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Clinical Evaluation of Diode Laser Compared to Systemic Antibiotics in the Treatment of Chronic Periodontitis

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ABSTRACT

Introduction: Periodontitis is an inflammatory disease of the periodontium. The most commonly used treatment modality involves scaling and root planing. However, complete removal of bacterial deposits is not always possible. Thus, adjunctive therapeutic strategies like systemic antibiotics and laser therapy have evolved.

Objective: To evaluate the clinical effect of diode laser compared to systemic antibiotics in the treatment of chronic periodontitis.

Methods: A non-randomised clinical trial was conducted in the department of Periodontics and Oral Implantology, People's Dental College and Hospital from 2022 April to 2023 March after ethical approval. Thirty-two patients with chronic periodontitis were assigned into two groups using convenience sampling. Group A received diode laser (980 nm) applications, and Group B received adjunctive systemic Amoxicillin 500 mg three times daily and Metronidazole 400 mg three times daily for seven days. Clinical parameters: probing depth, clinical attachment level, plaque index, and gingival index were evaluated at one month, three months, and six months post-treatment. Data were analysed in SPSS v.20.

Results: Mean values of probing depth, clinical attachment level, plaque index, and gingival index reduced significantly after treatment in both treatment groups, with more clinical improvement in the diode laser group. However, for the intergroup comparison, the clinical parameters were not significant.

Conclusions: The findings of the current study showed significant improvement in all clinical parameters as compared with baseline in both treatment groups. However, no significant differences between the treatment modalities were found regarding an increase in periodontal probing depth and clinical attachment level.

Keywords: Amoxicillin; antimicrobials; chronic periodontitis; diode laser; metronidazole; nonsurgical periodontal therapy.

INTRODUCTION

Chronic periodontitis (CP), is a multifactorial disease caused by various periodontal pathogens that destroy the tooth-supporting tissues.[1] Nonsurgical periodontal therapy can control infections, remove plaque and calculus, reduce bioburden, and accelerate tissue repair, however, it may not eliminate pathogenic subgingival microbiota due to its inability to reach deep pockets and furcations.[2] Thus, other adjunctive measures like antimicrobial therapy[3] and lasers[4] have evolved.

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Adjunctive systemic antimicrobial therapy can effectively combat periodontal pathogens in extra-crevicular sites and subgingival areas through saliva and gingival crevicular fluid.[5] Amoxicillin and Metronidazole have a synergistic bactericidal effect on the complex microbiology of periodontal disease by reducing the time and dosage needed to achieve optimal effects, minimizing toxicity, preventing resistance, and broadening the spectrum of antimicrobial action.[6] Diode laser is a successful technique for bacterial reduction when combined with conventional periodontal therapy.[7] It converts electrical energy into light energy, absorbed by haemoglobin and pigments, leading to ablation, coagulation, and antimicrobial effects.[8]

Despite numerous independent studies proving the effectiveness of diode laser and systemic antibiotics, few studies have compared their efficacy. Therefore, the present study was designed to evaluate the

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clinical effect of diode laser compared to systemic antibiotics in the treatment of chronic periodontitis.

METHODS

A non-randomised trial was used to compare the clinical outcomes of diode laser and systemic antibiotics in the treatment of chronic periodontitis. This study was based on a quantitative research method and the study was a quasi-experimental type. The study had a pretest and a post-test design and the study population was patients with chronic periodontitis who met the inclusion criteria attending People's Dental College and Hospital (PDCH), Sorhakhutte, Kathmandu, Nepal.

The study period was from 2022 April to 2023 March. Ethical approval was obtained from the Institutional Review Committee of PDCH (Ref. 1. Ch. No. 22. 2078/2079). Patients were selected using convenience sampling and informed consent was obtained from them. The sample size was **32** which was obtained by using the formula:

$$N = 2[(Z\alpha+Z\beta)^2 s^2/d^2]$$

Where, Z_α = 1.96 at a 95% confidence level; Z_β = 1.65 at 95% power

According to a reference article by Yilmaz et al.[9]

d = Mean difference of probing pocket depth = 0.2

s = Variability, the standard deviation of probing pocket depth = 0.15

Adding 20% of expected dropout 13 + 2.6 = 15.6 ≈ **16 per group.**

The sample included systemically healthy patients aged 35 years to 55 years with chronic periodontitis, each having at least 20 teeth in both jaws. A minimum of six teeth were chosen for this study, with each tooth exhibiting probing depths (PD) of 5-7 mm, Clinical Attachment Levels (CAL) of 2-4 mm, a Plaque Index (PI) of ≤1, and a Gingival Index (GI) of ≤1.

