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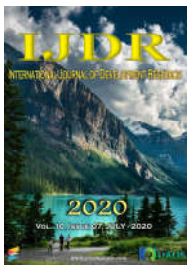

RESEARCH ARTICLE OPEN ACCESS

EFFECT OF LASER THERAPY IN PERIODONTAL SURGERIES: A SYSTEMATIC REVIEW

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ABSTRACT

Photodynamic therapy in periodontics is used to obtain antimicrobial effects and also to assist in the healing process by acting on tissue healing and regeneration after performing surgical procedures. The objective of this systematic review was to evaluate in the scientific literature the effectiveness of using laser therapy in the surgical approach of periodontal procedures. A systematic review of the literature was performed using the Scopus, Science Direct, Embase, Cochrane Collaboration Library, and PubMed/ MEDLINE databases. Studies on the use of laser therapy in periodontal surgical procedures were selected. The search strategy provided a total of 365 studies. After selection, ten articles m*et al*l the inclusion criteria and were included in this systematic review. Studies have shown that the use of laser therapy is an excellent approach to promote tissue repair, analgesia and antimicrobial activity in periodontal tissues. The use of LLLI associated with periodontal surgical treatment has proved to be promising and in the near future, new protocols are expected to emerge that can provide excellent treatments for patients who undergo periodontal surgery.

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INTRODUCTION

Periodontal tissues are composed of structures that support and surround the tooth. These tissues include the gum, periodontal ligament, cementum and the alveolar bone. The structure and role of the tissues that make up the periodontium are interconnected and must maintain a harmonious relationship under normal conditions (Ebersole, 2016 and Ryder, 2018). However, these structures are subject to aggressions from periodontopathogenic bacteria present in bacterial biofilm, resulting in diseases where an inflammatory process occurs, affecting the protection and support tissues of the periodontium (Ebersole, 2013 and Correa, 2013). Periodontal therapy has the primary role of guiding patients in appropriate oral hygiene techniques to control the periodontium's infectious-inflammatory responses (Bedi, 2015 and Worthington, 2019). Various treatment modalities have been introduced over the years to improve the patients' response to periodontal disease, such as scaling and root planing, using curettes and ultrasonic devices. However, other therapies such as periodontal surgical procedures have been used to treat periodontal diseases, keeping the harmony of these tissues (Ryder, 2018 and Giannelli, 2019). Currently, periodontics is not only focused on the treatment of periodontal pockets and excision of inflamed tissues, there has been an increasing increase in the number of patients who report problems related to the appearance and shape of the smile, thus opening up the field for performing periodontal aesthetic surgeries. However, after performing these procedures, some postoperative

complications may occur, among them, the presence of pain, excessive bleeding and difficulties in healing the periodontal tissue (Burkhardt, 2015). Difficulties in the repair process can lead to dehiscence of wounds and the formation of hypertrophic scars, so the closure of the surgical wound must be carefully evaluated and treated (Heo, 2011). Photodynamic therapy in periodontics is used to obtain antimicrobial effects and also to assist in the healing process by acting on tissue healing and regeneration after surgical procedures. Different types of lasers and protocols have been used to induce photobiomodulation in periodontal tissues, among them the use of low-level laser therapy (LLLI) has been highlighted. The energy fluency or radiation dose (shown in J/cm²) is considered a significant parameter of laser therapy, which in combination with other irradiation factors, such as power density and emission mode (continuous wave/pulse mode), can critically alter the irradiation protocol (Romagnoli, 2017 and Giannelli, 2019). Thus, it is observed that currently there are several safe protocols, as well as different types of effective lasers for the treatment of the periodontium. Therefore, this systematic review aims to evaluate in the scientific literature the effectiveness of using laser therapy in the surgical approach of periodontal procedures.

