

Periodontal Analysis of Teeth with Biological Space Invasion

submitted to Root Extrusion and Prosthetic Rehabilitation: Literature Review

Análise Periodontal de Dentes com Invasão de Espaço Biológico submetidos à Extrusão Radicular e Reabilitação Protética: Revisão da Literatura

Análisis Periodontal de Dientes con Invasión Biológica del Espacio Sometidos a Extrusión Radicular y Rehabilitación Protésica: Revisión de la Literatura

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Abstract

Aim: The purpose of this literature review was to identify whether root traction may maintain the periodontal health of teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated. **Materials and Methods:** A literature review was conducted, in which the periodontal effects of root traction provided on the ability to maintain teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated were searched in the electronic databases Scopus, PubMed, Web of Science, EMBASE, Scielo and Cochrane using the Mesh descriptors "orthodontic extrusions", "forced eruption" and "crown lengthening". The inclusion criteria considered studies published in English or Spanish that presented the relationship between root traction and the effect on periodontal health in prosthetically rehabilitated teeth. After collection of articles, they were evaluated by three reviewers, who selected the studies according to their relevance according to criteria as type of study, root traction present, rehabilitation with single fixed prosthesis and period of clinical follow-up. **Results:** A total of 644 references were identified and after exclusion according to eligibility criteria, 33 papers covered all parameters adopted and were included in the qualitative analysis. Satisfactory prosthetic rehabilitation, associated with periodontal health after root traction, could be observed in all studies, notably with variation only in the follow-up time observed up to the first six months, 1, 2, 3 and up to 4 years. **Conclusions:** Root traction is a conservative and effective tool in the maintenance of periodontal health in teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated.

Descriptors: Periodontium; Tooth Eruption; Orthodontic Extrusion; Crown Lengthening; Dental Prosthesis.

Resumo

Objetivo: O objetivo desta revisão de literatura foi identificar se a tração radicular pode manter a saúde periodontal de dentes com invasão do tecido de inserção supracrestal e reabilitados protéticamente. **Materiais e Métodos:** Foi realizada uma revisão de literatura, na qual os efeitos periodontais do tracionamento radicular proporcionado na capacidade de manter dentes com invasão de tecido supracrestal e reabilitados protéticamente foram pesquisados nas bases de dados eletrônicas Scopus, PubMed, Web of Science, EMBASE, Scielo e Cochrane utilizando os descritores Mesh "extrusões ortodônticas", "erupção forçada" e "alongamento da coroa". Os critérios de inclusão consideraram estudos publicados em inglês ou espanhol que apresentassem a relação entre a tração radicular e o efeito na saúde periodontal em dentes reabilitados protéticamente. Após a coleta dos artigos, os mesmos foram avaliados por três revisores, que selecionaram os estudos de acordo com sua relevância segundo critérios como tipo de estudo, tração radicular presente, reabilitação com prótese fixa única e tempo de acompanhamento clínico. **Resultados:** Foram identificadas 644 referências e após exclusão segundo critérios de elegibilidade, 33 artigos contemplaram todos os parâmetros adotados e foram incluídos na análise qualitativa. A reabilitação protética satisfatória, associada à saúde periodontal após a tração radicular, pôde ser observada em todos os estudos, notadamente com variação apenas no tempo de acompanhamento observado até os primeiros seis meses, 1, 2, 3 e até 4 anos. **Conclusões:** O tracionamento radicular é uma ferramenta conservadora e eficaz na manutenção da saúde periodontal em dentes com invasão de tecido de inserção supracrestal e reabilitados protéticamente.

Descritores: Periodonto; Erupção Dentária; Extrusão Ortodôntica; Aumento da Coroa Clínica; Prótese Dentária.

