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 Protésica: Revisão da Literatura

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.

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. Violation of this tissue will result in progressive inflammation in which the organism, at the expense of bone resorption, promotes restoration of the invaded dimensions. Clinically, these changes may be observed as

Laura Lourenço MOREL
Faculdade de Odontologia, UFPel Universidade Federal de Pelotas, 96015-560 Pelotas - RS, Brasil
https://orcid.org/0000-0002-4855-311X
 Lucas Jardim da SILVA
Faculdade de Odontologia, UFPel Universidade Federal de Pelotas, 96015-560 Pelotas - RS, Brasil
Giovane Hisse GOMES
Professor Doutor, Departamento de Odontologia, Faculdade de Odontologia, UCPel Universidade Católica de Pelotas, 96055-000 Pelotas - RS, Brasil
Josué MARTOS
Professor Titular, Departamento de Semiologia e Clínica, Faculdade de Odontologia, UFPel Universidade Federal de Pelotas, 96015-560 Pelotas - RS, Brasil
https://orcid.org/0000-0001-9580-6100
gingival retraction or periodontal pocket formation. 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 attachment. This anatomical area was previously described as a biological space. 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.

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 techniques.

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 limits. 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 performed.

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).
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.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Country</th>
<th>Title</th>
<th>Study design</th>
<th>Objective</th>
<th>OE</th>
<th>RFP</th>
<th>Follow-up</th>
<th>Outcome/Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rose et al. (1991)</td>
<td>United States</td>
<td>Orthodontic forced eruption case report of a maxillary central incisor for a subgingivally fractured permanent incisor</td>
<td>Case report</td>
<td>Support present the case report</td>
<td>Yes</td>
<td>Yes</td>
<td>6 months</td>
<td>Reestablish the biologic width: A case report</td>
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<tr>
<td>Köse et al. (1998)</td>
<td>United States</td>
<td>Multidisciplinary approach in the treatment of subgingivally fractured teeth</td>
<td>Case report</td>
<td>Case report describes in detail the chosen treatment for a subgingivally fractured permanent incisor</td>
<td>Yes</td>
<td>Yes</td>
<td>2 years</td>
<td>The keys to success are: the right indications for treatment and the dedication of the dentist to measure and motivate the patient for a successful course of treatment, as well as have a strict and regular recall regimen to guarantee the long-term prognosis.</td>
<td></td>
</tr>
<tr>
<td>Nair and Krishnaswami (1999)</td>
<td>United States</td>
<td>Multidisciplinary approach to treat crown root fracture: A case report</td>
<td>Case report</td>
<td>The case report describes the multidisciplinary and aesthetic approach to restore a mandibular first molar tooth</td>
<td>Yes</td>
<td>Yes</td>
<td>6 months</td>
<td>Multidisciplinary and aesthetic approach to the treatment of severely traumatized permanent molar teeth.</td>
<td></td>
</tr>
<tr>
<td>Acocella et al. (2008)</td>
<td>Italy</td>
<td>Combined endodontic and orthodontic approach to treat crown root fracture: a case report</td>
<td>Case report</td>
<td>The use of endodontic and orthodontic procedures was suggested as an alternative to subgingival crown lengthening in the management of a subgingivally fractured permanent central incisor</td>
<td>Yes</td>
<td>Yes</td>
<td>2 years</td>
<td>Orthodontic endodontic approach provides a safe and alternative to extraction or extensive periodontal surgery.</td>
<td></td>
</tr>
<tr>
<td>Jagtji and Ranganath (2001)</td>
<td>India</td>
<td>Multidisciplinary approach to treat crown root fracture: A case report</td>
<td>Case report</td>
<td>The case report describes the multidisciplinary and aesthetic approach used for a patient with extensive lengthening subgingivally placed finish</td>
<td>Yes</td>
<td>Yes</td>
<td>2 years</td>
<td>A combination of orthodontic extrusion and surgical crown lengthening produced a stable, functional and aesthetic result.</td>
<td></td>
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<tr>
<td>Mavragani et al. (2006)</td>
<td>Greece</td>
<td>Forced orthodontic eruption case report of an existing cast post and core</td>
<td>Case report</td>
<td>The case report describes an original solution for an existing cast post and core placed subgingivally</td>
<td>Yes</td>
<td>Yes</td>
<td>2 months</td>
<td>For both endodontic and orthodontic procedures, a combination of orthodontic and endodontic interventions is the best option for a superior premolar with extensive lengthening.</td>
<td></td>
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<tr>
<td>Efe et al. (2010)</td>
<td>Turkey</td>
<td>Multidisciplinary approach to treat crown root fracture: A case report</td>
<td>Case report</td>
<td>The case report describes an original solution for an existing cast post and core placed subgingivally</td>
<td>Yes</td>
<td>Yes</td>
<td>6 months</td>
<td>Use of an endodontic technique is shown to be valid in treating curvilinear fractures of an anterior tooth by providing adequate support and follow.</td>
<td></td>
</tr>
<tr>
<td>Sahu et al. (2011)</td>
<td>India</td>
<td>Mandibular left first premolar: a case report</td>
<td>Case report</td>
<td>The case report describes a clinical report is to present a report of a mandibular first premolar and an extensive fracture at the buccal aspect in a young patient.</td>
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<tr>
<td>Azizian et al. (2023)</td>
<td>India</td>
<td>Multidisciplinary approach to treat crown root fracture: A case report</td>
<td>Case report</td>
<td>The case report describes the management of a complicated crown root fracture using a combined treatment approach including endodontic treatment, orthodontic extrusion and intentional mobilization followed by second molar restoration.</td>
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<td>OA = Orthodontic Extrusion; RFP = Rehabilitation with Fixed Prosthesis</td>
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</table>
Table 1 (continuation) – Characteristics of the included studies.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Country</th>
<th>Title</th>
<th>Design</th>
<th>Objective</th>
<th>Outcomes</th>
<th>RFP</th>
<th>Follow-up</th>
<th>Outcomes/Conclusion</th>
</tr>
</thead>
</table>
| Ansar et al. (2015) | India | Orthodontic traction of maxillary incisor: a case report | Case report | To report a case of orthodontic traction of a maxillary incisor | Orthodontic traction of maxillary incisor | Yes | 12 months | This study concludes that orthodontic traction of maxillary incisor is a viable option for managing fractures.

