

Laser Biostimulation in Dental Implant Surgery: A Systematic Review of Clinical Literature

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Abstract

Objectives: Laser effect on postoperative status should attract researchers. The objective of this work is to assess different uses of laser therapy during the early phases of dental implant placement.

Methods: An electronic database search on PubMed, Cochrane library, LILACS and Web of Science without date restriction was undertaken and selection was done for clinical studies in which laser therapy was used for its biostimulatory effect during the surgical phase of dental implant placement.

Findings: Out of the initial search that yielded 943 studies, 21 were considered potentially relevant for the present study, out of which 5 were finally selected. They studied the effect of laser on implant stability, marginal bone level, bone healing inflammatory response and pain.

Application: The analysis of the results shows that the assessed clinical trials are not only too limited in number but also exhibit small sample sizes, short follow-up periods besides being clinically heterogeneous in methodology and outcomes so that a solid conclusion cannot be reached and randomized clinical trials are strongly recommended.

Keywords: Laser; Dental Implants; Photomodulation; Biostimulation; LLLT

Abbreviation

LLLT: Low-Level Laser Therapy

Introduction

Despite the long history of dental implants, the development of implant science is still a major research subject. Through research, dental implant methodology has been constantly improving in the recent years, providing higher levels of patient satisfactions [1].

Laser has been questioned whether it is an adjunctive dental tool or just an advanced tool looking for a purpose. Before the last decade, laser has been slower to gain relevance in dental profession, unlike other medical profession like ophthalmology [2].

The traumatized areas after surgery for dental implant suffers ischemic injuries, lack of nutrients, and oxygen supply, which can lead to apoptosis [3]. The unique properties of laser may offer advantages like improved control of possible hemorrhage, less mechanical trauma to the soft and hard tissues, prevention of local infection, less postoperative inflammation, improved healing, and decreased risk of postoperative bacteremia [4].

The main objective of this review is to analyze and describe different uses of low level laser therapy during the early phases of dental implant placement.

Materials and Methods

Protocol

The methods as well as inclusion/exclusion criteria employed for the present review were determined in advance. The current systematic review was performed following the PRISMA guidelines for identification, screening, eligibility, and inclusion [5]. The following focus question was developed: In patient requiring dental implants, what are the benefits that Laser Therapy offers for dental implant placement regarding its biostimulatory effects.

Information sources

The electronic search was performed in four databases, including MEDLINE (PubMed), Cochrane library, LILACS and web of science databases for articles with no date restrictions.

Search

The researched keywords were: (oral implant OR oral implants OR oral implantology OR dental implantology OR dental implant OR dental implants OR dental implantation) AND (laser healing OR laser therapy OR laser bio-stimulation OR low power laser OR low intensity laser OR low level laser OR laser bio modulation OR laser biomodulation OR laser biostimulation OR laser phototherapy OR laser photo modulation OR LLLT).

Selection of studies

Titles and abstracts resulted from the search were screened by authors in light of the inclusion criteria. Authors decisions about choices and their qualification for further analysis was affirmed after discussion.

Types of studies

- Population: Patients requiring dental implants.
- Intervention: Laser therapy alone.
- Control: Without laser.
- Outcome: Biostimulation.
- Study design: Only clinical studies.

Inclusion and exclusion criteria

Inclusion criteria:

- Investigated non-surgical use of laser during the early phase of implant insertion
- Clinical studies only
- Clinical and/or radiographic and/or laboratory results reported.

Exclusion criteria:

- *In vitro* and animal studies
- Laser use for peri-implantitis
- Human trials with missing information or unclear data.
- Laser use in implant manufacturing
- Surgical use of laser
- Laser use before the phase of surgical implant placement
- Combined intervention of laser with other treatment

Assessment of methodological quality

The quality of all chosen randomized trials was investigated utilizing The Cochrane Collaboration’s tool for evaluating risk of bias [6] while the Newcastle-Ottawa Scale (NOS) was used for non-randomized studies [7].

According to Cochrane risk of bias tools, each RCT was assigned; low risk of bias (if it is low for all key domains), high risk of bias (if it is high for one or more of key domains) and unclear risk of bias (if it is unclear for one or more of key domains).

