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Controversies in Lasers in Periodontics

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ABSTRACT

Introduction

The use of lasers for different periodontal therapies has remained controversial since time immemorial. The available literature fails to clarify its true benefits as an adjunctive treatment approach to conventional periodontal therapies. Therefore, this systematic review aims to elucidate the true potential of lasers and hence it's incorporation along with the routinely periodontal treatment modalities.

Material and Methods

An extensive computer based research was carried out using search engines like PubMed, Google Scholar, EBSCO and Medline.

Result

It has been found that laser as an adjunctive approach offers several benefits like anti-inflammatory action, accelerated wound healing, reduction in pain, antibacterial effect to name a few. Considering it's side effects as well it is found that they are negligible in comparison to the advantages offered by lasers. Therefore, lasers can be considered as an adjunct to other treatments along with proper precautions to be taken to minimize its side effects. Also, the main

disadvantage of lasers remains to be it's less cost effectiveness. Further, evidence based studies are needed to justify its effectiveness.

Conclusion

Lasers have proven to be beneficial in treatment of different periodontal diseases, however further long term clinical trials are needed to generalize its use.

Keywords

Laser, Periodontitis, Laser therapy, Conventional Periodontal Therapies.

INTRODUCTION

"Laser" (Rarely written as L.A.S.E.R.) is an acronym for "Light Amplification by Stimulated Emission of Radiation", the term was coined in the year 1957 by the laser pioneer Gordon Gould. The lasers are based on the Einstein's principle of stimulated emission of radiation theory. The ruby laser (a kind of solid-state laser), was the first laser developed by Theodore Maimane in the year 1960.(1)

Laser technology has undoubtedly revolutionized the dental practice. Due to the availability of wide range of wavelengths and devices now available in dentistry a variety of different applications, from hard tissue ablative or coagulative surgical applications and anti-infective effects using high powers to favorable tissue interactions using laser energy, are now possible. Recently, there has been an increase in demand in the dental practice to use less invasive methods and reduce the pain and discomfort of patients and promote tissue healing, and laser or light PBM has shown the evidence of the potential to be used as an adjunctive method to reach these goals.

The first laser application in dentistry was reported by Goldman et al in 1964. (2) The first lasers accepted by the US food and drug administration were namely CO_2, ND: Yag and diode lasers only for oral soft tissue procedures in periodontics. Since time immemorial it has been facing the controversies whether it's use or abuse.

The American Academy of Periodontology in 2011 issued a statement that the use of lasers as an adjunct to nonsurgical periodontal therapy (NSPT) has no additional benefits for the treatment of periodontal diseases.

Numerous studies and researches have suggested contrasting opinion regarding the efficacy of lasers along with periodontal therapies as a treatment modality for the different diseases of the supporting structures of the tooth. This systematic review has been undertaken in an attempt to clarify the controversial role of lasers by screening the literature available according to the inclusion criteria.

MATERIAL AND METHODS

This systematic review was conducted and reported according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta – Analysis) guidelines (Moheret al., 2009). This research focuses on evaluating whether use of laser for periodontal treatment has better performance in clinical and biochemical outcomes based on 6-month follow-up.

Focused Question

Is laser therapy beneficial or not in treating periodontal diseases?

SEARCH STRATEGY

Literature was searched systematically and studies were identified based on the PICO

(Glossary of evidence-based terms 2007).

Electronic database search of PubMed, Medline, Google Scholar and Scopus was performed

using MeSH terms – "lasers", "controversies in laser"," controversial aspect of laser", "laser dentistry", "laser use", "side effect of laser", "lasers in

periodontics". Articles published between year 2017-2022 were reviewed.

Inclusion Criteria

1. Randomized Clinical trial on patients diagnosed with periodontitis.
2. Subjects were allocated to experimental or control group based on having treatment with one adjunctive type of laser therapy or not
3. At least 6 months follow up
4. Articles which are PubMed indexed
5. Articles in English only.