Resumen

Objetivo: El propósito de esta revisión de la literatura fue identificar si la tracción radicular puede mantener la salud periodontal de los dientes con invasión del tejido de inserción supracrestal y reabilitados protéticamente. **Materiales y Métodos:** Se realizó una revisión bibliográfica, en la cual se buscó en las bases de datos electrónicas Scopus, PubMed, Web of Science, EMBASE, Scielo y Cochrane utilizando los descriptores de Mesh "extrusiones de ortodoncia", "erupción forzada" y "alargamiento de corona". Los criterios de inclusión consideraron estudios publicados en inglés o español que presentaran la relación entre la tracción radicular y el efecto sobre la salud periodontal en dientes reabilitados protéticamente. Luego de la recolección de los artículos, fueron evaluados por tres revisores, quienes seleccionaron los estudios según su relevancia según criterios como tipo de estudio, tracción radicular presente, rehabilitación con prótesis fija única y período de seguimiento clínico. **Resultados:** Se identificaron un total de 644 referencias y después de la exclusión según los criterios de elegibilidad, 33 artículos cubrieron todos los parámetros adoptados y se incluyeron en el análisis cualitativo. La rehabilitación protésica satisfactoria, asociada con la salud periodontal después de la tracción radicular, se pudo observar en todos los estudios, notablemente con variación solo en el tiempo de seguimiento observado hasta los primeros seis meses, 1, 2, 3 y hasta 4 años. **Conclusiones:** La tracción radicular es una herramienta conservadora y eficaz en el mantenimiento de la salud periodontal en dientes con invasión del tejido de inserción supracrestal y reabilitados protéticamente.

Descritores: Periodoncia; Erupción Dental; Extrusión Ortodôntica; Alargamiento de Corona; Prótesis Dental.

INTRODUCTION

The full knowledge on the biological dimensions of the periodontium reveals that preservation of the supracrestal tissue attachment is fundamental for periodontal health, especially in the presence of restorative

and/or prosthetic margins invading these structures^{1,2}. Violation of this tissue will result in progressive inflammation in which the organism, at the expense of bone resorption, promotes restoration of the invaded dimensions². Clinically, these changes may be observed as

gingival retraction or periodontal pocket formation¹.

The new classification of periodontal diseases and conditions detailed that the region composed of connective insertion and junctional epithelium around the tooth circumference is defined as supracrestal tissue attachment³. This anatomical area was previously described as a biological space⁴. To maintain the biophysiological integrity of this anatomical area, 3 to 4 mm of healthy dental structure coronal to the alveolar bone crest are required. Maintenance of this distance is necessary to avoid mechanical trauma of restorations on the periodontal supporting structures, with consequent migration and apical reorganization of these structures^{3,4}.

The clinical restoration of this invaded supracrestal tissue attachment can be achieved by surgical techniques to increase the clinical crown, based on gingivectomy and alveolar bone resection by osteotomy/osteoplasty or by more conservative maneuvers as root traction or also by the association of both techniques⁵.

The possibility of root traction is based on the combination of endodontic-orthodontic treatment in which the tooth is displaced in the direction of its eruption to restore the lost biological dimensions, optimizing the adaptation of restorations and/or dentures within biological limits⁵. The technique of traction or dental extrusion, when properly indicated, provides a more favorable esthetic effect than surgery for clinical crown lengthening, providing less bone sacrifice in adjacent non-compromised teeth and esthetic deformity by increasing the crown/root ratio.

Thus, the objective of this narrative literature review is to identify whether root traction is capable of maintaining the periodontal health of teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated over time.

MATERIAL AND METHOD

This study was based on the guidelines for synthesis without meta-analysis (Synthesis Without Meta-analysis – SwiM), developed to guide reviews of interventions in which the meta-analysis of effect estimates is not possible or cannot be performed⁶.

The focused patient, intervention, comparison, and outcome (PICO) question for this study was “What are the effects obtained by root traction on the ability to maintain teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated, with periodontal health”.

Six electronic databases (Scopus, PubMed, EMBASE, Web of Science, Scielo and Cochrane) were searched by two independent reviewers using the Mesh descriptors [orthodontic extrusions], [forced eruption] and [crown lengthening]. As inclusion criteria, studies published in English or Spanish, in national and international journals, and which presented the relationship between root traction and the effect on periodontal health in prosthetically rehabilitated teeth were considered. The survey included studies that presented root traction/extrusion treatment, prosthetic completion of the case and that also described longitudinal periodontal follow-up. Studies or articles with abstracts written in languages other than those aforementioned and that did not have concrete content with the research objective to be considered valid were excluded. The titles and abstracts of studies identified by the search strategies were evaluated by the reviewer and selected according to their relevance according to some criteria as type of study, root traction or orthodontic extrusion present, rehabilitation with single fixed prosthesis and period of clinical follow-up.

