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ORIGINAL ARTICLE

CLINICAL AND ANTIMICROBIAL EFFECTIVENESS OF DIODE LASER THERAPY AS AN ADJUNCT TO NON-SURGICAL PERIODONTAL TREATMENT: A CLINICAL-MICROBIOLOGICAL STUDY

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ABSTRACT

Aim: The clinical and antimicrobial efficacy of diode laser as an adjunct to scaling and root planing (SRP) was evaluated in chronic periodontitis patients.

Materials and Methods: The study included 8 Chronic periodontitis patients, of which 72 sites were randomly assigned into three groups; Group I : Scaling & root planing (SRP), Group II : Laser (L), Group III : Scaling & root planing followed by laser (SRP + L). The clinical parameters included were Plaque Index (PI), Gingival Index (GI), Bleeding on probing (BoP), Probing depth (PD) & Clinical attachment level (CAL) & subgingival plaque samples were taken for the microbiological assessment of the major periodontopathic bacteria (S.Mutans, P.Gingivalis, P.Intermedia, T.Denticola, T.Forsythia).These parameters were evaluated at baseline, 4weeks & 8weeks except for PD & CAL which were evaluated at baseline & 8 weeks.

Results: The clinical parameters showed significant reductions after 4weeks & 8weeks, in which the SRP+L group showed statistically significant reduction for PI, GI, BOP, PD & CAL compared to the other two groups. Also, the SRP group showed greater reductions compared to the laser group. The microbiological analysis also showed statistically significant reductions of the microbial colony count for the SRP+L group compared to the other two groups.

Conclusion: The use of diode laser as an adjunct to scaling & root planning may lead to improvement of clinical parameters as well as the reduction of the microbial load and therefore a potential advantage over SRP alone.

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INTRODUCTION

Periodontal disease results from inflammation of the supporting structures of the teeth in response to chronic infections caused by various periodontopathic bacteria. (Darveau *et al*., 2000) The main goals of periodontal therapy are to eliminate bacterial deposits and niches by removing the supragingival and subgingival biofilms (Teles *et al*., 2006; Takasaki *et al*., 2009) and to restore the biological compatibility of periodontally diseased root surfaces for subsequent attachment of periodontal tissues to the treated root surface. (Aoki *et al*., 2004) Generally, these objectives are achieved by mechanical scaling and root planing (SRP), which consists of hand or electronic instrumentation of the periodontally affected sites. (Lee *et al*., 1996) Complete removal of bacterial deposits and their toxins from the root surface and within the periodontal pockets is not necessarily achieved with conventional mechanical therapy. (Adriaens *et al*., 1988) To overcome these limitations of conventional mechanical therapy, several adjunctive protocols (local drug delivery, antimicrobials, lasers) have been developed. Among these, the use of lasers has been proposed for its bactericidal and detoxification effects and for its capacity to reach sites that conventional mechanical instrumentation cannot. (Sgolastra *et al*., 2013) Recent studies have proposed that laser-based root surface treatment might lead to improved periodontal therapy due to relatively conservative removal of tooth substance, as well as to the bactericidal effect towards periopathogenic bacteria. (Ando *et al*., 1996; Schwarrz *et al*., 2001; Folwaczny *et al*., 2002; Wang *et al*., 2005) In the treatment of inflammatory periodontal diseases, lasers may contribute to the bacterial reduction in periodontal pockets as well as to the removal of calculus and granulation tissue and can be used for contouring hyperplastic gingiva. (Centry *et al*., 1997; Israel *et al*., 1995; Quigley and

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Hein, 1962) Several laser systems such as Nd:YAG, Er:YAG, diode lasers with different characteristics and wavelengths, have been used for the treatment of periodontal disease. Among these, the diode laser have been indicated for the treatment of soft tissues and has a bactericidal effect, but does not ablate calculus on the root surface, therefore it may be useful as an adjunctive means for scaling and root planing due to its bactericidal and detoxification effects. (Moritz *et al*., 1998)