For non-randomized controlled trials, the assessment consists of 3 sections; the selection section included 4 items, with 1 star for each item, Comparability section included 1 item with almost 2 stars for this item and outcome included 3 items with 1 star at each item. The total quality score represents the quality of the study. If the total number of stars was less than 5, the study was low quality; otherwise, it was a high-quality study.

Data analyses

The heterogeneity between trials in design, population, laser parameters and results prevented meta-analysis. Rather, a descriptive analysis of the reported studies was performed.

Results

Out of the initial search that yielded 943 studies, 21 were considered potentially relevant for the present study, out of which 5 were finally selected. They studied the effect of laser on marginal bone level, implant stability, bone healing and inflammatory mediators. Figure 1 represents the flow chart for the study.

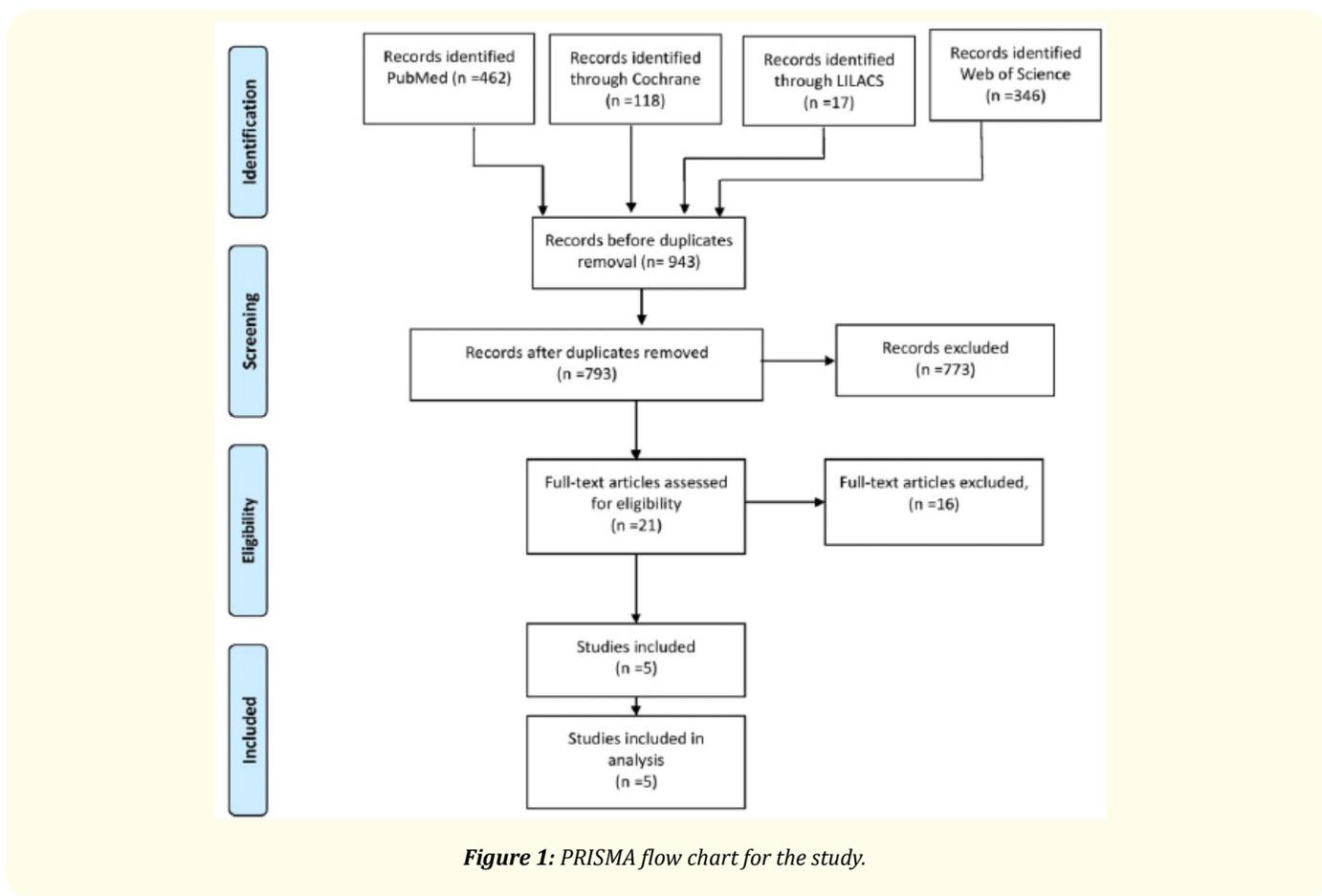


Figure 1: PRISMA flow chart for the study.

