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Review Article

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A Pedodontic Approach to Second Premolar Agenesis in Children

İkinci Küçük Azı Dişi Eksikliğinde Pedodontik Yaklaşım

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Abstract

Tooth agenesis is a very common craniofacial malformation in humans. Second molar agenesis is the most common condition after third molar agenesis. Second premolars play an important role in maintaining occlusion, and their absence may cause various problems. Various treatment alternatives are applied in the presence of retained deciduous second molars and congenital second premolar agenesis: Preservation and restorative treatment of the deciduous second molar, spontaneous space closure by extraction of the deciduous second molar before the eruption of the first molar, space closure with controlled slicing and hemisection of the deciduous second molar, orthodontic space closure following extraction of the deciduous second molar, autotransplantation, implant replacement, conventional fixed bridge and resin-bonded bridge. It is critical to choose the treatment plan that will give the best results in the long term. During treatment planning, various factors such as the condition of the deciduous second molar, the age of the patient, the space requirement for correction of the malocclusion, the facial profile, the patient's treatment preference and the duration of treatment should be taken into consideration. In this review, treatment planning for second premolar agenesis will be analysed, focusing on various strategies to ensure optimal oral health and function.

Keywords Hypodontia · congenital missing teeth · second premolar

Öz

Diş eksikliği, insanlarda çok yaygın görülen kraniyofasial malformasyondur. İkinci küçük azı eksikliği, üçüncü büyük azı dişi eksikliğinden sonra en sık karşılaşılan durumdur. İkinci küçük azı dişleri oklüzyonu sağlamada önemli bir rol oynamakta ve bu dişlerin eksikliği çeşitli sorunlara neden olabilmektedir. Retine süt ikinci azı dişi varlığında ve konjenital ikinci küçük azı dişi eksikliğinde çeşitli tedavi alternatifleri uygulanmaktadır: Süt ikinci azı dişin korunması ve restoratif tedavisi, birinci azı dişin sürmesinden önce süt ikinci azı dişinin çekilmesi ile spontan boşluk kapatılması süt ikinci azı dişinin kontrollü kesimi ve hemiseksiyon ile boşluk kapatılması, süt ikinci azı dişinin çekimini takiben ortodontik olarak boşluğun kapatılması, ototransplantasyon, implant uygulaması, geleneksel sabit köprü uygulaması, rezin bağlı köprü uygulaması. Uzun vadede en iyi sonuçları verecek tedavi planının seçimi oldukça önemlidir. Tedavi planlaması sırasında süt ikinci azı dişinin durumu, hastanın yaşı, maloklüzyonun düzeltilmesi için yer gereksinimi, yüz profili, hastanın tedavi tercihi ve tedavi süresi gibi çeşitli faktörler göz önünde bulundurulmalıdır. Bu derlemede ikinci küçük azı dişi eksikliği ile ilgili tedavi planlamaları incelenerek optimal ağız sağlığı ve fonksiyonu sağlamak için uygulanan çeşitli stratejilere odaklanılmaktadır.

Anahtar Kelimeler Hipodonti · ikinci küçük azı · konjenital diş eksikliği

INTRODUCTION

Tooth agenesis is the most prevalent craniofacial anomaly in humans (1, 2). Various classifications are used to describe the number of missing permanent teeth. When 1 to 5 teeth are absent (excluding third molars), it is referred to as "hypodontia," whereas the absence of six or more teeth is termed "severe hypodontia" or "oligodontia." The complete absence of all permanent teeth is defined as "anodontia" (3).

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Congenital tooth agenesis can arise from a range of internal and external factors. Among the permanent teeth, second molar agenesis is the most frequently observed condition after the third molars. Second premolars play a critical role in maintaining proper occlusion, and their absence may result in various clinical challenges. This review explores treatment strategies for second premolars, focusing on approaches to optimise oral health and function.

Prevalence

The prevalence of hypodontia varies between 2.3% and 15.7% among different ethnic groups, depending on the population studied, and recent epidemiological studies consistently report that mandibular second premolars are among the most commonly missing teeth in non-syndromic hypodontia (4, 5). Specifically, the left mandibular second premolar was noted as the most commonly missing individual tooth (5).

Excluding the third molars, the mandibular second premolars are the most frequently missing teeth, with a prevalence of 2.9%-3.2%, followed by the maxillary lateral incisors (1.6-1.8%), maxillary second premolars (1.4-1.6%), and mandibular incisors (0.2-0.4%), while other teeth are rarely absent (6).