Two types of diode lasers have been studied for their effects in laser-assisted periodontal therapy: the diode laser (high levels of light energy) and the low-level diode laser (low-intensity light energy). (RuthinéiaDiógenes Alves UchôaLins and Euler MacielDantas, 2010) Low level-laser enhances the phagocytic and chemotactic activity of human leukocytes in vitro. In the process of wound repair, activation of lymphocytes by laser radiation can make them more responsive to stimulatory mediators present in injured tissues (Walsh, 1997) At the cellular level, low-power laser causes biochemical, bioelectric and bioenergetic changes, leading to increased metabolism, cell proliferation and maturation, increased quantity of granulation tissue and reduction of inflammatory mediators, inducing the healing process. (Silva *et al*., 2007; Bourguignon *et al*., 2005) Molecular absorption of laser light allows for an increase in cellular metabolism characterized by stimulation of photoreceptors in the mitochondrial respiratory chain, changes in cellular ATP levels, release of growth factors, and collagen synthesis. (Posten *et al*., 2005; Kreisler *et al*., 2003)

The biostimulation of tissues leads to acceleration of the healing process due to the increase in cell proliferation, and induces changes in the physiological activity of cells excited by the laser. (Almeida-Lopes *et al*., 2001) Therefore, though the mechanical debridement results in decreased inflammation and wound healing, it is necessary that the adjunctive effect of laser therapy be considered, which will enhance the wound healing properties, thereby providing more favourable clinical results. Therefore an attempt has been made in this study, to compare and evaluate the adjunctive effect of laser therapy to non-surgical periodontal treatment in chronic periodontitis patients.

MATERIALS AND METHODS

Participants and Study Design

The study included of 8 chronic periodontitis patients (72 sites), PD ≥5mm, CAL ≥5mm, who were referred for periodontal treatment at the outpatient department of Periodontics, A.C.P.M. Dental College, Dhule. The study was carried out after the approval from the ethical committee of A.C.P.M. Medical College, Dhule. The subjects received detailed information about the proposed research & gave informed consent. The periodontal sites in each patient were randomly assigned into three groups: Group I (SRP), Group II (L) & Group III (SRP+L) by an investigator who did not collect data or perform the procedures. Exclusion criteria were periodontal treatment received for the last 1 year; systemic diseases that could influence the outcome of the therapy, pregnancy, smoking, immunosuppressive chemotherapy; and use of antibiotics and anti-inflammatory drugs for the last 6 months.

Clinical Procedure

The patients received oral hygiene instructions at the first appointment and the sites were treated with scaling & root planing (SRP), laser (L) or both depending on the group to which the groups were assigned. SRP and diode laser therapy was performed at three regular intervals on consecutive days. A Diode laser (Zolar Technology Photon) 980 nm operated at a power output of 2.5 W in pulsed mode was used. Laser light was delivered by means of a 600 micron optical fiber. The fiber was inserted into the periodontal pocket, the laser activated, and the fiber slowly moved from apical to coronal in a sweeping motion during laser light emission. This was done mesially, distally, buccally, and lingually. The treatment was repeated until the entire pocket was irradiated. Each pocket of the test group was lased for 30s twice, with a 60s interval in the contact mode, and a further 30s of biostimulation in the non-contact mode. All treatments were performed under local anesthesia. Both patients and the operator wore protective glasses. The clinical evaluation of the patients was determined by plaque index (PI; Silness & Loe 1964), gingival index (GI; Loe & Silness 1963), probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BoP). The clinical parameters were recorded at six sites per tooth (mesio- buccal, mid-buccal, disto-buccal, mesio-palatal, mid-palatal, and disto-palatal). Plaque sampling and clinical index scores (PI, GI, BoP) were recorded at baseline, 4 and 8 weeks after treatment, whereas the PD and CAL were assessed at the baseline and 8 weeks after treatment.

Subgingival Plaque Sampling and Analysis

The plaque samples were collected by using sterile paper points. Baseline samples were collected before the oral hygiene instructions and supragingival scaling. The area was isolated to prevent samples from being contaminated by saliva. The paper points were placed into the crevice until mild resistance was felt & left in place for 60 seconds. Strips contaminated with blood were discarded. The plaque samples were then placed in a transport medium (peptone broth) and send to the laboratory for the microbial culture.

Statistical Analysis

A total of 72 sites (8 patients) were evaluated with the parameters recorded at each periodontal site, means were calculated and used for further statistical analysis. The Multivariate test was used to compare the findings at 3 levels (baseline, 4 weeks and 8 weeks) within the SRP, Laser and SRP + Laser groups. The three treatment modalities were compared with each other at baseline, 4 weeks and 8 weeks by one way ANOVA test. PD and CAL findings between 0 to 8 weeks were compared used paired t test. The p value of<0.05 was considered as significant.

