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Original Research Article

"Analysis between 980 NM Diode Laser and Conventional Endodontic Treatment in the Management of Post-Operative Pain and Antibacterial Effect on Chronic Periapical Lesions."

Rohit Grover[1], Shivanjali Grover[2]

[1]Professor & Head Dentistry, Hind Institute of Medical Sciences, Mau, Sitapur, Lucknow

[2]Professor and Head, Dept. of Public Health Dentistry, Chandra Dental College, Lucknow

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Corresponding Author: Dr Shivanjali Grover
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Abstract

Introduction: Pain is after accompanied in a range of 3 to 5 on the VAS which night increases upto 12%, 24 to 48 hours later. Sodium hypochlorite (NaOCl) is a potent endodontic irrigation but has limited reach in the canal variations. Researchers advise combining NaOCl with EDTA to disinfect. Laser therapy, particularly diode lasers at 810–980 nm, may improve dentinal tubule sealer penetration, disinfection, and pain.

Aims and Objectives: This study compares a 980 nm diode laser to traditional endodontic therapy for post-operative discomfort and periapical lesion antibacterial efficacy.

Method: In this superiority-based 1:1 randomised controlled experiment from September 2022 to August 2023, diode laser (DL) and traditional endodontic therapy were tested for postoperative pain and microbiological parameters Based on probable follow-up losses, the sample size were increased from 90 to 99 consenting participants. Standard oral cavity antisepsis, rubber dams, and rigorous treatment methods, including microbiological sampling, were used here.

Result: The study showed that the Diode Laser and Control groups have similar age and gender distributions. The Diode Laser group reported higher "No Pain" incidence at various time intervals than the Control group. The Diode Laser group's mean aerobic and anaerobic bacterial counts were significantly lower throughout the trial. The Diode Laser group exhibited consistently lower mean bacterial counts compared to the Control group for aerobic and anaerobic bacteria ($p < 0.001$). Diode laser treatment effectively reduced bacterial populations. All Diode Laser patients reported no pain post-treatment, whereas the Control group experienced varying degrees of discomfort. Statistical analysis confirmed superior pain reduction efficacy of diode laser treatment over conventional methods.

Conclusion: This study concluded that a 980 nm diode laser can sterilise root canals and minimise postoperative discomfort in necrotic teeth with periapical lesions.

Keywords: "Sodium hypochlorite (NaOCl)", "photodynamic treatment (PDT)", Diode laser.

Introduction

Pain following endodontic treatment is a concern after root canal therapy (RCT), and discomforting Pain following surgery (PP) is not unusual. To aid in patient comfort, post-of pain should be minimized [1]. Pain following endodontic can be due to a variety of reasons such as intracanal medication delivery, overzealous mechanical, preparation chemical, extrusion of or irrigation [2] or medicament

Due to its strong antibacterial properties and capacity to degrade organic debris sodium, hypochlorite is used most commonly in practice. debris. Nevertheless, NaOCl can sometimes less to inadequate disinfection in locations that are hard to reach, owing to its restricted penetrating capabilities brought on by insufficient irrigation dynamics [3,4]. Demineralizing drugs are therefore suggested to be employed as supplements to endodontic therapy. By enabling NaOCl to pass through the dentinal tubules, opening them may improve the disinfection of the canal more easily, according to an earlier study. For the smear layer to be removed, researchers have recommended combining the usage of sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) [5].

Teeth with an iatrogenically damaged or physiologically broad apical foramen are at a higher risk of having irrigants extrude from them. PP and occasionally tissue necrosis may result from irrigation fluids that discharge into periapical tissues and have high cell toxicity. However, prior research

indicates that microbes are the most typical cause of PP [6]. A prior study also hypothesised that the root canal system's morphological complexity (such as its many dimensions), which prevents irrigation solutions from penetrating beyond the primary passageway, may be a factor in the limitation of microbial clearance. Canal debridement is compromised by these variations [7,8].

Leaders have the capacity to vaporize soft tissue and penetrate throughout the dentinal thickness and have a bactericidal impact. It has also been studied to stimulate bone development in the periapical region, and the findings are encouraging [9]. Laser irradiation's effects on biological tissues are contingent upon several factors, such as wavelength, pulse setting, fibre diameter, contact duration, energy radiation, and physical properties of the tissue [10].