Unilateral agenesis is more common in the second premolars. For bilateral agenesis, the occurrence in mandibular second premolars ranges from 43.5% to 47.7%, whereas in maxillary second premolars, it is 46.3% to 52.2% (6).

Diagnosis of Congenital Second Molar Agenesis

The timing of diagnosis is a key consideration in cases of tooth agenesis. Delayed mineralisation of tooth germs, such as those of the mandibular second premolars, may lead to a false-positive diagnosis of agenesis in radiographic examinations. Mineralisation of mandibular second premolars generally begins between 3 and 3.5 years of age but may occasionally start several years later. Studies have shown that mandibular second premolars diagnosed as agenesis at age 7 can subsequently develop after the age of 10. Thus, no definitive diagnosis of agenesis should be made before the age of 7 (7).

A thorough evaluation is required when a permanent tooth has not erupted more than 1 year beyond its expected timeframe or if it has not emerged within 6 months of its contralateral counterpart. Additional indicators include asymmetric eruption patterns, the presence of retained deciduous teeth, or ankylosis of the mandibular deciduous molars (8).

Aetiology

Various hypotheses regarding the aetiology of hypodontia have been proposed in the literature. The diversity of these theories highlights a multifactorial origin involving both genetic regulation and environmental influences. Tooth morphogenesis involves the expression of over 300 genes, with *PAX9*, *MSX1*, *AXIN2*, and *EDA* being the most commonly implicated in nonsyndromic hypodontia (9).

Tooth agenesis resulting from MSX1 gene variants demonstrates a characteristic pattern of tooth absence. Nieminen et al. reported that the second premolars and maxillary first premolars were the most frequently missing teeth associated with MSX1 mutations (10). In line with these findings, Zheng et al. identified the maxillary and mandibular second premolars, along with the mandibular first premolars, as the most commonly affected teeth in individuals with MSX1-related agenesis (11). Similarly, Zhao et al. confirmed that among patients with non-syndromic congenital tooth agenesis attributed to MSX1 variants, the second premolars and maxillary first premolars were most frequently absent (12).

Patients with tooth agenesis have been reported to exhibit a higher prevalence of associated dental anomalies such as taurodontism, microdontia, enamel hypoplasia, and distoangulation of the second premolars (13).

Treatment Planning for Congenital Second Premolar Agenesis

Mandibular second premolar agenesis ranks as the most frequent form of tooth agenesis after third molars. Determining the treatment approach for missing mandibular second premolars requires consultation with an orthodontist. Several treatment options are available for managing retained deciduous second molars and congenital agenesis of second premolars, including the following:

Maintenance and restorative treatment of the deciduous second molar

- Spontaneous space closure by extraction of the deciduous second molar before the eruption of the first permanent molar

Space closure with controlled slicing and hemisection of the deciduous second molar

- Orthodontic space closure following the extraction of the deciduous second molar
- Autotransplantation
- Implant replacement
- Conventional fixed bridge

- Resin-bonded bridge

Selecting the treatment plan that ensures optimal long-term results is crucial. Factors such as the condition of the deciduous second molar, the patient's age, space requirements for malocclusion correction, facial profile, patient preferences, and treatment duration should be carefully evaluated during planning. In cases involving multiple missing premolars, deciduous molar extraction may be an option in mild Class III cases. For patients with crowding, the missing premolar site can serve as an extraction site. Extraction of the mandibular second deciduous molar may help alleviate crowding, allow for anterior teeth retraction in patients with incisor proclination, or both. Conversely, early extraction of the second deciduous molar can result in decreased arch length, tipping of adjacent teeth, alveolar bone resorption, and extrusion of opposing teeth. In cases of mandibular retrusion, Class II molar relationships, or polydiastema, preserving the deciduous second molar is recommended because it may help prevent future malocclusion (14). Recent studies have highlighted an increasing clinical focus on treatment planning for second premolar agenesis, particularly regarding long-term space management, preservation of primary molars, and interdisciplinary approaches involving paediatric dentists and orthodontists (15, 16).

The current treatment options for second premolar agenesis have been summarised to support the clinical decision-making process (Table1).