Exclusion Criteria

1. Review articles
2. Animal Studies
3. Less than 6 months follow up

RESULTS

A total of 384 articles were identified based on PICO including patients with chronic periodontitis with or without healthy controls with a follow-up period of at least 6 months. Only 16 articles were included based on inclusion and exclusion criteria.

After analysing all these articles, it was concluded that the use of LASERs in clinical practice is solely based on the interest of clinician, cost factor being the major criteria for use of LASERs in the clinics.

All the studies have been summarised in the table below.

1.Sukumar et al (2020)	A split mouth RCT	33	SRP alone	SRP+ multiple PDT	Baseline 3 months 6 months	1. Pocket probing depth (PPD) 2. Clinical attachment level (CAL) 3. Plaque index (PI) 4. Gingival index (GI) 5. Gingival bleeding index (GBI)	**Variables Baseline** CG TG PPD 5.83±0.64 5.93±0.82 CAL 5.60±0.72 5.73±0.69 PI 2.00±0.00 2.00±0.00 GI 2.00±0.00 2.00±0.00 GBI 30(100.0) 30(100.0) **6 months** PPD 3.80±0.40 3.40±0.56 CAL 3.70±0.91 3.00±0.91 PI 5.73±0.69 0.13±0.34 GI 0.60 ± 0.35 0.17±0.37 GBI 14 (46.7) 5(16.7%)	The study showed statistically significant improvement in clinical parameters in the test group as compared to control group. Therefore, multiple applications of PDT as an adjunct to SRP resulted in superior outcomes compared with conventional therapy at 6 months follow-up.
2. Ciurescu et al (2019)	RCT	42	Subgingival Debridement (SD)	SD+ Laser (InGaAsP)	Baseline 6 months	1. Probing depth (PD) 2. Clinical attachment level (CAL) 3. Bleeding on probing (BOP)	**Variables Baseline** CG TG PD 5.95±0.66 5.62±0.81 CAL 5.79±1.13 5.38±0.95 BOP 65.05±23.19 79.43±21.05 **6 months** PD 2.59±0.37 4.43±0.70 CAL 3.62±0.87 4.40±1.00 BOP 6.00±5.55 42.33±23.86	The results of the study indicate that in patients with chronic periodontitis adjunctive use of InGaAsP laser to subgingival debridement showed higher improvement in clinical parameters as compared to subgingival debridement alone. Thus, stating benefits of lasers during NSPT.
3. Hill et al (2019)[3]	A split mouth RCT	20	SRP alone	SRP+ aPDT	Baseline 2 weeks 3 months 6 months	1.Bleeding on probing (BOP) 2.Relative attachment level (RAL) 3.Probing depth (PD) 4.Gingival recession (GR)	**Variables Baseline** CG TG BOP 35% 39% PD 4.34±0.64 4.38±0.63 GR 1.38±1.18 1.49±1.22 RAL 5.72±1.36 5.86±1.42 **6 months** BOP 17% 19.4% PD 3.18±1.04 3.22±1.09 GR 1.59±1.14 1.71±1.20 RAL 4.77±1.53 4.93±1.74	The outcomes of both the treatment modalities on clinical parameters show only a slight difference comparing the baseline and 6 months' data. Hence, does not provide sufficient evidence to stand the adjunctive use of laser with conventional treatment is better or not. A higher sample size in future studies of such kind would be required.