Data collection and extraction were independently performed by a pair of reviewers and, when there were disagreements in data collected, they were solved either by consensus between the pair or by consultation with a third reviewer. After the selection process was completed, a previous systematic, selective and analytical reading of studies included in the eligibility criteria was performed.

RESULTS

The searches conducted in the electronic databases established in the methodological description identified 644 articles and are detailed in the flowchart representing the studies (Figure 1).

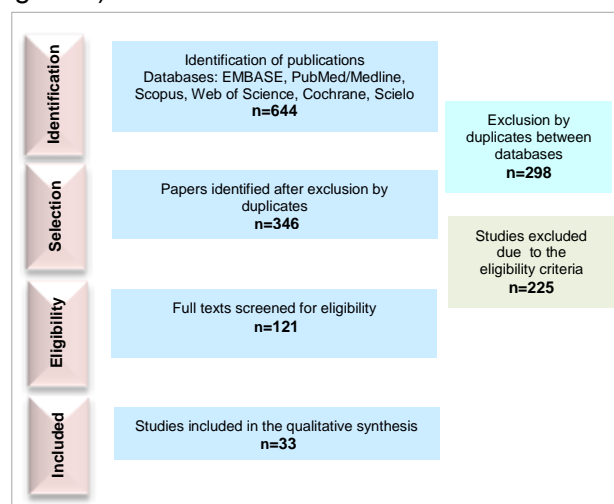


Figure 1: Search strategy.

A total of 121 articles were selected after reading the titles and abstracts, using the inclusion and exclusion criteria. After reading the full text of selected papers, they were examined and after careful analysis of their contents 33 articles had potential for a more qualified analysis (Table I).

Table 1 – Characteristics of the included studies.

