RESEARCH PAPER

Effect of 0.2% Chitosan and 970 nm Diode Laser Disinfection on Postoperative Pain Following Single-Visit Endodontic Therapy: A Randomized Clinical Trial

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Abstract

Objectives: To clinically assess and compare the effect of 0.2% chitosan irrigation and 970-nm diode laser–assisted disinfection on postoperative pain following single-visit endodontic therapy in mandibular premolars.

Materials and Methods: One hundred patients requiring single-visit endodontic treatment of permanent mandibular premolars were enrolled based on predefined inclusion and exclusion criteria. All procedures were performed by a single clinician. Patients were randomly allocated into three groups (n = 30). Following access preparation and cleaning and shaping with ProTaper Universal rotary instruments up to F3, final disinfection protocols were as follows: Group 1—3% sodium hypochlorite and 17% EDTA; Group 2—3% sodium hypochlorite and 0.2% chitosan; Group 3—3% sodium hypochlorite and 17% EDTA followed by 970 nm diode laser irradiation using a 200-µm fiber in four 10-second cycles. Canals were obturated using a single-cone technique with AH Plus sealer. Postoperative pain was assessed at 6, 24, 48, and 72 hours using a Visual Analogue Scale. Data were analysed using Kruskal–Wallis, Mann–Whitney U, Friedman's ANOVA, and Wilcoxon matched-pairs tests

Results: At 6 hours, the diode laser group demonstrated significantly lower pain scores (mean = 2.1) compared to the sodium hypochlorite plus EDTA group (mean = 2.8) and the chitosan group (mean = 2.9) ($p = 0.014$). At 24 hours, pain scores remained significantly lower in the diode laser group compared to Group 1 ($p = 0.034$). By 48 and 72 hours, pain levels declined significantly in all groups with no intergroup differences. The highest overall pain reduction from 6 to 72 hours was observed in the diode laser group (95.24%).

Conclusions: All protocols effectively reduced postoperative pain; diode laser–assisted disinfection provided faster and greater pain reduction, particularly within the first 24 hours.

Clinical Relevance: Adjunctive diode laser disinfection may improve patient comfort following single-visit endodontic therapy.

Keywords- Diode laser; Laser-assisted root canal disinfection; Chitosan irrigation; Postoperative pain; Single-visit endodontics

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INTRODUCTION

Post operative pain remains a key concern in endodontic therapy, particularly when performed as a single-visit procedure.[1] While advancements in endodontic techniques and materials have improved outcomes, many patients still report discomfort in the immediate hours and days following treatment. [2] Various factors influence post-operative pain, including microbial persistence, apical extrusion of debris and also the disinfection protocols used. Effective pain management not only enhances patient satisfaction but also contributes to better overall clinical success. [3]

Traditionally, NaOCl has been considered the gold standard among irrigants due to its potent antimicrobial and tissue dissolution properties. [4] However, its inability to effectively remove inorganic components of the smear layer, coupled with cytotoxicity concerns, necessitates the use of adjunctive chelating agents like EDTA. [5] Despite the effectiveness of EDTA in smear layer removal, it lacks sufficient antimicrobial action and can contribute to dentin demineralization, compromising structural integrity. [6]

In search of safer and more effective alternatives, natural biopolymers such as Chitosan have gained interest.

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Chitosan is a biodegradable and biocompatible polysaccharide, derived from Chitin. It has antimicrobial, chelating, and anti-inflammatory properties. [7] Studies have shown that 0.2% Chitosan provides comparable smear layer removal efficacy similar to EDTA while posing fewer risks to dentin and periapical tissues. [8] Its mechanism of action involves disrupting bacterial membranes and chelating essential ions, which impairs bacterial metabolism and supports healing. [9]

Technological advancements have introduced laser-assisted disinfection into endodontics. The 970 nm Diode laser penetrates deep into the dentinal tubules, delivering photothermal energy capable of disrupting bacterial biofilms and reducing inflammatory mediators. [10] It also promotes coagulation and aids in sealing dentinal tubules, further preventing reinfection. The synergistic effects of deep disinfection and reduced inflammation make it a promising adjunct in root canal therapy. [11]

This study was therefore designed to assess and compare the effects of conventional irrigation of 0.2% Chitosan, and 970 nm Diode laser disinfection on POP following SVE. The primary objective was to determine which method provided superior patient comfort in the critical postoperative period.

MATERIALS AND METHODOLOGY

The present study was conducted as a randomized clinical trial at the Department of Conservative Dentistry and Endodontics, KLE VK Institute of Dental Sciences, KAHER, Belagavi.

A total of 90 patients diagnosed with asymptomatic irreversible pulpitis in mandibular premolars were enrolled. Inclusion criteria were strictly defined to include patients aged between 18 and 65 years with no history of antibiotic or analgesic use within the past 3 months. Teeth with complex anatomical variations or periapical pathology were excluded. Patients were randomly allocated into three groups using a computer-generated table of random numbers. A single clinician performed all treatments to eliminate inter-operator variability.

