

# Prevalence and characteristics of ectopic eruption of the first permanent molar and predictive factors for clinical outcome

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## Abstract

**Background:** The primary objective of this study was to assess the occurrence, distribution, and features of ectopic first permanent molars (FPMs), as well as to investigate the clinical outcomes associated with ectopic eruption based on the degree of root resorption observed in primary second molars.

**Methods:** This study was performed retrospectively by examining panoramic radiographs of 7070 patients aged 5 to 12 years. The gender and age of the patients, the number, location, and distribution mode of ectopic FPMs, the resorption degree of the distal roots of primary second molars, and the clinical outcome of ectopic eruption were evaluated. Descriptive statistics and chi-square test were performed on the obtained data using SPSS version 22 (SPSS Inc, Chicago, IL, USA).

**Results:** In 144 of 7070 cases, a total of 221 ectopic permanent first molar teeth were detected (2% prevalence). The mean age of the 144 patients was 8.04 years. Ectopic eruption was most common in patients aged 7–8 years (48.63%), which was statistically significant ( $P < 0.05$ ). Ectopic eruptions were more common in females (58.30%) than males (41.70%;  $P < 0.05$ ). Of the ectopic permanent first molars, 78 (35.30%) were in the mandible, and 143 (64.70%) were in the maxilla. The relationship between the degree of resorption and the type of ectopic eruption was statistically significant ( $P < 0.05$ ).

**Conclusion:** The increase in the severity of root resorption in the primary second molars was a significant predictor for the prognosis of ectopic eruption in the present study. Early diagnosis and treatment of ectopic FPMs are of great importance to preventing premature loss of primary second molars resulting in malocclusion.

**Keywords:** Ectopic tooth eruption, Molar, Prevalence, Pediatric dentistry

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## Introduction

The process of tooth eruption is complex and involves the coordinated action of multiple factors, which can be influenced by genetic, cellular, molecular, or tissue-related factors.<sup>1,2</sup> Ectopic eruption, first described by Chapman in 1923, is a local eruption disturbance that causes a tooth to fail to erupt into the normal occlusal plane.<sup>3</sup> Ectopic eruption of first permanent molars (FPMs) occurs due to the abnormal eruption pathway of the tooth, leading to the impaction of the permanent molars under the distal undercut of the primary second molars. The prevalence rate of ectopic eruption of FPMs ranges from 0.75% to 11.8% in the normal population.<sup>4-11</sup> The variations in these prevalence rates have been associated with several factors including sample size, geographic location, ethnic background, age distribution, caries status, and genetic

factors.<sup>6,11</sup> Higher prevalence rates were reported in siblings and patients with cleft lips or palates.<sup>12,13</sup>

While the etiology of ectopic eruption of FPMs remains unclear, it is believed that both local factors and genetic factors play a role in its development.<sup>14</sup> According to extensive studies, the possible etiologic factors causing this anomaly include the abnormal eruption pathway of the permanent molars, bone-tooth size discrepancies (abnormally large first permanent and second primary molars),<sup>15,16</sup> delayed calcification and development of the FPM,<sup>15,17</sup> crowding,<sup>16</sup> malocclusion,<sup>17</sup> small arches,<sup>3,15</sup> posteriorly positioned maxilla relative to the cranial base,<sup>15,18</sup> and inadequate anterior movement of primary dentition.<sup>3</sup> Also, it has been reported that ectopic eruption has a familial tendency considering to the increased prevalence reported in siblings.<sup>18</sup> Young



described two types of ectopic eruptions. In cases classified as the reversible type, ectopic FPMs have the ability to spontaneously correct their eruption pathway and subsequently erupt in a normal manner. In the irreversible type, the FPM remains fixed in its ectopic position, which can lead to premature loss of the primary second molar. In both reversible and irreversible types, pathological resorption of the distal root of the primary second molars occurs. However, in cases of irreversible ectopic eruption, severe root resorption takes place.<sup>10</sup>

