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Comparison of Diode Laser-assisted Pocket Therapy with Open Flap Debridement in the Treatment of Periodontitis

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ABSTRACT

Introduction: Periodontal disease results from inflammation of the supporting structures of the teeth in response to chronic infections caused by various periodontopathic bacteria. Diode laser, being an excellent soft tissue laser, is indicated for soft tissue curettage or sulcular debridement.

Objective: To evaluate and compare the clinical outcomes of diode laser-assisted periodontal pocket therapy and open flap debridement (OFD) in the treatment of periodontitis

Methods: An experimental study (non-randomised trial) was done in the Department of Periodontics and Oral Implantology at People's Dental College and Hospital from 2019 August to 2020 July after ethical clearance from Nepal Health Research Council. Convenience sampling was used to select patients with chronic periodontitis with bilateral periodontal pockets in contralateral hemiarches exhibiting periodontal probing depth (PPD) of ≥5-8 mm. In group A, diode laser-assisted pocket therapy was performed and in group B, OFD was done. The parameters were evaluated accordingly at baseline, one, three, and six months.

Results: Comparison of baseline mean PPD scores of OFD group was significantly higher than diode laser associated pocket therapy group (p-value = 0.001). Comparison of baseline mean clinical attachment level (CAL) scores of OFD group was significantly higher than diode laser- assisted pocket therapy group (p-value = 0.012). At subsequent visit higher reduction in PPD was observed in OFD group, while higher reduction in CAL was observed in diode laser group.

Conclusions: Both groups showed significant improvements compared with baseline. However, the difference in improvement of the PPD and CAL between groups was not significant.

Keywords: Chronic periodontitis; clinical attachment level; diode laser; open flap debridement, periodontal probing depth.

INTRODUCTION

Periodontal disease is characterised by progressive destruction of periodontal supporting tissues.[1] Bacterial plaque, microbial by-products, and the host immune response play a major aetiologic role in the progression of periodontal disease, while environmental, behavioural, and genetic factors present as risk factors in disease progression.[2-4] Nonsurgical mechanical periodontal treatment is the cornerstone of periodontal therapy and is the first recommended approach to the control of periodontal infections.[5] Scaling and root planing (SRP), although considered as the gold standard for the treatment of chronic periodontitis,[5] has limited efficacy, for instance inadequate access to deep pockets, furcation areas, and root concavities, consequently increasing the risk of recurrence.[6] Hence, to facilitate SRP, flap surgery for better access and visualisation is recommended. Nonetheless, flap surgery has disadvantages of extreme post-operative pain, gingival recession, and long junctional epithelium formation precluding new connective tissue attachment. The quest to overcome these shortcomings has led to research into laser-assisted periodontal therapy.[7] Laser treatment alone or in combination with

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mechanical treatment has produced positive clinical outcome with respect to gain in clinical attachment level (CAL), decrease in periodontal probing depth (PPD) and bleeding on probing (BOP). The aim of the present study was to evaluate and compare the clinical outcomes of diode laser-assisted periodontal pocket therapy and open flap debridement (OFD) in the treatment of periodontitis.

METHODS

An experimental study (non-randomised clinical trial) was done to compare the effectiveness of diode laser-assisted pocket therapy and OFD in the treatment of periodontitis in patients visiting the Department of Periodontics and Oral Implantology, People's Dental College and Hospital, Sorahkhutte, Kathmandu, Nepal from 2019 August to 2020 July. Convenience sampling was used to determine the study population. Ethical clearance was obtained from the institutional review committee and Nepal Health Research Council (Ref. 3593) prior to data collection. Written informed consent was obtained from the patients before data collection and after explaining all the relevant details of the study. Sample size was calculated according to the study by Gupta et al.[8] using the formula:

$ES = \mu1 = \mu2 / \sigma$

Where, ES = effect size; $\mu1$ = mean PPD reduction after three months among patients undergoing laser; $\mu2$ = mean PPD reduction after three months among patients undergoing OFD; sd1 = standard deviation of PPD reduction after three months among patients undergoing laser; sd2 = standard deviation of PPD reduction after three months among patients undergoing OFD; σ = standard deviation (SD) calculated from sd1 and sd2; Level of significance (α) = 5%; Value of $Z_{1-\alpha/2}$ = 0.098; Power of the study (1- β) = 90%; Value of $Z_{1-\beta}$ = 1.28.