RESULTS

Clinical Assessment

The study included 8 chronic periodontitis patients (72 sites), which were evaluated at baseline, 4 weeks, 8 weeks, &

compared between the three groups: SRP, Laser, SRP+L. At baseline there was statistically no significant difference between either of the three groups for PI,GI & BoP, except for the GI being statistically significant ($p<0.05$) between Laser & SRP+ L group (Table 1). At 4 weeks, there was statistically significant difference for PI between SRP & Laser group (1.96), whereas for GI it was significant between SRP & SRP + L (1.72) & also for BoP was between the SRP & Laser group (0.52), Laser & SRP + L group (0.56) (Table 2). At 8weeks, there was statistically significant difference of PI in between SRP group and Laser group as well as Laser and SRP + L group. There was statistically highly significant ($p<0.01$) difference for GI & BoP of SRP group and Laser Group compared with SRP + L group, as well as in SRP group compared with the Laser group (Table 3). The measurements of PD & CAL at 8 weeks showed that the SRP + L group showed great reductions than the other two groups, which were statistically significant (Table 4).

Microbiological Assessment

The microbial analysis was done for all the major periodontal pathogens (S.Mutans, P.Gingivalis, P.Intermedia, T.Denticola, T.Forsythia) and compared for the change in the microbial colony count between the three groups. Before the treatment there was statistically no significant ($p>0.05$) difference of colony count for S Mutans, P Gingivalis, P. Intermedia and T Denticola, while there was significant ($p<0.05$) difference for T Forsythia in between the three groups (Table 5). After 4weeks, the SRP+L group showed increased colony count for S.mutans compared to the SRP group & Laser group, whereas for the other pathogens the SRP+L group showed statistically significant reduction of colony count compared to the other two groups except for the T.denticola which showed significant reduction for SRP+L group compared to the Laser group (Table 6). After 8 weeks also the SRP+L group showed statistically significant differences between the microbial colony count from the other two groups. There was also a significant difference between SRP group & Laser group for P.Intermedia & T.Forsythia (Table 7).

Table 1. Inter comparision of PI, GI, BoP in between the groups before treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
PI	SRP	Laser	0.63	0.416
	SRP	SRP + Laser	0.68	0.376
	Laser	SRP + Laser	0.05	0.947
GI	SRP	Laser	0.47	0.381
	SRP	SRP + Laser	-0.77	0.147
	Laser	SRP + Laser	-1.23	0.020*
BoP	SRP	Laser	0.00	1.000
	SRP	SRP + Laser	0.00	1.000
	Laser	SRP + Laser	0.00	1.000

Values are presented as mean±standard deviation.
PI: plaque index, GI: gingival index, BoP: bleeding on probing
*The mean difference is significant at the 0.05 level.

Table 2. Inter comparision of PI, GI, BoP in between the groups after 4weeks of treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
PI	SRP	Laser	1.96	0.008**
	SRP	SRP + Laser	.88	0.227
	Laser	SRP + Laser	-1.08	0.139
GI	SRP	Laser	.52	0.367
	SRP	SRP + Laser	-1.72	0.004**
	Laser	SRP + Laser	-2.24	<0.01
BoP	SRP	Laser	.52	0.026*
	SRP	SRP + Laser	-0.04	0.862
	Laser	SRP + Laser	-.56	0.017*

Values are presented as mean±standard deviation.
PI: plaque index, GI: gingival index, BoP: bleeding on probing
*The mean difference is significant at the 0.05 level.
**The mean difference is significant at the 0.01 level

Table 3. Inter comparision of PI, GI, BoP in between the groups after 8weeks of treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
PI	SRP	Laser	2.08	0.024*
	SRP	SRP + Laser	.12	0.894
	Laser	SRP + Laser	-1.96	0.033*
GI	SRP	Laser	1.88	0.004**
	SRP	SRP + Laser	-2.32	<0.01
	Laser	SRP + Laser	-4.20	<0.01
BoP	SRP	Laser	1.16	<0.01
	SRP	SRP + Laser	-1.76	<0.01
	Laser	SRP + Laser	-2.92	<0.01