Reference, Year Country	Title	Study design	Objective	OE	RFP	Follow-up	Outcome/Conclusion
Ross et al. ⁷ (1981) (United States)	Orthodontic extrusion: a multidisciplinary treatment approach	Case report	Report the management of a periodontal defect associated with an endodontic perforation leading to successful restoration of the tooth by a multidisciplinary approach.	Yes	Yes	6-months	Orthodontic extrusion can be used to treat periodontal defects and allow adequate restoration without compromising the esthetic appearance and prognosis of the involved tooth or adjacent teeth.
Zyskind et al. ⁸ (1992) (Israel)	Orthodontic forced eruption: case report of an alternative treatment for subgingivally fractured young permanent incisors	Case report	This case report describes in detail the chosen treatment for a subgingivally fractured young permanent incisor	Yes	Yes	2-year	The keys to success are the right indications for treatment and the dedication of the dentist to reassure and motivate the patient throughout the whole course of treatment, as well as institute a strict and regular recall regimen to guarantee the long-term prognosis.
Ngan and Knobloch ⁹ (1993) (United States)	Multidisciplinary and esthetic approach to clinical crown lengthening: report of a case	Case report	This case report describes a multidisciplinary and esthetic approach to restore a maxillary lateral incisor that was originally treatment planned for extraction.	Yes	Yes	2-months	Clinical crown lengthening may be used as an alternative approach to the treatment of severely broken-down anterior teeth.
Kocadereli et al. ¹⁰ (1998) (Turkey)	Combined endodontic-orthodontic and prosthodontic treatment of fractured teeth. Case report	Case report	The use of orthodontic extrusion has been suggested as an alternative to periodontal crown lengthening in the dental management of a subgingivally fractured permanent left central incisor.	Yes	Yes	2-year	Forced orthodontic eruption provides a useful alternative to extraction or extensive periodontal surgery.
Jorgensen and Nowzari ¹¹ (2001) (United States)	Orthodontic forced eruption: case report of an alternative treatment for subgingivally fractured young permanent incisors	Case report	Discusses crown-lengthening procedures with particular attention to aesthetic considerations.	Yes	Yes	2-year	A combination of orthodontic extrusion and surgical crown lengthening produced a stable, functional and aesthetic result.
Smidt and Venezia ¹² (2003) (Israel)	The use of an existing cast post and core as an anchor for extrusive movement	Case report	This article describes an original solution for a tooth with an existing cast post and core placed subgingivally.	Yes	Yes	2-year	The intent in the presented case was to supragingivally elevate the subgingivally placed finish line of a cast post and core away from the biologic width.
Felippe et al. ¹³ (2003) (Brazil)	Reestablishing biologic width with forced eruption	Case report	This clinical case describes a technique to reestablish the biologic width of a central incisor using forced eruption.	Yes	Yes	6-months	Use of an eruption technique is shown to be valid in treating cervical fracture of an anterior tooth by providing adequate biologic width prior to final restoration.
Wehr et al. ¹⁴ (2004) (Germany)	Forced eruption for preservation of a deeply fractured molar	Case report	Report a case of deeply fractured lower molar treated by forced eruption.	Yes	Yes	2-months	The presented procedure is a practicable alternative to extraction followed by implantation or to surgical crown lengthening.
Smidt et al. ¹⁵ (2005) (Israel)	Orthodontic extrusion of an extensively broken-down anterior tooth: A clinical report	Case report	To report a case of a maxillary right lateral incisor, extensively broken-down following trauma, treated with orthodontic extrusion combined with gingival fibrotomy, without a need for a corrective surgical procedure.	Yes	Yes	3-year	Forced eruption was used to solve the restorative problem, elevating the fracture line from within the alveolar socket to allow the placement of crown margins on sound tooth structure without harming the biologic width.
Arhun et al. ¹⁶ (2006) (Turkey)	A conservative multidisciplinary approach for improved aesthetic results with traumatized anterior teeth	Case report	The following case shows multidisciplinary management of a case of dental trauma.	Yes	Yes	19-months	Orthodontic forced eruption is incorporated using endodontic posts and restoration with porcelain fused to metal crowns, leading to successful restoration of the traumatized teeth.
Smidt et al. ¹⁷ (2007) (Israel)	Invasive cervical root resorption: treatment rationale with an interdisciplinary approach	Case report	To report an interdisciplinary approach combining orthodontic extrusive movement and fibrotomy in a case of invasive cervical root resorption.	Yes	Yes	4-year	Forced eruption combined with fibrotomy in such events might assist in maintaining teeth in the arch, saving the need for extraction and implant placement.
Türker and Köse ¹⁸ (2008) (Turkey)	Multidisciplinary approach in the treatment of subgingivally fractured anterior teeth	Case report	This study presents the multidisciplinary approach in the treatment of subgingivally fractured anterior teeth.	Yes	Yes	2-year	Orthodontic eruption procedure is useful, if there is enough root length.

OE = Orthodontic Extrusion ; RFP = Rehabilitation with Fixed Prosthesis

Table 1 (continuation) – Characteristics of the included studies.