Twelve subjects were included in the study divided into 24 sites. Diode laser-assisted pocket therapy was done on one side and OFD on the other side for the treatment of periodontitis. Systemically healthy patients in the age range of 35 years to 55 years, with maxillary and mandibular first and second molars exhibiting bilateral pockets of ≥5-8 mm in the contralateral arches, and clinical attachment level of 4-6 mm, were included in the study. The plaque (Silness and Loe) and gingival (Loe and Silness) indices following initial therapy, and Simplified Oral Hygiene Index (OHI, Greene and Vermilion) had to be ≤1, and ≤1.2 respectively. Patients with any systemic disease or medication known to interfere with periodontal healing and regeneration, or contradict periodontal surgery, history of smoking or tobacco, pregnancy or lactation, undergoing orthodontic treatment, Grade II or III mobility, Grade II, III or IV furcation involvement, endodontic-periodontic lesions, and third molars were excluded from the study. An occlusal stent of self-curing acrylic resin with grooves was fabricated for each site to standardise the position and angulation of periodontal probe prior and after the treatment (Figures 1, 2).

Preoperative therapy constituted of scaling and root planing, patient education and motivation, and detailed oral hygiene instructions. Patients were re-evaluated after two weeks, and scaling and root planing was performed if necessary. After the completion of phase I therapy, periodontal evaluation was done to confirm the suitability of the sites for the study. The study sites were divided into two groups, as Group A (diode laser-assisted pocket therapy) and Group B (open flap debridement). Baseline parameters were recorded prior to the treatment procedure by University of North Carolina-15 (UNC-15) Hu-Friedy periodontal probe, by a single examiner. Group A patients were treated with semi-conductor diode laser of wavelength 980 nm associated pocket therapy (SIRO Laser Advance) in a continuous and non-contact mode. A 320 µm fibre-optic system was introduced parallel to the root surface, moved laterally and apically along the lateral pocket wall eventually reaching close to the base of the pocket in a paint brush like stroke for 20 seconds per site. The patients were recalled on third and seventh day for reinforcement of diode laser therapy. Group B were treated with Kirkland flap (open flap debridement).

The area planned for surgery was anaesthetised by 2% Lidocaine infiltration. Once the area was anaesthetised, buccal and lingual sulcular incisions were made extending one tooth mesially and one tooth distally of the tooth being treated. Full thickness mucoperiosteal flaps were elevated by using periosteal elevator. Interproximal soft tissues were preserved as much as possible. With the help of Gracey curettes, the defect was thoroughly cleaned

to remove granulation tissue and root surfaces were planed to remove calculus and altered cementum. The flap was then sutured with interrupted 3-0 non-absorbable silk sutures. Post-operative instructions were given. Capsule Amoxicillin 500 mg thrice daily for five days, Tablet Ibuprofen 400 mg thrice daily for three days followed by intake if necessary, and 0.2% chlorhexidine mouth rinse twice daily for two weeks were prescribed. Sutures were removed one week post-operatively. Patients were re-evaluated at one month and then followed at three and six months, and oral hygiene instructions were reinforced at each recall visit. No subgingival instrumentation was attempted until three months of follow up. Probing depth and clinical attachment level were evaluated at baseline, three, and six months, whereas gingival index, plaque index, and simplified oral hygiene index were evaluated at baseline, one, three, and six months. All the measurements were repeated with previously used acrylic stents and UNC-15 periodontal probe.

Data were analysed with IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA). Distribution of study data was checked for normal distribution through Shapiro-Wilk test. Parametric tests were applied for testing hypothesis. The numerical variables like age and dental indices were summarised using descriptive statistics like mean, standard deviation, and range while sex was summarised using proportions. Within each study group, comparison of dental indices over different time intervals were tested using analysis of variance (ANOVA) with post hoc comparisons. Between the groups, comparisons of change in mean scores of dental indices at different time intervals were tested for significant difference using Independent sample t test. The level of significance was set at 5%.

RESULTS

The average age of the patients was 40.58 years, from 29 years to a maximum age of 55 years. A total of 12 patients with 24 clinical sites were included, with equal gender distribution. Out of 12 patients, two lost the follow up of six months period. Thus, a total number of 10 patients with 20 clinical sites were included in the study.

Mean PPD of the OFD (Surgery) group was higher than the diode laser-assisted pocket therapy group. In the consecutive follow up visits, PPD reduced in both the study groups. The range of values at baseline and consecutive visits also reduced in both the groups (Table 1).

Mean CAL of open flap debridement (Surgery) group was higher than the diode laser-assisted pocket therapy group. In the consecutive follow up visits, the CAL reduced in both the study groups. The CAL values were lower in diode laser-assisted pocket therapy group at follow up visits. The range of values at baseline and consecutive visits also reduced in both the groups (Table 1).

In the sites receiving the diode laser-assisted pocket therapy, the mean PPD and CAL reduced significantly at three months and six months when compared with baseline values, with p-value of 0.003 and 0.015 respectively (Table 2), with highest reduction in the PPD seen at first three months after treatment.

In the sites receiving open flap debridement, the mean PPD reduced significantly at three months and six months with p-value <0.001 (Table 3), while the reduction of CAL, although present at three and six months, was not statistically significant (Table 3).