A diode laser that fits the size and form of the root canal that emits laser light. Diode lasers with a wavelength range of 810–980 nm have been discovered in laboratory experiments to have an antibacterial impact on common bacterial strains linked to endodontic illness [11]. Additionally, this wavelength might lessen postoperative discomfort, eliminate the smear layer, and therefore enhance sealer penetration within dentinal tubules wherein irrigating solutions are not reachable [12].

Following "photodynamic treatment (PDT)", clinical data have shown bacterial decrease using diode lasers operating in the 635-808 nm wavelength range. Unfortunately, using Low-power & low-wavelength irradiation methods needs the use of a membrane-targeting dye photosensitizer to determine the target cells before exposing them to a light source [13,14].

Method

Research Design

This parallel randomised controlled trial was conducted from September 2022 to August 2023 in our hospital. The study compared postoperative pain and microbiological parameters after diode laser (DL) and conventional endodontic therapy. 90 informed consenting volunteers were initially enrolled in the study. The sample size was estimated with a two-tailed α level of 0.05 and a power of 0.80 to assure statistical power. To identify the difference between groups, 90 patients were needed assuming a 0.37 mm absolute difference in periapical lesions and a 0.46 standard deviation. To accommodate for follow-up losses, the sample size was raised by 10% to 99 participants. The study used chlorhexidine gluconate mouthwash to standardise oral cavity antisepsis before treatment. The teeth were isolated using rubber dams and access cavities were made. Irrigated with sodium hypochlorite, EDTA, and saline, ProTaper Universal Ni-Ti files were used to prepare root canals. Microbial samples were taken pre, during and post treatment to count bacteria. Participants were randomly assigned to the Diode Laser group and Control groups. Diode Laser group root canals were irradiated with a 980 nm diode laser, whereas the Endo group underwent traditional endodontics. To evaluate postoperative pain and microbiological outcomes impartially, assessors and statisticians were blinded. The study's primary end measure was pain assessment using the Numeric Rating Scale (NRS), which labels pain as No pain, Mild, Moderate, or Severe. The secondary outcome was microbiological analysis, including bacterial counts at various treatment stages. Blinding and randomization reduced study bias.

Inclusion and Exclusion Criteria

Inclusion

- Patients aged 18-35.
- Patients without major medical issues that could affect the study.
- Necrotic pulp in maxillary central incisor permanent teeth.
- Apex of maxillary central incisors should be closed.
- A sinus tract may be present or absent.
- Radiographs revealed periapical radiolucency.

Exclusion

- Patient illiteracy may make research instructions and informed consent harder.
- For pregnant women.
- Systemic diseases that could affect research outcomes or participation.
- Patients who took analgesics 12 hours before care.

Statistical Analysis

The statistical analysis was conducted using SPSS 23.0 software (SPSS, Chicago, IL, USA). The statistical analysis involved the use of an unpaired t-test to assess the significance of the difference between the two groups, based on parametric data about patients' age and bacterial colony development. The chi-square test was employed to compare the qualitative pain levels. The level of significance was established at a significance level of $P<0.05$.

Result

Table 1 shows the age distribution of Diode laser and Control group participants. The Diode laser group averages 25.28 years, while the Control group averages 26.25 years. The Diode laser group had

5.09 SD and the Control group 5.51, indicating similar age variability. Both groups have minimum and maximum ages of 20–40. The t-test value of 1.31 and p-value of 0.1967 indicate that the two groups are similar in age. The Diode laser group contains 25 men and 30 women, whereas the Control group has 15 men and 20 women. The chi-squared (X2) test value of 3.699 with a p-value of 0.061 shows no gender-based difference between the two groups, however, the Diode laser group has a slightly larger number of females.

