

Minimally invasive surgical techniques in clinical crown lengthening: A systematic review

Técnicas cirúrgicas minimamente invasivas no aumento da coroa clínica: Uma revisão sistemática

Técnicas quirúrgicas mínimamente invasivas para aumentar la corona clínica: una revisión sistemática

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Abstract

The surgical procedure for the clinical crown lengthening, aims for an aesthetic or functional form to compensate for the reabsorption of the alveolar bone tissue caused by the invasion of the biological space. The conditions that must be taken into account during surgical planning are related to an excessive gingival exposure, altered passive eruption and lack of height of the dental element for restorative purposes. The objective of this systematic review was to evaluate in the scientific literature the minimally invasive surgical techniques used to clinical crown lengthening. A systematic review of the literature was performed using the databases, Science Direct, Embase, Cochrane Collaboration Library, and PubMed/MEDLINE. The search strategy provided a total of 157 studies. After selection, five articles met all the inclusion criteria and were included in this systematic review. Studies have shown that conventional surgical techniques for clinical crown lengthening are presented as an effective approach that promotes good aesthetic and functional results. However, they have some limitations. After evaluating the minimally invasive surgical techniques included in this systematic review, it was possible to infer that they presented satisfactory results in the soft and hard tissue contouring, with no complications and dissatisfaction being observed by the patients.

Keywords: Periodontics; Periodontal Attachment Loss; Surgery Oral.

Resumo

O procedimento cirúrgico para o aumento da coroa clínica dentária, busca de forma estética ou funcional compensar a reabsorção do tecido ósseo alveolar ocasionado pela invasão do espaço biológico. As condições que devem ser levadas em consideração durante o planejamento cirúrgico estão relacionadas a presença de exposição gengival excessiva, erupção passiva alterada e falta de altura do elemento dentário para fins restaurativos. O objetivo desta revisão sistemática foi avaliar na literatura científica as técnicas cirúrgicas minimamente invasivas utilizadas no aumento da coroa clínica dentária. Uma revisão sistemática da literatura foi realizada utilizando as bases de dados, Science Direct, Embase, Cochrane Collaboration Library, and PubMed/MEDLINE. A estratégia de busca forneceu um total de 157 estudos. Após a seleção, seis artigos atenderam a todos os critérios de inclusão e foram incluídos na presente revisão sistemática. Os estudos demonstraram que as técnicas cirúrgicas convencionais para o aumento da coroa clínica apresenta-se como uma abordagem eficaz que promove bons resultados estéticos e funcionais. No entanto, as mesmas apresentam algumas limitações. Após avaliar as técnicas cirúrgicas minimamente invasivas incluídas nesta revisão sistemática, foi possível inferir que as mesmas apresentaram resultados satisfatórios no recontorno dos tecidos moles e duros, não sendo observado nenhum tipo de intercorrência e insatisfação pelos pacientes.

Palavras-chave: Periodontia; Perda da inserção periodontal; Cirurgia bucal.

Resumen

El procedimiento quirúrgico para el aumento de la corona clínica dental, busca una forma estética o funcional para compensar la reabsorción del tejido óseo alveolar provocada por la invasión del espacio biológico. Las condiciones que se deben tener en cuenta durante la planificación quirúrgica están relacionadas con la presencia de exposición gingival excesiva, erupción pasiva alterada y falta de altura del elemento dental con fines restaurativos. El objetivo de esta revisión sistemática fue evaluar en la literatura científica las técnicas quirúrgicas mínimamente invasivas utilizadas para aumentar la corona dental. Se realizó una revisión sistemática de la literatura utilizando las bases de datos Science Direct, Embase, Cochrane Collaboration Library y PubMed / MEDLINE. La estrategia de búsqueda proporcionó un total de 157 estudios. Después de la selección, seis artículos cumplieron con todos los criterios de inclusión y se incluyeron en esta revisión sistemática. Los estudios han

demostrado que las técnicas quirúrgicas convencionales para aumentar la corona clínica se presentan como un abordaje eficaz que promueve buenos resultados estéticos y funcionales. Sin embargo, tienen algunas limitaciones. Luego de evaluar las técnicas quirúrgicas mínimamente invasivas incluidas en esta revisión sistemática, se pudo inferir que presentaban resultados satisfactorios en el contorneado de tejidos blandos y duros, sin que se observaran complicaciones e insatisfacción por parte de los pacientes.

