

Therapeutic extraction of permanent first molars severely destroyed in mixed denture

Extracción terapéutica de primeros molares permanentes severamente destruidos en dentición mixta

Extração terapêutica de primeiros molares permanentes severamente destruídos em dentição mista

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Abstract

during mixed dentition, the 1st permanent molar is the most susceptible to caries, triggering a repetitive restorative cycle and loss. This study aimed to evaluate determinants of therapeutic extraction of severely damaged 1st permanent molars in mixed dentition before the eruption of the second permanent molar with favorable spontaneous closure of the residual space. The methodology involved a scoping review on PubMed using a specific search strategy. Ten articles were included addressing factors such as the ideal chronological age, stage of development of the second premolar and permanent molar, presence of the third molar, residual spontaneous closure, prognosis, and need for orthodontic treatment. In conclusion, therapeutic extraction of the 1st molar before the eruption of the second molar is associated with favorable spontaneous closure of the residual space. Greater success is evident with the presence of the third molar, the second molar in stage E, and the second premolar in stage F (Demirjian).

Keywords: Molar, Molar hypomineralization, Permanent Molar Primer, Extraction, Dental extraction.

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Resumen

En dentición mixta, el 1° Molar permanente es el más susceptible a caries, que desencadena un ciclo restaurador repetitivo y pérdida. El objetivo de este estudio fue evaluar factores determinantes de la extracción terapéutica de 1° Molares permanentes severamente destruidos en dentición mixta antes de la erupción del segundo molar permanente con un favorable cierre espontáneo del espacio residual. La metodología consistió en una revisión sistemática exploratoria en PubMed mediante búsqueda estratégica/específica. Incluyó diez artículos que abordaron factores como la edad cronológica ideal, etapa de desarrollo del segundo premolar y molar permanente, presencia del tercer molar, cierre espontáneo residual, pronóstico, y necesidad de tratamiento ortodóncico. En conclusión, la extracción terapéutica del 1° Molar antes de la erupción del segundo molar permanente está asociada con un favorable cierre espontáneo del espacio residual. Se evidencia mayor éxito con la presencia del tercer molar, segundo molar en etapa E y segundo premolar en etapa F (Demirjian).

Palabras clave: Molar, Hipomineralización molar, Primer Molar Permanente, Extracción, Extracción dental.

Abstrato

Em dentição mista, o 1° molar permanente é o mais suscetível a cáries, desencadeando um ciclo restaurador repetitivo e perda. O objetivo deste estudo foi avaliar fatores determinantes da extração terapêutica de 1° molares permanentes severamente destruídos na dentição mista antes da erupção do segundo molar permanente com uma região espontânea favorável do espaço residual. A metodologia utilizada no PubMed consistiu em uma revisão exploratória por meio de busca estratégica/específica. Foram incluídos dez artigos, abordando fatores como a idade cronológica ideal, estágio de desenvolvimento do segundo pré-molar e molar permanente, presença do terceiro molar, cierre espontâneo residual, pronóstico e necessidade de tratamento ortodôntico. Em conclusão, a extração terapêutica do 1° molar permanente antes da erupção do segundo molar permanente está associada a um fechamento espontâneo favorável do espaço residual. Maior sucesso está descrito quando na presença de terceiro molar, segundo molar no estágio E e segundo pré-molar no estágio F (Demirjian).

Palavras-chave: Molar, Hipomineralização molar, Primer Molar Permanente, Extração, Extração dentária.

Introduction

Most oral diseases, despite being preventable, pose a significant burden on healthcare systems worldwide. Untreated dental caries in permanent teeth is the most common health condition. According to the World Health Organization (WHO), an estimated 2 billion people globally suffer from caries in permanent teeth, while 514 million children are affected by caries in primary teeth⁽¹⁾. Among those in mixed den-

tion, the first permanent molar (FMP) emerges as the tooth most susceptible to this disease⁽²⁾, typically erupting around the age of 6 years. It becomes the first permanent tooth to coexist with the oral environment, featuring multiple cusps and deep grooves⁽³⁾. Furthermore, these teeth are prone to enamel developmental defects such as incisor-molar hypomineralization (IMH). Defined in 2001 by Weerheijm et al., IMH represents a qualitative enamel defect characterized by demarcated opacities and de-