After rubber dam isolation and access cavity preparation, working length was established using an electronic apex locator and confirmed radiographically. Cleaning and shaping were carried out using the ProTaper Universal rotary system up to F3. Disinfection protocols differed across the three groups. Group 1 received 5 ml of 3% NaOCl followed by 5 ml of 17% EDTA for 3 min. Group 2 received 5 ml of 3% NaOCl followed by 5 ml of 0.2% Chitosan solution for 2 min. Group 3 received the same irrigation as Group 1, but this was followed by using a 970 nm diode laser irradiation with a 200-µm fiber tip.

Laser disinfection was done in four cycles of 10 seconds each, with a 10-second interval between cycles. The fiber tip was inserted 1-2 mm short of the apex and moved in a helical manner to cover the canal walls. After drying with paper points, all canals were obturated using the single cone technique with AH Plus sealer and gutta-percha. Patients were educated on the VAS and instructed to record their pain levels at 6, 24, 48, and 72 hours. Ibuprofen 600 mg was provided as a rescue medication only if severe pain occurred.

Statistical analysis was performed using appropriate tests based on the distribution of data. Pain scores were compared using ANOVA, followed by post-hoc analysis. Significance was set at $p<0.05$.

RESULTS

A total of 90 patients were included in the study and were equally distributed into three groups (n = 30 per group): Group 1 (NaOCl + EDTA), Group 2 (Chitosan), and Group 3 (Diode laser). Post-operative pain was assessed using the Visual Analogue Scale (VAS) at 6, 24, 48, and 72 hours following single-visit endodontic therapy.

Comparison of post-operative pain among groups

At 6 hours post-treatment, a statistically significant difference in pain scores was observed among the three groups (Kruskal–Wallis test, $H = 8.5171$, $p = 0.0141$). Group 3 (Diode laser) demonstrated the lowest mean pain score (2.1 ± 1.1), followed by Group 1 (2.8 ± 1.1) and Group 2 (2.9 ± 1.3).

At 24 hours, although pain scores decreased in all groups, the intergroup difference was not statistically significant ($H = 4.9705$, $p = 0.0833$). Similarly, no statistically significant differences were observed among the groups at 48 hours ($H = 4.1635$, $p = 0.1247$) and 72 hours ($H = 4.8206$, $p = 0.0898$), despite Group 3 consistently demonstrating the lowest mean pain scores at all time points (Table 4, Figure 1).

Pairwise intergroup comparisons

Pairwise comparisons using the Mann–Whitney U test revealed that at 6 hours, Group 3 showed significantly lower pain scores compared to Group 1 ($p = 0.0170$) and Group 2 ($p = 0.0150$). No statistically significant difference was observed between Group 1 and Group 2 at this time point ($p = 0.9764$).

At 24 hours, a significant difference was observed only between Group 1 and Group 3 ($p = 0.0339$), with Group 3 reporting lower pain scores. No significant differences were noted between Group 2 and Group 3 ($p = 0.2170$) or between Group 1 and Group 2 ($p = 0.4464$). At 48 and 72 hours, none of the pairwise comparisons demonstrated statistically significant differences ($p > 0.05$ for all comparisons) (Table 5).

Intragroup comparison over time

Within-group analysis using Friedman's ANOVA demonstrated a statistically significant reduction in post-operative pain over time in all three groups ($p < 0.0001$). In Group 1, mean pain scores decreased from 2.8 at 6 hours to 0.6 at 72 hours, corresponding to a total pain reduction of 78.57%. Group 2 showed a reduction from 2.9 to 0.3, representing an 89.66% decrease. Group 3

exhibited the greatest reduction, with mean pain scores decreasing from 2.1 at 6 hours to 0.1 at 72 hours, corresponding to a 95.24% reduction in pain. Wilcoxon matched-pairs tests confirmed statistically significant reductions at all subsequent time points compared to baseline within each group ($p < 0.05$) (Table 6, Figure 2).

Gender distribution

The gender distribution among the three groups was comparable. Group 1 comprised 43.33% males and 56.67% females, Group 2 included 40.00% males and 60.00% females, and Group 3 consisted of 46.67% males and 53.33% females. Chi-square analysis revealed no statistically significant difference in gender distribution among the groups ($\chi^2 = 0.2710$, $p = 0.8730$), indicating that gender was not a confounding factor (Table 7, Figure 3).

Age distribution

The mean age of participants was 34.60 ± 9.65 years in Group 1, 37.17 ± 11.89 years in Group 2, and 37.27 ± 14.21 years in Group 3. One-way ANOVA revealed no statistically significant difference in mean age among the groups ($F = 0.4713$, $p = 0.6258$), confirming homogeneity of age distribution across the study population (Table 8, Figure 4).