Table 1: Age and Gender of Participants

Age (years)	**Diode laser group**	**Control group**
Mean	25.28	26.25
SD	5.09	5.51
Min	20	20
Max	40	40
t-test	1.31	
P-value	0.1967	
Gender		
Male	25	15
Female	30	20
X2	3.699	
P-value	0.061	

Figure 1 shows a column chart of Diode Laser group and Control groups patients' qualitative pain scores with time. Each bar reflects the percentage of patients in each group who reported "No Pain" or "Moderate Pain" at the respective time intervals. Most Diode Laser patients reported "No Pain" at all times, with the proportion of "Moderate Pain" patients decreasing over time. In the ENDO group, many patients experienced "Moderate Pain" at 12 and 48 hours, which decreased and increased to "No Pain" by 7 days. This graphic shows that diode laser treatment reduces pain better than conventional endodontic treatments, with more patients having pain-free periods over time.

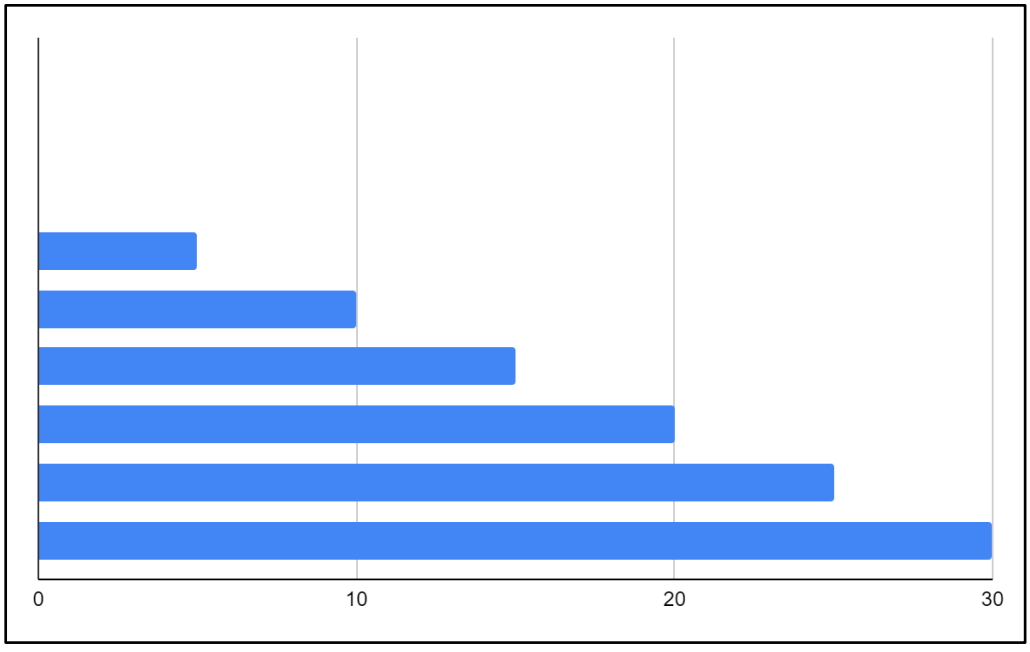

Figure 1: Column chart showing the qualitative score of pain in patients enrolled in both groups

Table 2 shows a line chart of the bacterial count in aerobic and anaerobic settings for the Diode Laser and Control groups for samples 1 to 5. For Sample 1, the Diode Laser group had 105 aerobic microorganisms while the Control group had none, showing a significant difference. From S2 to S5, the Diode Laser group had a much lower aerobic bacterial population than the Control group had fewer bacteria. At different stages, the Diode Laser group had lower anaerobic bacterial counts than the Control group. In endodontic therapy, diode laser treatment may reduce aerobic bacteria, which are oxygen-dependent.

Table 2: The line chart presented illustrates the bacterial count, specifically differentiating between aerobic and anaerobic conditions.

	Aerobic bacteria		Anaerobic bacteria	
	Diode Laser group	Diode Laser group	Diode Laser group	Diode Laser group
Sample 1	105	0	100	75
Sample 2	10	0.08	0.08	0.05
Sample 3	0	0	0	0
Sample 4	0.2	0.25	0.1	0.3
Sample 5	0	0	0	0

Table 3 compares Diode Laser and Control pain intensity over time. All subjects in both groups reported no pre-operative pain. However, the treatment caused considerable changes. Even 48 hours and 7 days after treatment, 100% of Diode Laser patients reported no pain. After 7 days, 65.93% of the Control group reported no discomfort, but more had mild, moderate, and severe pain. At all periods, the Chi-squared (X^2) test showed that diode laser treatment reduced postoperative pain more than conventional treatment.