creased mineral density, primarily affecting at least one FMP, typically the most affected tooth⁽⁴⁻⁶⁾. These lesions can manifest with or without involvement of the incisors, and sometimes affect the second primary molar⁽⁴⁻⁶⁾. This process of dysfunctional enamel mineralization is classified from mild, characterized by demarcated opacities without post-eruptive enamel breakdown (PEB), to severe, involving PEB with pulp compromise⁽²⁾. The clinical appearance varies from creamy/white to yellow or brown, with or without PEB⁽⁴⁾. Hypomineralized enamel is less hard and more porous than normal enamel due to its higher protein content. Consequently, it has reduced strength and may lead to PEB soon after tooth eruption or later under the influence of masticatory forces, promoting plaque accumulation and early-onset dental caries⁽²⁾. The overall prevalence of IMH has been determined to be 19%, meaning approximately 1 in 5 children are affected. No differences have been noted regarding sex and geographic location⁽⁷⁾.

Before determining an appropriate treatment plan for a severely decayed FPM, several factors should be taken into account, including the extent of crown destruction and pulp involvement, the condition of the developing dentition, the severity of dental pain, the attitude of the child and/or parents, the patient's tolerance for prolonged treatment under local anesthesia, socioeconomic factors, and treatment expectations⁽⁸⁾. Treatment options are diverse; a purely preventive approach may be adopted, especially for mild cases, while restorative approaches using temporary or definitive restorations may be adopted for moderate or severe cases. These may later involve endodontic treatment and prosthetic rehabilitation of the affected teeth⁽⁹⁾, potentially culminating in tooth extraction at an appropriate or later stage⁽¹⁰⁾. As such, with the frequent development of caries and dental fractures in these cases, increasingly complex and repetitive restorative treatments are required, which have an uncertain long-

term prognosis⁽¹⁰⁾. Consequently, young FPMs with severe damage and pulp involvement often enter a cycle of restorative treatment that ultimately leads to extraction. Nonetheless, if extraction is performed at an appropriate time, it can act as a therapeutic extraction (ExT)⁽⁹⁾. Therefore, some practitioners advocate for the early extraction of these molars, given their likely poor long-term prognosis and potential future need for extraction.

This study aimed to conduct a Scoping Review to assess the determinants of therapeutic extraction of severely damaged first permanent molars in mixed dentition before the eruption of the second permanent molar, with favorable spontaneous closure of the residual space.

Methodology

A Scoping Review was performed using the PubMed database. The search strategy incorporated MeSH terms and text words (tw): (Molar*[MeSh] OR "First permanent molar*" [tw]) AND ("Tooth Extraction*" [MeSh] OR Extraction[tw]). Additionally, the search included filters for articles in Spanish or English, studies conducted on humans, and with a publication date no older than 10 years.

Initially, 1890 articles were identified based on predefined criteria at the identification stage. During the screening phase, 1863 articles unrelated to the study objective were excluded, resulting in the selection of 27 articles. In the eligibility stage, articles that addressed the extraction of FPMs in mixed dentition were considered for inclusion, while those not focusing on FPM ExT, perception surveys, and editorials were excluded. Ultimately, 7 articles meeting these search criteria were included, then, 3 additional articles were added, totaling 10 articles. The search results are detailed in a flow chart adapted and translated from the PRISMA protocol for systematic reviews⁽¹¹⁾. (See Figure 1).

Results

The findings from ten studies assessing the determinants of therapeutic extraction of first permanent molars for spontaneous closure of the residual space were presented in both narrative text and table format (See Table 1).

Ideal chronological age:

Four articles concur that the ideal chronological age for FPM extraction ranges from 8 to 10.5 years⁽¹²⁻¹⁵⁾. In contrast, three articles suggest an approximate age of 9 years (9, 9.4, and 8 to 9 years)⁽¹⁶⁻¹⁸⁾. Among the remaining articles, one does not specify chronological age, implying that timing is not significant⁽¹⁹⁾, while another references the stage of formation and dental development of the second permanent molar (SPM), as described by Demirjian, whose method delineates eight stages of calcification

for each tooth, denoted by letters A through H, where 0 indicates no calcification⁽²⁰⁾.