The diagnosis of ectopic eruption of FPMs is established by considering and assessing both the radiographic and clinical findings in conjunction.<sup>19</sup> During the clinical examination, the presence of a prolonged delay or asymmetry in the eruption of one or more FPMs, exceeding a six-month timeframe compared to other teeth, along with the distal cusps of the FPMs emerging before the mesial cusps, can indicate a potential case of an ectopic eruption.<sup>20-22</sup> Examination of radiographs plays an essential role in the differential diagnosis of ectopic eruption.<sup>23</sup> Periapical, bitewing, occlusal, panoramic radiographs, and cone beam computed tomography (CBCT) can be used to diagnose ectopic eruption.<sup>5</sup> Studies report that among the techniques used, CBCT is more reliable than other techniques.<sup>5,9</sup> Since CBCT is expensive and exposes patients to comparatively high radiation doses, panoramic radiographs are frequently preferred. The ectopic positioning of FPMs can be identified by observing the superposed image of the distal root of the primary second molar in radiographic scans.<sup>19,20</sup> There is a scarcity of studies investigating the occurrence of ectopic eruption of FPMs specifically within the Turkish population. This study aimed to provide insights into the prevalence, distribution, and characteristics of ectopic eruption of FPMs in a Turkish population. Additionally, it aimed to assess the prognosis of ectopic eruption based on the degree of root resorption observed in the primary second molar.

## Methods

The Clinical Research Ethics Committee of Gaziantep University (Turkey) has approved this retrospective study (2020/337). This study conducted by STROBE guidelines.

### Patient selection

This retrospective analysis involved a review of digital panoramic radiographs obtained from a group of 7070 children aged 5 to 12 years who visited the Department of Pediatric Dentistry, Gaziantep University, Faculty of Dentistry during the period 2019 to 2020. Systemically healthy patients who had panoramic radiographs with sufficient image quality for diagnostic evaluation were included in the study, and written consents was obtained from all individuals. Patients suffering from any craniofacial malformation, cleft lip or palate, and systemic

diseases with oral effects were excluded from the study.

### Assessment of panoramic images

Panoramic radiographs were taken by a digital panoramic device (Gendex-700 Digital Panoramic Machine, Dentoptix model, Gendex Dent Systems, IL, USA) using 64 kVp, 6 mA for ages four and five and 66 kVp, 7 mA for ages 6 to 12. Data were evaluated retrospectively using patient records and digital panoramic radiographs from the hospital automation system. In this study, the researchers evaluated the age, gender, ectopic eruption status, number of ectopic FPMs, location, and distribution patterns (in terms of maxilla/mandible, left/right, unilateral/bilateral), as well as the degree of root resorption in primary second molars. To ensure accuracy, two investigators independently collected and recorded the data, aiming to minimize errors. Additionally, to assess the reliability of the assessments, 255 radiographs were randomly selected and rescored two weeks later to determine both intra- and inter-observer errors. The kappa correlation coefficient for intra- and inter-observer agreement was found to be 87%.

During the initial assessment, the degree of distal root resorption in the primary second molars was categorized using a classification system proposed by Barberia-Leache et al.<sup>1</sup> The classification included the following grades:

- Grade I - Mild: Characterized by a limited amount of resorption in the cementum or minimal penetration into the dentin.
- Grade II - Moderate: Involves dentin resorption without exposing the pulp.
- Grade III - Severe: Involves dentin resorption that leads to exposure of the pulp.
- Grade IV - Very severe: Specifically refers to resorption occurring in the mesial root of the primary second molar.

Patients diagnosed with ectopic eruption were called for a follow-up examination. The current condition of the ectopic FPMs was examined clinically and radiographically, and ectopic FPMs were classified according to Young's reversible and irreversible ectopic eruption classification.<sup>10</sup>

### Statistical analysis

The prevalence and characteristics of ectopic eruption of FPMs were analyzed using SPSS version 22 (SPSS Inc, Chicago, IL, USA). Initially, descriptive statistics such as frequency and percentage values were calculated to summarize the data. Subsequently, the chi-square test was utilized to examine the relationships between various study variables, including the presence of ectopic eruption, age groups, gender, degree of resorption, and type of ectopic eruption. *P* values lower than 0.05 were considered statistically significant, with a confidence level of 95%.