Reference, Year Country	Title	Study design	Objective	OE	RFP	Follow-up	Outcome/Conclusion
Kim et al. ²⁰ (2011) (Brazil)	Rapid orthodontic extrusion using an interocclusal appliance for the reestablishment of biologic width: A case report	Case report	This case report describes a simple method involving an interocclusal appliance and an elastic band for rapid orthodontic extrusion to reestablish biologic width	Yes	Yes	1-year	Rapid orthodontic extrusion using a interocclusal appliance and elastic bands is a simple, safe, and fast nonsurgical option for reestablishing biologic width.
Goenka, et al. ²¹ (2011) (India)	A Multidisciplinary approach to the management of a subgingivally fractured permanent mandibular incisor.	Case report	This clinical report describes the procedure of forced eruption in detail for the treatment of a subgingivally fractured permanent mandibular incisor.	Yes	Yes	1-year	A number of treatment options are available for the management of subgingivally fractured teeth; however, none should be used as rule. Rather, the selection should always be customized to the individual case, and a multidisciplinary approach should always be considered to rehabilitate such cases.
Fidel et al. ²² (2011) (Brazil)	Clinical Management of a Complicated Crown-Root Fracture: A case report	Case report	This report describes the clinical procedures involved in the treatment of a complicated crown-root fracture in the maxillary left central incisor.	Yes	Yes	3-year	Orthodontic extrusion and root canal treatment using calcium hydroxide dressing were successful in repairing the periradicular tissue of a crown-root fracture in permanent tooth with open apex.
Kumar and Patil ²⁵ (2012) (India)	Forced orthodontic extrusion and use of CAD/CAM for reconstruction of grossly destructed crown: A multidisciplinary approach	Case report	The aim of this study is to present a report of a case where forced orthodontic extrusion and computer-aided design and computer-aided manufacturing (CAD/CAM) technique was used for reconstruction of right maxillary central incisor with grossly destructed crown.	Yes	Yes	3-months	This technique can provide a complete aesthetic rehabilitation of a grossly destructed tooth without hampering the biological width and thus has a better prognosis.
Cesar-Neto et al. ²³ (2012) (Brazil)	Mandibular molar rehabilitation using orthodontic extrusion associated with odontology	Case report	The aim of this clinical report is to describe the successful treatment of a mandibular first molar presenting an extensive fracture at the buccal aspect in a young patient	Yes	Yes	3-year	It can be concluded that orthodontic forced eruption associated with odontology promoted favorable conditions for prosthetic rehabilitation and is a feasible procedure in the treatment of tooth fracture extended below the cemento-enamel junction.
Martos et al. ²⁴ (2012) (Brazil)	Orthodontic extrusion and biologic width realignment procedures for rehabilitation in a permanent premolar with an extensive dental fracture	Case report	The aim of this article is to describe an orthodontic technique for a second permanent superior premolar with an extensive coronoradicular fracture.	Yes	Yes	1-year	It can be concluded that orthodontic extrusion is a useful tool in the management of extensive subgingival fractures.
Seshu and Gash ²⁶ (2012) (United Kingdom)	Multidisciplinary management of a fractured upper first premolar: a case report with follow-up	Case report	This case report describes the multidisciplinary management of a fractured upper first premolar in a general dental practice.	Yes	Yes	21-months	The treatment described requires time, commitment, and motivation from the patient and the dentist. However, it is less destructive of tissue than the other treatment options available and is more natural to a patient than a denture.
Shin et al. ²⁸ (2013) (South Korea)	Multidisciplinary approach in the management of a complicated crown root fracture.	Case report	This case presents the management of a complicated crown root fracture using a combined treatment approach including endodontic treatment, orthodontic forced eruption, and intentional replantation, followed by aesthetic restoration.	Yes	Yes	24-months	Clinical and radiographic follow-up of the maxillary left central incisor after 24 months showed no signs of bone resorption or pathology and good aesthetics and functions were maintained.
Sun et al. ²⁷ (2013) (China)	An interdisciplinary approach to treat crown-root fractured tooth	Case report	The objective of this report is to display a new interdisciplinary approach which combining endodontic root canal treatment, orthodontic extrusion, periodontal crown lengthening surgery and prosthodontic post-core-crown restoration procedures to restore a crown-root subgingival fractured maxillary central incisor.	Yes	Yes	1-year	the combination of endodontic, orthodontic, periodontal and prosthodontic disciplines is a satisfied and promising way to restore the crown-root-fractured tooth
Patil et al. ³⁰ (2014) (Malaysia)	Multidisciplinary Treatment Approach to restore deep horizontally fractured maxillary central incisor	Case report	This case report demonstrates sequential Periodontic, Orthodontic and Prosthodontic treatment modalities to save and restore deep horizontally fractured maxillary central incisor.	Yes	Yes	6-months	Forced eruption is preferred to surgical removal of supporting alveolar bone since forced eruption preserves the biologic width, maintains esthetics, and at the same time exposes sound tooth structure for the placement of restorative margins.