Group 1						
Name	**Sex**	**Age**	**6 hrs**	**24 hrs**	**48 hrs**	**72 hrs**
A1	F	19	0	1	0	5
A2	M	36	2	4	4	4
A3	F	39	4	2	0	0
A4	M	43	3	2	2	0
A5	F	37	4	1	0	0
A6	M	35	3	2	2	0
A7	M	51	2	2	0	0
A8	F	27	2	0	0	0
A9	M	34	4	2	0	0
A10	F	53	1	0	0	0
A11	F	25	4	2	4	2
A12	M	48	4	3	1	0
A13	M	36	4	2	1	0
A14	F	28	3	2	2	0
A15	F	31	4	2	0	0
A16	F	51	3	1	0	2
A17	M	24	2	0	1	0
A18	F	31	3	1	0	1
A19	M	28	2	3	1	0
A20	M	27	3	1	0	0
A21	F	32	2	2	0	0
A22	F	30	4	3	2	1
A23	F	24	3	2	0	0
A24	F	28	2	3	1	1
A25	M	53	2	2	1	0
A26	F	26	5	3	2	1
A27	M	34	3	2	2	0
A28	F	49	2	2	0	0
A29	F	24	2	1	0	0
A30	F	28	1	0	0	0

Postoperative pain was assessed in all three groups at intervals of 6 hours, 24 hours, 48 hours, and 72 hours using the Visual Analogue Scale (VAS) to evaluate pain intensity following single-visit endodontic therapy.

Group 2	

Name	Sex	Age	6 hrs	24 hrs	48 hrs	72 hrs
B1	F	45	2	1	0	0
B2	M	53	3	2	0	0
B3	F	38	6	0	0	2
B4	F	46	3	1	0	0
B5	M	55	3	3	1	0
B6	F	34	4	3	3	0
B7	M	42	2	0	0	0
B8	F	36	0	0	0	0
B9	M	27	6	3	2	0
B10	M	26	2	2	1	0
B11	M	33	1	1	0	0
B12	F	45	3	0	0	0
B13	F	16	3	2	0	0
B14	F	37	2	0	0	0
B15	M	34	4	2	1	0
B16	F	47	3	2	1	1
B17	M	21	5	3	2	0
B18	F	34	2	0	0	1
B19	F	38	3	2	0	0
B20	F	56	2	2	0	0
B21	F	43	3	2	1	1
B22	M	37	4	2	0	0
B23	M	28	2	0	0	0
B24	F	32	2	2	1	1
B25	M	18	3	2	0	0
B26	F	24	2	3	2	1
B27	F	24	3	2	0	0
B28	F	29	4	2	0	0
B29	F	34	3	2	0	1
B30	M	44	3	1	0	0

Group 3						
Name	Sex	Age	6 hrs	24 hrs	48 hrs	72 hrs
C1	M	43	0	0	0	0
C2	F	32	3	1	1	0
C3	F	47	2	0	0	0
C4	M	38	3	0	0	0
C5	F	55	0	0	0	0
C6	F	45	2	2	1	0
C7	F	40	4	2	0	0
C8	F	47	2	2	0	0
C9	M	16	3	2	1	0
C10	F	15	4	2	0	1
C11	F	37	2	1	1	0
C12	M	22	2	3	2	0
C13	M	24	0	0	0	0

C14	F	65	2	0	0	0
C15	M	27	2	1	1	0
C16	F	37	1	1	0	0
C17	M	17	4	2	0	0
C18	F	28	2	1	1	0
C19	F	40	3	1	0	0
C20	M	64	2	2	0	1
C21	M	50	1	0	0	0
C22	F	44	2	3	1	0
C23	M	40	3	2	0	0
C24	M	16	2	1	0	0
C25	M	53	3	1	0	0
C26	M	21	2	3	0	0
C27	M	40	1	2	0	0
C28	F	29	0	0	0	0
C29	F	58	3	2	0	0
C30	F	28	2	0	0	0

Table 4: Comparison of Group 1, Group 2 and Group 3 with pain scores at different treatment time points by Kruskal Wallis ANOVA

Time points	Group 1				Group 2				Group 3				H-value	p-value
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Mean	SD	Median	IQR		
6 hrs	2.8	1.1	3.0	2.0	2.9	1.3	3.0	1.0	2.1	1.1	2.0	1.0	8.5171	0.0141*
24 hrs	1.8	0.9	2.0	1.0	1.6	1.0	2.0	1.0	1.2	1.0	1.0	2.0	4.9705	0.0833
48 hrs	0.9	1.2	0.0	2.0	0.5	0.8	0.0	1.0	0.3	0.5	0.0	1.0	4.1635	0.1247
72 hrs	0.6	1.2	0.0	1.0	0.3	0.5	0.0	0.0	0.1	0.3	0.0	0.0	4.8206	0.0898

*p<0.05

Pairwise Comparisons (Mann-Whitney U Test)

The diode laser group exhibited significantly lower post-operative pain (mean = 2.1) compared to the NaOCl + EDTA group (mean = 2.8) and the Chitosan group (mean = 2.9). At the 6-hour mark, a statistically significant difference in pain levels was observed among the groups (p = 0.0141), with the diode laser showing the most rapid pain relief. By 24 hours, pain levels had decreased across all groups, though the differences were not statistically significant (p = 0.0833). Pain reduction continued at 48 and 72 hours, with the diode laser group consistently reporting the lowest scores.