Comparison of mean PPD and CAL scores between two study groups showed that baseline PPD and CAL scores of open flap debridement group were significantly higher than diode laser-assisted pocket therapy group with p-value of 0.001 (Table 4) and 0.012 (Table 4) respectively. At subsequent visits, higher reduction in PPD was observed in open flap debridement group, while higher reduction in CAL was observed in diode laser group, however, not statistically significant, showing that both the treatment options are comparable and their effects on PPD and CAL are similar.

Comparison of mean scores of plaque index at different intervals did not show significant reduction at subsequent follow up visits in any group. Comparison of mean scores of gingival index showed significant improvement in gingival health in the laser group, however, there was no such significant improvement in the open flap debridement group.

Table 1: Descriptive statistics of periodontal probing depth (PPD) and clinical attachment level (CAL) among patients in the study.

Dental Indices	Time Intervals	Mean±SD		Range (Min.–Max.)	
		Laser	Surgery	Laser	Surgery
Clinical attachment level (in mm)	Baseline	5.40±0.69	6.0±0.0	4.0-6.0	6.0-6.0
	After three months	4.20±1.03	5.0±1.25	3.0-6.0	3.0-7.0
	After six months	4.20±1.03	5.0±1.25	3.0-6.0	3.0-7.0
Periodontal probing depth (in mm)	Baseline	5.50±1.05	6.30±0.48	5.0-6.0	6.0-7.0
	After three months	4.0±1.10	4.10±0.87	3.0-6.0	3.0-6.0
	After six months	3.90±1.10	3.70±1.06	3.0-6.0	2.0-6.0

Table 2: Change in mean scores of periodontal probing depth (PPD) and clinical attachment Level (CAL) in sites which underwent diode laser-assisted pocket therapy (Group A).

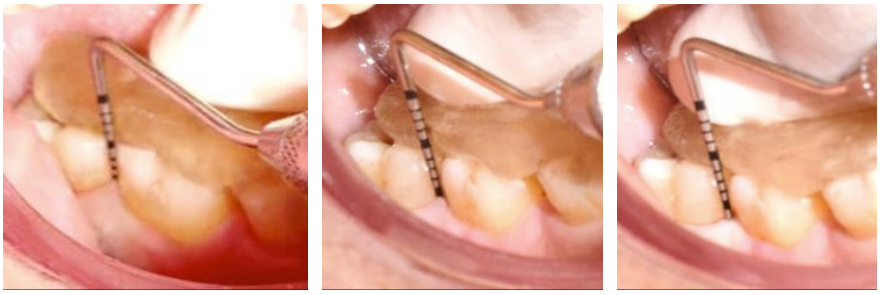
Dental Indices (PPD)	Comparator	Mean Diff.	95% CI		p-value
			Lower	Upper	
At baseline (5.40±0.63)	At three months (4.20±1.03)	1.20	0.242	2.158	0.015
	After six months (4.20±1.03)	1.20	0.242	2.158	0.015
At three months (4.20±1.03)	After six months (4.2±1.03)	0			
At baseline (5.50±0.52)	At three months (4.0±1.05)	1.50	0.559	2.401	0.003
	After six months (3.90±1.10)	1.60	0.603	2.597	0.003
At three months (4.0±1.05)	After six months (3.90±1.10)	1.10	-0.193	0.393	1.000

Table 3: Change in mean scores of periodontal probing depth in sites which underwent open flap debridement.

Dental Indices (PPD)	Comparator	Mean Diff.	95% CI		p-value
			Lower	Upper	
At baseline (6.30±0.48)	At three months (4.10±0.87)	2.20	1.348	3.052	<0.001
	After six months (3.70±1.06)	2.60	1.603	3.597	<0.001
At three months (4.10±0.87)	After six months (3.70±1.06)	0.40	-0.249	1.049	0.312
At baseline (6.0±0.0)	At three months (5.0±1.25)	1.00	-0.157	2.157	0.09
	After six months (5.0±1.25)	1.00	-0.157	2.157	0.09
At three months (5.0±1.25)	After six months (5.0±1.25)	-	-	-	-

Table 4: Comparison of mean scores of periodontal probing depth (PPD) and clinical attachment level (CAL) between study groups at different intervals.

Mean Scores of PPD	Laser Therapy (mean±SD)	Surgery (mean±SD)	p-value
PPD at baseline (in mm)	5.50±1.05	6.30±0.48	0.001
PPD at three months (in mm)	4.0±1.10	4.10±0.87	0.842
PPD at six months (in mm)	3.90±1.10	3.70±1.06	0.684
CAL at baseline (in mm)	5.40±0.69	6.0±0.0	0.012
CAL at three months (in mm)	4.20±1.03	5.0±1.25	0.115
CAL at six months (in mm)	4.20±1.03	5.0±1.25	0.136



Baseline Three months Six months

Figure 1: Periodontal probing depths (Group A).

