

## ECTOPIC ERUPTION OF PERMANENT FIRST MOLARS: A RETROSPECTIVE STUDY

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**ABSTRACT**

**Objective:** The aim of this study was to describe the occurrence, angulation and mesialization ratio of the ectopic eruption of the maxillary permanent first molar (PFM) and its correlation with the pathological resorption of maxillary primary second molar (PSM).

**Methods:** This retrospective study was performed using the panoramic radiographs of 11.924 child patients aged 6–10 years. Ectopic eruption status is categorized as self-corrected and impacted types. To evaluate the differences between the two groups (self-corrected and impacted), the angulation of PFM, mesialization ratio of PFM, and degree of adjacent PSM root resorption were also assessed. The data were statistically analyzed using ANOVA and chi-square tests. Pearson correlation was used to analyze whether a quantitative relationship exists between PFM mesialization ratio and PSM root resorption.

**Results:** Ectopic eruption frequency was determined as 0.83%. The distribution of ectopic eruption according to gender shows a higher prevalence in males than females. In most of the eruption status of cases with ectopic eruption were impacted. The impacted PFMs showed more negative vertical and positive horizontal angle between the PSM and PFM. There was no significantly difference eruption status and angles. Mesialization ratio of impacted PFMs were significantly higher than self-corrected PFMs. There was significant difference between the PFM mesialization ratio and the degree of PSM root resorption.

**Conclusion:** It is important to predict the ectopic eruption of PFMs earlier because early diagnosis can provide optimal treatment and prevent resorption of the PSMs. Early diagnosis and detailed imaging techniques evaluation are important to prevent premature loss of arch size; but our study has proven that panoramic radiographs routinely used in dentistry are useful for the early diagnosis of PFMs.

**Key Words:** Ectopic Eruption, Eruption Failure, Impacted Teeth

## **INTRODUCTION**

The term 'eruption' refers both to the process of axial movement of a tooth from its non-functional position in the bone to functional occlusion and to the moment the tooth appears in the oral cavity.<sup>1-2</sup> The eruption process is a complex phenomenon, with multiple factors needing to occur simultaneously to achieve a normal eruption.<sup>3</sup>

Ectopic eruption of permanent first molars (PFMs) may be defined as a local disturbance characterized by eruption of these teeth under the distal undercut of the primary second molars (PSMs) and failure of the PFMs to erupt to the normal occlusal plane.<sup>4-6</sup> It is a common case in mixed dentition and is usually diagnosed by a pediatric dentist.<sup>7</sup> The most common ectopic erupted permanent teeth are the maxillary PFMs and canines, followed by the mandibular canines, mandibular second premolars, and maxillary lateral incisors.<sup>3</sup> Ectopic PFMs are usually in contact with the distal prominence of the crown of the adjacent PSMs.<sup>8</sup> As a result, ectopic eruption of PFMs may cause many complications, such as impaction of permanent second premolars, pulp obliteration, neuralgic pain, space loss in the dental arch, atypical resorption, and premature loss of PSMs.<sup>7, 9-10</sup>

The reasons for ectopic eruption are multifactorial, including a genetic component and local factors.<sup>11</sup> The increased prevalence reported in siblings is considered to have a genetic component.<sup>3</sup> In fact, a recessive inheritance pattern with reduced penetrance in girls has been proposed as a form of heredity.<sup>12</sup> The ectopic eruption of PFMs depends on the combination of the following factors: larger approximate size of the maxillary primary and permanent teeth in affected patients, posterior position of the maxilla according to the cranial base, and unusual angulation of the eruption of PFMs.<sup>10</sup> Moreover, inaccurate restoration of PSMs, inadequate crown morphology of PSMs, development of tuberosity, and asynchronous appearance of maxillary PFMs and iatrogenic causes can be considered as etiologic factors.<sup>6, 9</sup>

The aim of this study was to describe the occurrence, angulation and mesialization ratio of the ectopic eruption of the PFMs and its correlation with the pathological resorption of maxillary PSMs.