## Results

Of the 7070 reviewed patients (3531 females and 3539 males), ectopic eruption was detected in 221 FPMs in 144 patients, giving a frequency of 2%. The distribution of FPMs with ectopic eruption according to various variables are presented in Table 1. The highest occurrence of ectopic eruption was observed in the age group of 7-8 years, accounting for 48.63% of the cases ( $P < 0.05$ ). The mean age of the 144 patients aged 5 to 12 years diagnosed with ectopic eruption was 8.04 years. Among the 144 patients analyzed, 84 (58.30%) were identified as female, while 60 (41.70%) were identified as male in terms of the distribution of ectopic eruption by gender ( $P < 0.05$ ). Of the 221 ectopic permanent first molars, 143 (64.70%) were in the maxilla, and 78 (35.30%) were in the mandible. Of the 144 patients, 78 (54.16%) had one, 56 (38.88%) had two, 9 (6.25%) had three, and 1 (0.69%) had four ectopic FPMs. Ectopic eruptions, both unilateral and bilateral, were more frequently observed in the maxilla compared to the mandible, and this difference was found to be statistically significant ( $P < 0.05$ ). Among the unilateral cases, 86 (63.70%) were found on the right side, while 49 (36.29%) were located on the left side.

The distribution of the primary second molar root resorption degree in the initial evaluation of the panoramic radiographs is shown in Table 2. There was a higher occurrence of both mild-moderate and severe-very severe root resorptions in the maxilla compared to the mandible, and this difference was statistically significant ( $P < 0.05$ ). The relationship between the degree of resorption and the type of ectopic eruption is presented in Table 3, and it was found to be statistically significant, indicating a correlation between the degree of resorption and the type of ectopic eruption ( $P < 0.05$ ). Most irreversible ectopic eruption cases were seen in the maxilla ( $P < 0.05$ ).

## Discussion

The ectopic eruption is often overlooked by clinicians, as it is often identified as an incidental discovery during panoramic radiographic examinations conducted for other dental complaints. This anomaly tends to be asymptomatic, leading to its oversight in clinical practice. Early diagnosis and ideal treatment planning after a clinical and radiographic evaluation of the ectopic eruption are essential to preventing problems and reducing the need for expensive and long treatments required later.<sup>4,6</sup> Panoramic radiographs provide reliable data for the diagnosis of ectopic eruption and in predicting possible outcomes.<sup>5,9</sup> This study presented the prevalence and characteristics of ectopic FPMs using panoramic radiographs and also examined the prognosis of the ectopic eruption depending on the resorption degree. The findings of this study revealed a correlation between the degree of root resorption in the primary second molar

**Table 1.** Distribution of ectopic FPMs according to various variables

Variables	No.	%	
Gender	Female	84	58.30
	Male	60	41.70
Age	5-6	22	15.27
	7-8	70	48.63
	9-10	38	26.38
	11-12	14	9.70
Distribution	Maxilla right	83	37.55
	Maxilla left	60	27.14
	Mandible right	45	20.36
	Mandible left	33	14.93
Distribution mode	Unilateral	101	70.13
	Bilateral	34	23.61
	Unilateral-bilateral	9	6.25

**Table 2.** Distribution of ectopic FPMs according to the primary second molar root resorption degree

	Mild	Moderate	Severe	Very severe	Total
Maxilla	41 (28.67)	54 (37.76)	42 (29.37)	6 (4.19)	143 (100)
Mandible	27 (34.61)	45 (57.69)	5 (6.41)	1 (1.28)	78 (100)
Total	68 (30.10)	99 (38.78)	47 (26.79)	7 (4.34)	221 (100)

Data are expressed as No. (%).

**Table 3.** Relation of primary second molar root resorption degree with ectopic eruption type

	Mild	Moderate	Severe	Very severe	Total
Reversible	59 (40.70)	86 (59.30)	-	-	145 (100)
Irreversible	-	6 (14.28)	32 (76.19)	4 (9.50)	42 (100)

Data are expressed as No. (%).

and the type of ectopic eruption.