OE = Orthodontic Extrusion ; RFP = Rehabilitation with Fixed Prosthesis

Table 1 (continuation) – Characteristics of the included studies.

Reference, Year Country	Title	Study design	Objective	OE	RFP	Follow-up	Outcome/Conclusion
Jeon et al. ²⁹ (2014) (South Korea)	An esthetic appliance for the management of crown-root fracture: a case report	Case report	The purpose of this case report is to describe a modified orthodontic extrusion appliance that is useful when conventional orthodontic treatment is not possible.	Yes	Yes	2-year	When forced eruption is considered for a tooth that is structurally compromised due to trauma, the treatment option that is chosen depends on the conditions of periodontal support and of the adjacent teeth, the material of restoration, and so on.
Ali et al. ³¹ (2015) (India)	Forced eruption in the management of subgingival crown fracture - an interdisciplinary approach: Case reports	Case report	The cases presented in this report describe an interdisciplinary approach involving orthodontic extrusion, conservative periodontal surgery, fracture and cast core with porcelain-metal crown prostheses.	Yes	Yes	12/24-months	This study concludes that a multidisciplinary treatment approach with cooperation among specialists to manage such a type of dental injury is essential for favorable orthodontic and functional rehabilitation.
Bajaj et al. ³² (2015) (India)	Multidisciplinary approach to the management of complicated crown-root fracture: A case report	Case report	To report a predictable solution in overcoming an oblique crown-root fracture caused by trauma. Orthodontic extrusion was used to elevate the fractured tooth from within the alveolar socket to allow the placement of crown margins on sound tooth structure without harming the biologic width.	Yes	Yes	2-year	Orthodontic extrusion combined with fibrotomy presents the most suitable and predictable treatment modality for the management of oblique crown-root fractures that invade the biologic width.
Ansari et al. ³³ (2015) (India)	Aesthetic Rehabilitation of Subgingival Fractures with Forced Eruption: Case	Case report	To discuss two different cases in which a traumatized tooth was treated endodontically and extruded using two different techniques of forced eruption.	Yes	Yes	2-months	Different clinical techniques can be employed for orthodontic extrusion depending on the scenario of the case. A multidisciplinary approach is necessary for the restoration of tooth fractured at subgingival level. In these case reports placement of the final restoration after orthodontic extrusion resulted in good esthetics and function postoperatively.
Lishen et al. ³⁴ (2018) (Malaysia)	An interdisciplinary approach for management of an extensive carious premolar	Case report	This clinical case report describes a treatment of crown that combines non-surgical endodontic treatment, orthodontic extrusion and prosthetic rehabilitation to restore the function and aesthetic aspect of an extensively carious premolar with compromised prognosis.	Yes	Yes	1-year	Orthodontic extrusion has been very beneficial in the establishment of biological width, maintaining the periodontal support of the adjacent teeth and restore aesthetics. Therefore, orthodontic extrusion could be a useful treatment option to consider, to retain the tooth as long as possible.
Artieda-Estanga et al. ³⁵ (2018) (Spain)	Management of a crown-root fracture: A novel technique with interdisciplinary approach	Case report	This case report describes the management of a crown-root fractured maxillary left central incisor.	Yes	Yes	4-year	This report provides a highly conservative approach that combines function, health of periodontal tissues and aesthetics, postponing the extraction of a compromised anterior incisor.
Scholtes et al. ³⁶ (2018) (Netherlands)	Combined orthodontic, surgical, and restorative approach to treat a complicated crown-root fracture in a maxillary central incisor	Case report	To report the treatment of a complicated crown-root fracture in the esthetic region.	Yes	Yes	3-year	Orthodontic extrusion and crown-length surgery were performed to bring the fracture line above the alveolar bone crest.
Alotaib ³⁸ (2019) (Saudi Arabia)	Multidisciplinary approach to the treatment of a complicated crown-root fracture	Case report	This case report demonstrates sequential endodontic, restorative, orthodontic, periodontal, and prosthodontic modalities for the conservative management of a complicated crown-root fracture of the maxillary left central incisor.	Yes	Yes	9-months	This case report demonstrates that complicated crown-root fractures can be predictably and conservatively managed by the forced eruption technique.
Thakur et al. ³⁷ (2019) (India)	Management of subgingivally fractured maxillary anterior tooth: a multidisciplinary approach	Case report	To report a case of the fractured maxillary anterior tooth at the subgingival level that was managed by forced orthodontic extrusion after endodontic therapy followed by aesthetic rehabilitation.	Yes	Yes	6-months	This case report demonstrates that is definitely cost-effective for the patient and at the same time preserves the integrity of the tooth and the tissue, simultaneously
Parthiban et al. ³⁹ (2020) (India)	Multidisciplinary approach to the management of a subgingivally fractured anterior tooth using an aligner based treatment with the help of orthodontic extrusion appliance - a case report	Case report	This case report describes the management of a subgingivally fractured central incisor of a healthy 27-year-old male patient using a conservative approach while maintaining esthetics throughout the treatment with the help of a clear aligner.	Yes	Yes	1-year	Immediate esthetic resolution using a passive clear aligner is an immediate and less expensive method, which offers satisfactory esthetic and functional rehabilitation of the fractured tooth. Extrusion of the tooth with optimal orthodontic forces can give good physiological tooth and bone response. Hence, these minimally invasive approaches should be thought of before resorting to implants.