Patients with medical conditions requiring prophylactic coverage, those with known hypersensitivity to amoxicillin and metronidazole, pregnant and lactating individuals, and patients with systemic diseases that may influence the outcomes or progression of periodontal therapy were excluded. Additionally, teeth exhibiting grade II and III mobility (Miller's classification, 1938) and grade II, III, and IV furcation involvement (Glickman's classification, 1953) teeth with crowns, bridges, or orthodontic appliances, as well as smokers, alcoholics, and drug abusers were excluded. Patients who had undergone professional surgical or non-surgical periodontal therapy within past six months before the study initiation and those who consumed medications known to affect periodontal status (including antibiotics, anti-inflammatories, anticonvulsants, immunosuppressants, or calcium channel blockers) within the past six months, along with periapical alterations of teeth and third molars, were also excluded from this study.

After selecting subjects, alginate impressions of the arches were taken and casts were made. An occlusal stent was made from self-curing resin to establish stable landmarks and standardise periodontal probe placement. The occlusal stent was designed to cover the tooth being treated and at least one adjacent tooth in both mesial and distal directions.

A thorough history and clinical examination were performed. Patient education, motivation, and detailed oral hygiene instructions were given. Patients were encouraged to use the Modified Bass brushing technique before the initiation of the study. Before the treatment, patients received complete information about the risks and benefits.

All subjects underwent full mouth scaling with an ultrasonic scaler. Patients were recalled within 7-10 days for complete scaling and root planing (SRP) with Gracey curettes under local anaesthesia. Patients fulfilling the inclusion criteria were selected as a sample and divided into two equal groups, and a treatment plan was provided. The study assigned odd subjects to group A and even subjects to group B. Patients in group A received diode laser applications. Group B patients received treatment with adjunctive systemic Amoxicillin and Metronidazole.

Appropriate laser safety measures were taken. Both patient and operator had to wear protective eyeglasses during laser decontamination therapy. On the affected pocket site, a 320µm fibre-optic delivery

system was introduced parallel to the root surface 1 mm short of measured periodontal probing depth using an endodontic stopper on the fibre in an apical-coronal direction. The fibre-optic tip was moved in a sweeping motion for 20 seconds per site almost parallel to the tooth and moving from apical to coronal directions continuously. Precautions were implemented to prevent any contact with the root surface or the alveolar bone. Reinforcement for the diode laser was performed on the third and seventh day.

Patients falling under Group B received a combination of systemic Amoxicillin 500 mg and Metronidazole 400 mg three times daily for seven days. All patients were advised to avoid alcohol while taking the medication. Every appointment included oral hygiene instructions. Patients had all clinical parameters re-evaluated at one, three, and six months.

The collected data were cleaned, coded, and entered in Microsoft Excel Sheet. The data were then transported to IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA) for further analysis. An independent t-test was done for the intergroup comparison of probing depth, clinical attachment level, plaque index, and gingival index. A paired t-test was done for the intragroup comparison of probing depth, clinical attachment level, plaque index, and gingival index. The level of significance was set at p-value ≤0.05.

RESULTS

Out of 32 patients, two lost the follow-up. Thus, a total of 30 patients were included in this study. The mean age of the study participants was 45.50±5.22 years, with a minimum of 37 years and a maximum of 53 years. The mean age of study participants in Group A was 45.87 years, and in Group B it was 45.13 years.

Out of the total of 15 participants in Group A, seven were female and eight were male. Similar to Group A, Group B also consisted of seven females and eight males.

Among the study participants, there was a statistically significant difference in mean probing depth and clinical attachment level at baseline, one month, three months and six months (Table 1).

Table 1: Intragroup comparison of probing depth and clinical attachment level of study participants.

Probing depth

Group	Probing depth		SE	t - value	95% confidence interval		p-value
					Lower bound	Upper bound	
A	Baseline	1 month	0.114	12.09	1.13	1.62	0.002
		3 months	0.104	20.82	1.94	2.38	0.001
		6 months	0.09	24.45	2.01	2.4	<0.001
B	Baseline	1 month	0.14	8.05	0.83	1.43	0.018
		3 months	0.148	10.14	1.18	1.82	0.003
		6 months	0.145	10.8	1.25	1.87	0.001

Clinical attachment level

Group	Clinical attachment level		SE	t - value	95% confidence interval		p-value
					Lower bound	Upper bound	
A	Baseline	1 month	0.058	6.42	0.24	0.49	0.003
		3 months	0.053	11.63	0.51	0.74	0
		6 months	0.058	11.58	0.54	0.79	0.002
B	Baseline	1 month	0.029	10.78	0.25	0.37	0
		3 months	0.055	8.51	0.35	0.59	0.002
		6 months	0.07	7.69	0.39	0.69	0.006

The mean PD reduction from baseline to six months was 2.21 mm in Group A and 1.57 mm in Group B. The mean clinical attachment level reduction from baseline to six months was 0.68 mm in Group A and 0.55 mm in Group B. However, no statistically significant difference in probing depth and clinical attachment level was observed between the two groups at baseline, one month, three months, and six months (p >0.05) (Table 2).