## **METHODS**

### ***Study Design and Setting***

The study protocol was approved by the ..... Non-Interventional Clinical Research Ethics Committee (2019/77-12). This retrospective study was performed using the panoramic radiographs of 11,924 child patients aged 6–10 years who attended the Pediatric Dentistry clinics at the Faculty of Dentistry, ....., between March 2016 and March 2018.

Data were collected retrospectively from clinical notes and panoramic radiographs. Among the 11,924 radiographs, only the children who had at least one ectopically erupted PFM were included. The exclusion criteria are as follows: presence of any history of extraction due to impaction, orthodontic treatment, or caries; presence of any craniofacial anomalies, congenital deformities, or syndromes involving dental eruption; absent adjacent PSMs; and presence of any cyst, tumor, or other pathological condition in the molar area.

Every evaluation and measurement were performed by two examiners (C.O. and S.K.) to minimize errors. Intra- and inter- observer error was calculated by rescoring 20 randomly selected radiographs two weeks after the initial assessments. From the pre-study test, the inter- and intra-examiner kappa correlation was found to be 85%.

### ***Assessment of Ectopic Eruption Prevalence***

Ectopic eruption of PFM was diagnosed according to O'Meara's definition.<sup>5</sup> The total prevalence of ectopic eruption, age, gender, jaw distribution, and bilateral versus unilateral occurrence were determined.

### ***Status of Ectopic Eruption***

Ectopic eruption status is categorized as self-corrected and impacted types.<sup>13</sup> Categorization of ectopic eruption for assessments the minimum time interval was set at 6 months. To evaluate the differences between the two groups (self-corrected and impacted)

(Figure 1), the angulation of PFM, and degree of adjacent PSM root resorption, mesialization ratio of PFM were also assessed.

### ***Assessment of PFM Angulation***

For assessment of PFM angulation, both vertical and horizontal angles were measured. The angle was measured using ImageJ application (1.50 n, National Institutes of Health, Bethesda, MD, USA). The angles between the long axes of the PSMs and PFMs were measured for vertical angle. The angles between the occlusal lines of the PSMs and the PFMs were measured for horizontal angle.

The vertical and horizontal angle were defined as negative or positive according to Sun et al.<sup>8</sup> (Figure 2; 2a, 2b, 2c and 2d).

### ***Assessment of PSM Root Resorption***

The distal root resorption level of the PSM was determined using Barberia-Leache et al.'s classification<sup>3</sup> as follows:

Grade I: mild-limited resorption of the cementum or with minimum dentin penetration

Grade II: moderate-resorption of the dentin without pulp exposition

Grade III: severe-resorption of the distal root leading to pulp exposure

Grade IV: very severe-resorption that affects the mesial root of the PSM.

### ***Assessment of PFM Mesialization Ratio***

The mesiodistal size of the PFM and the amount of mesialization were measured by the ImageJ application to evaluate the differences between self-corrected and impacted ectopic eruption. The mesiodistal size was measured from the largest part of the crown, and the amount of mesialization was measured using the distance between the drawn tangent on the distal wall of the PSM and the mesial convexity of the PFM (Figure 2; 2e and 2f). Afterwards, the amount of mesialization was proportioned to the mesiodistal size of the PFM.

### ***Statistical Analysis***

Data were analyzed using SPSS version 22 (SPSS Inc., Chicago, IL, USA). The chi-square test was performed to compare the frequency of each variable. ANOVA (gender, bilateral or unilateral occurrence, impacted or self-corrected, self-corrected/ impacted age) was used for multivariate analysis. Pearson correlation was used to analyze whether a quantitative relationship exists between PFM mesialization ratio and PSM root resorption. The level of significance was set to 0.05.

## **RESULTS**

### ***Prevalence of Ectopic Eruption***

Among the 11.924 children in the sample, 99 cases were identified as having ectopic eruption of PFM, giving a frequency of 0.83%. The mean age of ectopic eruption diagnosis in 99 cases was 7.05 years.