OE = Orthodontic Extrusion ; RFP = Rehabilitation with Fixed Prosthesis

DISCUSSION

The purpose of this study was to identify the relationship between root traction and its effects on periodontal health in prosthetically rehabilitated teeth. All parameters of periodontal health evaluated during follow-up, such as a periodontal result incompatible with health or inflammation of periodontal tissues, were analyzed for each tooth that had undergone extrusive root action due to tooth fracture or any other event that would lead to invasion of the supracrestal tissue attachment and required prosthetic rehabilitation. To reduce the possibilities of errors and/or mistakes during selection and evaluation of identified studies, the criteria for clinical follow-up after placement of the prosthetic element were adopted in an excluding manner. The clinical description in the texts were accurately observed, showing maintenance or not of periodontal health throughout the follow-up time, as an unequivocal condition after placement of the fixed denture, either by radiographic and/or clinical/periodontal methods. Studies that performed root traction, but that the restorative procedure involved the use of restorations with composite resins, were not included in our analysis since the presence of bacteria commonly found in the tooth/crown interface can be minimized by the adhesive nature of the restorations and this form would directly influence our assessment.

It is worth mentioning the use of SWiM guidelines in this review. This guideline is specifically related to reporting, in a transparent manner, the methods and results of the narrative synthesis of the effect estimates in reviews that incorporate several sources of data that are not subject to meta-analysis⁶.

From the analyzed studies, it was observed that orthodontic traction enabled a viable alternative to tooth extraction or more extensive periodontal surgery⁷⁻³⁹. Root traction is preferable to surgical removal of the supporting alveolar bone, since the forced eruption preserves integrity of the supracrestal tissue attachment, the esthetics and simultaneously exposes the healthy dental structure for placement of restorative margins in a biophysiological situation⁵. It has been shown that greater loss of periodontal insertion is a direct consequence of clinical crown lengthening surgery where recovery of the supracrestal tissue attachment through osteotomy is necessary⁴⁰. Maintaining a healthy dental element within the stomatognathic system is also important for subsequent implant placement, as it is essential to maintain dense bone to support an implant.

Most that culminated in invasion of supracrestal insertion tissues observed in this review were due to trauma and dental fractures^{8-16,18-34,36-39}, however, cases of external cervical resorption¹⁷ or even carious cervical lesions with invasion of supracrestal insertion tissues were also observed^{7,35}. Anterior teeth corresponded to 82.8% of all teeth treated in these studies, 4 teeth were upper premolars^{12,24,26,35} and only 2 studies reported this treatment approach in lower molars^{14,23}. Orthodontic extrusion, combined or not with fibrotomy, presented the most conservative and predictable treatment option for the management of oblique coronal fractures that invaded the supracrestal insertion tissues according to almost all studies evaluated. The International Association of Dental Traumatology (IADT) recommends orthodontic extrusion of the apical segment for cases of dental fractures complicated with invasion of periodontal structures as a therapeutic approach⁴¹. This study highlighted that many cases of dental trauma solved with this approach of root traction were not included in the qualitative synthesis because they were finished with bonding of dental fragments or composite resin restorations, rather than prosthetic rehabilitation.