Table 5: Pair wise comparison of Group 1, Group 2 and Group 3 with pain scores at different treatment time points by Mann-Whitney U test

Time points	Groups	Mean	SD	Median	Mean rank	Mean rank	Z-value	p-value
6 hrs	Group 1	2.8	1.1	3.0	30.4			
	Group 2	2.9	1.3	3.0	30.6	447.5	-0.0296	0.9764
	Group 1	2.8	1.1	3.0	35.9			
	Group 3	2.1	1.1	2.0	25.1	288.0	2.3877	0.0170*
	Group 2	2.9	1.3	3.0	36.0			
	Group 3	2.1	1.1	2.0	25.0	285.0	2.4320	0.0150*
24 hrs	Group 1	1.8	0.9	2.0	32.2			

	Group 2	1.6	1.0	2.0	28.8	398.0	0.7614	0.4464
	Group 1	1.8	0.9	2.0	35.3			
	Group 3	1.2	1.0	1.0	25.7	306.0	2.1216	0.0339*
	Group 2	1.6	1.0	2.0	33.3			
	Group 3	1.2	1.0	1.0	27.7	366.0	1.2345	0.2170
48 hrs	Group 1	0.9	1.2	0.0	32.9			
	Group 2	0.5	0.8	0.0	28.1	377.0	1.0719	0.2838
	Group 1	0.9	1.2	0.0	34.4			
	Group 3	0.3	0.5	0.0	26.6	334.0	1.7076	0.0877
	Group 2	0.5	0.8	0.0	31.9			
	Group 3	0.3	0.5	0.0	29.1	408.5	0.6062	0.5444
72 hrs	Group 1	0.6	1.2	0.0	31.4			
	Group 2	0.3	0.5	0.0	29.6	424.0	0.3770	0.7062
	Group 1	0.6	1.2	0.0	33.6			
	Group 3	0.1	0.3	0.0	27.4	356.0	1.3823	0.1669
	Group 2	0.3	0.5	0.0	33.0			
	Group 3	0.1	0.3	0.0	28.0	374.0	1.1162	0.2643

*p<0.05

The results demonstrated a significant reduction in post-operative pain among the diode laser group compared to the other two groups, particularly at the 6-hour mark. This early pain reduction is critical as it influences patient comfort and reduces the need for post-treatment analgesics. The statistical analysis indicated that the diode laser group (mean pain score = 2.1) had significantly lower pain levels compared to the NaOCl + EDTA group (mean = 2.8) and the Chitosan group (mean = 2.9) ($p = 0.0141$). Pairwise comparisons further confirmed that the diode laser group had significantly lower pain than the NaOCl + EDTA group ($p = 0.0170$) and the Chitosan group ($p = 0.0150$) at 6 hours. At 24 hours, while pain levels continued to decrease in all groups, statistical significance was observed only between the diode laser and NaOCl + EDTA groups ($p = 0.0339$), with the laser group maintaining the lowest pain levels (mean = 1.2). However, no significant differences were found between Chitosan and NaOCl + EDTA at any time point. By 48 and 72 hours, pain had reduced significantly in all groups, and the differences were not statistically significant, though the diode laser group continued to show the lowest pain scores.

Figure 1: Comparison of Group 1, Group 2 and Group 3 with pain scores at different treatment time points