Table 1. Clinical Decision-Making Guide

Clinical Condition	Recommended Treatment Option	Notes
The retained deciduous molar is intact, no infraocclusion, no root resorption	Preservation or restoration	Maintain until complications arise or skeletal maturity is reached
Maintain until complications arise or skeletal maturity is reached	Extraction + Orthodontic space closure	Particularly effective in Class I/II profiles
Advanced infraocclusion or ankylosis	Early extraction	Consider timing for implant planning
Orthodontic closure not feasible, patient still growing	Autotransplantation	Best when the donor tooth has an open apex
Skeletally mature patient with adequate bone	Implant placement	Ensure the completion of facial growth with cephalometric confirmation

Maintenance and Restorative Treatment of the Deciduous Second Molar

When evaluating patients with retained primary teeth, overall health, motivation, expectations, and oral condition should be assessed first. Locally, tooth shape, colour, structural integrity, gingival alignment, and occlusion must be examined. Radiographic analysis should consider the root length, morphology, apical condition, and periodontal support. For implant planning, the vertical bone height and inter-root space are crucial.

Research indicates that maxillary and mandibular deciduous canines and second molars generally exhibit a better prognosis than other primary teeth (17). Additionally, studies suggest that root resorption in deciduous teeth slows with age, and clinically significant resorption is rarely observed after the age of 20 (14). If both the crown and root are in good condition and the tooth remains functionally and aesthetically acceptable, it may be preserved unless orthodontic extraction is necessary. This approach allows the tooth to maintain bone and soft tissue integrity, remaining in function with minimal intervention (18). In a systematic review of the literature evaluating the survival rate of primary molars in cases of premolar agenesis, it was reported that 82% to 89% of the retained primary molars remained in good condition over a follow-up period of 5 to 13 years, suggesting that this approach represents a clinically viable treatment option (19).

It has also been reported that if infraocclusion is mild and non-progressive, retaining the tooth may be advantageous, as the alveolar crest can decrease by 25% within 4 years after extraction. Thus, an early extraction of primary teeth could compromise future implant placement (20).

For cases where infraocclusion persists despite a sound crown and root structure, or when aesthetic concerns arise, the retained deciduous tooth may be restored using direct composite applications or indirect restorations, such as composite, porcelain, or gold onlays. Some studies proposed that onlays are effective in restoring infraoccluded deciduous molars, preventing both the tipping of adjacent teeth and the extrusion of opposing teeth (21).

Since the longevity of deciduous teeth is comparable to that of implants or other fixed restorations, they can be preserved if no pathology is present and their crown-root structure is adequate (18).

The application of direct or indirect restorations in deciduous teeth can postpone or even eliminate the necessity for more invasive procedures while being a more cost-effective option. Managing retained primary teeth in this manner aligns with the principles of minimally invasive dentistry and should be

considered when appropriate. Further research is required to support clinical decision-making regarding the prognosis of retained primary teeth and their restorations (8).

Pulp Treatment of the Primary Second Molars

The primary objective of restorative treatments is to preserve pulp vitality. When pulp exposure occurs in deciduous molars, pulpotomy may be indicated. The commonly used pulpotomy agents include formocresol, ferric sulphate, calcium hydroxide, and mineral trioxide aggregate (MTA) (22). Research has demonstrated that MTA minimises microleakage, supports tissue regeneration upon contact with pulp or periradicular tissues, maintains pulp vitality, promotes the formation of a tubular hard dentine bridge, and exhibits low toxicity. Compared with formocresol, MTA has shown greater long-term clinical and radiographic success in deciduous teeth and is the most biocompatible pulpotomy material. Unlike formocresol, MTA does not trigger adverse reactions, making it a preferred choice for pulpotomy. Although its cost is relatively high, MTA is considered a viable alternative for extending the longevity of deciduous teeth (23).

Root Canal Treatment of Primary Second Molars

Because of their thin enamel, prominent pulp horns, and prolonged retention, primary second molars are highly susceptible to caries and pulpal involvement. Pulpectomy aims to preserve these teeth until their natural exfoliation. However, complex root canal morphology and accessory canals pose significant challenges in effective cleaning and obturation (24). The quality of root canal sealing is essential for success. Inadequate sealing allows bacterial survival, while effective obturation cuts off nutrient supply, leading to bacterial elimination. MTA, used in both pulpotomy and pulpectomy, has demonstrated antibacterial effects against Enterococcus faecalis, enhancing its effectiveness (25). Moreover, treatment outcomes are better in cases of irreversible pulpitis than in necrotic pulp conditions (26). Radiographic studies confirm that MTA provides superior results compared to gutta-percha, particularly in cases with permanent tooth agenesis, due to its excellent sealing and antimicrobial properties (24).

