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Original Research Paper

Paediatric Dentistry

ECTOPIC ERUPTION OF MAXILLARY FIRST PERMANENT MOLARS: A REVIEW

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ABSTRACT Ectopic eruption of permanent molars arises when a permanent tooth diverges from its expected eruption trajectory. The etiology of this condition is multifactorial, incorporating both systemic and local influences. The severity of the impaction of the first permanent molar serves as a critical predictor of irreversible effects. While self-correction predominantly occurs between the ages of 7 and 8, intervention becomes necessary if this does not happen. Early intervention is paramount to avert potential occlusal complications, and the choice of treatment is influenced by factors such as mesial tilting, root resorption, and the status of the second primary molar. Primary treatment approaches include interproximal wedging and distal tipping, with the possible use of fixed or removable appliances. Delayed treatment is inadvisable, underscoring the necessity of early diagnosis. This review provides a thorough examination of ectopic permanent molars, emphasizing the critical need for early detection and intervention, and calls for further research into the determinants of irreversible outcomes.

KEYWORDS : ectopic eruption; molar; early treatment; interceptive; distalization; wedging

INTRODUCTION

Dental eruption constitutes the physiologic process where a tooth is vertically displaced from its initial non-functional, developmental position towards its functional position, emerging through the bone of the alveolar process and the mouth epithelium, to occlude with its antagonist. This process is triggered by the formation of the periodontal ligament.[1]

Eruption can be disrupted by local or genetic factors, leading to various clinical conditions. Eruption failure is often attributed to genetic factors and can be associated with syndromes such as cleidocranial dysplasia and Gardner syndrome.[2] While genetics play a significant role, general factors like gender, socioeconomic status, and craniofacial morphology can also influence tooth eruption.[3] A variety of eruption problems arise during the transitional dentition period and one such problem is ectopic eruption.[4]

Nikiforuk defined ectopic eruption as a process in which the permanent successor, due to deficient jaw growth or part of the jaw, takes a path of eruption that affects the predecessor tooth, leading to its premature loss resulting in malposed permanent tooth.[5]

The process of normal tooth eruption is an integral part of normal tooth development, and a thorough understanding of the biologic underpinnings is critical for any dental practitioner. Every member of the dental team needs to have a comprehensive and functional understanding of the patterning and sequencing of eruption to provide optimal care. Hence, this review draws extensively from an in-depth examination of the contributing factors, clinical manifestations, treatment and implications of ectopic molar eruptions.

Ectopic Eruption Of First Molars

Ectopic eruption (EE) of the maxillary first permanent molar is defined as a local disturbance characterized by a mesial path of eruption causing the permanent tooth to be locked under the distal undercut of the second primary molar (Figure 1). Other paths of ectopic eruption can be buccal or lingual. This phenomenon causes various degrees of resorption of the roots of the primary tooth. Ectopic eruption of the first permanent molar may occur unilaterally or bilaterally in the maxilla or in the mandible (Young, 1957). [6]

Figure 1: The first permanent molar may become impacted and cease to erupt, causing premature resorption of the neighbouring primary molar as seen in routine bitewing radiograph. [7]

Prevalence

Ectopic eruption of the maxillary first permanent molar has a prevalence that ranges between 0.75 to 4.3%. A higher prevalence, 19.8%, has been reported in siblings.[8,9] Some authors report a higher incidence in males [6,10], while others found no statistically significant difference between sexes. [11-16]

The abnormality is present in numerous syndromes [17]; also, in children exhibiting concurrent orofacial and dental anomalies, such as cleft palate (with a prevalence four times higher), congenitally missing teeth, supernumerary teeth, and tooth size abnormalities.[9,13,18]

Ectopic first permanent molars occur 25 times more often in the maxilla than mandible [11,19], and most of these anomalies are of bilateral.[15,20,21] This variability in prevalence rates across different studies highlights the diverse nature of EE occurrence and the factors influencing its manifestation in pediatric dental populations.