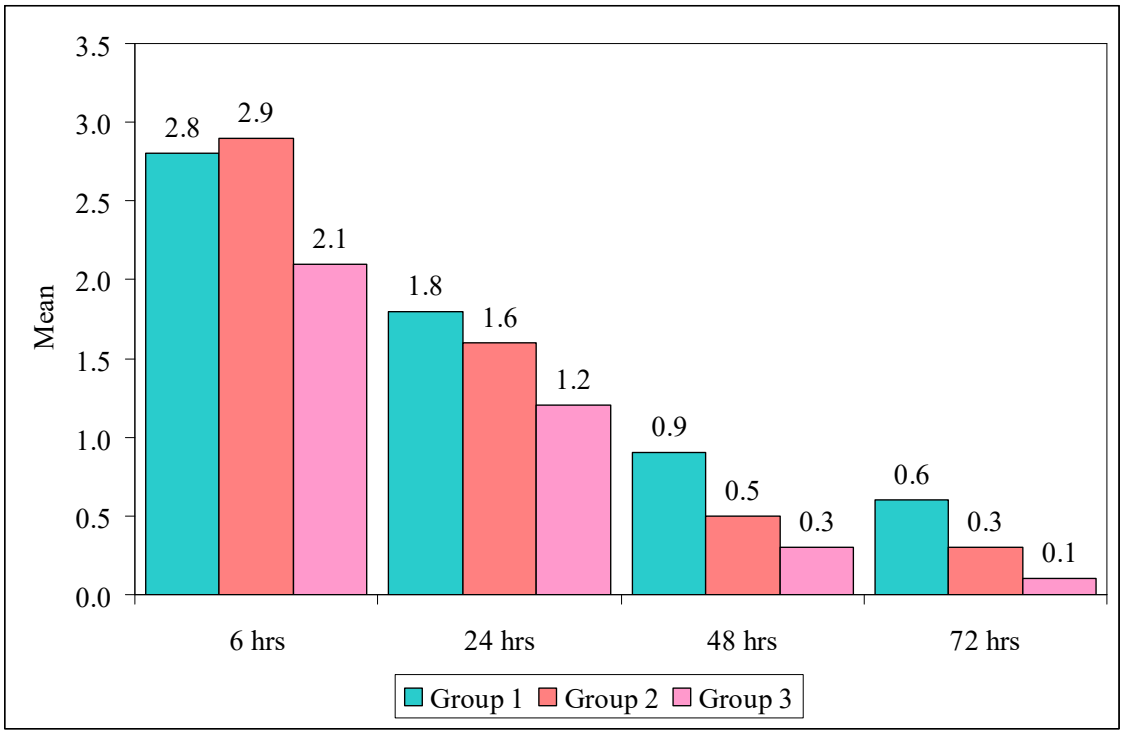

Table 6: Comparison of different treatment time points with pain scores in Group 1, Group 2 and Group 3 by Friedman's ANOVA followed by Wilcoxon matched pairs test

Group	Time points	Mean	SD	Median	% of change (6hrs to)	Z-value	p-value	Friedman test	p-value
Group 1	6 hrs	2.8	1.1	3.0	-	-	-		
	24 hrs	1.8	0.9	2.0	35.71	3.4037	0.0007*	54.7671	0.0001*
	48 hrs	0.9	1.2	0.0	67.86	4.3266	0.0001*		
	72 hrs	0.6	1.2	0.0	78.57	3.9800	0.0001*		
Group 2	6 hrs	2.9	1.3	3.0	-	-	-		
	24 hrs	1.6	1.0	2.0	44.83	4.1143	0.0001*	70.284	0.0001*
	48 hrs	0.5	0.8	0.0	82.76	4.6226	0.0001*		
	72 hrs	0.3	0.5	0.0	89.66	4.7030	0.0001*		
Group 3	6 hrs	2.1	1.1	2.0	-	-	-		
	24 hrs	1.2	1.0	1.0	42.86	3.2628	0.0011	60.722	0.0001*
	48 hrs	0.3	0.5	0.0	85.71	4.3724	0.0001*		
	72 hrs	0.1	0.3	0.0	95.24	4.4573	0.0001*		

***p<0.05**

This Table compares the percentage of reduction of pain at various time intervals among the 3 groups

The statistical analysis revealed a significant reduction in pain over time within each group ($p < 0.0001$). Among the three groups, the diode laser group (Group 3) exhibited the highest percentage of pain reduction (95.24%) from 6 to 72 hours, followed by the Chitosan group (Group 2) with an 89.66% reduction, and the NaOCl + EDTA group (Group 1) with a 78.57% reduction. These findings indicate that while all three disinfection methods effectively reduced post-operative pain, diode laser disinfection resulted in the most substantial pain relief over time.

Figure 2: Comparison of different treatment time points with pain scores in Group 1, Group 2 and Group 3