The distribution of ectopic eruption according to gender shows a slightly higher prevalence in males ( $n = 55$ ) than in females ( $n = 44$ ) with no statistically significant differences ( $p = 0.201$ )

88 ectopic eruption cases were observed in the maxilla, 7 cases in the mandible, and 4 cases in both the maxilla and the mandible. The chi-square test revealed a significant difference between affected jaws (maxilla/mandible/both) ( $p = 0.02$ ). There was no significant difference between the distribution of ectopic eruption by jaw and gender ( $p=0.670$ ).

Ectopic eruption occurred unilaterally in 64 cases (28 right side, 36 left side), bilaterally in 32 cases, and both in 3 case. No significant difference was found between gender and ectopic eruption side ( $p = 0.21$ ).

### ***Status of Ectopic Eruption***

15 of the 99 cases were excluded because there were no continuous radiographs required for a definitive diagnosis. So, categorization and measurements were performed on the remaining 84 cases.

In terms of the eruption status of cases with ectopic eruption, 27 cases were self-corrected, 51 cases were impacted, and 6 cases were both. A significant difference was found between gender and eruption status of the cases ( $p = 0.02$ ). However, no significant relationship was found between eruption status and ectopic eruption side ( $p = 0.130$ ) (Table 1).

The average age at the time of first diagnosis of ectopic eruption in 84 cases was 7.14 years. The mean diagnostic age of the self-corrected and impacted types is 8.11 and 8.04 years, respectively. The mean observation time between diagnosis of PFM ectopic eruption and eruption status was 0.97 years for the self-corrected types and 0.90 years for the impacted types.

### ***PFM Angulation***

Ectopic eruption was observed in a total of 117 teeth in 84 cases. The frequently affected teeth of ectopic eruption were found to be the maxillary right PFM ( $n= 56$ ), followed by the maxillary left PFM ( $n= 49$ ), mandibular right PFM ( $n= 7$ ), and mandibular left PFM ( $n= 5$ ).

Mean scores of vertical angles for self-corrected and impacted groups were  $-9.4^\circ$ ,  $+11.8^\circ$  and  $-9.3^\circ$ ,  $+10.4^\circ$  respectively (Table 2). Mean scores of horizontal angles for self-corrected and impacted groups were  $-7.9^\circ$ ,  $+9.1^\circ$  and  $-6.6^\circ$ ,  $+10.7^\circ$  respectively (Table 2). When vertical angles were evaluated, negative angles of self-corrected type (53.6%) and positive angles of impacted type (52.3%) were observed more. When horizontal angles were evaluated, positive angles were observed more in both self-corrected (85.4%) and impacted types (68.4%). When PFM angulations were evaluated according to eruption status, there was no significantly difference (Table 2).

When PFM angulation evaluated according to jaw and side, only negative vertical angles showed significantly difference ( $p = 0.045$ ). The mean of the negative vertical angles of maxillary right PFM was significantly higher than others (Table 3).

### ***PSM Root Resorption***

Distribution of the PSMs root resorption degree is as follows: 9 teeth were grade I, 56 teeth were grade II, 43 teeth were grade III, and 9 teeth were grade IV (Table 4). No significant relationship was found between eruption status of PFM and degree of PSM root resorption ( $p = 0.068$ ). Although no statistical significance was found, self-correction of PFM was reduced in PSM with grade III and IV root resorption.

### ***PFM Mesialization Ratio***

Although there was no significant difference between PFM mesialization ratio and jaw-side (maxillary/mandibular, left/right PFM) ( $p = 0.099$ ), the mesialization ratio of the maxillary right PFMs was higher than that of other PFMs (Table 5).

The mesialization ratio of the impacted type was significantly higher than the self-corrected type ( $p=0.011$ ).

Resorption degree of PSMs were 9 teeth (Grade I), 56 teeth (Grade II), 43 teeth (Grade III) and 9 teeth (Grade IV) respectively. There was significant difference between the PFM mesialization ratio and the degree of PSM root resorption ( $p<0.001$ ). The mean mesialization ratio of the patients with the grade IV resorption was significantly higher than the other groups. Moreover, PSMs with grades II and III resorption had a significantly higher mesialization ratio than the PSM with a resorption grade I ( $p=0.02$ ). Also, according to the correlation test results, degree of resorption was positively correlated with mesialization ratio at 44.9%.