Controlled Slicing and Hemisection in Deciduous Second Molars

Hemisection of the mandibular primary molars has been suggested as a preventive approach against alveolar bone atrophy in cases where the second premolars are congenitally absent (27). This approach serves as an effective method to prevent long-term complications and minimise the need for future restorations, facilitating the natural medialization of permanent molars. The technique involves removing 1.5-2 mm from the distal crown of the second deciduous molar, followed by hemisection of the distal crown and root once the first molar has shifted mesially. The second deciduous molar is then extracted. This controlled cutting technique helps preserve the buccolingual ridge while preventing both vertical and horizontal bone loss. Performing this procedure at an early age (8-9 years) has been associated with higher success rates, ensuring controlled medialization of the first permanent molar. However, studies indicate that the likelihood of success diminishes as the child grows older. A notable drawback of this method is the necessity for two separate dental visits—one for hemisection and another for extracting the deciduous molar. For the initial cutting of the distal crown, topical anaesthesia is generally sufficient. Special attention must be given to protecting the first permanent molar during the procedure (28).

Space Closure

Various factors should be considered when determining the appropriate approach for space closure in cases of second premolar agenesis.

Age

The timing of diagnosis significantly influences treatment planning. If the condition is identified before the second molar develops, all treatment options remain viable. However, if diagnosed after the completion of permanent dentition, space closure may have aesthetic implications.

Facial Shape

The patient's facial structure plays a crucial role in deciding whether to maintain or close spaces. In hypodivergent individuals, tooth extraction should be avoided to prevent an increase in overbite, and the space should be preserved. Conversely, in hyperdivergent individuals, extraction of the second deciduous molar and subsequent space closure is recommended.

Skeletal and Dental Abnormalities

Orthodontic space closure is often a preferred approach for young patients due to its long-term stability. Since no additional space maintenance or restorations are needed after the growth is complete, the decision should be based on a comprehensive orthodontic diagnosis. Factors such as arch length, facial profile, and occlusion must be carefully evaluated. Orthodontic space closure is particularly indicated when there is inadequate space, incisor proclination, or lip protrusion. Additionally, retaining deciduous molars may impact occlusion due to the discrepancy between the mesiodistal crown widths of the deciduous second molar and the permanent second premolar.

Number of Missing Teeth

The extent of missing teeth also influences the choice of treatment. In cases of severe oligodontia, closing the spaces may result in a significantly shortened dental arch, which could compromise masticatory function.

Integrity of the Deciduous Molar

The long-term retention of healthy deciduous second molars is associated with favourable clinical outcomes in some patients. However, several factors must be considered, including the risk of root resorption, Bolton tooth size discrepancies, pulpal pathology, crowding, ankylosis, and infraocclusion. In many cases, these concerns favour the extraction of the deciduous second molar (29). Infraocclusion, in particular, is linked to permanent tooth loss and root resorption, making it a critical factor in extraction decisions for patients with remaining growth potential. Ankylosed deciduous second molars can lead to infraocclusion and vertical bone defects. Therefore, extraction is recommended to allow the alveolar crest to shift occlusally as adjacent teeth continue to erupt. If space maintenance is required for future implant placement, the alveolar ridge width may decrease over time, increasing the likelihood of requiring bone grafting (30).

A study reported that between 11 and 20 years of age, 60% of the mesial roots and 46% of the distal roots of deciduous second molars exhibited resorption. Findings also indicate that root resorption rates decline with age, and these teeth remain occlusally stable beyond the age of 20. However, their potential loss in later years would necessitate closing a significant space (14).

Extraction of Ankylosed Deciduous Teeth

Ankylosis is frequently observed in deciduous molars exhibiting infraocclusion. When these teeth are extracted, significant alveolar bone loss may occur, which can compromise future implant placement and disrupt the overall orthodontic treatment plan (31).

Patient and Parent Motivation

Orthodontic space closure is a long-term treatment that demands a high level of cooperation and motivation from both the patient and their parents (32).

A wider range of treatment options is available for younger patients. However, after the age of nine, these options become more restricted, and spontaneous space closure is no longer a feasible approach. Early extraction of the second deciduous molar has been proposed to prevent the tipping of adjacent teeth and to facilitate spontaneous space closure through the mesial movement of the first molar as it erupts. Nonetheless, some studies indicate that congenital second premolar agenesis cannot be reliably diagnosed before the age of nine. Another study reported that spontaneous space closure can successfully occur when the second deciduous molar is extracted around 8-9 years of age, before the root development of the mandibular first premolar is complete and before the eruption of the permanent second molar (33).