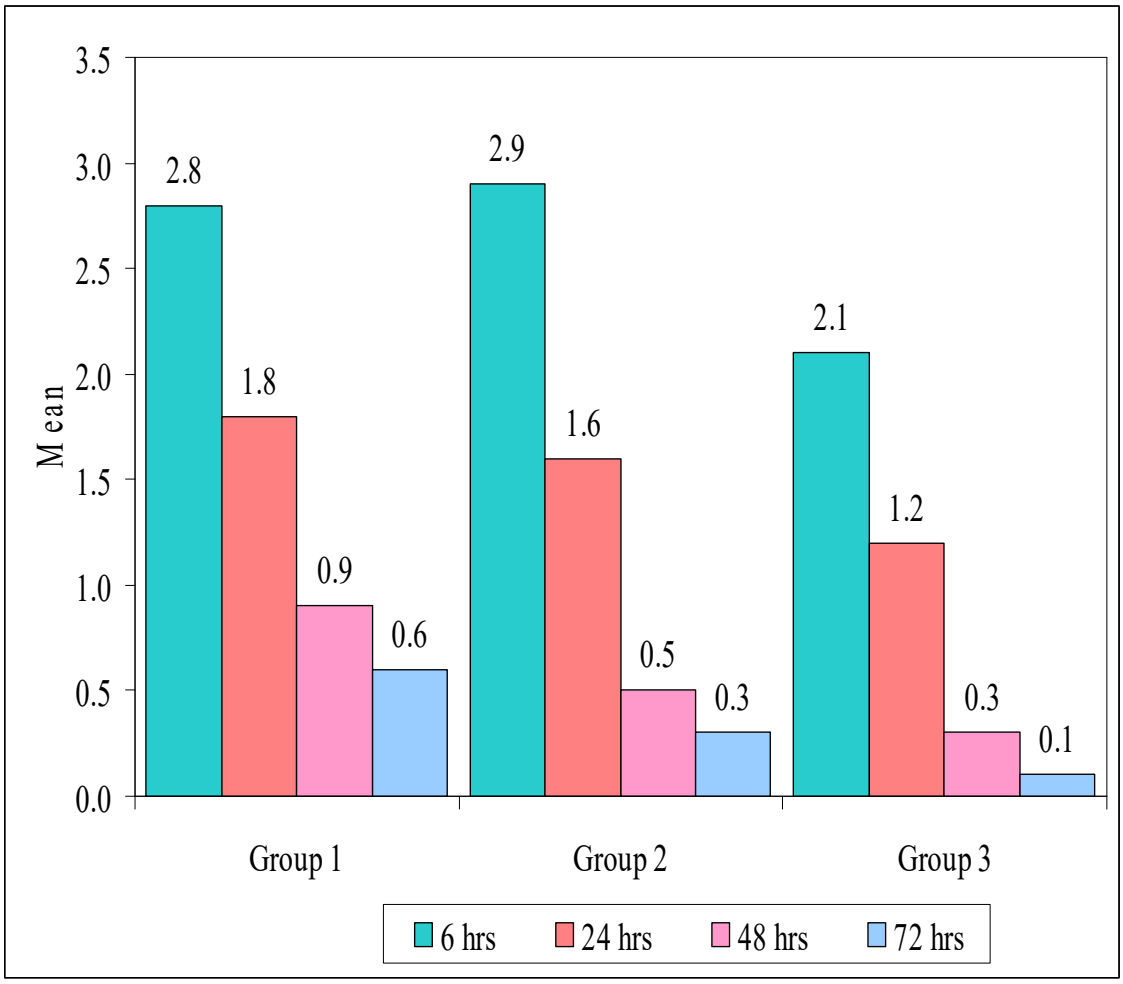

Table 7: Comparison of Group 1, Group 2 and Group 3 with gender

Group	Male	%	Female	%	Total
Group 1	13	43.33	17	56.67	30
Group 2	12	40.00	18	60.00	30
Group 3	14	46.67	16	53.33	30
Total	39	43.33	51	56.67	90
Chi-square=0.2710, p=0.8730					

Gender Distribution (Chi-Square Test)

The gender distribution across the three groups was similar, with Group 1 (NaOCl + EDTA) consisting of 43.33% males and 56.67% females, Group 2 (Chitosan) comprising 40.00% males and 60.00% females, and Group 3 (Diode Laser) including 46.67% males and 53.33% females. The chi-square test yielded a value of 0.2710 with a p-value of 0.8730, indicating no statistically significant difference in gender distribution between the groups ($p > 0.05$). This confirms that gender was not a confounding factor in post-operative pain outcomes, ensuring the validity of the comparative analysis

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Figure 3: Comparison of Group 1, Group 2 and Group 3 with gender