Palabras clave: Periodoncia; Pérdida de la inserción periodontal; Cirugía bucal.

1. Introduction

The periodontium consists of structures that support and involve the dental element. The vitality of periodontal tissues is extremely important for dental elements with or without restorative treatment. The surgical procedure for the clinical crown lengthening aims for an aesthetic or functional form to compensate for the resorption of the alveolar bone tissue caused by the invasion of the biological space. Often the indication for this surgical technique is related to restorative procedures, in which the presence of subgingival cavity margins caused by caries, imperfect amelogenesis, fracture and dental malformation are usually found. (Tomar et al., 2013; Ebersole et al., 2016; Lavu et al., 2019).

The width of the keratinized gingiva is of fundamental importance to keep the periodontium healthy. The biological space corresponds to the groove epithelium, junctional epithelium and conjunctive insertion, showing an average value equivalent to 2.75 mm and ranging between 2.16 and 3.34 mm. The conditions that must be taken into account during the surgical planning of the clinical crown lengthening are related to the presence of excessive gingival exposure, altered passive eruption (alveolar crest equal to or less than 2 mm of the cementum-enamel junction) and lack of height of the tooth for restorative purposes (Tomar et al., 2013; Ryder., Couch., & Chaffee, 2018; Lavu et al., 2019).

The forms of treatments proposed to perform the clinical crown lengthening, include procedures such as soft tissue gingivectomy, flap repositioned apically or flap repositioned apically with bone contour. The literature also points out other types of approaches, such as exposing the crown through orthodontic dental extrusion, using the Er:YAG laser and performing piezosurgery that provides a precise cut of bone tissue, without causing damage to adjacent soft tissues (Gaspirc., & Skaleric, 2007; Tomar et al., 2013; Lavu et al., 2019; Worthington et al., 2019). Thus, it is observed that the surgical procedures used to restore the contour of the soft and hard tissues of the dental elements, present several advantages.

However, it is not yet fully clear which surgical techniques provide less postoperative morbidity, being classified as minimally invasive. Therefore, the objective of this systematic review was to evaluate in the scientific literature the minimally invasive surgical techniques used to clinical crown lengthening.

2. Materials and Methods

This study followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Statement (Moher et al., 2009).

Information of sources and search strategies

The following review question was developed according to population, intervention, comparison, and outcome (PICO): “Which minimally invasive surgery techniques are effective in Clinical Crown Lengthening?” and a keyword search was performed. A literature search was performed in June of 2020 in the following electronic databases: Science Direct, Embase, Cochrane Collaboration Library, and PubMed/MEDLINE.

The search was carried out without time and language restrictions. Hand searches were also conducted by cross-checking the reference lists of the included articles. Duplicates were removed upon identification. Manuscripts that were not published in English were translated for further evaluation.

The search strategy was based on different combinations of the following keywords and its synonyms: ("Clinical Crown Lengthening"[tw] OR "alveolar bone loss"[tw] OR "clinical attachment level"[tw]) AND ("Periodontal Treatment"[tw]) AND ("Periodontal Surgery"[tw] OR "Minimally Invasive Surgical"[tw]) AND ("Prognosis").