MATERIALS AND METHODS

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

Information of sources and search strategies: The following review question was developed according to population, intervention, comparison, and outcome (PICO): "What are the effect of low-level laser therapy in periodontal surgeries: A Systematic Review?" and a keyword search was performed. A literature search was performed in June of 2020 in the following electronic databases: Scopus, 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 combinations of the following keywords: ("Low-Level Laser Therapy"[tw] OR "LLLT"[tw] OR "phototherapy"[tw] OR "laser irradiation"[tw] OR "laser therapy"[tw] OR "diode laser"[tw] OR "biostimulation"[tw]) AND ("Flap Surgery"[tw] OR "Periodontal Surgery"[tw]) AND ("Periodontal Wound Healing"[tw] OR "Periodontal Regeneration"[tw]).

Eligibility criteria and Study selection: The reviewer independently screened and assessed potential articles. Studies that did not fulfil 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: Studies included were randomized clinical trials that examined the adjunctive effects of LLLT in periodontal surgeries. Exclusion criteria: Animal studies, in vitro studies, opinion articles, letters to the editor, review articles, interviews, updates, abstracts, and unpublished studies were excluded.The review authors independently screened the articles for data extraction. Any disagreements were resolved by discussion.

RESULTS

Study selection and characteristics: The search strategy developed in this systematic review identified a total of 365 studies located in the evaluated databases. After screening by reading the titles and abstracts, and excluding duplicate articles, 38 studies were considered potentially eligible and were read in full by the evaluators. At the end of the analyzes, ten articles published between 2003 and 2018 m*et al*l the inclusion criteria and were selected in the systematic review. The flowchart applied for the article selection and selection process is illustrated in Figure 1. All included studies were randomized controlled clinical studies. In total, 232 patients were evaluated in the ten selected studies, with the sample ranging from 10 patients (Retzepi, 2007) to 40 patients (Kohale, 2018). In two studies, the sex of the patients included was not mentioned (Schwarz, 2003 and Gokhale, 2012).Among the studies that reported the sex of the patients, there was a female/male ratio of 1:1.04, respectively. The average age of patients ranged from 30 to 50 years, and in two studies the age of the patients included was not mentioned (Schwarz, 2003 and Sculean, 2004). The follow-up time varied from 1 month (Heidari, 2018) to 60 months (Gaspirc, 2007). All included studies evaluated different types/protocols of laser and their effectiveness in periodontal surgery. The main methodological aspects and observed results can be seen in Table 1.

Main results: Kohale *et al*. (2018) used laser therapy after gingivectomy in 40 patients, a diode laser (InGaAsP) was applied to the surgical area on the 1st, 3rd and 7th postoperative days. The surgical areas were visualized by a solution (Alpha Plac) to locate the areas where the epithelium was absent. In this study, the places where low power laser therapy (LLLI) was used had significantly lower stained areas, which means an improvement in wound healing performed more effectively compared to controls in the 7^{th} and 30^{th} postoperative days. Heidari *et al*. (2018) aimed to evaluate the effectiveness of the low power 940 nm diode laser (Biolase, USA) in postoperative pain after flap surgery without displacement. Patients reported less pain on days 2, 3, 4, 5, 6 and 7 after surgery in the laser-treated group ($p < 0.05$). In addition, less analgesics were used in this group on days 3, 4, 5, 6 and 7 after surgery ($p < 0.05$). Therefore, in addition to showing an important role in the healing process, laser therapy can have an important analgesic effect according to the selected studies. Dogan *et al*. (2014) showed that the use of the Nd:YAG laser in LLLI can improve the effects of guided tissue regeneration (GTR) in the treatment of periodontal defects. In addition, the group where the GTR was performed plus the LLLT was observed to have a statistically significant lower gingival recession ($p = 0.025$), less bleeding on probing ($p = 0.008$), less probing depth ($p = 0.009$) and gain in level of clinical insertion ($p = 0.002$) compared to GTR without laser application in the sixth month. An important result observed in the study by Gokhale *et al*. (2012) demonstrated that there was a statistically significant reduction in the colony-forming units (CFU) of obligate anaerobes in the test group that used CO2 laser compared to the control group. In addition, the CO2 laser was well tolerated by patients. Gaspirc *et al*. (2007) observed