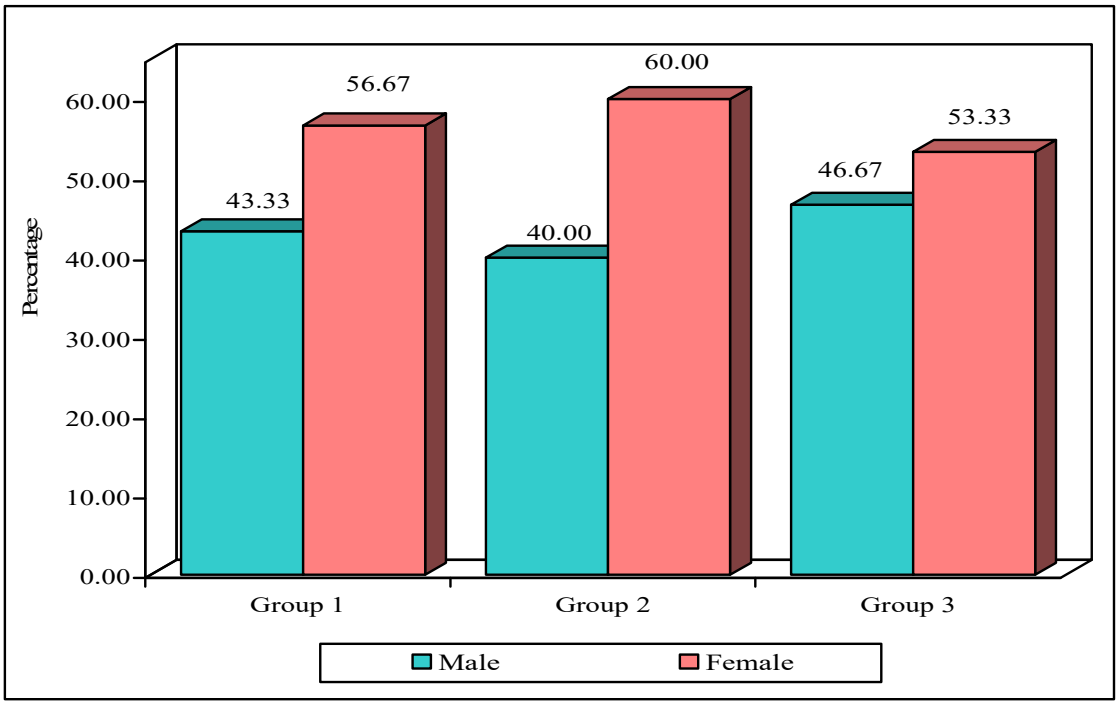
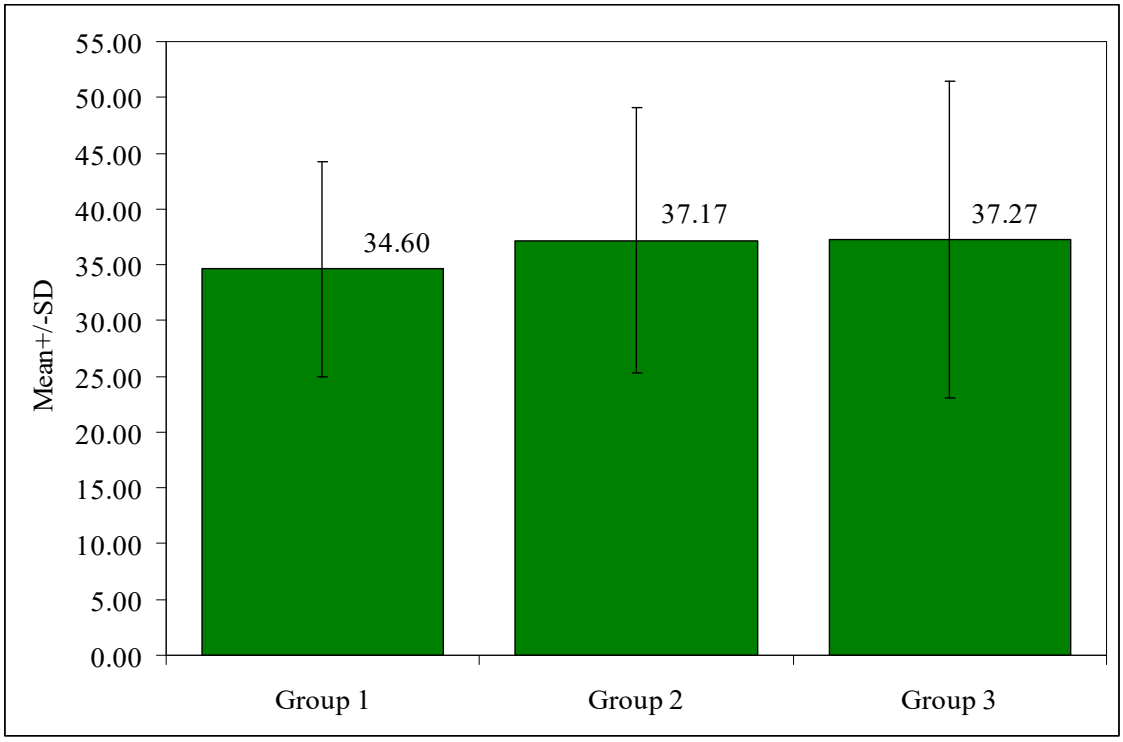


Table 8: Comparison of Group 1, Group 2 and Group 3 with mean age by one way ANOVA

Group	Mean	Std. Dev.	Std. Err.
Group 1	34.60	9.65	1.76
Group 2	37.17	11.89	2.17
Group 3	37.27	14.21	2.59
Total	36.34	11.99	1.26
F-value	0.4713		
p-value	0.6258		

The mean age of participants across the three groups was comparable, with Group 1 (NaOCl + EDTA) having a mean age of 34.60 ± 9.65 years, Group 2 (Chitosan) at 37.17 ± 11.89 years, and Group 3 (Diode Laser) at 37.27 ± 14.21 years. Statistical analysis using a one-way ANOVA revealed an F-value of 0.4713 and a p-value of 0.6258, indicating no statistically significant difference in age distribution among the groups ($p > 0.05$). This confirms that age was not a confounding factor in the comparison of post-operative pain scores.