Values are presented as mean±standard deviation.
PI: plaque index, GI: gingival index, BoP: bleeding on probing
*The mean difference is significant at the 0.05 level.
**The mean difference is significant at the 0.01 level

Table 4. Inter comparision of the PD and CAL in between groups after 8 weeks of treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
PD	SRP	Laser	0.40	0.201
	SRP	SRP + Laser	-2.84	<0.01
	Laser	SRP + Laser	-3.24	<0.01
CAL	SRP	Laser	.28	0.518
	SRP	SRP + Laser	-2.72	<0.01
	Laser	SRP + Laser	-3.00	<0.01

Values are presented as mean±standard deviation.
PD: probing depth, CAL: clinical attachment level

Table 5. Inter comparison of microbial colony count within the three groups before treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
S.mutans	SRP	Laser	.00	1.000
	SRP	SRP + Laser	-.38	0.262
	Laser	SRP + Laser	-.38	0.262
P.Gingivalis	SRP	Laser	1.25	0.110
	SRP	SRP + Laser	.25	0.742
	Laser	SRP + Laser	-1.00	0.196
P.Intermedia	SRP	Laser	.13	0.748
	SRP	SRP + Laser	-.75	0.064
	Laser	SRP + Laser	-.88	0.033*
T.Denticola	SRP	Laser	.25	0.526
	SRP	SRP + Laser	-.50	0.211
	Laser	SRP + Laser	-.75	0.067
T.Forsythia	SRP	Laser	1.38	0.006**
	SRP	SRP + Laser	.13	0.786
	Laser	SRP + Laser	-1.25	0.012*

Values are presented as mean±standard deviation
*The mean difference is significant at the 0.05 level.
**The mean difference is significant at the 0.01 level

Table 6. Multiple pairwise comparison of microbial colony count within the three groups after 4 weeks of treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
S.Mutans	SRP	Laser	0.43	0.19
	SRP	SRP + Laser	-1.71	<0.01
	Laser	SRP + Laser	-2.14	<0.01
P.Gingivalis	SRP	Laser	-1.71	<0.05
	SRP	SRP + Laser	3.14	<0.01
	Laser	SRP + Laser	4.86	<0.01
P.Intermedia	SRP	Laser	-1.29	<0.01
	SRP	SRP + Laser	1.71	<0.01
	Laser	SRP + Laser	3.00	<0.01
T.Denticola	SRP	Laser	-0.57	0.074
	SRP	SRP + Laser	0.57	0.074
	Laser	SRP + Laser	1.14	<0.01
T.Forsythia	SRP	Laser	-0.43	0.268
	SRP	SRP + Laser	2.29	<0.01
	Laser	SRP + Laser	2.71	<0.01

Values are presented as mean±standard deviation

Table 7. Inter comparison of microbial colony count in between the three groups after 8 weeks of treatment

Dependent Variable	(I)	(J)	Mean Difference (I-J)	*P*-value
S.Mutans	SRP	Laser	-0.29	0.526
	SRP	SRP + Laser	-6.86	<0.01
	Laser	SRP + Laser	-6.57	<0.01
P.Gingivalis	SRP	Laser	-1.57*	0.039
	SRP	SRP + Laser	3.71	<0.01
	Laser	SRP + Laser	5.29	<0.01
P.Intermedia	SRP	Laser	-3.0	<0.01
	SRP	SRP + Laser	0.29	0.665
	Laser	SRP + Laser	3.29	<0.01
T.Denticola	SRP	Laser	0	1
	SRP	SRP + Laser	1.14	<0.01
	Laser	SRP + Laser	1.14	<0.01
T.Forsythia	SRP	Laser	-7.43	<0.01
	SRP	SRP + Laser	-2.29	<0.01
	Laser	SRP + Laser	5.14	<0.01

Values are presented as mean±standard deviation.
*The mean difference is significant at the 0.05 level.