Table 1. Summary of the descriptive characteristics and results of the included studies (n=10)

Author (year)	Study design	Numberofpatients	Group (Test/Control)	Age (years)	Gender	Surgerytype	Type of laser	Followup (months)	Summary of the results
Schwarz et al. (2003)	RCT	22	Laser + EMD + CAF (T) and CAF alone(C)	NI	NI	Open flap debridement	Er:YAG (160 mJ/pulse, 10Hz) plus	6	Both protocols analyzed led to short-term improvements in the investigated clinical parameters.
Sculean et al. (2004)	RCT	23	flap+ laser(T) and flap(C)	NI	17 M 6 F	Open flap debridement	Er:YAG laser (KEY3s) (160 mJ, 10 Hz)	6	an Er:YAG laser may represent a suitable alternative for defect and root surface debridement in conjuction with periodontal surgery.
Gaspirc et al. (2007)	RCT	25	flap+laser(T) and ModifiedWidmanflap(C)	46.3±9.2	11 M 14 F	Modified Widman Flap	Er:YAG (600microseconds,180 mJ/pulse at20 Hz)	60	Surgical treatment of single-rooted teeth with chronic periodontitis using the Er:YAG laser yields greater PD reduction and gains in CAL for up to 3 years compared to conventionalWidman flap surgery.
Ozcelik et al. (2007)	RCT	22	EMD+ laser(T) EMD and alone (C)	31-49	12 M 10 F	Openflapdebridement+EMD	Diode laser (588 & 4J/cm)	6	The application of the laser in conjunction with a surgical approach can result in substantial regeneration of the root cementum, periodontal ligament and bone, thus improving clinical results.
Retzepi et al. (2007)	RCT	10	Laserdopplerflowmetryin papillapreservationflap (T) andMWF(C)	35-65	4 M 6 F	Papillapreservationflap and MWF	Laser doppler flowmetry	2	Laser doppler flowmetry may present clinical applicability in recording changes in the microcirculatory blood perfusion following periodontal surgery.
Dilsiz et al. (2010)	RCT	21	EMD+laser(T) and EMD alone	33-46	9 M 12 F	OFD+EMP	Nd:YAG laser (1 W, 10 Hz,100 Mj, 1064nm)	12	Within the limits of the present study, it may be concluded that both therapies led to improvements of the clinical parameters.
Gokhale et al. (2012)	RCT	30	Flap+ laser(T) and Flap alone (C)	30-50	NI	OFD	CO2 (980 nm, laser dose, 50 J/cm2 S)	3	The bactericidal effect of the diode laser was clearly evident by greater reduction of CFU of obligate anaerobes in the test group than in the control group.
Dogan et al. (2014)	RCT	13	GTR+laser (T) and GTR(C)	26-49	7 M 6 F	GTR	Nd:YAG(1064nm,100 mW, 100 mJ)	6	This study showed that GTR is an effective treatment for periodontal regeneration, and thatlow level laser therapy may improve the effects of GTR in the treatment of periodontal defects.
Heidari et al. (2018)	RCT	26	One side of the mandible was subjected to undisplaced flap surgery plus treatment with a 940-nm diode laser, and on the contralateral side, the surgery was conducted without applying the laser.	23–63	10 M 16 F	Undisplaced flap surgery	Diode laser (Biolase, USA), 940 nm, 0.5 W, continuous mode, whitening handpiece, 112 s) was applied to the buccal and lingual surfaces of the flap from a distance of 3 mm.	1	The 940-nm diode laser with the settings used in this study could significantly reduce pain and the number of analgesics taken by patients after undisplaced flap surgery.
Kohale et al. (2018)	RCT	40	Surgical gingivectomywith laser (T) and Surgical gingivectomy without laser (C).	14–30	19 M 21 F	Surgical gingivectomy	940nm diode laser(InGaAsP)	6	Within the limitations of this study, the results indicated that low level laser therapy might improve woundhealing aftergingivectomy.