## **DISCUSSION**

Early diagnosis of ectopic eruption and determination of eruption status are very important. If the ectopic eruption received without treatment, it may cause space loss, malocclusion and decreased arch length. The premature loss of PSM may allow serious forward movement of adjacent PFM. This type of problems can be prevented with early diagnosis treatment. In the literature, various methodologies (clinical, and radiographic assessments, biometric and orthodontic measurements, etc.) have been used for the early diagnosis of ectopic eruption. (2,7,9,18) In this study related many factors were analyzed and the mesialization ratio was also measured unlike previous studies. In this way, it is thought that it will contribute to the literature.

The ectopic eruption prevalence of PFMs varies at 0.75%–4.3%.<sup>3-4, 6, 14</sup> Obtaining different prevalence results may be related to the fact that the frequency of ectopic eruption varies according to many variables, such as ethnicity, geography, age of population, and genetic factors.<sup>3-4, 6, 14</sup> In line with study's findings by Chintakanon et al.<sup>6</sup>, the ectopic eruption prevalence of the PFMs was 0.83% in the present study.

In the analysis of the distribution of the prevalence of ectopic eruption according to gender, many studies found to be higher in males than in females,<sup>3-4, 6, 8-9</sup> similar to this study (54.8%).

Ectopic eruption of the PFMs is 25 times more common in the maxilla than in the mandible.<sup>6, 13, 15</sup> The greater prevalence in the maxilla was associated with lack of bony growth in the angle of the tuberosity region at the right time and posterior position of the maxilla in relation to the cranial base. In the present study, similar to the Mooney et al.,<sup>16</sup> ectopic eruption of maxillary PFM was detected more frequently.

There are contradictory results due to the diversity of diagnostic criteria regarding the direction of ectopic eruption (unilaterally/bilaterally) in the literature.<sup>3-4, 8-9</sup> If the diagnosis was conducted without considering the root resorption of the PSM and a number of self-corrected PFM, the total frequency and bilateralism would be less. Sun et al. reported that ectopic

eruption occurred 42.6% bilaterally and 57.4% unilaterally.<sup>8</sup> Dabbagh et al. found bilateral ectopic eruption in 21 patients and unilateral ectopic eruption in 23 patients, with the right-sided ectopic eruption being more common than the left-sided ectopic eruption.<sup>17</sup> Similar to these studies,<sup>8, 17</sup> the prevalence of unilateral ectopic eruption case was higher than bilateral ectopic eruption case in this study.

The ectopic eruption of PFMs can be classified in two ways: self-corrected (reversible) and impacted (irreversible).<sup>13</sup> An observation period of 3-6 months has been proposed to diagnose an ectopic erupted PFM to determine whether it is self-corrected or impacted.<sup>3, 11, 18-19</sup> In the self-corrected type, the ectopic erupted PFM can disregard the self-locking position and continue in a normal direction, but the distal root of the PSM remains more or less a significant atypical resorption.<sup>9, 13</sup> In the impacted type, until an active treatment for the PFM is started or the early exfoliation of PSM occurs, the tooth remains in a self-locking position.<sup>9</sup> In this study, impacted type ectopic eruption was found higher than self-corrected type. The status of ectopic eruption (self-corrected or impacted) in the present study is similar to Chintakanon et al.'s study, which evaluated ectopic eruption using cone-beam computed tomography (CBCT).<sup>6</sup>

The present study found that the mean observation time of the self-corrected and impacted types were 0.97 and 0.90 years, respectively. It has been reported that self-correction could occur between six months and two years after the first diagnosis of ectopic eruption.<sup>11</sup>

When the distribution of ectopic eruption according to the jaw-side is examined, the higher prevalence on right side than left side was found in this study. This finding was compatible with the many studies.<sup>3, 20</sup> It is stated in the literature that this situation can be associated with other multi-factor abnormalities and side frequency variations.<sup>3, 20</sup>