Eligibility criteria and Study selection

The reviewer independently screened and assessed potential articles. Studies that did not fulfill the inclusion criteria were excluded. In the first stage, the titles and abstracts of all retrieved reports were screened for potentially eligible studies. The full text articles of the previously identified studies were then examined in detail according to predefined eligibility criteria for inclusion in the qualitative review. Disagreements were solved by discussion between the authors. Eligibility criteria: the included studies were randomized clinical trials

that examined different minimally invasive surgical techniques in clinical crown lengthening. Exclusion criteria: animal studies, in vitro studies, opinion articles, letters to the editor, review articles, interviews, updates, abstracts and unpublished studies were excluded.

Data extraction/analysis

The review authors independently screened the articles for data extraction. Any disagreements were resolved by discussion. In order to increase the strength of the present systematic review the studies that were included underwent a quality assessment following the recommendations of the Consolidated Standards of Reporting Trials (CONSORT) statement (Moher., Liberati., & Tetzlaff., 2001). The CONSORT tool uses a systematic approach based on 7 specific criteria which are: (1) sample size calculation (minimum number of participants required to detect a significant difference among compared groups); (2) randomization and allocation concealment methods; (3) clear definition of inclusion and/or exclusion criteria; (4) complete follow-up; (5) experimental and control groups comparable at study baseline; (6) presence of masking; and (7) appropriate statistical analysis.