Figure 4: Comparison of Group 1, Group 2 and Group 3 with mean age



DISCUSSION

The findings from this study highlight significant differences in the effectiveness of the three disinfection protocols in reducing post-operative pain, with Diode laser disinfection proving to be the most effective. [12] The remarkable efficacy of Diode laser in the early postoperative period is largely attributed to its ability to reach deep into the dentinal tubules and eradicate bacteria through photothermal effects. [13] This deep penetration is not achievable with conventional irrigants, which are limited by the anatomy of the root canal system and the inherent fluid dynamics of syringe-based irrigation. [14] Laser irradiation not only eliminates residual microorganisms more effectively but also disrupts endotoxins and reduces inflammatory cytokine expression. [15] These effects collectively contribute to lower levels of inflammation, improved healing, and reduced pain perception in the immediate hours following the procedure. [16]

In addition to its antimicrobial capabilities, the Diode laser's ability to promote coagulation and seal dentinal tubules helps in preventing further microbial infiltration, thereby enhancing long-term treatment outcomes. [17] The photobiomodulation of the laser is another factor that likely contributed to pain reduction. [18] This effect involves the stimulation of cellular metabolism, increased blood flow, and acceleration of tissue repair processes, which together facilitate faster resolution of inflammation and better healing of the periapical tissues. [19]

Chitosan, though not as effective as the Diode laser, showed superior performance compared to the conventional NaOCl + EDTA combination. The antimicrobial action of Chitosan is primarily due to its polycationic nature, which enables it to bind to the negatively charged bacterial cell walls, thereby increasing membrane permeability, leading to leakage of intracellular contents and eventual bacterial death. [20] Its high biocompatibility ensures that even if extruded beyond the apex, it is less likely to cause periapical irritation, unlike EDTA which has demonstrated cytotoxic potential. [21] Furthermore, Chitosan's mild chelating ability allows for effective smear layer removal without compromising the structural integrity of the dentin, thus maintaining the mechanical properties of the tooth and reducing the risk of postoperative sensitivity. [22]

The conventional protocol using NaOCl and EDTA, while still effective in bacterial reduction and smear layer removal, demonstrated the least reduction in POP among the three groups. This can be attributed to EDTA's lack of antimicrobial properties and its potential to cause periapical irritation when extruded. [23] NaOCl, although potent against organic tissue, is limited in its action against the inorganic smear layer and is known for its cytotoxicity. [24] These shortcomings may have contributed to the relatively higher levels of pain observed in this group, particularly within the first 24 hours.

An important observation in this study was that age and gender did not significantly influence POP, which supports the hypothesis that the choice of disinfection protocol is a more critical determinant of postoperative discomfort. This finding is consistent with previous

literature suggesting that biological and procedural factors, rather than demographic characteristics, predominantly dictate pain outcomes. [25]

Overall, the results of this study underscore the clinical advantages of incorporating Diode laser disinfection and Chitosan into endodontic protocols. These methods not only enhance microbial control but also offer additional benefits such as improved biocompatibility, reduced inflammation, and better patient comfort. This is particularly important in single-visit endodontics, where efficient and effective disinfection in a single session is essential for successful outcomes. Future research may focus on combining these modalities or optimizing their application parameters to further enhance their effectiveness.

CONCLUSION

Within the limitations of this study, it can be concluded that Diode laser disinfection significantly reduces postoperative pain following single-visit endodontic therapy when compared to conventional irrigation and Chitosan-based irrigation. Chitosan also offers better pain relief than the NaOCl + EDTA combination, supporting its use as a biocompatible alternative. No significant differences in pain perception were observed based on age or gender. The results highlight the importance of selecting appropriate disinfection methods to enhance patient comfort and treatment outcomes, with Diode laser presenting as a highly effective tool in modern endodontic practice.

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Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

Anjali R. Dhamale: Conceptualization, methodology, data collection, formal analysis, manuscript drafting.
Vidula V. Jain: Study design supervision, critical revision of manuscript, final approval.
Anand C. Patil: Statistical analysis, interpretation of data, manuscript review and editing.
All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no competing interests.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee of KLE VK Institute of Dental Sciences, Belagavi. The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from all participants prior to inclusion in the study.

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