Autotransplantation

Autotransplantation has gained renewed interest in recent years as a viable treatment option for children with second premolar agenesis, especially when donor teeth such as developing third molars are available. Studies have demonstrated favourable long-term outcomes when performed during the optimal stage of root development (34, 35). When orthodontic space closure is not feasible following the extraction of a second deciduous molar, maintaining the space and alveolar bone for future implant placement becomes challenging. In such cases, autotransplantation serves as a viable alternative, especially in growing patients. This technique, which requires technical precision and careful case selection, should be planned within a multidisciplinary framework, considering factors such as age, extraction timing, adjacent tooth condition, and the patient's general health and motivation. Unlike implants, autotransplantation enables biological integration and can promote alveolar bone development during skeletal growth. The success of the procedure largely depends on the preservation of the periodontal ligament, while complications such as root resorption, apical periodontitis, and ankylosis often related to ligament damage remain major risks. Immediate transplantation after extraction is recommended to minimise resorption and improve prognosis (36).

Even in cases of replacement resorption, the surrounding bone typically remains intact, allowing the transplanted tooth to remain functional until implant placement becomes appropriate. While resorption tends to progress more rapidly in younger patients due to higher bone turnover, transplanted teeth can remain clinically functional for extended periods. In adolescents or adults with limited vertical bone growth, ankylosed teeth may remain asymptomatic with slow resorption. When necessary, occlusal and proximal function may be restored using composite restorations or fixed prosthetics (37).

Optimal timing of the procedure is linked to the donor tooth's stage of development. The highest success rates were observed when the root reached approximately three-quarters of its total length and the apex remained open,

supporting continued pulpal circulation and apexogenesis. If the apex is closed, endodontic treatment is recommended to prevent pulp necrosis and subsequent inflammatory resorption (38).

There is variation in the literature regarding the splinting duration and the timing of orthodontic intervention. Some authors recommend delaying tooth movement for several months, whereas others support initiating orthodontic forces as early as 6-8 weeks post-transplantation. In cases with compromised periodontal support or a high risk of ankylosis, early orthodontic movement promotes periodontal ligament regeneration and may help prevent ankylosis (39).

Root morphology is another determinant of success. Teeth with curved or multiple roots are less suitable because of the increased risk of damage to the periodontal ligament and cementum during extraction (40). Overall, autotransplantation has emerged as a biologically and economically favourable alternative to implants in the management of congenital tooth agenesis (41).

Implant Replacement

Osseointegrated single-tooth implants are the preferred treatment when space closure is not feasible. They are considered the most biologically conservative option for replacing congenitally missing teeth. However, implants are contraindicated in growing patients as they interfere with skeletal development. Orthodontists must ensure adequate bone height and width while managing vertical and mesiodistal positioning with proper root parallelism. For implant placement, retaining the deciduous second molar until the vertical facial growth is complete is recommended. Serial cephalometric radiographs should be used to assess facial growth, which typically continues until approximately age 17 in females and 21 in males (42).

Studies indicate that 4 years after mandibular second deciduous molar extraction, the alveolar crest undergoes a 25% reduction, reaching 30% after 7 years. Resorption occurs more on the buccal side, leading to lingual implant shifting. Adjusting occlusal forces can help prevent abutment and crown fractures. Because deciduous second molars are wider than premolars, reducing their width can prevent occlusal issues (20).

Congenital second premolar agenesis is often associated with ankylosis of the deciduous molar. If ankylosis occurs early, the alveolar bone fails to develop vertically, leading to severe defects when extraction is delayed. This complicates the implant placement and may require bone grafting. Timely extraction considering the patient's growth potential is critical. If vertical defects develop, repositioning the mandibular first premolar into the second premolar space can be an alternative to grafting. Another preventive measure is extracting the deciduous first molar once half of the first premolar root has developed to stimulate alveolar ridge formation (43).

In cases of molar extraction due to caries, infraocclusion, or severe root resorption, a space maintainer is needed until implant placement. Options include a band/crown loop, nance palatal arch, or lingual arch (32).