4. Gandhi et al (2019)	A split mouth, double blind RCT	26	SRP alone	SRP+ LLLT	Baseline 6 month 9 month	1. Plaque index (PI) 2.Gingival index (GI) 3.Probing depth (PD) 4.Clinical attachment level(CAL)	**Variables Baseline** CG TG PD 5.57±0.57 5.52±0.87 CAL 5.01±0.90 4.87±0.76 PI 1.35±0.21 1.29±0.21 GI 1.44±0.22 1.42±0.42 **6 months** PD 5.05±0.90 4.24±0.97 CAL 4.54±1.31 3.68±1.24 PI 0.51±0.13 0.52±0.19 GI 0.70±0.31 0.46±0.25	Nonsurgical periodontal therapy (NSPT) using low level laser therapy in periodontitis patients with SRP is seen to be more effective than SRP alone according to the results showing significant improvement in the parameters recorded in this study.
5.Katsikanis et al (2019)	A split mouth RCT	21	SRP alone	SRP+ diode laser	Baseline 3 months 6 months	1.Bleeding on probing (BOP) 2.Plaque index (PI) 3.Probing depth (PD) 4.Clinical attachment level(CAL)	**Variables Baseline** CG TG PD 4.80(0.76) 4.82 (0.78) CAL 5.29(1.17) 5.30(1.08) BOP 81.9% 80% PI 77.6% 85.5% **6 months** PD 3.14(1.06) 3.19(1.02) CAL 4.05(1.67) 4.32(1.52) BOP 13.3% 14.6% PI 21% 30.6%	Both the treatment modalities in this study lead to statistically significant improvements in the evaluated clinical parameters at 3 months and 6 months compared with baseline. There was no statistically significant difference in PD and BOP between groups. There was only a tendency for greater reduction of PD in the test group.
6.Chong et al (2019)	RCT	27	Placebo group	Laser group	Baseline 6 months	1. Pocket probing depth (PPD) 2. Clinical attachment level (CAL) 3. Plaque index (PI) 4. Gingival index (GI) 5.Bleeding on probing(BOP) 6. Gingival recession (GR)	**Variables Baseline** CG TG PPD 1.62(0.32) 1.62(0.36) CAL 3.17(1.48) 3.09(1.37) PI 0.36(0.24) 0.32(0.25) GI 0.51(0.24) 0.51(0.30) BOP 14.25(7.4) 12.24(8.08) GR 1.78(1.4) 1.62(1.23) **6 months** PPD 1.77(0.30) 1.76(0.33) CAL 3.29(1.18) 3.25(1.16) PI 0.59(0.37) 0.53(0.31) GI 0.71(0.28) 0.61(0.32) BOP17.62(9.83) 12.04(0.88) GR 1.55(1.15) 1.46(1.17)	LLLT appears to be a promising adjunctive approach to mechanical debridement in the control of periodontal inflammation and wound healing for patients with chronic periodontitis when compared with mechanical debridement alone. This study proves superior results with lasers on clinical parameters.
7.Celik et al (2019)	RCT	38	SRP	SRP+L	Baseline 3 months 6 months	1.Bleeding on probing (BOP) 2.Plaque index (PI) 3.Probing depth (PD) 4.Clinical attachment level(CAL)	**Variables Baseline** CG TG PD 4.6±0.3 4.6±0.2 CAL 4.8±0.5 4.8±0.4 BOP 80.4±19.3 77.5±32.7 PI 0.7±0.3 0.8±0.2 **6 months** PD 2.7±.5 2.3±0.3 CAL 2.9±0.7 2.5±0.4 BOP 34.7±21.5 34.9±20.3 PI 0.5±0.2 0.5±0.3	The adjunctive use of Er: YAG laser with mechanical treatment showed improvement in clinical parameters in the moderately deep and deep pockets, however it failed to demonstrate any additional microbiological benefits. This can be associated with the positive features of laser for epithelial attachment on the root surface.