Several studies have been conducted to explore the prevalence of ectopic eruptions. Research by Anoush et al,<sup>24</sup> focused on the prevalence of ectopic eruption involving both FPMs and canines, reporting a prevalence rate of 2.1%. Another study by Shojaeipoor et al<sup>25</sup> aimed to establish a connection between growth parameters (height and weight) and ectopic eruption in children aged 6-9 years, finding a prevalence rate of 2.8%. In the Turkish population, Güven<sup>7</sup> conducted a study that examined 7649 patients, identifying ectopic eruption in 203 individuals and reporting a prevalence rate of 2.65% specifically for the ectopic eruption of FPMs. Later, a study on the predictive factors of reversible and irreversible ectopic eruption of maxillary FPMs in a Turkish population was conducted by Çalışkan et al and ectopic eruption was detected in 0.83% of the 11 924 patients.<sup>5</sup> The prevalence of ectopic eruption of FPMs was reported between 0.75% and 11.8%, depending on the population studied.<sup>4-11</sup> In the present study, a prevalence of 2% was found, consistent with the prevalence results of some studies in the literature.<sup>7,24-27</sup> The differences in these rates have been

attributed to many factors, such as different sample sizes, patient inclusion criteria, diagnostic methods, assessment criteria, geography, ethnicity, age of the population, caries status, and genetic factors.<sup>5-7</sup>

In the literature, there is no consensus regarding the distribution of ectopic eruptions between genders. In the present study, the prevalence of ectopic eruption in females was more than in males, consistent with some previous studies.<sup>2,28,29</sup> On the contrary, some studies concluded that ectopic eruption is more common in males than females.<sup>5,7,9</sup> Regarding age group distribution, in the study of Rai et al,<sup>28</sup> ectopic eruption was most common in the 7–9 age group, and in the study of Chen et al,<sup>9</sup> in patients aged 6–7 years. In the research conducted by Shojaeipoor et al., it was observed that ectopic eruption of FPMs occurred more frequently during the early mixed dentition phase.<sup>25</sup> Similarly, in the present study, the highest prevalence of ectopic eruption was found among children aged 7–8 years.

In line with the majority of studies available,<sup>1,5,7,9,10,25</sup> the current study also found that ectopic eruption was more prevalent in the maxilla compared to the mandible. The higher occurrence of ectopic eruption in the maxilla has been attributed to the posterior positioning of the maxilla relative to the cranial base and inadequate bone growth in the tuberosity region.<sup>5</sup> In the studies evaluating unilateral and bilateral localization of ectopic eruption, some have reported bilateral localization to be more common than unilateral localization<sup>1,4</sup> while some studies reported the contrary.<sup>25,29,30</sup> In the present study, unilateral localization of ectopic FPMs was more common than bilateral localization, which is in line with some other studies.<sup>5,7,25,29,30</sup> The study of Salbach et al<sup>17</sup> reported that in the maxilla, bilateral ectopic eruption occurs significantly more than unilateral ectopic eruption. Chen et al<sup>9</sup> reported that ectopic eruption was detected mostly symmetrically, and 89.7% of symmetrical cases were seen in the maxilla. Consistent with these studies, bilateral ectopic eruption was seen at a higher rate in the maxilla in the present study.

The root resorption of primary second molars is an important criterion that is evaluated when deciding on the treatment of ectopic eruption. For this purpose, a semi-quantitative grading system was designed by Barberia-Leache et al<sup>1</sup> according to the severity of the resorption and is frequently used in studies.<sup>1,7,29</sup> In the present study, mild and moderate root resorption degrees were more common than severe and very severe degrees, consistent with the reported studies.<sup>2,5,7</sup> Furthermore, consistent with previous literature, severe and very severe degrees of root resorption were found to be more frequently observed in the maxilla.<sup>7,31</sup> Güven<sup>7</sup> reported that severe and very severe resorption degrees were more common in the maxilla, and moderate resorption was more common in the mandible. Contrary to these results,

mild and moderate resorption was seen more frequently in the maxilla in the present study.