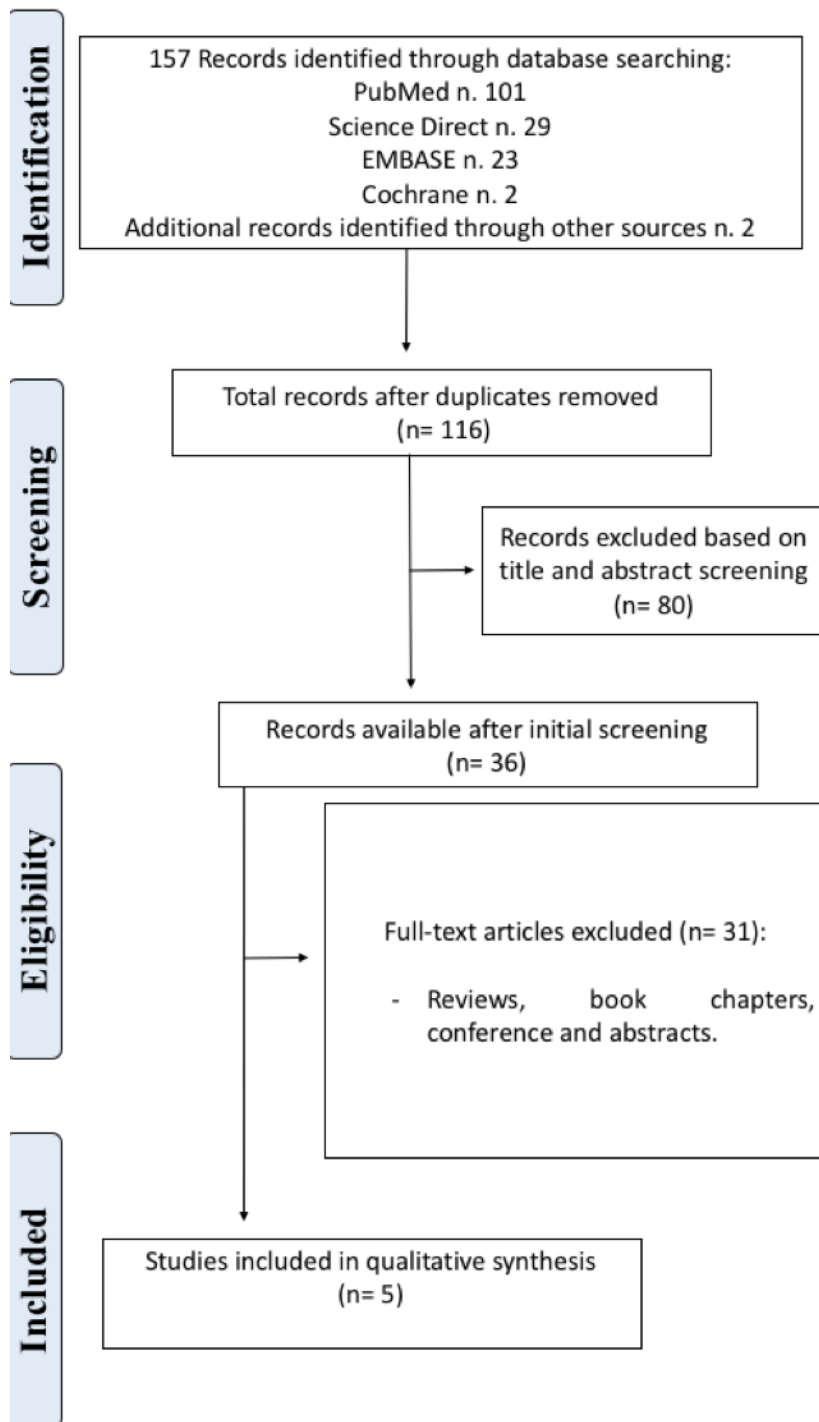
3. Results

Study selection and characteristics

A search strategy developed in this systematic review identified a total of 157 studies located in validated databases. After a screening through the reading of two titles and summaries and excluding duplicate articles, 36 studies were considered potentially eligible and fully qualified. After further analysis, five articles published between 2013 and 2017 attended to all the inclusion criteria and were selected for the systematic review (Nethravathy., Vinoth., & Thomas, 2013; Ribeiro et al., 2014; Paolantoni et al., 2016; Chen et al., 2016; Koppolu et al., 2017). The flowchart applied for the triage process and selection of items can be found in Figure 1.

According to the CONSORT evaluation criteria, all studies presented clear definition of inclusion and/or exclusion criteria, complete follow-up and appropriate statistical analysis. However, analysis of sample size, allocation and randomization concealment methods and presence of results masking were not observed.

Figure 1. PRISMA flowchart of screened studies.



Source: Authors.

All of the included articles dealt with randomized controlled clinical studies. In total, 119 patients were analyzed on the selected studies, with a sample varying from 14 patients (Koppolu et al., 2017) to 36 patients (Paolantoni et al., 2016). The follow-up time varied from

1 month (Koppolu et al., 2017) to 12 months (Ribeiro et al., 2014). All the included studies will assess different types/protocols of laser and its effectiveness in periodontal surgery. The main methodological aspects and observed results can be visualized in Table 1.

Table 1. Summary of the descriptive characteristics and results of the included studies (n=5).

Author (year)	Number of patients	Gender	Age (mean)	Methods	Followup (months)	Summary of the results
Nethravathy., Vinoth., & Thomas, (2013)	15	6 F 9 M	NI	Fifteen patients who reported to the department of Periodontology, were included in the study. Patients were randomly divided into three groups, which include patients who underwent gingivectomy (Group A), apically repositioned flap (Group B) and surgical extrusion using periostome (Group C).	3	Clinical and radiographic evaluation after 3 months suggests that surgical extrusion technique offers several advantages over the other conventional surgical techniques such as preservation of the interproximal papilla, gingival margin position and no marginal bone loss.
Ribeiro et al. (2014)	28	20 F 8M	27,5	A split-mouth randomized controlled trial was conducted in 28 patients presenting excessive gingival display. Contralateral quadrants received esthetic crown lengthening using flapless or open-flap techniques.	12	Flapless and open-flap surgeries produced stable and similar clinical results up to 12 months. flapless esthetic crown lengthening may be a predictable alternative approach for the treatment of excessive gingival display.
Paolantoni et al. (2016)	36	20 F 16 M	42	Flapless and open-flap surgeries produced stable and similar clinical results up to 12 months. Flapless esthetic crown lengthening may be a predictable alternative approach for the treatment of excessive gingival display.	6	Crown lengthening using a papilla-preservation flap approach and osseous recontouring is a viable alternative approach and could be useful in esthetic regions.
Chen et al. (2017)	26	NI	40,2	An Er:YAG laser was used in 26 consecutive patients referred for osseous crown lengthening in 32 posterior teeth.	6	Minimally invasive Er:YAG laser surgery decreases the time needed to establish the gingival margin necessary for definitive restoration.
Koppolu et al. (2017)	14	8 F 6 M	18-30	Fourteen patients who presented with a “gummy smile” or an excessive gingival display associated with an altered passive eruption were recruited for the study. They were randomly assigned to either the laser or the	1	The visual analog scores for pain and discomfort were significantly lower intra operatively and after the first day for the laser group compared to the scalpel. The outcome of this study demonstrated that laser can be used effectively

