>
</table>

Chi-square = 40.66 $p<0.0001$

### Table 2 - Occurrence of centric and ectopic eruption of the maxillary first premolar in cases of presence or absence of deep caries of the corresponding primary molar.

<table>
<thead>
<tr>
<th>Eruption pattern of the maxillary first premolar</th>
<th>Centric</th>
<th>Ectopic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary molar</td>
<td>N %</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>No deep caries</td>
<td>104 (95.4)</td>
<td>5 (4.6)</td>
<td>109</td>
</tr>
<tr>
<td>Deep caries</td>
<td>34 (54.0)</td>
<td>29 (46.0)</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>138</td>
<td>34</td>
<td>172</td>
</tr>
</tbody>
</table>

Chi-square = 40.66 $p<0.0001$

### Table 3 - Occurrence of centric and ectopic eruption of the maxillary second premolar in cases of presence or absence of deep caries of the corresponding primary molar.

<table>
<thead>
<tr>
<th>Eruption pattern of the maxillary second premolar</th>
<th>Centric</th>
<th>Ectopic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary molar</td>
<td>N %</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>No deep caries</td>
<td>104 (96.2)</td>
<td>4 (3.8)</td>
<td>108</td>
</tr>
<tr>
<td>Deep caries</td>
<td>59 (90.8)</td>
<td>6 (9.2)</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
<td>10</td>
<td>170</td>
</tr>
</tbody>
</table>

Chi-square = 1.264 $p>0.05$, not significant

### Table 4 - Occurrence of centric and ectopic eruption of the mandibular first premolar in cases of presence or absence of deep caries of the corresponding primary molar.

<table>
<thead>
<tr>
<th>Eruption pattern of the mandibular first premolar</th>
<th>Centric</th>
<th>Ectopic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary molar</td>
<td>N %</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>No deep caries</td>
<td>78 (96.3)</td>
<td>3 (3.7)</td>
<td>81</td>
</tr>
<tr>
<td>Deep caries</td>
<td>70 (79.6)</td>
<td>18 (20.4)</td>
<td>88</td>
</tr>
<tr>
<td>Total</td>
<td>148</td>
<td>21</td>
<td>169</td>
</tr>
</tbody>
</table>

Chi-square = 9.39 $p<0.01$

### Table 5 - Occurrence of centric and ectopic eruption of the mandibular second premolar in cases of presence or absence of deep caries of the corresponding primary molar.

<table>
<thead>
<tr>
<th>Eruption pattern of the mandibular second premolar</th>
<th>Centric</th>
<th>Ectopic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary molar</td>
<td>N %</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>No deep caries</td>
<td>79 (100.0)</td>
<td>0 (0.0)</td>
<td>79</td>
</tr>
<tr>
<td>Deep caries</td>
<td>84 (91.3)</td>
<td>8 (8.7)</td>
<td>92</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>8</td>
<td>171</td>
</tr>
</tbody>
</table>

Chi-square = 5.39 $p<0.05$
The prevalence of ectopic eruption was 4.6% in the control group (no deep caries), and 46.0% in the test group (deep caries). On the contrary, no significant association could be demonstrated in the maxillary second premolars (Table 3). The prevalence of ectopic eruption was 3.81% in the control group and 9.0% in the test group.

A significant association was found for both first (p<0.01) and second (p<0.05) mandibular premolars (Tables 4, 5). The prevalence of ectopic eruption of first mandibular premolars was 3.7% in the control group and 20.5% in the test group. The corresponding prevalences for the second mandibular premolar were 0% and 8.7%, respectively.

Discussion

The study was aimed at verifying the existence of an association between the deep caries with pulp involvement of primary molars and the eruption of the corresponding premolars out of the centre of the alveolar ridge (ectopic eruption) (Fig. 4). The entry criteria for this prospective study required both sufficient length of the arch and normal size of the permanent teeth. The required distance between the incisors and the permanent first molar included the lee-way space and was assumed to allow space enough for the premolars [Giannelly and Goldman, 1971], provided these were not abnormally large (beyond the 97th percentile) [Moorrees, 1959]. The cases of arch length inadequacy or abnormal tooth size were excluded from the study, since ectopic eruption could be anticipated even without any relationship with the condition of the primary molars [McDonald and Avery, 1983].

Each primary molar and corresponding premolar (maxillary first, maxillary second, mandibular first, mandibular second) were chosen as an analysis unit irrespectively of left/right side, because the eruption pattern of the premolars could be different for individual premolars in the same subject. In fact, the occurrence of eccentric eruption was quite different for the different types of premolars. Even if patient-related factors cannot be excluded, the focus of this study was on the relationship between deep caries of each primary molar and eruption pattern of the corresponding premolar. Therefore, each primary molar with its corresponding premolar was considered adequate as the unit of analysis. Each tooth type was evaluated separately, since the different anatomical relationship between the teeth and the surrounding tissues and between primary and permanent teeth could affect the eruption pattern.

The ectopic eruption of the premolars was rare (3.2%) when the primary molars were healthy, while it was remarkably more frequent (19.8%) if they had deep caries with pulp involvement. The results of this study agree with previous experimental data on dogs and with clinical reports on human subjects, which had shown a correlation between deep caries of primary molars and ectopic eruption of the corresponding premolars [Lauterstein, 1962; McCormick and Filostrat, 1967; Valderhaug, 1974; Aida, 1984].

The difference in the occurrence of ectopic eruption was highly significant in the case of the maxillary first premolars (4.6% in control teeth vs. 46.0% in test teeth). The difference was still significant in the cases of both first and second mandibular premolars. The null hypothesis of independence between ectopic eruption of...
premolars and pulp damage of the primary molars could not be rejected in the case of maxillary second premolars. For these teeth, the eccentric eruption was rare (9.2%) even when the corresponding primary molars exhibited deep caries. This fact could be explained, at least in part, by the relatively large buccal-lingual width of the alveolar ridges and of the primary tooth at the maxillary second premolar level.

Three different mechanisms can be hypothesized to explain the greater relative risk of ectopic eruption of premolars when the primary molars are affected by deep caries.

The first hypothesis is that the pulp necrosis affects the resorption of the roots of the primary molars [Alexander, 1980]: in this case, the persistence of unresorbed roots would deviate the eruption pathway of the premolar.

The second hypothesis is that the periapical osteolysis induced by the pulpal necrosis involves the cortical plate, thereby creating a locus minoris resistentiae for the erupting premolar, usually on the buccal side. The eruption follows the pattern where the least resistance is found.

The third hypothesis is that the deviation in the eruption pathway of the premolar is due to a disruption in the activity of the dental follicle. This plays a fundamental role in the timing and the direction of tooth eruption [Cahill et al., 1988; Baccetti et al., 1993].

Further research could clarify the mechanisms of the change induced in the eruption pattern by the caries of the primary teeth, especially with regard to the maxillary first premolars. The knowledge of the association between deep caries of some primary teeth and ectopic eruption of the corresponding permanent teeth is clinically relevant, because the altered eruption pattern can imply need for orthodontic treatment, at least if a scissors bite occurs as a consequence of ectopic eruption. Moreover, periodontal hazards [Bowers, 1963; Parfitt and Mjö, 1964; Maynard and Ochsenbein, 1975; Hall, 1977; Pini Prato et al., 2000a; Pini Prato et al., 2000b] may result from the loss of the keratinized tissue destroyed by the crown of the erupting premolar.

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References