DISCUSSION

The purpose of this study was to identify the relationship between root traction and its effects on periodontal health in prosthodontically 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-analysis.

From the analyzed studies, it was observed that orthodontic traction enabled a viable alternative to tooth extraction or more extensive periodontal surgery. 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 biophysiologic situation. It has been shown that greater loss of periodontal insertion is a direct consequence of clinical crown lengthening where recovery of the supracrestal tissue attachment through osteotomy is necessary. 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 resorption\(^17\) 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 approach\(^11\). 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\(^7,9,13,14,16,25,30,33,37\), 9 months\(^38\), 1 year\(^21,24,27,35,39\) between 19 and 21 months\(^6,26\), 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 mechanism\(^16\). 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\(^1,11,12,15,21,25,29,32\), 6 to 8 weeks\(^9,10,14,16,19,26,28,30,31,34,35,38\), 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 implants\(^39\). 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 alveolus\(^39\).

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/implant\(^38\). 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.

**REFERENCES**


CONFLICTS OF INTERESTS
The authors declare no conflicts of interests.

CORRESPONDING AUTHOR
Josué Martos
Department of Semiology and Clinics, School of Dentistry, Federal University of Pelotas, Brazil. Gonçalves Chaves st., 457 96015-560 Pelotas – RS, Brazil Phone: +55 53 3221 4162 e-mail: josue.sul@terra.com.br

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