Indication for compensating extractions (Extraction of the antagonist) and balancing (Extraction of the contralateral):

Two studies concur that compensating extractions in the mandible are unnecessary for Angle Class II malocclusions^(12, 13). However, while one⁽¹²⁾ suggests the same approach for Class I and II malocclusions⁽¹²⁾, the other indicates the necessity of compensating extraction of the maxillary FPM specifically in Class I cases⁽¹³⁾. Regarding mandibular FPM extraction, it emphasizes the necessity for balancing extraction⁽¹³⁾. Another article argues that in class I, if a maxillary FPM is extracted, compensating extraction is not considered. However, if the mandibular FPM is extracted, compensating extraction is considered. They conclude

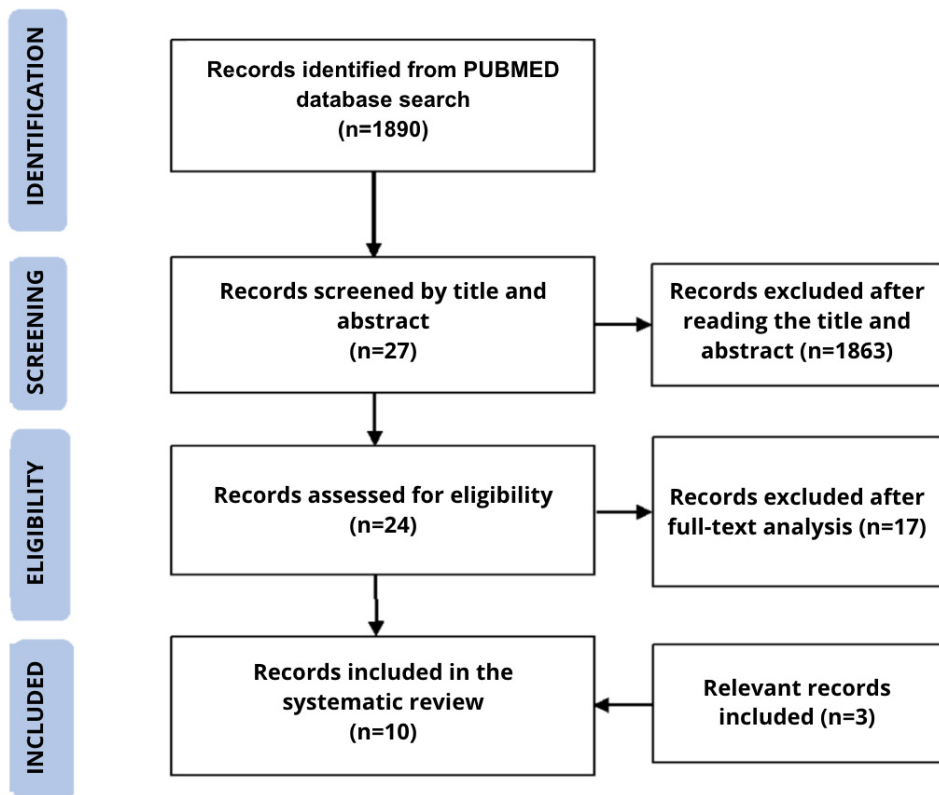


Figure 1. PRISMA flowchart.

that in class II, balancing and compensating extractions are not recommended, and in class III, referral to an orthodontist is preferable⁽¹⁵⁾. One article suggests that the traditional approach of compensating for mandibular FPM extraction, and balancing for severe maxillary crowding, has become less common. Instead, alternatives such as anchorage with palatal bars and removable appliances have emerged⁽¹⁷⁾.

Factors favoring spontaneous closure between the second permanent molar and the second premolar following therapeutic extraction:

Most authors regard ExT as a successful treatment with a promising long-term prognosis when complete closure of the residual space is achieved. A favorable trend in the prognosis of ExT for maxillary permanent molars compared to mandibular ones is noted. The significance of the development stage of the SPM is emphasized, particularly its presence at Demirjian's stage E, characterized by the initial formation of the furcation, indicated by a crescent-shaped calcification, and shorter root length compared to the crown. Additionally, the importance of the second premolar being at stage F is highlighted, characterized by well-defined roots, a wider apical portion than the canal diameter, and root length equal to or greater than the crown. Likewise, the relevance of the radiographic presence of the third molar (TM) is stressed^(12,13,15-17,19-21).

At the same time, it is highlighted that the favorable chronological age for ExT is within the range of 8 to 10.5 years⁽¹²⁻¹⁸⁾. There is a focus on radiographically observing mesialized angulation of the SPM in relation to the FPM^(12,15). In turn, Alkhadra T. et al. suggest that the extraction of FPMs is feasible when the following factors are present:

1. Carious lesions with pulp involvement.
2. Crowding in the corresponding quadrant.
3. Age range of 8-10 years.
4. No sagittal deviations.
5. No absence of another tooth in the same quadrant.