Fixed Prosthesis

When a deciduous molar has a poor prognosis due to caries, root resorption, or periodontal problems, extraction followed by prosthetic rehabilitation is necessary. For young patients with healthy adjacent teeth, resin-bonded bridges (RBBs) are preferred over conventional bridges due to their minimally invasive nature and ability to preserve tooth structure (44). RBBs, first introduced in the 1970s, have improved with resin cements that bond to both enamel and metal. Despite slightly lower survival rates (~88%) compared to implants, they offer advantages such as shorter treatment time, reduced cost, and less need for anaesthesia, making them suitable for children and anxious patients (41).

Clinical success depends on sufficient enamel for bonding, proper design (e.g., 180° wrap), and minimising forces in cases of bruxism (45). Aesthetic concerns with metal retainers can be addressed using opaque cement or adjusted design approaches. With appropriate case selection, RBBs represent a functional and cost-effective interim solution for young patients (46).

Literature Review

A study investigating the survival of mandibular second primary molars in cases of missing mandibular second premolars analysed radiographs from 99 patients (37 males and 62 females) ranging in age from 12 years to adulthood. In cases of bilateral tooth loss, only one deciduous molar was randomly selected for inclusion to ensure statistical independence among all evaluated molars. The radiographic assessment focused on the distance between the missing premolar and the adjacent premolar, the degree of infraocclusion, and the extent of root resorption. The average age at the final assessment was 24 years and 7 months. Throughout the follow-up period, only 7 out of the 99 retained deciduous molars were lost due to significant root resorption, severe infraocclusion, or caries. Based on these findings, it was concluded that over 90% of patients with retained deciduous molars in cases of mandibular second premolar agenesis could expect long-term tooth survival (45).

A study involving 34 patients (20 males and 14 females) with 52 missing second premolars compared two treatment approaches: controlled slicing and extraction of the deciduous second molar. The aim was to facilitate the physiological mesial shift of the permanent molars, thereby preventing long-term complications and minimising the need for restorative treatment. Of the 52 missing premolars, 42 (81%) were located in the mandible, while 10 (19%) were in the maxilla. Among these cases, 28 (54%) were managed using controlled slicing, 14 (27%) underwent extraction of the mandibular deciduous second molars, and 10 (19%) had the maxillary deciduous second molars extracted. All 10 maxillary extraction cases resulted in successful outcomes. The bodily movement of the maxillary first molar was more effective than that of the mandibular first molar. Due to the root anatomy of the maxillary deciduous second molar, controlled slicing is not recommended in these cases, as extraction of the deciduous molar provides a more favourable condition for the permanent molar to move truncally. Among the 20 missing teeth in the 8-9 year-old group treated with controlled slicing, 18 (90%) demonstrated the most favourable clinical outcomes, while the remaining 2 (10%) exhibited moderate responses. In contrast, in the 10-11 year-old group, controlled slicing was associated with a higher tendency for moderate or poor results, with only 2 cases (25%) achieving good clinical outcomes. In the extraction group within the 8-9 year-old category, only 2 cases (28.5%) showed favourable outcomes, 3 cases (42.8%) had moderate responses, and 2 cases (28.5%) had poor results. Similar trends were observed in the older age group. When analysing the clinical responses across both treatment approaches regardless of age, controlled slicing yielded the best outcomes, with 71.4% achieving favourable results and 21.4% showing moderate responses. Conversely, the extraction group exhibited a greater tendency towards moderate to poor outcomes, with 71.5% falling into these categories. The overall success rate of controlled slicing exceeded 90%, significantly outperforming the extraction method, which was associated with poor outcomes in more than 75% of cases (28).

A study comparing 2 groups of 30 patients with congenital second molar agenesis examined the effects of space closure treatment using hemisection. Among these patients, 23 underwent hemisection with space closure, involving 4 molar extractions—one group had their first molars extracted, while the other group had their second molars extracted. The degree of anchorage loss was analysed and compared between these 2 groups. Additionally, to establish an untreated control group, the changes observed in a Bolton sample of 9-to 12-year-olds were also evaluated. To enhance the correction process in the hemisection-treated group, patients were further divided into two subgroups: those who underwent upper tooth extractions and those who did not. The hemisection groups demonstrated a statistically significant reduction in the distal movement of the upper anterior teeth, as well as a decrease in the retraction of the upper and lower lips. Additionally, there was a significant increase in the mesial movement of the lower molar and an improvement in the molar relationships. The corrections in molar positioning were statistically significant, with a greater degree of molar relationship correction observed in the hemisection group compared with the premolar extraction group. However, there was no statistically significant difference in the overjet changes between the groups. This treatment approach enhances facial fullness by preserving the upper premolars. Hemisection plays a role in minimising the distal movement of the anterior teeth and reducing the flattening effect on the facial profile that can occur with space closure. The benefits provided by hemisection treatment make it possible to avoid extractions in the upper arch, significantly improving the overall treatment outcome (47).