The excluded studies before final inclusion was either uncontrolled studies [8,9], narrative reviews [10,11], surgical use of laser [12,13], laser used in treatment of peri-implantitis [14,15], experimental studies [16,17], studies on light emitting diode [18,19], combined laser with other intervention (cortisone) [20] or Laser effect on bone before implant placement [21,22] and uncontrolled study [23].

The included trial which matches the inclusion criteria evaluate the effect of laser therapy on the osseointegration of implants, postoperative inflammatory response, postoperative pain and swelling, preservation of the marginal bone around implant, and on the stability of implants [24-28]. Table 1 represents summary of findings.

Authors and date	Population	The laser intervention	Control	Outcome	Results
Lizarelli, <i>et al.</i> 1999 [25]	45 patients in three groups: Group I, analgesic and anti-inflammatory medication with no laser Group II and III patients were irradiated with laser	Diode laser (790 nm and 30 mW) according to group: Group II: the day of the surgery, and in the two subsequent days; Group III, patients were irradiated two days before the surgery, in the day of the surgery, and in the two subsequent days	Group 1 (15 patients)	Measures of pain and edema, accomplished in the immediate postoperative and in the 72 hours postoperative	1) Laser gives a comparable effect to the analgesic and anti-inflammatory systemic medication 2) For pain control, pre-operative laser therapy sessions were more effective than the postoperative laser therapy
García-Morales, <i>et al.</i> 2012 [27]	Eight patients indicated for bilateral reconstruction in the posterior mandibular region without requiring bone reconstruction procedures	Diode laser (830 nm, 86 mW) Immediate postoperative and every 48 h in the first 14 days.	Other side of the same jaw	Implants stability by means of resonance frequency analysis (RFA) after 10 days and every 3 weeks for 12 weeks	No evidence was found of any effect of LLLT on the stability of the implants when measured by RFA
El-Kholey and ElShenaway 2012 [26]	Eight patients indicated for bilateral dental implant placement	Diode laser (970 nm, 0.6 watt) Immediately; 4th day and 7th day after implant insertion.	Other side of the same jaw	Radiographic evaluation of marginal bone level at 3 and 6 months	Statistical significant difference was found between the marginal bone level in the two sides in favor of lased side
Mandic, <i>et al.</i> 2015 [24]	12 patients indicated for bilateral self-tapping implant insertion in the posterior maxilla	Diode (637 nm, 40 mW), immediately after the surgery and repeated every day for one week	Other side of the jaw	Implant stability, alkaline phosphatase activity and early implant success rate	No significant effect

Table 1: Summary of findings table (SOFT).

The review included 5 studies, 2 were RCT and 3 were prospective controlled trials. 4 studies used split mouth study design and one used parallel design. The age range was wide for 4 studies (18 to 68 years) and not mentioned in one study. Sex distribution was mentioned in all studies except one.

For RCT studies, according to Cochrane Risk of Bias Tool, the two studies were judged to be of low risk of bias. For non-randomized controlled trial, two studies were considered to be of high quality while it was considered low quality for one study. Evaluation of risk of bias and study quality is in tables 2 and 3 according to study design.

	Sequence generation	Allocation concealment	Blinding of participants, personnel	Blinding of outcome assessors	Incomplete outcome data	Selective outcome reporting	Other potential threats to validity
Mandic., <i>et al.</i> 2015 [24]	+	+	+	+	+	+	+
García-morales., <i>et al.</i> 2012 [27]	+	+	+	+	+	+	+

Table 2: Evaluation of risk of bias for RCT.