Future Orthodontic Treatment Necessity:

In general, the need for post ExT orthodontic treatment is affirmed^(12-17,19). In Alkhadra T. et al.'s study, the evaluation of malocclusion and implementation of a space maintainer prior to orthodontic intervention are deemed necessary⁽¹⁴⁾. Additionally, three radiographic factors are cited as favorable indicators for avoiding future orthodontic treatment: TM presence, the SPM at stage E of development, and the second premolar positioned within the bifurcation of the second primary molar. Conversely, if these factors are absent, post-extraction orthodontic treatment is recommended⁽¹⁹⁾.

Consequences of FPM extraction:

It is noted that FPM extraction can have positive effects on the anterior teeth vertically, resulting in a slight overjet and a wider interincisal angle⁽¹⁴⁾. Similarly, Saber A. et al. suggest that overbite tends to deepen in over 50% of cases while overjet remains stable, leading to favorable outcomes in the maxilla. Regarding closure of the residual space, spontaneous closure is mentioned as a possibility^(19,20). Another beneficial effect is the increase in eruption space, thereby reducing the likelihood of impaction of the TM against the SPM. Acceleration in the development and eruption of the SPM is also observed⁽¹⁹⁾. Additionally, C. Hahn et al. suggest that this treatment may benefit individuals with dolichofacial and hyperdivergent craniofacial features⁽¹⁷⁾.

On the contrary, unfavorable effects are observed in the mandible. Due to bone characteristics, mesial inclination of the SPM may occur, resulting in residual space^(12,14-16,19,20). Similarly, rotation and distal inclination of the second premolar towards the space of the extracted FPM can occur^(15,19). Furthermore, there is a possibility of extrusion of the antagonistic FPM following extraction, which can be prevented by splinting or cementing a transpalatal bar⁽¹⁷⁾.

Authors, year of publication, and country	Study type	Prognosis of residual space closure following therapeutic extraction of the FPM	Prognosis by arch: Maxillary or mandibular	Stage of formation and development of the second permanent molar	Stage of formation and development of the second premolar	Radiographic presence of the third molar
Cobourne M. et al. 2014. United Kingdom ⁽¹²⁾ .	Clinical Guideline	Questionable.	Maxillary: Generally good prognosis. Mandibular: More variable and less predictable occlusal outcome.	Extraction at Demirjian's stage E of SPM is recommended, when early root bifurcation is observed.	--	Cannot always be confirmed.
Eichenberger M. et al. 2015. Switzerland ⁽¹³⁾ .	Systematic Review	Overall success rate of spontaneous clinical outcome after extraction of maxillary FPMs is 72%, and for mandibular ones, 48%.	--	Recommended FPM extraction before SPM eruption.	--	The combination of crowding and TM presence can also have a positive effect on spontaneous closure of space in the mandible, but the inclination of neighboring teeth may increase.
Alkhadra T. et al. 2017. Saudi Arabia ⁽¹⁴⁾ .	Systematic Review	Closure of space occurred in 89.9% of maxillary cases and 49% of mandibular cases.	No significant issues arise in the maxilla following extraction. However, in the mandible, the impact of FPM loss on occlusion is age-dependent, with optimal outcomes observed between 8-10 years and to be avoided in cases of distal occlusion, deep bite, and increased overjet.	58% of FPMs extracted during Demirjian's stage E of SPM had complete space closure.	--	--
Teo T. et al. 2016. Singapore ⁽¹⁵⁾ .	Retrospective Study	FPM extractions performed in patients exhibiting three radiographic factors (SPM at stage E of development, second premolar at stage F, and presence of TM) may lead to higher success rates in residual space closure.	Mesialized angulation of SPM in relation to FPM may be associated with greater space deficiency in the mandibular arch.	"Ideal timing" for FPM extraction is when SPM is at stage E of development. This was associated with spontaneous residual space closure, but only resulted in satisfactory outcomes in just over half of cases. Results did not demonstrate that extraction during Demirjian's stage E of SPM was inherently ideal over stage D, considered too early, or stage F, considered too late.	Demirjian's stage F is the ideal development stage for the second premolar. The germ of the second premolar should be located within the bifurcation of the second temporary molar, as it is necessary for proper guidance during eruption to prevent rotation or distal inclination into the space of the extracted FPM.	Because the TM may not be radiographically visible before 8 years of age, confirming its presence and subsequently extracting the FPM at a later age (such as stage F of second premolar development) may favor therapeutic extraction. Therefore, it may be wise to delay extractions until all three radiographic factors can be adequately evaluated. However, this should be done before half of the SPM root is developed.