Etiology

The etiology of EE of the first permanent molars is recognized as both multifactorial and complex, combining genetic predispositions with a variety of local environmental factors.

Genetic influences are underscored by an increased prevalence of EE among siblings and by research suggesting a recessive inheritance pattern with notably reduced penetrance in females, indicating a potential genetic underpinning in the manifestation of this dental anomaly.[8]

From a mechanical perspective, EE is influenced by various developmental disturbances in dental and jaw growth. According to Chapman (1922),[22] EE may occur when the forward movement of the first permanent molar is excessive compared to its downward movement. He proposes that this could result from a lack of forward movement of all deciduous teeth and the bone containing them, premature forward movement of the first permanent molar, or an early eruption of the molar. Similarly, O'Meara (1961)[23] emphasized that a significant factor in EE is the insufficient intercuspid and anteroposterior growth of the jaws, which fails to accommodate the developing teeth properly.

Further complicating the picture are factors such as inadequate bony growth in specific regions like the angle of the tuberosity (Cheyne & Wessels, 1947)[24], larger than average sizes of maxillary permanent and primary teeth, and variations in maxillary growth such as a smaller or more posteriorly positioned maxilla relative to the cranial base. These anatomical peculiarities can exacerbate the risk of EE. Pulver, 1968 [25] also noted that delayed calcification of affected first permanent molars and their abnormal angulation of eruption, especially pronounced in irreversible cases of EE, are critical contributing factors.

Iatrogenic factors have also been recognized, with incorrect placements of stainless-steel crowns on second primary molars identified as a potential cause of EE. Properly adapting these crowns can often lead to self-correction of the eruption pathway, highlighting the impact of dental interventions on the course of EE (Harrison & Michal, 1984).[11]

Types Of Ectopic Eruption

In 1957, Young[6] delineated two distinct patterns of ectopic eruption for the first permanent molars: the "jump type," which is self-correcting or reversible, where the molar eventually navigates past the adjacent primary second molar into the correct occlusal position, and the "hold type," which is irreversible or impacted, where the molar remains trapped under the distal contour of the primary second molar until either the primary molar exfoliates prematurely or intervention is undertaken.

Another way of classifying ectopic eruption is based on the resorption severity effect on the second primary molars as proposed by Barberia-Leache et al.[20] in their study (Figure 2).

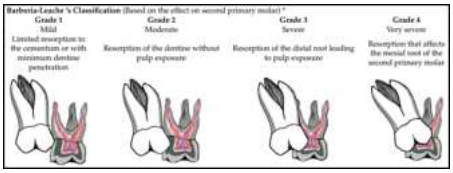

Figure 2: Grading of degree of resorption of ectopically erupting first permanent molars[26]

Harrison and Michal [11] categorized ectopic eruptions based on the lock's severity, by utilizing the marginal ridge of the second primary molar as a reference point on bitewing radiographs (Figure 3).

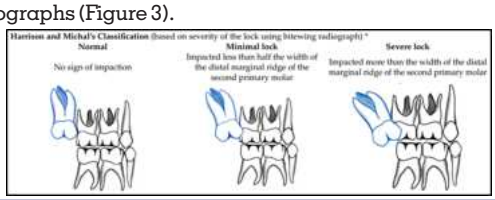

Figure 3: Classification of ectopic first molars based on severity of lock [26]

Diagnosis

EE of the first permanent molar is diagnosed through clinical observations and radiographic examinations. Typically identified between ages 5 to 7, this condition may be initially suspected if there is a delay in eruption of over six months or asymmetrical eruption compared to the opposite molar. Radiographically, the first signs include the ectopic molar appearing impacted against the distobuccal root of the primary second molar, often indicated by the tilting of the occlusal plane of this molar and the first signs of root resorption.