Legends:Randomized controlled trial, EMD= Enamel matrix derivative, CAF=Coronally advanced flap, T, Test group, C, Control group, M, Male, F, Female, MWF, MWF= ModifiedWidman Flap, OFD, intrabony defects withopen flap debridement, EMP, enamel matrix proteins, CFU, colony forming units, GTR, Guided tissue regeneration, NI, Not informed.

that surgical treatment of uniradicular teeth with chronic periodontitis using the Er: YAG laser produces reduction of periodontal disease and gains in the level of clinical insertion for up to 3 years compared to conventional Widman flap surgery.

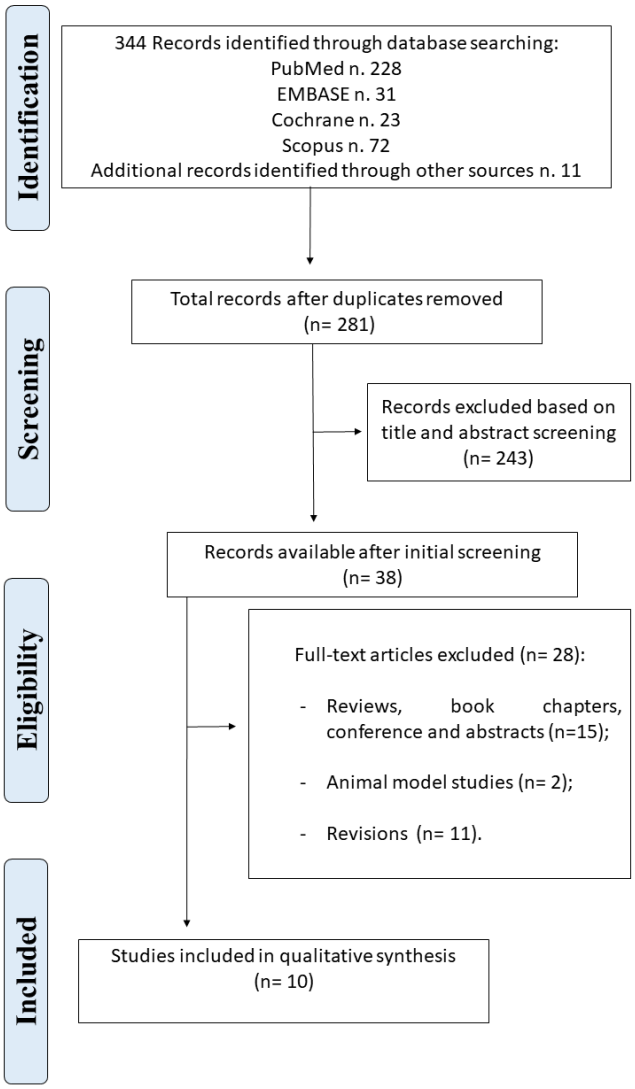

Figure 1. PRISMA flow diagram of screened studies

DISCUSSION

The appearance of the smile does not depend only on the harmony between the teeth and the lips. It also depends on their interaction with the gingival tissue. Periodontal surgery aims to recreate tissue structure, function and aesthetics (Windisch, 2019). The morbidity associated with the postoperative healing process has been a major concern in the clinical dental routine. However, supporting therapies such as laser therapy have been shown to be effective in the process of repairing periodontal wounds (Romagnoli, 2017). Laser therapy uses the application of light to tissues, favoring increased cell proliferation and microvascular blood flow (Giannelli, 2019). Blood flow is an important parameter to be evaluated in soft tissue surgery to prevent the occurrence of necrosis due to lack of blood nutrition. It was observed in the study by Retzepi *et al*. (2007) that the flowmetry doppler laser showed excellent clinical applicability in recording changes resulting from microcirculatory blood perfusion after periodontal surgery. The healing of periodontal tissues after laser therapy is directly influenced by the degree of thermal side effects that occur on the surfaces of injured tissues. Each wavelength of the laser acts differently on the tissues, depending on the degree of absorption and depth of penetration of the same (Aoki, 2015). The studies by Ozcelik *et al*. (2007) and Kohale *et al*. (2018) performed the use of laser therapy using the diode laser in the postoperative period in patients who underwent periodontal surgical procedures. It was observed that the use of this type of therapy promoted an improvement in the healing of periodontal wounds when compared to the control groups. In the study ofHeidari *et al*. (2018) it was observed that the diode laser, in addition to acting in the regeneration of tissues, also acted in an analgesic way on pain control. These findings corroborate the study by Giannelli *et al*. (2019), where the authors highlight the benefits of using laser therapy in relation to improving wound healing, reducing local inflammation and reducing pain.