8. Dalvi et al (2019)[4]	A split mouth RCT	20	OFD	OFD+ aPDT	Baseline 6 months	1. Probing pocket depth (PPD) 2. Relative attachment level (RAL) 3. Relative gingival margin level (RGML) 4. Plaque index (PI) 5.Gingival index (GI) 6. Gingival bleeding index (GBI)	**Variables Baseline** CG TG PPD 3.1±0.53 3.18±0.41 RAL 2.76±0.63 2.83±0.54 RMGL 0.92±0.16 0.67±0.15 PI 1.56±0.54 1.46±0.50 GI 1.31±0.36 1.67±0.29 GBI 58.5±9.3 60.2±8.9 **6 months** PPD 2.38±0.42 2.24±0.39 RAL 5.48±0.53 8.25±0.36 RMGL 4.07±0.51 3.16±0.48 PI 2.10±0.38 2.14±0.39 GI 2.2±0.34 2.2±0.32 GBI 70.5±9.99 70.5±9.99	The data of the present study could ascertain the beneficial role of adjunctive aPDT using ICG photosensitizer activated with 810 nm diode laser, following open flap debridement in the treatment of chronic periodontitis. There were statistically significant improvement in al the clinical parameters assessed.
9. Erbil et al (2019)	A RCT	59	SRP	SRP + Laser	Baseline 6 months	1. Bleeding on probing (BOP) 2. Probing depth (PD) 3. Clinical attachment level (CAL)	**Variables Baseline** CG TG PD 90–0.20 95–0.20 CAL 4.70–0.70 4.70–0.70 BOP 4.80–0.90 4.77–1.06 **6 months** PD 31–0.50 18–0.40 CAL 3.30–0.70 2.70–0.70 BOP 3.70–0.9 03.40–1.07	The study results indicated that in addition to ultrasonic instrumentation, the use of the Er,Cr:YSGG laser has shown better clinical results than using conventional method in terms of pocket depth reduction and gingival bleeding, especially in deeper pockets in periodontitis patients.
10. Petrovic et al (2018)	A clinical trial	60	SRP	LLLT+ SRP	Baseline 6 months	1. Plaque index (PI) – Greene and Vermilion 2. Bleeding Index (BI) – Muhlemann 3. Clinical attachment level (CAL)	**Variables Baseline** CG TG PI 1.92±0.56 1.95±0.58 BI 1.33±0.48 1.53±0.51 CAL 4.34±0.74 4.40±0.70 **6 months** PI 1.01±0.49 0.68±0.31 BI 0.58±0.66 0.16±0.29 CAL 3.77±0.73 3.32±0.63	In this clinical study the outcome shows LLLT as an adjunct to periodontal therapy demonstrate additional clinical and cytological effects. There is statistically marked difference between the groups.
11. Karthikeyan et al (2018)	A split mouth RCT	20	Kirkland flap surgery	Kirkland flap surgery + diode laser	Baseline 3 months 6 months	1.Bleeding on probing (BOP) 2.Plaque index (PI) 3.Probing depth (PD) 4.Clinical attachment level(CAL)	**Variables Baseline** CG TG PD 6.13–0.80 6.45–0.84 CAL 6.50–0.94 6.74–0.93 BOP 85.62–14.31 89.4-12.4 PI 2.57–0.22 2.54–0.19 **6 months** PD 3.01–0.47 1.72–0.39 CAL 3.35–0.72 2.05–0.52 BOP 37.05–7.45 16.51–5.98 PI 1.39–0.17 1.03–0.06	This split-mouth, RCT indicated that Laser assisted Kirkland flap surgery showed marked clinical improvement and significant effect over a period of 6 months. The results of this study prove to be promising and encourage the use of laser in the surgical periodontal therapy.
12. Giannelli	A RCT	24	SRP	SRP + iPad	Baseline 1 year	1.Bleeding on probing (BOP) 2.Plaque index (PI)	**Variables Baseline** CG TG	Improvement seen in the clinical parameters is