Authors, year of publication, and country	Study type	Prognosis of residual space closure following therapeutic extraction of the FPM	Prognosis by arch: Maxillary or mandibular	Stage of formation and development of the second permanent molar	Stage of formation and development of the second premolar	Radiographic presence of the third molar
Saber A. et al. 2018. Saudi Arabia ⁽¹⁶⁾ .	Systematic Review	--	The decision to extract an FPM in the mandible is more challenging than in the maxilla due to potential consequences.	"Ideal timing" for FPM extraction with fewer consequences is when the SPM is at Demirjian's stage E (early bifurcation) or stage D (developed crown).	--	Significant association was found between mesial angulation of the SPM in relation to the FPM and TM presence. Evidence suggests that the TM adjacent to extraction undergoes accelerated eruption compared to the non-extraction side.
Scheu J. et al 2019. Chile ⁽¹⁷⁾ .	Literature Review	--	The overall success rate of clinical outcome for maxillary extraction was higher than mandibular.	Chronological age should be complemented with the dental development stage of the SPM, considering clinical characteristics of each case.	Identification of the second premolar development within the bifurcation of the second primary molar is necessary to achieve favorable eruptive guidance.	Presence of TM and mesial angulation of the SPM are suggested to be favorable for space closure. FPM extraction facilitates TM eruption by increasing eruption space and reducing potential impaction.
M.A. Barceló. et al. 2014. Spain ⁽¹⁸⁾ .	Retrospective Study	FPM extraction at the ideal age (8-10 years) may resolve crowding with residual space closure, but should be avoided or performed with orthodontic treatment in cases with diastemas.	Spontaneous closure of residual space can be expected, especially in the maxilla. Residual space closure in the mandible is more age-dependent, hence, in late extraction, it will hardly close properly without inclinations.	There are higher success chances when, radiographically, the first third of the SPM root calcifies its furcation, meaning Nolla stages 6 to 7.	--	TM presence is associated with proper space closure, and there is also a higher probability of it erupting correctly at an earlier age due to increased eruption space.

Authors, year of publication, and country	Study type	Prognosis of residual space closure following therapeutic extraction of the FPM	Prognosis by arch: Maxillary or mandibular	Stage of formation and development of the second permanent molar	Stage of formation and development of the second premolar	Radiographic presence of the third molar
C. Hahn. et al. 2013. Spain ⁽¹⁹⁾ .	Literature Review	--	--	If spontaneous space closure is desired, the "ideal timing" for extraction is when the SPM is just above the cementoenamel junction of the FPM and before the mandibular SPM eruption, with evidence of furcation calcification. Extracting prior to this moment may result in second premolar ectopia. Evaluating the extraction of the second molar at the same time is advisable to avoid second premolar ectopia. To prevent mandibular FPM extrusion, a transpalatal bar can be splinted or cemented.	--	Extraction of the FPM precedes confirmation of TM development in many cases. A wisdom tooth agenesis cannot be ensured until 16 years old. FPM extraction accelerates TM eruption, although it does not always translate to obtaining the necessary space for it.
V Çiftçi, AU Güneş. et al. 2021. Turkey ⁽²⁰⁾ .	Cross-Sectional Study	Therapeutic extraction of FPMs was performed at a mean age of 9.4 years, and 52.5% of the 177 quadrants had successful residual space closure without the second premolars moving distally.	--	--	--	In the mandibular arch, TM presence proved to be a statistically significant factor in predicting successful residual space closure.
Sameer Patel. et al. 2019. United Kingdom ⁽²¹⁾ .	Retrospective Cohort Study	Residual space closure occurred in 89.9% of maxillary cases and 49% of mandibular cases.	--	Stage E corresponds to SPM bifurcation development and is recorded as the "ideal timing."	--	The presence of TM has a statistically and clinically significant relationship with space closure in the mandibular arch.

Table 1. Therapeutic Extraction Determinants of the First Permanent Molar for Spontaneous Closure of the Residual Space According to the Reviewed Articles. Abbreviations: FPM (First Permanent Molar), SPM (Second Permanent Molar), and TM (Third Molar).