				scalpel group. Visual analog scores for pain and patient perceptions related to the esthetic change and expectations from the treatment were evaluated.		as an alternative treatment to scalpel in smile correction associated with an altered passive eruption.
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Legends: Randomized controlled trial; EMD= Enamel matrix derivative; CAF= Coronally advanced flap; T, Test group; C, Control group; M, Male; F, Female; MWF, MWF= Modified Widman Flap; OFD, intrabony defects with open flap debridement; EMP, enamel matrix proteins; CFU, colony forming units; GTR, Guided tissue regeneration; NI, Not informed. Source: Authors.

Main results

In the study by Nethravathy, Vinoth and Thomas (2013) the sample is subdivided into three groups according to the treatment carried out for the clinical crown lengthening: (1) gingivectomy; (2) repositioned apically; (3) surgical extrusion using periotome. For the authors, the surgical extrusion technique using periotome can be used in succession, especially in the anterior region, where aesthetics are of great concern to the patient.

Ribeiro et al. (2014) pointed out that the traditional procedures to the clinical crown lengthening will usually be delayed, requiring sutures and can cause postoperative morbidity for the patient. Aiming to reduce the undesirable results of conventional surgeries and to increase the patient's oil, new minimally invasive techniques were developed for this purpose. This has been validated for two techniques to the clinical crown lengthening: (1) open flap technique; (2) technique of aesthetic augmentation of the not invasive flap. A technique of aesthetic augmentation of the invasive or bone alveolar flap is removed and recontoured, as necessary, with micro-chisels, by means of incisions, not elevation of flap. In this study, it was stated that the technique of aesthetic crown lengthening was based on the use of invasive retaliation was a viable method and that economized time for the treatment of gingival smile due to altered passive eruption.

Paolantoni et al. (2016) evaluated a dental papilla preservation procedure to clinical crown lengthening for the treatment of upper anterior teeth (canine to canine) and compared two traditional techniques. In this study, although no statistically significant differences were reported in many of the clinical parameters examined, traditional surgical procedures demonstrated a significantly greater loss of interproximal clinical insertion when compared to the dental papilla preservation procedure in the crown lengthening. In the dental papilla preservation group in crown lengthening, there was also a significant increase in aesthetic evaluation by patients.

In the study by Chen et al. (2016) the patients selected for the study had as reasons for the clinical crown lengthening, the presence of caries (22 patients), dental fracture (6 patients) and subgingival prosthetic preparation (4 patients) in the posterior region. The authors noted that clinical crown lengthening using the Er:YAG laser is effective and less traumatic compared to the traditional surgical procedure. Clinical crown lengthening procedures are often performed to provide access for the treatment of subgingival cavities, fractures or defective restorations. Using a minimally invasive procedure through the use of the Er:YAG laser can bring more advantages to the dental surgeon and patients than traditional approaches, avoiding bleeding, suturing and scar formation and allowing a less traumatic treatment for the tissue.