The difference in mean plaque index between group A and B was not found to be statistically significant at baseline, one month, three months, and six months of intervention (Table 3).

The difference in mean gingival index between group A and B was not found to be statistically significant at baseline, one month, three months and six months of intervention (Table 4).

Table 2: Intergroup comparison of probing depth and clinical attachment level of study participants.

Probing depth (mm)	Group	Mean±SD	t-value	95% confidence interval		p-value
				Lower bound	Upper bound	
Baseline	A	5.92±0.51	0.86	-0.19	0.47	0.39
	B	5.78±0.38				
1 month	A	4.53±0.63	-0.45	-0.60	0.38	0.65
	B	4.64±0.67				
3 months	A	3.75±0.63	-2.02	-1.04	0.005	0.052
	B	4.27±0.76				
6 months	A	3.71±0.60	-1.96	-1.02	0.02	0.06
	B	4.21±0.77				
Clinical attachment level (mm)	**Group**	**Mean±SD**	**t-value**	**95% confidence interval**		**p-value**
				Lower bound	**Upper bound**	
Baseline	A	3.68±0.15	0.108	-0.11	0.13	0.91
	B	3.67±0.18				
1 month	A	3.30±0.30	-0.54	-0.25	0.14	0.58
	B	3.36±0.21				
3 months	A	3.05±0.30	-1.30	-0.37	0.08	0.20
	B	3.20±0.30				
6 months	A	3.00±0.31	-0.98	-0.37	0.13	0.33
	B	3.12±0.36				

Table 3: Intergroup comparison of plaque index scores of study participants.

Plaque index score	Group	Mean±SD	SD	t-value	95% confidence interval		p-value
					Lower bound	Upper bound	
Baseline	A	0.85±0.05	0.05	0.28	-0.04	0.05	0.77
	B	0.84±0.08	0.08				
1 month	A	0.73±0.73	0.73	-0.45	-0.06	0.03	0.65
	B	0.74±0.74	0.74				
3 months	A	0.66±0.66	0.66	-1.32	-0.11	0.02	0.19
	B	0.71±0.71	0.71				
6 months	A	0.65±0.65	0.65	-1.03	-0.14	0.04	0.31
	B	0.70±0.70	0.70				

Table 4: Intergroup comparison of gingival index scores of study participants.

Gingival index score	Group	Mean±SD	t-value	95% confidence interval		p-value
				Lower bound	Upper bound	
Baseline	A	0.85±0.06	-0.12	-0.05	0.05	0.90
	B	0.85±0.07				
1 month	A	0.73±0.06	-0.14	-0.06	0.05	0.88
	B	0.73±0.08				
3 months	A	0.66±0.10	-1.13	-0.12	0.03	0.26
	B	0.70±0.10				
6 months	A	0.64±0.12	-1.07	-0.14	0.04	0.29
	B	0.69±0.13				

DISCUSSION

The main goal of periodontal therapy is to eradicate supra- and subgingival bacterial accumulations via mechanical debridement, including SRP. The traditional approach does not completely eradicate bacteria and their toxins from periodontal pockets. This has led to the development of alternative or adjunct treatments that provide added benefits along with scaling and root planing.

Studies on individuals suffering from chronic periodontitis have demonstrated that the use of antibiotics as an adjunct to mechanical therapy leads to better treatment outcomes compared to using SRP alone.[10] Antibiotic therapy, despite its positive outcomes, is often linked to negative side effects, such as digestive system and genitourinary tract issues and antibiotic resistance development, prompting extensive research on alternative adjunctive methods for treating periodontitis.

Lasers are used in traditional SRP due to their ability to generate tissue ablation, strong bactericidal detoxifying effects, and reach deeper areas. A diode laser with a wavelength between 655 and 980 nm accelerates wound healing by promoting collagen production, angiogenesis, and growth factor augmentation.[11]

Relatively few studies have compared the effectiveness of diode laser and systemic antibiotics, despite a large body of research demonstrating their respective efficacy. Therefore, this study aims to evaluate the clinical effect of diode laser compared to systemic antibiotics in the treatment of chronic periodontitis.