DISCUSSION

The basic approach to periodontal infections has always been and remains the removal of supra and subgingival bacterial deposits. Non surgical periodontal therapy is still considered the gold standard to which other methods are compared. Several clinical studies conducted in the past few decades confirmed the effectiveness of the non-surgical approach in treating periodontal infection. However, the use of lasers in dentistry has been growing since the last decade and its application in dentistry has found greater significance over the years. More importantly, it has also been studied for the treatment of periodontal disease. Therefore in this study, the efficacy of diode laser was assessed in its added benefits towards the non-surgical therapy, thereby providing more favourable clinical and microbiological results. The clinical parameters (PI, GI, BoP) assessed, had no differences at baseline, but the results at 4 weeks showed greater reductions for SRP+L compared to SRP & Laser alone. These results are in accordance with the previous studies, in which Caruso *et al*. (2008) found significant reductions in the PI, GI & BoP at 4 & 8 weeks. It was also observed that between the SRP & Laser groups, the SRP group showed better results for all the parameters, thus suggesting the advantage of mechanical debridement over laser alone. Similarly at 8 weeks, all the three groups showed significant reduction in all the clinical parameters, in which the laser group showed significantly less reduction compared to the other two groups, whereas the SRP group differed significantly from the SRP+L group only for the PI. Also, at 8 weeks the reduction in PD & CAL was significant for the SRP and SRP+L group, but not for the laser group. Similarly, Saglam *et al*. (2014) observed with the use of diode laser, a reduced PD & CAL for the test & control group at 1, 3 & 6 months, but the difference between the test & control group was not statistically significant. Also, Kriesler *et al*. (2015) revealed a significantly higher reduction in tooth mobility, pocket depth, and clinical attachment loss for the teeth treated with diode laser. Thereby, suggesting the application of the diode laser in the treatment of inflammatory periodontitis, recommending it as a safe clinical procedure and as an adjunct to conventional scaling and root planing. In this study, the laser group provided the most inferior results compared to the other two groups at 4 weeks & 8weeks, but the results between 4weeks & 8weeks showed raised PI for the SRP & L group. After 4 weeks, the no of bleeding sites were reduced more significantly in the SRP+ L group (64%) & SRP group (60%), whereas the Laser group showed less reduction (28%). Similarly after 8 weeks, the mean BoP reductions were greater for the SRP+ L group (76%) and SRP group (44%), and comparatively less for the laser group (20%).

The microbiological data was assessed for the major periodontal pathogens (S.mutans, P.gingivalis, P.intermedia, T.forsythia, T.denticola) at baseline, after 4 & 8 weeks. The reduction of the microorganisms showed a similar pattern for all the groups, but it was significantly more reduced in the SRP+L group compared to the other two groups with the SRP group showing improved results over the laser group. Among these microorganism, S Mutans count was significantly ($p<0.01$) raised after 4 and 8 weeks of treatment, whereas P.Gingivalis, P. Intermedia and T Forsythia count had reduced after 4 and 8 weeks of treatment compared to baseline count which was statistically highly significant ($p<0.01$). But, T. Denticola had reduced after 4 weeks, but it further raised after 8 weeks of the treatment and it was statistically highly significant ($p<0.01$). Moritz *et al*. (1998) had shown similar bacterial reductions in the laser group (100%) compared to the control group (58.4%), where all the major periodontal pathogens had a significantly increased reduction of microbial load in the laser group than the control group. However, Alves *et al*. (2013) found no association between the group of patients treated with laser and control group in terms of the presence of periodontal microorganisms. Thereby, concluding with diode lasers having no added benefits to the conventional periodontal treatment. The results of the present study showed an added advantage of the use of diode laser along with SRP compared to SRP and Laser alone. Though all the groups showed reduction in the clinical parameters, but it was more significant for the SRP+L group.

In conclusion, based on the results of this study, the use of diode laser definitely provides an added advantage over the mechanical debridement alone. Both clinically & microbiologically, the lasers proved to be a successful adjunct & thereby assisting in a better soft tissue healing as well as in the resolution of inflammation. Therefore, the study concludes that the use of diode laser as an adjunct to scaling & root planing is more beneficial than the use of SRP alone. Though mechanical debridement always remain the initial & gold standard approach for non-surgical periodontal therapy, but considering the added benefit of diode lasers, it becomes important that the use of diode lasers should be accelerated along with the mechanical debridement, which will help provide improved results. Thereby increasing the efficacy of nonsurgical periodontal therapy & contributing a more efficient approach towards the treatment of periodontal disease.

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