et al (2018)						3.Probing depth (PD) 4.Clinical attachment level(CAL)	PD 4.9±0.1 5.1±0.2 CAL 5.3±0.1 5.4±0.1 BOP 42±4.6 36.7±5.3 PI 26.5±3.7 25.5±3.6 **6 months** PD 3.8±0.3 1.2±0.2 CAL 5.2±0.1 3.1±0.3 BOP 23.2±2.1 1.2±0.6 PI 8.2±1.5 7.4±1.5	indicative of the beneficial effect of the laser on srp. Hence lasers can be used as an adjunct to periodontal treatment procedures.
13. Martins et al (2018)	RCT	20	Surgical periodontal treatment (ST)	PDT+ST	Baseline 6 months	1. Pocket probing depth (PPD) 2. Clinical attachment level (CAL) 3. Plaque index (PI) 4.Bleeding on probing(BOP) 5. Gingival recession (GR)	**Variables Baseline** CG TG PPD 5.70±0.53 5.63±0.45 CAL 6.18±0.74 6.05±0.82 PI 87.5% 77.5% BOP 82.5% 82.5% GR 0.48±0.53 0.43±0.73 **6 months** PPD 3.40±0.50 2.70±0.3 CAL 4.18±0.66 3.70±0.8 PI 47.5% 32.5% BOP 32.5% 50% GR 0.78±0.49 1.00±0.60	Adjunctive aPDT with open flap debridement was able to significantly reduce levels of bacteria in subgingival plaque samples and clinical parameters analyzed 6 months after treatment. The use of aPDT adjunct to surgical periodontal treatment in sites with pockets is a clinical option which should be considered.
14. Vidal et al (2017)	A single blind RCT	60	SRP	SRP+PDT	Baseline 3 months 6 months	1.Plaque index (PI) 2.Probing depth (PD) 3.Clinical recession (CR) 4.Clinical attachment level (CAL) 5.Bleeding on probing (BOP)	**Variables Baseline** CG TG PD 5.69 ±1.02 5.83 ±1.11 CAL 6.19±1.42 6.47±1.60 PI 1.11±0.60 1.08±0.71 BOP 100 100 CR 0.50±1.00 0.63±1.01 **6 months** PD 3.62±1.15 3.93±1.36 CAL 4.19±1.60 4.67±1.83 PI 0.49±0.53 0.58±0.61 BOP 40.6 37.0 CR 0.56±0.97 0.74±1.09	Based on the findings of the study that show no statistically significant changes in clinical parameters from baseline to 6 months it cannot be suggested that the use of PDT as a coadjutant in the treatment of chronic periodontitis has any beneficial effects.
15. Saglam et al (2017)	A Split mouth RCT	25	SRP	SRP + Nd:YAG	Baseline 3 months 6 months	1.Bleeding on probing (BOP) 2.Plaque index (PI) 3.Gingival index (GI)	**Variables Baseline** CG TG PI 1.54±0.51 1.61±0.47 BOP 57±23 56±25 GI 1.56±0.47 1.50±0.42 **6 months** PI 0.86±0.43 0.85±0.40 BOP 13±15 17±20 GI 0.62±0.41 0.75±0.48	The results of the study indicate that laser therapy combined with SRP achieved greater improvements in probing depth and clinical attachment level in deep pockets compared to SRP alone which have limitations in inaccessible areas like deep periodontal pockets, furcations etc.
16. Wang et al (2017)	A split mouth RCT	27	SRP	SRP+ Er:YAG	Baseline 3 months 6 months	1.Bleeding index (BI) 2.Clinical attachment level (CAL) 3.Probing depth (PD) 4.Plaque index (PI)	**Variables Baseline** CG TG PD 4.78±0.79 4.73±0.63 CAL 5.03±0.46 5.03±0.53 BI 3.24±0.25	It is clear from the results that in patients with chronic periodontitis laser as an adjunct to conventional therapy provides additional benefits in improvement

							3.19±0.37 PI 2.50±0.81 2.48±0.78 **6 months** PD 3.38±0.70 3.55±0.55 CAL 4.01±0.90 4.24±0.74 BI 1.81±0.64 1.87±0.84 PI 2.30±0.75 2.38±0.74	of periodontal health.

LASER THERAPY AS AN ADJUNCT TO NONSURGICAL PERIODONTAL THERAPY

The 8 articles out of 16 compared the efficacy of low level laser therapy/laser biostimulation as an adjunct to SRP, 7 studies showed improvement in terms of clinical parameters in patients in the test group. Photodynamic therapy as an adjunct to SRP also showed better results than SRP alone in various RCTs included in the systematic review.