The measurement of PD and CAL forms the basis for diagnosing periodontitis. The GI and PI were assessed to evaluate the gingival condition and oral hygiene status of the patients and to motivate the patients at each recall interval. The current study evaluated these clinical parameters at follow-up periods of one, three, and six months, aligning with the periodontal tissue healing duration.

The results of the present study demonstrated statistically significant improvements for both treatment groups, Group A (diode laser application) and Group B (systemic amoxicillin and metronidazole administration) when intragroup comparisons of probing depth and clinical attachment level were done at baseline, one month, three months, and six months.

Full-mouth scaling and root planing were performed to disrupt plaque biofilm, enhancing adjunct effectiveness against subgingival pathogens. Laser therapy was avoided during initial sessions due to the increased risk of heat injury from blood in the gingival sulcus. Following the research conducted by Zare et al.(2014)[12] we implemented diode laser therapy during the final session of the first phase of periodontal therapy in this study.

Laser therapy was performed using a 980nm diode laser to target subgingival bacteria until the sulcular and junctional epithelium was restored, typically taking 2-7 days.[13] Laser reinforcement was limited to three cycles to avoid unintentional damage to healing connective tissue fibres.

Group B patients were given adjunctive systemic antibiotics like Amoxicillin and Metronidazole post-scaling and root planing, as these antibiotics are more effective against planktonic species than those in biofilms.[14] The plasma half-life of amoxicillin and metronidazole ranges from 6-8 hours. This study implemented a regimen of systemic Amoxicillin 500 mg and Metronidazole 400 mg, both administered three times daily, following this principle. A weeklong course of systemic administration of Metronidazole combined with Amoxicillin, as the sole therapy for patients with moderate to advanced adult periodontitis, was successfully demonstrated by Lopez et al. (2000)[15]. This treatment effectively halted the progression of periodontal disease. Thus, this corresponds with the present research.

The benefits of laser periodontal treatment in this study are consistent with the findings of Moritz et al. (1998),[16] which showed quicker healing and a reduction in periodontal probing depth. In the study by Cobb et al. (2010),[17] an average of the means was calculated. When comparing the laser treatment groups with the control, the laser groups showed a reduction in PD but a nearly equivalent gain in CAL, which is in accordance with this study. The mean periodontal probing depth at the one month, three month, and sixth month was found to be higher in Group A as compared to that of Group B. This could be due to the bactericidal, curettage, and bio-stimulatory effects of diode lasers.[18] In a study by Toshi et al. (2023),[19] it was concluded that diode laser treatment causes an immediate reduction in bacterial load in individuals with chronic periodontitis..

Moeintaghavi et al. (2007),[20] studied the impact of metronidazole and amoxicillin on periodontal therapy in patients with chronic periodontitis. The results showed significant changes in PD, CAL, and PI, as well as a reduction in pathogens in the treatment group. The current study suggests that the probing depth may have been reduced through decreased inflammation, formation of a long junctional epithelium, and collagen reorganization.[21]

Teughels et al. (2020),[22] discovered that systemic antimicrobials led to increased side effects even though they significantly improved clinical outcomes in periodontitis therapy. Hence, the study suggests that the efficacy of the recommended treatment may have been increased by using subgingival biofilm samples for a microbiological and antibiotic sensitivity test.

The study used plaque index and gingival index as clinical outcome variables. Both groups had significant plaque and gingival index reductions at different intervals. However, no significant differences were found between groups, suggesting that oral hygiene efforts are primarily responsible for plaque reduction.

The study demonstrated that both adjunctive therapies significantly improved clinical parameters from baseline to six months; however, no statistically significant differences were observed in the intergroup comparison. Adjunctive therapies, such as antimicrobial laser therapy and systemic antibiotics, serve to augment the effects of scaling and root planing, thereby reinforcing the role of non-surgical management in the treatment of most periodontal patients.

The limitations of this study could be it being a single centre study with small sample size.

CONCLUSIONS

The study found that both Group A (Diode Laser Application) and Group B (Systemic Amoxicillin and Metronidazole Administration) showed significant improvements in periodontal clinical parameters compared to baseline. However, the study found no significant differences in periodontal probing depth and clinical attachment level. Hence, further research in this area with a larger sample size and a microbiological analysis may be necessary to conclude the evaluation of diode laser compared to systemic antibiotics in the treatment of chronic periodontitis.

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Conflict of interest: None.

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