In addition, the severity of root resorption in the second primary molar was identified as a dependable clinical indicator for predicting the irreversible type of ectopic eruption. In the present study, ectopic FPMs causing mild and moderate resorption were reversible and spontaneously self-corrected without the need for active treatment. Conversely, when ectopic FPMs led to severe and very severe resorption, they became irreversibly impacted under the distal undercut of the primary second molars. Consistent with the data in the literature, this study concluded that the increasing severity of root resorption raised the possibility of the irreversible type of ectopic eruption.<sup>1,29</sup> Barberia-Leache et al<sup>1</sup> reported that reversible ectopic eruption was seen in 69.4% of the 36 teeth. Dabbagh et al<sup>29</sup> reported that 71% of cases self-corrected. Similar to the literature data,<sup>1,10,29</sup> 77.50% of the ectopic FPMs identified in the present study were reversible.

### Strengths and Limitations

The strength of this study lies in its comprehensive evaluation of the prevalence and characteristics of ectopic eruption, as well as the prognosis based on the degree of root resorption. By examining a large sample size, the study provides valuable insights into the prevalence of ectopic eruption in the population under investigation. The study's findings are consistent with previous research, further supporting the reliability and validity of the results. The identification of a relationship between the degree of root resorption and the type of ectopic eruption provides valuable information for treatment planning and management decisions. The study's conclusion regarding the reversibility of ectopic eruption based on the severity of root resorption contributes to the understanding of the prognosis and potential outcomes associated with this condition. Overall, this study enhances our knowledge of ectopic eruption and emphasizes the importance of early diagnosis and appropriate treatment planning for optimal patient outcomes.

One limitation of this study is that it relied on panoramic radiographs as the primary diagnostic tool for detecting ectopic eruption. While panoramic radiographs provide valuable information, they have inherent limitations in terms of resolution and potential distortion. The study's reliance on this imaging modality alone may have limited the accuracy of the prevalence estimates and the ability to fully characterize the extent and distribution of ectopic eruption. Furthermore the present study was that it was conducted in a single center. Although a significant population was screened in the present study, multicenter studies with larger populations are needed to generalize the conclusions. Another limitation is that although individuals with systemic diseases were excluded from



the study, the systemic conditions of the included patients were self-reported.

### Conclusion

Early diagnosis of ectopic eruption has great importance for beginning treatment at an optimal time. Consistent with the literature, the increase in the severity of root resorption in the primary second molar was a significant predictor for the prognosis of ectopic eruption in the present study. Although resorption was present in mild and moderate resorption grades, it was observed that the ectopic eruption self-corrected spontaneously without the need for treatment. However, it is important to note that the majority of cases with severe or very severe resorption grades did not undergo spontaneous correction. Clinicians should be completely aware of the presence, characteristics, and clinical and radiographic diagnostic parameters of ectopic eruptions to avoid possible adverse outcomes. Further studies in larger populations may help establish a clinical guideline for the diagnosis and treatment of the condition and the follow-up of prognoses.

### Authors' Contribution

**Conceptualization:** Emine Kurkutan, Gül Keskin, Zübeyde Uçar Gündoğar.

**Data Curation:** Emine Kurkutan.

**Investigation:** Emine Kurkutan, Gül Keskin, Zübeyde Uçar Gündoğar.

**Formal analysis:** Emine Kurkutan, Zübeyde Uçar Gündoğar.

**Methodology:** Emine Kurkutan, Zübeyde Uçar Gündoğar.

**Project administration:** Gül Keskin, Zübeyde Uçar Gündoğar.

**Software:** Zübeyde Uçar Gündoğar.

**Validation:** Zübeyde Uçar Gündoğar.

**Visualization:** Gül Keskin, Zübeyde Uçar Gündoğar.

**Writing—original draft:** Zübeyde Uçar Gündoğar.

**Writing—review & editing:** Emine Kurkutan, Gül Keskin, Zübeyde Uçar Gündoğar.

### Competing Interests

There are no conflicts of interest.

### Data Availability Statement

The data used in this study is not publicly available. Requests for data access or additional information can be directed to the corresponding author.

### Ethical Approval

This retrospective study (2020/337) has been approved by the Clinical Research Ethics Committee of Gaziantep University in Turkey.

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