This study aimed to evaluate space closure and occlusal changes following the extraction of the lower second premolar and the upper second premolar on the side of agenesis in 11 patients (mean age: 11.8 years), consisting of 7 girls and 4 boys, all with normal occlusion and lower second premolar agenesis. Treatment started once the first premolar had occluded, and patients were monitored over a 4-year period. Dental cast models were obtained at the start of treatment and at 1, 2, and 4 years post-extraction. Additionally, lateral cephalograms were taken at the beginning of treatment and after 2 and 4 years. Measurements of space closure, sagittal movements, rotational movements, tilting of the first molar and first premolar, and dental midline shifts were assessed using photographs of the dental casts. The sagittal movement of the incisors was evaluated through lateral cephalograms. Findings indicated that most extraction space closed within the first year, with 55% closure in the upper jaw and 46% in the lower jaw. By the end of the four-year follow-up, 89% of the extraction space in the upper jaw and 80% in the lower jaw had closed, leaving an average remaining extraction space of 0.9 mm in the upper jaw and 2 mm in the lower jaw. In the upper jaw, 70% of the extraction space was closed through the mesial and rotational movements of the first molars. The upper premolar exhibited distal movement only during the first year of observation. In the lower jaw, extraction space closure was primarily achieved through mesial rotational movement and tilting of the first molars, as well as distal movement and tilting of the first premolars. Unilateral

extraction did not impact the upper midline; however, a statistically significant shift towards the extraction side was observed in the lower midline. Based on these results, the extraction of the lower second deciduous molar, combined with the extraction of the upper second premolar, is proposed as a viable treatment approach. However, in certain cases, active space closure may be necessary (48).

A study evaluating the treatment of second molar agenesis through autotransplantation and preoperative orthodontic preparation examined 80 patients (39 girls and 41 boys), in whom a total of 110 teeth were transplanted to replace the missing lower second molars. The age range for patients receiving transplanted premolars was 10.2-22 years, while those undergoing molar transplantation were between 17.1 and 21 years old. At the 4-year follow-up, failure was observed in 8 of 99 teeth with incomplete root formation and in 2 of 11 teeth with complete root formation. Overall, 100 transplanted teeth (91%) were classified as successful. Among the transplanted teeth, 58 were placed in the left mandible and 52 in the right mandible. In 101 cases, the deciduous molar was still present at the time of transplantation. Orthodontic treatment was performed in 52 cases, with 11 patients requiring preoperative orthodontic intervention specifically to enlarge the space for autotransplantation. The remaining patients underwent orthodontic treatment for reasons unrelated to tooth loss. On average, the duration of preoperative orthodontic treatment was 12 months.

Four years post-transplantation, all transplanted teeth exhibited either partial or complete pulp chamber degradation. A total of 44 molars and 66 premolars were autotransplant to replace missing premolars, with the premolars extracted primarily due to crowding. The success rate was 92% for teeth with incomplete root formation and 82% for those with fully developed roots. These findings indicate that when carefully planned and appropriately timed, autotransplantation offers a favourable prognosis for patients with lower second molar deficiencies (49).

CONCLUSION

The management of second premolar agenesis requires an interdisciplinary approach, considering patient age, skeletal growth, occlusion, and the condition of the retained deciduous molar. Preserving the deciduous molar is an option if it remains functional, but risks like root resorption and infraocclusion must be monitored.

If extraction is necessary, spontaneous space closure, orthodontic treatment, or autotransplantation may be considered. Orthodontic space closure is ideal when feasible, while autotransplantation is a good alternative for growing patients. Implants and prostheses are best suited for skeletally mature patients to avoid complications.

A personalised treatment plan is essential to balance function, aesthetics, and long-term stability. Further research is needed to refine the treatment protocols for optimal outcomes.

Ethics Committee Approval: The manuscript is a narrative review based solely on the analysis and synthesis of previously published studies available in the literature. As no new data collection, clinical trials, or research involving human or animal subjects have been conducted in relation to this review, ethical committee approval is not applicable.

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