Depending on the level of energy applied, treatments using different types of lasers can be divided into high intensity laser therapy and low intensity laser therapy. High intensity laser therapy aims to eliminate diseased periodontal tissues, making the area aseptic and subsequently promoting the regeneration of the treated area. Low-level laser therapy, on the other hand, stimulates cells present in tissues through the photobiomodulatory effect that promotes rapid healing of the periodontal wound (Aoki, 2015). In the studies by Dilsiz *et al*. (2010) and Dogan *et al*. (2014) the positive effects of using LLLI on GTR in the treatment of periodontal defects were evidenced, and this therapy was observed to help increase the level of clinical insertion in the treated areas. The effects of LLLI can be observed in the behavior of several cell types, such as macrophages that increase their phagocytosis and increase the levels of fibroblast growth factors secretion, thus intensifying the reabsorption of both fibrin and collagen. These factors contribute to decrease the synthesis of inflammatory mediators (Gomez, 2011). In the studies evaluated in this systematic review, it was observed that the use of diode laser, Er: YAG laser, Nd: YAG laser, CO2 laser and flowmetry doppler laser in different application protocols promoted tissue healing and a long-term antimicrobial effect, also working to control pain through its analgesic effect (Gomez, 2011). The photobiological effects of using the laser can be seen in the short and long term. Short-term responses are those in which the effects can be seen a few seconds or minutes after irradiation, as is the case with postoperative pain control. Long-term effects, on the other hand, occur hours or even days after the end of irradiation and usually involve new cell biosynthesis, especially in the proliferative phase of inflammation (Dogan, 2010 and Aoki, 2015). The bactericidal effect of laser therapy has several advantages for the healing process of periodontal surgical wounds. Laser therapy acts mainly on Porphyromonasgingivalis bacteria, which are associated with periodontal disease, eliminating or inactivating its endotoxins (lipopolysaccharides). The additional effects of decontamination of periodontal tissues positively influence the healing of surgical wounds (Badran, 2012). These findings corroborate the studies by Schwarz *et al*. (2003), Sculean *et al*. (2004) and Gaspirc *et al*. (2007) in which it was observed that the use of the Er: YAG laser promoted an excellent result in the gain of clinical insertion levels in uniradicular teeth that presented chronic periodontitis, representing an adequate alternative for the debridement of the root surface together with periodontal surgery.

Conclusion

The studies have shown that the use of laser therapy is an excellent approach to promote tissue repair, analgesia and antimicrobial activity in periodontal tissues. After evaluating the use of the diode laser, Er: YAG laser, Nd: YAG laser, CO2 laser and the flowmetry doppler laser included in this systematic review, it was possible to infer that they presented satisfactory results in the surgical procedures performed, with no observed complication of any kind. It is important to note that in order to perform photodynamic therapy, one must have knowledge of the different protocols established by the literature. The biological effects obtained from the application of laser therapy are related to the metabolism of several cell types, acting positively in the regeneration of periodontal tissues. The use of LLLI associated with periodontal surgical treatment has proved to be promising and in the near future, new protocols are expected to emerge that can provide excellent treatments for patients who undergo periodontal surgery.

Conflict of Interest: The authors declare no conflicts ofinterests.

Ethics approval: Not applicable.

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