Early detection through periapical or bitewing radiographs allows for monitoring and intervention planning. In addition to clinical signs, cephalometric radiographs are useful for analysing morphogenetic patterns associated with EE. Studies, such as those by Helm et al. (2021)[9], show common cephalometric features in children with EE, including a shortened anterior cranial base and a retropositioned maxilla, often linked to a dolichocephalic pattern.

Identifying eruption anomalies on radiographs can be challenging and highly dependent on practitioner experience. To assist with this, Liu J. et al. (2022)[27] developed a semi-automated deep learning model to detect ectopic eruption of maxillary first permanent molars in panoramic images. This model demonstrated greater sensitivity and specificity than manual detection by skilled pediatric dentists. Although the model provides relatively high specificity, regular follow-ups and re-evaluations are necessary to minimize potential false negatives.

Consequences

Reversible ectopic eruption often leads to varying degrees of resorption of the primary second molar, which typically remains until its normal exfoliation time. Conversely, irreversible ectopic eruption usually results in the early loss of the primary second molar, which can precede the normal exfoliation date by 4 to 5 years, leading to complications such as mesial migration of the first permanent molar, space loss, crowding, and potential impaction of the second premolar (Yuen, Chan, & Tay, 1985).[28] Additionally, ectopic eruption may lead to undetected caries and occasionally pain due to the resorbing primary tooth. Abscess formation can occur, often related to carious exposure or infection in the surrounding periodontal area rather than direct resorption into the pulp (Kupietzky, 2000)[29]. Interestingly, tertiary dentin formation has been observed in these cases, potentially sealing off pulpal exposure.[6] Histological examination of these teeth typically shows active resorption and hard tissue deposition, which may be interpreted as bone formation.[8]

Indications For Intervention

Accurate diagnosis is crucial to determine the appropriate intervention, especially since predictive guidelines are still under refinement. Differentiating between reversible and irreversible ectopic eruptions involves assessing the rotation and angle of the permanent first molar during eruption. Typically, self-correcting molars exhibit less severe rotation and may not require immediate treatment, whereas those with significant rotation often leads to greater space loss and necessitate early intervention.[6] Age is also a critical factor; most assessments can be made by the child's 7th year, with delayed treatment recommended only when diagnosis is uncertain.[8,11]

Severity of impaction, assessed by the extent to which the permanent molar is impacted beneath the primary molar, and the presence of an enamel ledge are key indicators for

immediate treatment to prevent malocclusion (Kennedy & Turley, 1987) (Figure 4).[30] The degree of root resorption of the primary molar, although a common occurrence in ectopic eruptions, varies and does not consistently predict the need for intervention.[20]

In summary, the management of ectopic eruption relies on careful evaluation of the molar's eruption path, severity of impaction, and specific clinical signs such as pain or infection. Understanding these factors helps in deciding the timing and necessity of treatment to prevent further complications and ensure optimal dental development.

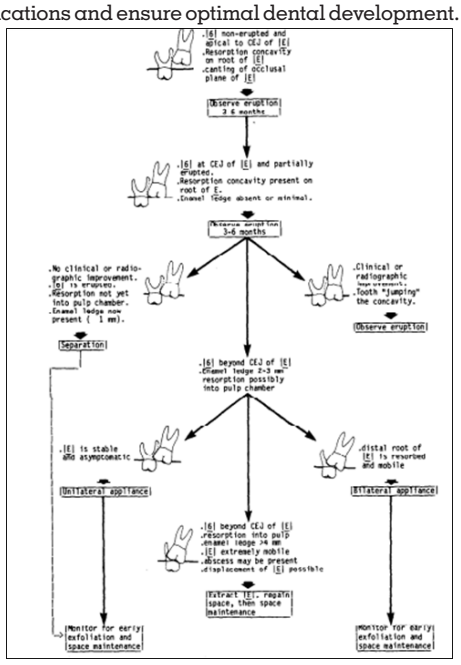

Figure 4: UCLA flowchart showing guidelines for management of ectopically erupting first permanent molars [30]