To Koppolu et al. (2017) who also made use of the surgical laser aiming at the clinical crown lengthening, the surgical lasers really show efficacy in such procedure, with a lower rate of bleeding and painful post-surgical symptoms. Therefore, they have some clinical relevance and can provide a precise and safe treatment modality for the patient, with a superior aesthetic result, satisfying the patient's aesthetic demands in smile corrections, and being a less traumatic procedure.

4. Discussion

The procedures used to perform the increase of the clinical crown lengthening have often been used to favor the return of the aesthetics and functionality of the teeth, maintaining the harmony of the stomatognathic system. To perform this procedure, the amount of bone tissue to be removed must be previously evaluated, using periapical radiographs and probing the site (Kalaivani et al., 2015; Lavu et al., 2019).

The distance between the alveolar crest and the enamel-cement junction is of fundamental importance to determine the choice of the surgical technique to be used. In cases in which the periodontium is thin or intermediate, osteotomy should be performed using only manual instruments, as the risks of tissue laceration are greater. Micro-chisels are the recommended instruments, and they must be positioned through the gingival sulcus, eliminating the need to lift a flap (Shobha et al., 2010; Ganji., Patil., & John, 2012). These findings corroborate the study by Ribeiro et al. (2014) in which it was observed that the use of minimally invasive techniques for the aesthetic clinical crown lengthening without the flap using instruments such as micro-chisels, promoted better results in relation to the correction of the gingival smile.

The bone contouring procedures used in surgical procedures to clinical crown lengthening are efficient when associated with the accomplishment of an apically positioned flap. The apically repositioned flap eliminates the periodontal pocket, protecting the inserted gingiva and providing a bone contour similar to the healthy structure (Ganji., Patil., & John., 2012; Patil et al., 2016). However, in the study by Nethravathy, Vinoth and Thomas (2013) it was observed that the surgical extrusion technique using periosteum presented better results when compared to the use of the flap repositioned apically to promote an increase of minimally invasive clinical crown lengthening, especially in the anterior region.

The interdental gingival papilla plays an important role in maintaining the aesthetics of dental elements and in protecting adjacent soft tissues. The absence of papillae causes the presence of black spaces that compromise the health of periodontal tissues, which can cause diastemas in the anterior region and aesthetic dissatisfaction related to the smile (Mohan et al., 2013; Lavu et al., 2019). Paolantoni et al. (2016) performed different procedures to increase the clinical crown lengthening seeking to promote the preservation of the dental papilla of the upper anterior teeth, taking into account its aesthetic and functional importance. However, it was observed that the use of the minimally invasive surgical technique exhibited a lower loss of interproximal clinical insertion, leading to greater patient satisfaction.

The mechanisms of action of lasers in hard and soft dental tissues depend directly on the absorption of light by the chromophore in the target tissue. Er:YAG lasers are a non-invasive modality, effective to promote bone recontouring in surgical procedures for clinical crown lengthening (Elavarasu., Naveen., & Thangavelu., 2012; Deeb et al., 2019). These findings corroborate the studies by Chen et al. (2016) and Koppolu et al. (2017) in which it was observed that the use of the Er:YAG laser was less traumatic for dental hard and soft tissues when compared to the traditional surgical procedure. In addition, surgical lasers promoted a lower rate of bleeding during the operation and less painful postoperative symptoms.

5. Conclusion

Studies have shown that conventional surgical techniques to clinical crown lengthening are presented as an effective approach that promotes good aesthetic and functional results. However, they have some limitations related to bleeding and painful symptoms in the postoperative period. After evaluating the minimally invasive surgical techniques included in this systematic review, it was possible to infer that they presented

satisfactory results in the soft and hard tissue contouring, with neither complications or dissatisfaction being observed by the patients.

It is important to note that in clinical crown lengthening, correct planning must be carried thoroughly, individually analyzing each case to be operated. In addition, the use of Er:YAG lasers has shown promise and in the near future new studies are expected that better elucidate the parameters of laser use in periodontal surgical procedures.

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