Table 3: Mean and SD values of pain intensity of different periods within each group.

	Pain		Pre-operative	6 hrs	12hrs	24hrs	48hrs	7 days	X^2	P-value
Diode laser group	No pain	n	45	18	23	25	45	45	33.25	<0.001
		%	100	40	51.11	55.55	100	100		
	Mild	n	0	5	1	1	0	0		
		%	0	11.11	2.22	2.22				
	Mod	n	0	3	0	1	0	0		
		%	0	6.66		2.22				
	Severe	n	0	0	0	2	0	0		
		%			7.2					
Control group	No pain	n	45	6	3	7	15	24	65.93	<0.001
		%	100	13.33	6.66	15.55	33.33	53.33		
	Mild	n	0	6	9	6	3	3		
		%	0	13.33	20	13.33	6.66	6.66		
	Mod	n	0	5	6	13	7	2		
		%	0	11.11	13.33	28.88	15.55	4.44		
	Severe	n	0	11	8	0	0	0		
		%	0	24.44	17.77					
X^2 test	X2		3.744							
P-value			1	<0.001	<0.001	<0.001	<0.002	<0.044		

Table 4 shows the mean and SD values of aerobic and anaerobic bacterial counts (CFU/ml × 10^4) in the Diode Laser and Control groups for different samples (Sample 1-5). For aerobic bacteria, the Diode Laser group regularly had lower mean bacterial counts than the Control group, with p-values below 0.001. For anaerobic bacteria, the Diode Laser group has considerably lower mean bacterial counts at all phases than the Control group (p-values below 0.001). Diode laser treatment reduced aerobic and anaerobic bacterial populations during the research. Statistics are indicated by the letters 'a', 'b', 'c', and 'd', with lowercase letters showing group differences and uppercase letters indicating stage differences

within the same group. The study compares two groups: the Diode laser group and the Control group. In the Diode laser group, the mean bacterial counts for S1, S2, S4, and S5 were 105.21, 15.00, 12.678, and 0.00 respectively, with standard deviations of 35.05, 4.39, 9.81, and 0.00. In contrast, the Control group had lower mean counts for S1, S2, S4, and S5 at 59.50, 8.31, 39.25, and 5.31 respectively, with standard deviations of 18.77, 2.81, 37.39, and 1.03. The P-values indicate the statistical significance of the differences observed. The results show statistically significant differences between the two groups across all variables for both aerobic and anaerobic bacteria, with p-values less than 0.001. This suggests that the Diode laser group generally had higher bacterial counts compared to the Control group for both aerobic and anaerobic bacteria, indicating a potential effect of the Diode laser treatment on bacterial populations.

Table 4: Mean and standard deviation values of the bacterial count (CFU/ml ×10^4) of anaerobic bacteria of different groups.

Variables	Aerobic bacteria						Variables	Anaerobic bacteria					
	Diode laser group		Control group		P-value			Diode laser group		Control group		P-value	
	Mean	SD	Mean	SD				Mean	SD	Mean	SD		
S1	105.21aA	35.05	59.50aB	18.77	0.012*	<0.001*	S1	97.81aA	31.37	69.49aB	15.21	0.047*	<0.001*
S2	15.00cA	4.39	8.31cB	2.81	0.006*		S2	18.810cA	6.79	7.41cB	2.29	0.016*	
S3	0.276dC	0.08					S3	0.041dC	0.009				
S4	12.678bB	9.81	39.25bA	37.39	0.01*		S4	8.81bB	7.428	36.597bA	10.71	0.002*	
S5	0.00dB	0	5.31dA	1.03	0.002*		S5	0.00dB	0	3.59dA	1.09	0.012*	
P-value	< 0.001*		< 0.001*				P-value	< 0.001*		< 0.001*			