Studies	Yanaguiz., et al. 2016 [25]	Lizarelli., et al. 1999 [26]	El-Kholey and El-Shenaway 2012 [27]
Selection			
Representativeness of the treatment group (true representation of the average in the community or somewhat representative of the average in the community)	+	-	+
Selection of the untreated control group (drawn from the same community of the treated group)	+	-	+
Ascertainment of treatment group	+	+	+
Demonstration that the outcome of interest was not present at the day of start (yes)	+	+	+
Comparability			
Comparability of the group and control group (comparison of starting forms: baseline characteristics of age, sex, skeletal maturity, and skeletal characteristics)	+	-	+
Outcome			
Assessment of the outcome with independent blinding (independent blind assessment)	+	-	-
Was follow-up adequate enough for outcomes to occur? (Yes, an adequate follow up for short-term findings)	+	+	+
Loss to follow-up acceptable (complete follow-up, subjects lost to follow-up unlikely to introduce bias, description provided of those lost, small number of loss to follow up\10%)	+	+	+
Total quality (score)	8	4	7

Table 3: Evaluation of risk of bias and study quality for non-randomized trials.

Discussion

Peri-implant tissue healing and remodeling after dental implant surgery are keys for prognosis. From that point of view, new interventions for accelerating healing and improving bone-implant interface attract researchers [29]. Laser therapy is not a new technique and despite the large number of studies suggesting efficacy, few of them are randomized blinded controlled trials and a little of them are related to implant dentistry. The success of dental implants depends to a large extent on peri-implant bone healing which lead some researchers to target their studies toward methods that could improve and accelerate bone healing, among which is low level laser therapy [27]. From that points of view comes the research question, what can laser therapy offer for patients requiring dental implants as it can be of benefit regarding both pain and bone healing.

Mandić, *et al.* [24] studied the effect of laser therapy on implants inserted in the posterior maxilla because laser may be of benefit to increase the success rate in this particular area. Although their results might suggest increased bone apposition by laser therapy but still not clinically significant. The study of Garcìa-Morales, *et al.* [28] also found no evidence on the implants stability which may be due to the masking effect of high initial stability attained in posterior mandible. Due to different irradiation protocol, different implantation sites combining or comparing their results cannot be done.

The results of Yanaguizawa, *et al.* [25] suggest that laser therapy may modulate the inflammatory response which can improve the bone metabolism and turnover.

Despite the fact that split mouth study is one of the best evidence based clinical study designs, there is a debate on it regarding laser therapy. Some authors [30,31] are with the systemic effect of laser therapy while others are not [32,33]. In the study of Yanaguizawa, *et al.* [25] the significant difference between tissue inflammations not only on both groups but also with normal tissue provides evidence against the systemic effect of laser therapy. The results of El-Kholey and El-Shenaway [27] are also against the systemic effect of laser therapy.

When doing laser therapy parameters like dose, wavelength, contact mode, exposure time, type of tissue, repetition times and others should be in considerations [34]. There is no total agreed upon Laser therapy protocol in the literature neither for the optimal wave length nor the irradiation methodology which leads to a research question that should be answered [24]. The research gap is not only in laser protocols and whether it is effective or not but also regarding the effect of other factors such as implant design, surgical site, surgical techniques and the patient condition. The irradiation with a near infrared wavelengths may be suggested for allowing good penetration for both gingiva and bone [25,28] while noncontact laser applications may be of benefit for producing a more homogeneous irradiation [25].

For a patient relevant treatment outcome, pain after implant placement is of concern not only for the patient but also for the dentist. Patients will experience pain following dental implant placement as with any other dental surgical procedures [35-37].

Pain reduction after dental implant placement motivated researchers because in the literature there is still a research gap in the management of post-implant placement pain in contrast to the greater proportion of studies investigating management of post-operative pain after common dental surgical procedure like third-molar extraction [35,38,39]. Laser therapy can be of benefit regarding postoperative pain.

The lack of standardization in studies not only for the samples but also for the methods and parameters complicate the determination of the efficiency of laser as regards to surgical models [40]. This has been shown clearly by the results of this systematic review. Randomized clinical trials in each aspect of laser therapy with dental implants should motivate researchers to close a very interesting research gaps.

Conclusion

The found clinical trials are not only too limited in number but also exhibit small sample sizes, short follow-up periods besides being clinically heterogeneous so that a solid conclusion cannot be reached. Researchers should pay attention to this interesting field to work upon. Each kind of laser application should pull attention of researchers in oral and maxillofacial field to close very obvious, yet important, research gaps including lack of enough randomized clinical trials that can be relied upon to get a standard clinical practice.

Conflict of Interest

The authors have no conflicts of interest to disclose.

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