ADJUNCTIVE ROLE OF LASERS IN SURGICAL PERIODONTAL THERPY

5 RCTs have shown improvement in clinical, microbiological and biochemical parameters in the laser group as compared to non-laser group proving antibacterial and anti-inflammatory effect of laser. It also showed better wound healing with the use of lasers.

DISCUSSION

Lasers have a multitude of applications, an abundance of evidence is already mentioned in literature regarding the same ranging from mechanical to life sciences. In Periodontology, Lasers are mostly known for their clinical application in the removal of tissues or haemostasis through their ability to enhance the cellular processes throughout the applied energy in terms of space, time, and surface. [(5)]

The provision of large quantities of energy per unit area (High Level Laser therapy or HLLT), can cause the following : photothermal or photomechanical or photoablative phenomena which are utilized when laser radiation is used for the removal of hard or soft tissues.

Another important laser application is the low energy treatment, better known as LLLT or photodynamic therapy. This process has been described as Laser therapy or Low Intensity Laser therapy. It is based on the ability of light to function as a photo-stimulant in viable cells by exerting its effects through photoelectric, photo-physical and photochemical phenomena.[(6)]

However, despite of numerous significant research efforts around the effects of LLLT in various cells or tissues, the optimum doses of radiation, energy densities, time, and irradiation conditions as well as the appropriate individual settings in the various laser devices, which will predictably lead to optimal therapeutic effects have not been clarified yet. However, the existence of several laser types of many different parameters to be selected as referred above, seem rather confusing to the reader and the researcher, without providing a clarified view.

According to the literature it is accepted that the energy density required is very less, at the level of 2-4 J/cm2 and the transmit power is lower than 0.5 Watts.[(7)] The bio-stimulatory activity in tissues is related to shorter wavelengths, since the best results

are displayed in red and near infrared spectrum of light.

Abud et al (2022) in his study observed that there are no additional benefits of using laser as an adjunct as both the groups showed similar improvement in clinical parameters. A lot of studies have been in contrast of this study contradicting the results of this study.[8]

Chen et al (2020) in the study found that laser when used as an adjunct to non-surgical periodontal therapy (NSPT) showed in All examined sites exhibited significantly reduced probing pocket depth (PD), clinical attachment level (CAL), gingival bleeding index, plaque score, and visual analog scale. This study in contrast to abud et al highlighted the benefits of lasers in reducing clinical parameters as well as accelerating wound healing.[9]

Gandhi et al (2019) in a RCT evaluated effect of low level laser as an adjunct to SRP and found significant improvement in clinical parameters with the use of lasers stating its benefits as an adjunctive method.[10]

There have been conflicts of interest in laser therapy regarding its use or abuse. The studies conducted are in favour of laser usage in both surgical and non surgical therapies as well as its adjunctive effects are commendable. The only limitation which might disengage the clinicians for its use in their practice would be the cost factor which is undoubtedly high. It might also depend on personal interest to either use lasers or continue with the conventional techniques as clinicians are quite comfortable with it.

SUMMARY AND CONCLUSION

Lasers have been used popularly nowadays as an adjunctive or alternative to conventional therapy for various periodontal procedures and considered superior due to to easy ablation, antimicrobial decontamination, and hemostasis along with less requirement for local anaesthesia, less operative and post-operative pain. It can be used as low level laser therapy or antimicrobial photodynamic therapy either with single or multiple applications at different time intervals. According to literature using different combinations of lasers has also shown remarkable benefits.

Introduction of lasers in periodontal therapy and newer laser technical modalities has revolutionised the periodontal treatment outcome with more patient acceptance.

Also it has been shown in studies that it is effective in improving periodontal health due to its ability of penetration in deeper tissues and accessibility to areas inaccessible to hand instruments. Lasers have the potential advantages of bactericidal effect, and removal of the diseased or infected epithelium lining and granulation tissue, accelerated wound healing which are desirable properties for the treatment of periodontal diseases.

However, cost of laser has always been the biggest limiting factor.

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