Discussion

In scientific literature, the indication for compensating extractions (extraction of the antagonist) and balancing extractions (extraction of the contralateral) has been discussed, with various proposals suggesting that these treatments may not be necessary, especially in patients with Angle Class II and dental crowding^(12,13,15,17). However, the majority of authors assert that orthodontic treatment should follow therapeutic extraction^(12-17, 19).

Determining the ideal chronological age for ExT has also sparked discussion. While some emphasize specific age ranges, such as between 8 and 10.5 years, others focus on the age of 9 years. Some prioritize the developmental stages of the FPM, SPM, and second premolar⁽¹²⁻¹⁸⁾.

As a result of the ExT, a verticalization effect on the anterior teeth is observed, characterized by a small or stable overjet, increased interincisal angle, and overbite⁽¹⁴⁾. This would be particularly favorable in patients with dolichofacial and hyperdivergent growth patterns⁽¹⁷⁾. Additionally, extraction is noted to have a positive impact on the development and eruption of TM, by increasing eruption space and reducing the likelihood of impaction⁽¹⁹⁾. Moreover, an early eruption of the SPM is observed⁽²⁰⁾.

Most authors consider ExT a successful treatment with a favorable long-term prognosis when total closure of the residual space is achieved. Furthermore, a higher success rate has been observed in the maxilla, ranging between 70% and 90% of cases. However, this rate decreases to 48% and 49% in mandibular cases^(13,14,21). Consequently, a positive trend is noted in the prognosis of ExT for maxillary permanent molars compared to mandibular ones. Conversely, Teo T. et al. emphasize that adhering to the three key radiographic factors—development stage of the SPM and second premolar, and the radiographic presence of the TM—can lead to a higher degree of closure of the residual space⁽¹⁹⁾. Additionally, M.A. Barceló et al. suggest benefits in crowded dentition and, conversely, advise against ExT in dentitions with diastemas⁽¹⁶⁾. Moreover, the decision-making pro-

cess for ExT in the mandible is complicated by factors such as the mesial inclination of the SPM and chronological age, which simultaneously influence the prognosis and potential sequelae^(12, 14-16, 19, 20). Similarly, another factor contributing to a better prognosis is to consider the stage of development of the SPM. Hence, it is crucial to estimate Demirjian's stage E, observing the early bifurcation of its root^(12,15,19-21). Also, according to Nolla's classification, the first third of the calcified root—corresponding to stages 6 and 7—should be observed⁽¹⁶⁾. Expanding on this, other authors suggest that the SPM should be positioned above the cemento-enamel junction of the FPM⁽¹⁷⁾ and exhibit a mesial angulation^(12,19).

Another significant factor to take into account is the development of the second premolar; it is advisable that it reaches Demirjian's stage F⁽¹⁹⁾. Furthermore, it is proposed that the favorable positioning of this second premolar would entail the crown being located within the bifurcation of the second primary molar to avoid collateral effects such as ectopia of the second premolar, i.e., the distal rotation and inclination of this premolar towards the space of the extracted FPM^(15,19). In this regard, C. Hahn et al. recommend extracting the second primary molar when the SPM exhibits furcation calcification⁽¹⁷⁾.

In the mandibular arch, the presence of the TM proves to be a significant factor in predicting successful closure of the residual space^(18,21). However, its presence cannot always be confirmed, as the appearance of the germ may be delayed⁽¹²⁾. It is worth noting that following the extraction of the FPM in both jaws, there is an increased likelihood of earlier and adequate eruption of the TM, attributed to the additional eruption space created by the extraction⁽¹⁶⁾. These findings underscore the complexity and necessity of a comprehensive assessment when considering this treatment option in the pediatric population. It is crucial to consider dental maturity, developmental stages, and specific anatomical aspects of each tooth to thoroughly and effectively address strategies for therapeutic extraction.

Conclusion

Therapeutic extraction of the permanent first molar before the eruption of the second molar (around 9 years of age) can often anticipate favorable spontaneous closure of the residual

space, particularly in the maxillary arch. Greater success has been observed when three key radiographic factors are met: presence of the third molar germ, the second molar at Demirjian's stage E, and the second premolar at Demirjian's stage F.

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Conflict of Interest Statement

The authors of this work declare that there is no potential conflict of interest.

Authorship Contribution Note

- a) Study conception
- b) Data acquisition
- c) Data analysis
- d) Results discussion and editing
- e) Manuscript drafting
- f) Approval of the final version of the manuscript

CFM has contributed to a, b, c, d, f

CBF has contributed to b, c, d, e, f

BGP has contributed to c, d, f

APF has contributed to d, e, f

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