It can be noted that all studies evaluated were case reports and showed full success, among other factors, due to the clinical follow-up, assuring the good prognosis of the rehabilitation treatment in the long term. A satisfactory prosthetic rehabilitation, associated with periodontal health after root traction, could be observed in all studies, notably with variation in the follow-up time observed in the first six months^{7,9,13,14,18,25,30,33,37}, 9 months³⁸, 1 year^{20,21,24,27,35,39}, between 19 and 21 months^{16,26}, and also in those maintaining a strict follow-up regime of 2 years^{8,10,11,12,19,28,29,31,32}, 3 years^{15,20,23,36} and even up to 4 years of follow-up^{17,34}.

Another interesting aspect is that root traction in most studies (88%) presented orthodontic apparatus to activate the root extrusion mechanism; however, some studies used non-orthodontic appliances, e.g. occlusal acrylic plates^{20,29,39} or even magnets attached to the traction mechanism¹⁸. The mean time of root traction for the different evaluated cases varied according to the technique used, whether fast or slow, the appliance used or depending on each individual case concerning the amount of traction required. This period varied from 1 to 2 weeks^{13,18,20,33}, 3 to 5 weeks^{11,12,15,21,25,29,32}, 6 to 8 weeks^{8,9,10,14,16,19,26,28,30,31,34,35,38}, 9 to 12 weeks^{7,23,27} and also over 13 weeks^{22,24,36,37,39}.

Cases evaluated with longer maintenance of the traction appliance were due to association between the active period and the retention period.

Root traction is a simple, safe and fast non-surgical option to restore the biological dimensions of the periodontium. Root traction with ideal orthodontic forces provides a good physiological response to both tooth and bone tissue. This minimally invasive approach must be considered before indicating dental implants³⁹. The therapeutic approach should aim at the exposure of subgingival margins of the fractured tooth without compromising the supracrestal tissue attachment. Different from other orthodontic procedures, besides not causing bone resorption, the extrusion promotes additional bone deposition lining the alveolus³⁷.

It can also be highlighted that it was not possible to identify studies where there was eventual periodontal inflammation during follow-up, i.e. cases where root traction followed by prosthetic rehabilitation showed failure from a periodontal standpoint. The effects of root traction on the maintenance of periodontal health of teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated were observed in all studies, thus showing clinical success. Notwithstanding, it is important to emphasize that the clinical evaluations used in longitudinal follow-ups in most studies were conducted by periapical radiographic examination and visual aspect of the gingival tissue by photographic image. Monitoring of periodontal clinical parameters of probing depth and clinical attachment level, as well as the gingival index, were not presented. In addition, no important factors have been reported that could influence the gingival inflammatory process, such as the presence of behavioral and systemic risk factors, susceptibility, and history of periodontal disease in individuals.

In this respect, the only variation observed in this narrative synthesis and how they could affect the conclusions related to the question of the original review refer only to the time of clinical follow-up.

Root traction should be offered to the patient, as long as the indication is met, as a fully viable option before making a decision for more radical procedures as resective bone surgeries for clinical crown lengthening or extraction/implant³⁸. Nothing compares to the natural compatibility and proprioception of the root to the alveolar bone tissue. The indication of implants instead of compromised teeth should be guided by clinical signs that indicate a

superior result or greater predictability. The indication for maintenance or extraction of a tooth should be based on the clinical and periodontal status, the available scientific evidence and also the patient's objectives and/or expectations.

CONCLUSION

It can be concluded, by the studies included in this narrative literature review, that root traction is a conservative and effective tool in the treatment of teeth with invasion of supracrestal tissue attachment and prosthetically rehabilitated and is capable of maintaining the periodontal health over time.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interests.

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