Previous studies indicated that increase in negative vertical angle of PFM were significant factors of impacted ectopic eruption of the PFM. Based on this study, between the

angle of long axis and occlusal line of PFM and PSM was measured using panoramic radiograph.<sup>3, 8, 20</sup> In this study findings showed that negative vertical angles and mean values was found more in impacted PFM consistent with the results in Sun et al.<sup>8</sup> However, the results of this study at negative horizontal angles for impacted PFM were not consistent with previous study.<sup>8</sup> This may be due to the many factors affecting eruption status.<sup>7, 9-10</sup> and methodological differences with Sun et al. study.<sup>8</sup>

From an evolutionary perspective, the self-correction of resorption degrees I and II and the impaction of resorption degrees III and IV are expected. In line with Barberia et al. and Chintakanon,<sup>3, 6</sup> the present study showed no significant relationship between the eruption status of PFMs and the root resorption degree of PSMs. Also, it was observed that self-correction of PFM was reduced in PSM with grade III and IV root resorption.

In previous studies, mesialization of PFM (distance from the area of maximum convexity of the mesial contour of the permanent tooth to a tangential plane to the distal surface of the primary tooth) was performed by measuring millimetrically on OPG and determined that these values did not differ statistically according to the ectopic status and PSM root resorption.<sup>3, 6</sup> Also Barberia et al emphasize that a small impaction of PFM sometimes causes severe resorption of PSM and a relatively large impaction of PFM causes less pathological root resorption of PSM.<sup>3, 6</sup> When evaluated from this perspective, these results are contradictory.<sup>3, 6</sup>

In the literature, mesialization ratio was used the first time in this study to minimize errors due to image distortion in millimetric measurements. In present study, the mesialization ratio differs significantly according to the degree of resorption ( $p < 0.05$ ). It has been determined that in the most of the ectopic eruption cases, PSM mesialization ratio and PSM root resorption increase in direct proportion. Also mesialization ratio of impacted PFMs was significantly higher than self-corrected PFMs.

## **CONCLUSIONS**

- Even if eruption disturbances do not occur frequently, making an early diagnosis is important to begin treatment at an optimal time.
- Although the relationship between horizontal and vertical angles and the ectopic eruption pattern is controversial, it is one of the clinical determinants that should be considered in the diagnosis, treatment, and follow-up of prognosis.
- A small mesialization amount of the PFM does not mean that the PSM root resorption lesion is also small. With substantial displacements, a proportionally diminutive lesion can exist, so using mesialization ratio of PFM can be useful to determine eruption status of PFM.
- Although resorption is present in grades I and II, spontaneous self-correction can be expected without treatment. However, if the grade is III or IV, the majority of the cases will not self-correct.
- All parameters should be evaluated objectively and separately, for which we have proposed a method. Using detailed imaging techniques should be considered in case of doubt. Further studies with larger sample size can be useful to create a clinical guideline.

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## **DISCLOSURES**

The authors declare no conflicts of interest.

## **AUTHOR CONTRIBUTION**

SC, NT, CO and SK have made contributions to data collection. SC, CO and SB contributed to analysis, interpretation of data and drafting of the manuscript with input from other team members. All authors involved in the conception and design of the study approved the final manuscript.

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## **FIGURE LEGENDS**

**Figure 1.** Panoramic radiographs of reversible and irreversible ectopic eruption.

Panoramic radiograph classified as impacted ectopic eruption Initial **(a)** and follow-up **(b)**

Panoramic radiograph classified as self-corrected ectopic eruption Initial **(c)** and follow-up **(d)**

**Figure 2.** Measurement methods of the angles on panoramic radiograph.

**a:** Measurement method of the positive vertical angles between the long axes.

**b:** Measurement method of the negative vertical angles between the long axes.

**c:** Measurement method of the positive horizontal angles between occlusal lines.

**d:** Measurement method of the negative horizontal angles between occlusal lines.

**e, f:** Measurement method of the amount mesialization between PSM and PFM.