Treatment

Several factors such as patient's age, the severity of impaction, the degree of mesial tilting, the level of root resorption, and the status of the second primary molar could play an important role in determining the possible treatment options. [11]

Treatment may be classified into three main categories (Table 1):

- minimal intervention,
- appliance therapy with retention of the primary second molar and
- appliance therapy with extraction of the second primary molar (Gungor & Altay, 1998). [31]

Table 1: Clinical treatment options for different grades of ectopic eruption of the first permanent molar[32]

Grading of the second primary molar root resorption and clinical manifestations	Timing of treatment	Orthodontic solutions
Grade I	7-8 years old	Follow up to observe the eruption of the first permanent molar; if it has not erupted at 3-6 months, the method of tooth splitting, distal incision of the second primary molar, and distal movement of the first permanent molar can be used
Grade II	7-8 years old	Follow up to observe the eruption of the first permanent molar; if it has not erupted at 3-6 months, the method of tooth splitting, distal incision of the second primary molar, and distal movement of the first permanent molar can be used
Grade III	Timely interventions	Tooth splitting, distal incision of the second primary molar, and distal movement of the first permanent molar can be used
Grade IV		
①Looseness of the second primary molar is less than 1 mm and there are no clinical signs	Timely interventions	Distal movement of the first permanent molar
②Looseness of the second primary molar is more than 1 mm and there are clinical signs	Timely interventions	Crown amputation of the second primary molar or extraction of the second primary molar for space maintenance

Minimal Intervention: Interproximal wedging involves creating a separation between the mesial surface of the permanent first molar and the distal surface of the second primary molar to free the permanent molar from the undercut of the primary tooth. Techniques such as elastic separators [33], brass wire, and helical springs [34] are utilized for this purpose. Elastic separators, the simplest method, are placed between the primary second molar and the permanent first molar, replaced every 7 to 14 days until overcorrection occurs. [30] The Kesling separator is an alternative but can be challenging to place if the contact point is deep. [35] The brass wire technique, requiring local anaesthesia, involves threading a wire through the interproximal area and twisting it to create separation, with regular tightening until correction. [36] Helical [34] and De-Impactor [37] springs offer additional methods, with reactivation or replacement every few weeks. These approaches minimize chair time, do not require impressions or lab procedures, and avoid damaging permanent teeth.

For more complex cases, surgical exposure of the permanent tooth or disking of the distal surface of the second primary molar may be necessary. Surgical exposure involves excising overlying tissue to allow for the eruption of the permanent tooth, often leading to self-correction within 3 to 4 months. [11] Disking is recommended in cases of severe crowding or absence of premolars, reducing the undercut by contouring the primary tooth's distal surface, facilitating the eruption of the permanent tooth while maintaining space for future orthodontic treatment (Figure 5). [13,30,34] These minimal interventions aim to correct the impaction with minimal invasiveness, preserving the integrity of the permanent teeth and surrounding tissues.

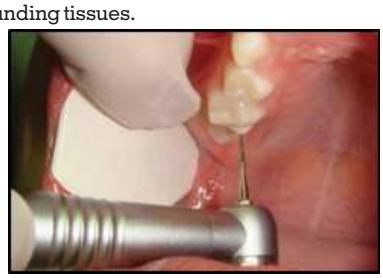

Figure 5: 169-L bur to disk the distal of the maxillary second primary molar. [7]

Appliance therapy with retention of the second primary molar: Multiple appliances anchored on the second primary molar apply distalizing or tipping forces to correct ectopic eruptions, particularly in irreversible cases where the tooth is partially erupted. If the tooth has not emerged, a gingivectomy is needed before placing the appliance. The devices, such as transpalatal arches, distal arms, and piston-elastics, [38] can be used. The Humphrey-type appliance and Halterman appliance are common options. The Humphrey appliance [39] uses a distal arm to move the first permanent molar and requires activation every 3 to 4 weeks. Modified versions incorporate helical loops or Nance holding arches for better anchorage and multidirectional movement. The Halterman appliance [40] uses an elastic chain between a distal hook on the primary molar and a button on the permanent molar, with follow-ups every 3 weeks for adjustments.