Baseline Three months Six months

Figure 2: Periodontal probing depth (Group B).

DISCUSSION

Periodontal regeneration implies the formation of new connective tissue attachment, that is the new cementum with inserting collagen fibres, at previously diseased or denuded root surfaces, and also preferably the regrowth of alveolar bone. This can only be achieved when epithelial migration can be prevented on the treated root surface. In contrast to the conventional treatments, ablating the inflamed lesions and epithelial lining of the soft tissue wall within periodontal pockets with a diode laser has been shown to retard epithelial migration and promote periodontal regeneration. Therefore, this study was carried out to compare the effect of open flap debridement and diode laser-assisted closed pocket debridement in the treatment of chronic periodontitis. A split-mouth design was used as this excludes the influence of individual patient characteristics and helps to obtain a more powerful estimate of treatment effect with a smaller sample size.[9] The CAL being the gold standard for evaluating the success of periodontal therapy[5] and PPD being an important factor affecting the long-term stability of the results, these were the primary outcomes measured. The gingival index was assessed to evaluate the gingival condition clinically after treatment. Additionally, plaque index, and oral hygiene index were assessed to monitor the oral hygiene status of the patients and to motivate them at each recall interval.

Significant reduction in PPD and gain in CAL in the consecutive follow up periods in the open flap debridement group is in accordance with the study by Lindhe et al.,[10] Philstrom et al.,[11] and Isidor and Karring.,[12] suggesting the effectiveness of the treatment in reducing signs of inflammation. However, the GI scores were not improved significantly over the follow up period in this group. Similar to the open flap debridement group, significant reduction in PPD and gain in CAL were found in the diode laser pocket therapy group. Moreover, significant improvement in the GI scores was found in the laser group. These findings could be attributable to the advantages like bactericidal, curettage, and bio-stimulatory effects of diode laser.[13]

The intergroup comparison, however demonstrated statistically insignificant differences in the reduction of PPD and gain in CAL, though both groups demonstrated statistically significant improvement in terms of PPD and CAL in the consecutive follow up visits.

The significant improvement in the GI in the laser group

given that subjects had similar oral hygiene status may be attributable to the reduction in the counts of *Porphyromonas gingivalis*, a periodontopathogen belonging to the red complex,[14,15]such as checkerboard DNA-DNA hybridization, permit enumeration of large numbers of species in very large numbers of samples. Digoxigenin-labeled whole genomic probes to 40 common subgingival species were tested in a checkerboard hydridization format. Chemifluorescent signals resulting from the hybridization reactions were quantified using a Fluorimager and used to evaluate sensitivity and specificity of the probes. Sensitivity of the DNA probes was adjusted to detect 10(4 which has high affinity for the diode laser.[16,17]diode laser treatment (LAS In a similar study by Moritz et al.,[18] evaluation of microbiological parameters after six months of laser therapy, showed 100% bacterial reduction, with significant reduction in the counts of *Porphyromonas gingivalis* and improvement in gingival scores. Soliman et al., in a study, great improvement in the bleeding on probing in the study group receiving diode laser therapy as 96.9%, compared with the 20.5% in the control group, thereby suggesting that the antimicrobial effect of laser supports healing of periodontal pockets.

Calibration for the initial therapy with laser tip was done at 1 mm less than the probing depth as this measurement allows for the laser energy to penetrate the tissue and reduce the bacterial load without the fibre touching the epithelial attachment at the bottom of the pocket.[19]

Laser reinforcement was not done beyond three cycles to prevent any inadvertent damage to the healing connective tissue fibres within the pocket. Also, the sulcus heals from the bottom up and hence during the second and third reinforcement, the tip was placed 2 mm less than the periodontal probing depth of the treatment site to allow healing at the floor of the pocket.[20] Re-probing treatment sites was not attempted before three months as tissue reattachment to the root surface could be damaged with a probe, delaying the healing process.[21] Although the lack of microbial data in current study does not allow us to correlate the levels of microbiota in baseline pockets and in residual pockets after the surgery with clinical parameters at different time periods in study. However, a clinical indicator of inflammation, bleeding on probing (GI scores) roughly reflects the level of periodontal pathogens in the pocket.[22] So, it can be hypothesised that the reduction in GI scores might be due to a bactericidal and detoxification effect of the laser. Nevertheless, these results are based on a single-centred study with comparatively smaller sample size.

CONCLUSIONS

Thus, in accordance with the data in the present study, it can be summarised that, diode laser can be considered as an alternative and effective newer treatment modality to surgical approach for mild to moderate periodontitis. However, further research is needed along in a larger sample size and multicentred trial with a longer follow up period to establish a definite conclusion on the effects of diode laser-assisted pocket therapy in comparison to the surgical flap debridement in the treatment of periodontal pockets.

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