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.
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 METHODS

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 potent evidence. Therefore, 33 full text of selected papers, they were examined and after careful analysis of their contents, 33 articles had potent evidence. Therefore, 33 articles had potent evidence.

### Table 1 – Characteristics of the included studies.

| Reference Year | Title Design | Objective | Outcome Conclusion |
|----------------|--------------|-----------|--------------------|
| 2022 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2022 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2021 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2021 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2020 (China) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2019 (Japan) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2018 (Israel) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2017 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2016 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2015 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2014 (China) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2013 (Turkey) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2012 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2011 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2010 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2009 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2008 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2007 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2006 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2005 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2004 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2003 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2002 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 2001 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 2000 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 1999 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 1998 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 1997 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 1996 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |
| 1995 (India) | Multidisciplinary approach to treatment of subgingivally fractured teeth | Oral case report | Yes | Yes |
| 1994 (Brazil) | Orthodontic extravasation using an interdisciplinary appliance for fixed orthodontic biomechanics | Oral case report | Yes | Yes |

OE = Orthodontic Extrusion; RFP = Rehabilitation with Fixed Prosthesis
Table 1 (continuation) – Characteristics of the included studies.

| Reference | Year | Country | Title | Study design | Objective | Outcome | RFP | Follow-up | Outcome | Conclusion |
|-----------|------|---------|-------|-------------|-----------|---------|-----|-----------|---------|------------|
| Aruogn et al. (2016) (India) | 2016 | India | Orthodontic extrusion of a devitalized crown fracture: A case report | Case report | The case report describes the orthodontic extrusion appliance that is useful when conventional orthodontic treatment is not possible. | Yes | 2-year | Yes | 2-year | A case report describes the orthodontic extrusion appliance that is useful when conventional orthodontic treatment is not possible. |
| Swinburn et al. (2015) (India) | 2015 | India | Multidisciplinary approach to the management of complications: composite crown fracture | Case report | The report presents a multidisciplinary approach to the management of complications: composite crown fracture. | Yes | 3-month | Yes | 3-month | The report presents a multidisciplinary approach to the management of complications: composite crown fracture. |
| Pinho et al. (2015) (Brazil) | 2015 | Brazil | Multidisciplinary approach to the management of a complicated crown fracture | Case report | The report presents a multidisciplinary approach to the management of a complicated crown fracture. | Yes | 1-year | Yes | 1-year | The report presents a multidisciplinary approach to the management of a complicated crown fracture. |
| Aruogn et al. (2015) (India) | 2015 | India | Multidisciplinary approach to the management of a complicated crown fracture | Case report | The report describes the multidisciplinary approach to the management of a complicated crown fracture. | Yes | 1-year | Yes | 1-year | The report describes the multidisciplinary approach to the management of a complicated crown fracture. |
| Bhatia et al. (2015) (India) | 2015 | India | Multidisciplinary approach to the management of a complicated crown fracture | Case report | The report describes the multidisciplinary approach to the management of a complicated crown fracture. | Yes | 6-month | Yes | 6-month | The report describes the multidisciplinary approach to the management of a complicated crown fracture. |
| 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 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 surgery 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.

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Most that culminated in invasion of supracrestal insertion tissues observed in this review were due to trauma and dental fractures; however, cases of external cervical resorption or even carious cervical lesions with invasion of supracrestal insertion tissues were also observed. Anterior teeth corresponded to 82.8% of all teeth treated in these studies, 4 teeth were upper premolars and only 2 studies reported this treatment approach in lower molars. Orthodontic extrusion, combined or not with fibrootomy, 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. 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, 9 months, 1 year, 2 years, 3 years, and also in those maintaining a strict follow-up regime of 2 years, 3 years, and even up to 4 years of follow-up.

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 or even magnets attached to the traction mechanism. 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, 3 to 5 weeks, 6 to 8 weeks, 9 to 12 weeks, and also over 13 weeks.

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. 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.

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. 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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