Discussion

Clinicians face several difficulties, particularly when working with necrotic teeth that have persistent periapical lesions. Following standard endodontic treatment, postoperative discomfort may caused, and complete eradication of the germs is almost impossible, even with newly developed procedures [15,16]. Diode laser use in the field of endodontics has become more widespread in recent years. Thus, the study's goal was to investigate the diode laser's (DL) potential for reducing postoperative discomfort and achieving root canal sterility. The qualitative pain assessments revealed that throughout the course of the study, Statistically speaking, the DL group's pain rates were lower than those of the Endo group points, except preoperatively, when A statistically significant change was not seen [17]. There was a statistically significant decrease in the total number of microbes in the S3 samples (subsequent laser treatment) as well as S4 samples (bacterial colonization) for the DL group, both anaerobic and aerobic, as compared to the Endo group. For necrotic individuals who have chronic periapical lesions, the wavelength of the 980 nm laser diode may be a helpful addition to traditional endodontic operations regarding postoperative pain and root canal cleanliness [18,19].

This research sought to assess a diode laser's impact operating at 980 nm on the level of acute discomfort following surgery (PP) after receiving root canal treatment (RCT) following chemomechanical preparation for root canal therapy [20]. Compared to the group that received laser treatment, the untreated group's average level of discomfort was much higher treatment group 24 hours following the first visit. The control group's average pain level was considerably greater between 24 and 48 hours following the follow-up. The concentrations for Neither in the case of the control group did PP 24 hours following the first visit surpass those after the second visit. Analgesic usage in the comparison group after the first visit was substantially greater following 8 hours (40%) & 24 hours (23%), in contrast to the group that received laser therapy [21].

Even with a successful chemomechanical preparation, residual infection might still cause postoperative discomfort. In nonvital teeth with symptomatic apical periodontitis, this research compared postoperative discomfort after chemomechanical preparation against placebo as well as laser irradiation [22]. At all periods, the laser group's pain ratings were significantly lower than those of the placebo group. The assessments for percussion pain before and after surgery differed significantly as well. Groups 1 and 2 each included 9 and 3 participants who needed rescue medicine, respectively. Following chemomechanical

preparation, laser irradiation significantly reduced postoperative discomfort and may be seen as an important adjuvant [23].

Put eradication pain must be taken into account for the well-being of the patient. There have been many risk factors identified that may contribute to its emergence. Several writers [24] previously discussed the antibacterial impact of laser-assisted disinfection. The relationship between laser disinfection as well as its impact on the post of pain was only briefly discussed in research. The purpose of the review is to clarify how different intracanal laser cleaning techniques relate to post of pain effects. Concerning PEP reduction, diode lasers demonstrated the most promising outcomes, although Er: YAG had greater short-term effectiveness (6 hours after surgery). The various research designs made it impossible to analyse the variables uniformly. To develop a particular strategy for the best results, more RCTs comparing various laser disinfection procedures with the same baseline endodontic disease are required [25].

Our goal was to evaluate two distinct low-level laser application techniques using diode lasers, such as low-level laser therapy (LLLT) and laser-activated irrigation (LAI), which are used to treat post of pain since treatment one of the primary goals of endodontics. The three groups' median pain levels differed statistically significantly after 24 hours, with the ML group scoring the greatest, followed by the LLLT group and LAI. Upon comparing the three groups after 48 hours, between them, a difference of statistical significance was observed, with the ML group recording the greatest median pain levels and the LLLT and LAI recording statistically insignificant results. There wasn't Between the three groups, there was no statistically significant change after 72 hours. When it comes to managing acute postoperative pain after 24 hours, LLLT outperforms the LAI & ML group, whereas After 48 hours, the effectiveness of LAI and LLLT was almost identical, although nevertheless distinguished themselves from the ML group in a substantial way [26].

Conclusion

This study found that intracanal diode laser irradiation on necrotic teeth with periapical lesions reduces postoperative discomfort after conventional root canal treatment. Using proper wavelengths and standard cleaning and shaping techniques can sterilise root canals, dentin, and periapical regions, reducing bacterial recolonization. This study suggests that the 980 nm diode laser could improve the outcome of endodontic therapy. No comparison of single or two-visit intracanal diode laser therapy for postoperative pain and bacterial count in necrotic teeth with chronic periapical lesions limits the study. In order to determine the processes by which the intracanal Diode laser alleviates postoperative pain, additional in vivo and immunological research must be conducted.

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