This modified Croll's appliance (Figure 6) can be used to treat bilateral ectopic eruption of the first permanent molar. The bands are placed on the first primary molars and joined by a transpalatal bar with an acrylic button for stabilization. Bilateral distal extensions with hooks are fabricated on which chain elastics are placed on buttons bonded to the permanent teeth and to the distal hooks. [41]

Figure 6: Cemented modified Croll's appliance [7]

Distal tipping is used when severe resorption of the primary molar occurs, causing the permanent molar to drift mesially. Fixed appliances with a TPA and flexible sectional nickel-titanium wire are another option to upright the molar. [35] K-loops [41] and spring-loaded distalizers [7] are also effective, particularly in cases of severe root resorption. Early intervention with these appliances can correct the eruption path, allowing the proper eruption of permanent teeth and reducing the need for extensive orthodontic treatments later.

Appliance therapy with extraction of the second primary molar: In cases where the second primary molars are lost prematurely, space regainers are used to distalize the first permanent molar after it has erupted. This approach is also recommended for irreversible ectopic eruptions with severe resorption, mobility, pain, or infection. [22] Removable appliances with Adams clasps and finger springs can also be utilized, particularly in unilateral cases, to allow for better oral hygiene. However, patient compliance is crucial, and bilateral cases may require additional clasps for stability. [8] Removable appliances can function both as passive retainers and active devices for minor tooth movements, such as distalization.

Other methods include using light wires, where a 0.012-inch nickel titanium wire is bonded to the first and second primary molars to tip back the first molars [43] (Figure 7), and cervical headgear, which applies extra-oral traction to distalize molars and promote maxillary growth. [44] Despite some controversy, [25] cervical headgear has shown success in creating space for the second premolar in many cases. After active treatment, space maintenance is essential until the second premolar erupts, with band and loop appliances or transpalatal arches being common choices. Proper cephalometric analysis is recommended before certain treatments, like cervical headgear, to avoid inhibiting maxillary growth.

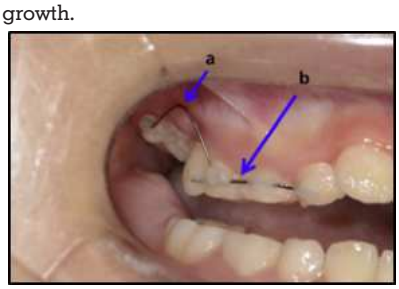

Figure 7: Appliance design for unlocking an ectopically erupting first molar. A 0.012-inch nickel titanium wire (a) and a 0.0195-inch multistranded wire (b). [45]

The choice of treatment must consider the specific clinical situation, the patient's developmental stage, and the overall goal of preserving or regaining arch space while ensuring the normal eruption of adjacent teeth. By adopting a tailored approach that considers these factors, dental practitioners can effectively manage ectopic eruptions, improving long-term dental health and alignment. [41,46]

CONCLUSION

Dental eruption naturally positions teeth within the dental arch, but ectopic eruption disrupts this process, commonly affecting maxillary first permanent molars and canines. These teeth may remain lodged under the second deciduous molars, causing root resorption. Ectopic eruption's causes are multifactorial, including genetic and local factors, with prevalence varying by population. Early detection through panoramic radiographs is vital to prevent malocclusions. Classified as reversible or irreversible, treatment depends on patient age, molar condition, and premolar presence. Methods like interproximal wedging and distal tipping correct the eruption path, aiming to allow proper permanent tooth eruption and maintain the deciduous molar until natural replacement. Pediatric dentists have at their disposal a variety of corrective alternatives available for the successful resolution of ectopic permanent molars. If an ectopic permanent molar is opportunely detected and treated, there will be more chances to limit the extent of malocclusions and to reduce the possibility of further lengthy, aggressive, and complicated orthodontic/orthopaedic treatment.

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