

Comparative Evaluation Of Diode Laser And Two Different Desensitizing Agents, And Their Combined Effect On Dentinal Hypersensitivity In Cuspids And Bicuspid: An In-Vivo Study

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ABSTRACT

Background: Dentinal hypersensitivity is characterized by short, sharp pain arising from exposed dentin in response to external stimuli. Although numerous desensitizing agents and laser-based therapies have been investigated, no single treatment has demonstrated consistently predictable and sustained efficacy. Combination approaches that simultaneously reduce dentinal permeability and modulate pain transmission may provide enhanced clinical benefit.

Aim: To evaluate and compare the efficacy of nanohydroxyapatite, 38% silver diamine fluoride, diode laser, and their combined application in the management of dentinal hypersensitivity affecting cuspids and bicuspid.

Materials and Methods: Seventy-five patients aged 20–50 years with clinically diagnosed dentinal hypersensitivity involving cuspids or bicuspid and associated with cervical abrasion or abfraction were randomly allocated into five groups of 15 patients each. Group A received nanohydroxyapatite, Group B received 38% silver diamine fluoride, Group C received diode laser therapy, Group D received nanohydroxyapatite followed by diode laser, and Group E received silver diamine fluoride followed by diode laser. Hypersensitivity was elicited using a standardized air-blast stimulus and assessed using the Short-Form McGill Pain Questionnaire. Assessments were performed at baseline, immediately after treatment, and on Days 1, 7, and 14. Intragroup and intergroup comparisons were performed using nonparametric statistical analyses.

Results: All five treatment modalities produced statistically significant reductions in dentinal hypersensitivity over the study period ($p < 0.001$). Baseline scores were comparable among the groups ($p = 0.679$). At Day 14, mean hypersensitivity scores were 1.73 ± 0.80 for nanohydroxyapatite, 1.53 ± 0.92 for silver diamine fluoride, 1.07 ± 0.70 for diode laser, 0.40 ± 0.51 for nanohydroxyapatite plus diode laser, and 0.33 ± 0.49 for silver diamine fluoride plus diode laser. The overall intergroup difference was highly significant ($p < 0.001$). Both combination groups demonstrated significantly lower Day-14 scores than either desensitizing agent alone, whereas neither combination differed significantly from diode laser alone.

Conclusion: All evaluated modalities significantly reduced dentinal hypersensitivity. The combination of diode laser with either nanohydroxyapatite or 38% silver diamine fluoride produced the greatest reduction over 14 days, suggesting that laser-assisted desensitization may provide an enhanced clinical effect compared with desensitizing agents used alone. Longer-term randomized clinical trials are required to establish whether this advantage persists beyond the short-term follow-up period.

Keywords: dentinal hypersensitivity; diode laser; nanohydroxyapatite; silver diamine fluoride; desensitizing agents; air-blast stimulus; McGill Pain Questionnaire.

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INTRODUCTION

Dentinal hypersensitivity (DH) is a common clinical condition characterized by a short, sharp pain arising from exposed dentin in response to thermal, tactile, evaporative, osmotic, or chemical stimuli. It generally occurs following loss of the protective enamel, cementum, or gingival covering of dentin, resulting in exposure of dentinal tubules to the oral environment. The condition is particularly frequent in the cervical regions of canines and premolars, where gingival recession, abrasion, erosion and other non-carious tooth surface loss may expose dentin.

The clinical management of DH remains challenging because its etiology is multifactorial and its clinical presentation is influenced by both structural and patient-related factors. Gingival recession, cervical abrasion, erosion, inappropriate toothbrushing, periodontal therapy and occlusal factors may contribute to dentinal exposure. Consequently, treatment is generally directed either toward reducing dentinal permeability and fluid movement or toward modifying neural transmission and pain perception.

The hydrodynamic theory proposed by Brännström remains the most widely accepted explanation for the pain mechanism of DH. According to this theory, external stimuli applied to exposed dentin produce movement of fluid within dentinal tubules, resulting in mechanical stimulation of nerve endings at the pulp–dentin interface. The magnitude and velocity of fluid movement are therefore important determinants of the painful response.

Accordingly, conventional desensitizing agents have predominantly been developed to occlude dentinal tubules or reduce dentinal permeability. Nanohydroxyapatite (nHA) is of particular interest because of its chemical similarity to the mineral phase of dental hard tissues and its potential to deposit within and over exposed dentinal tubules. Clinical evidence has demonstrated that hydroxyapatite-containing formulations can reduce DH following tactile, evaporative and thermal stimulation. A randomized controlled trial evaluating a nanohydroxyapatite dentifrice reported significant reductions in sensitivity following four weeks of treatment. [1]

Silver diamine fluoride (SDF), another chemically active desensitizing material, has attracted increasing attention because of its ability to interact with mineralized dental tissues and produce mineral precipitates. Although SDF has been extensively investigated for caries arrest, its potential to modify exposed dentin and reduce dentinal permeability provides a rationale for its investigation as a desensitizing material.

Laser therapy represents a different therapeutic approach. Depending on the laser system, wavelength, power and irradiation parameters, laser application may influence dentinal permeability, dentinal tubule patency and neural transmission. Previous clinical studies have demonstrated significant reductions in DH following diode laser treatment, although comparative effectiveness between lasers and topical desensitizing agents remains uncertain. A systematic review and meta-analysis published in 2025 found that lasers were superior in the long-term air-blast subgroup but that evidence was insufficient to establish overall superiority of laser therapy over topical desensitizing agents because of substantial heterogeneity and very-low-certainty evidence. [2]

More recent evidence has continued to support the potential role of laser-assisted desensitization while emphasizing the limitations of the existing evidence base. A 2025 umbrella review encompassing 25 systematic reviews concluded that laser therapy, either alone or combined with desensitizing agents, was consistently associated with short-term reductions in DH-related pain, although methodological weaknesses and heterogeneity limited the certainty of conclusions. [3]

Combination therapy is therefore of particular clinical interest. The rationale is that a topical desensitizing material and laser irradiation may act through complementary mechanisms: the desensitizing agent can provide physical or chemical tubule occlusion, while laser irradiation may contribute to neural modulation and/or alteration of dentinal permeability. Previous clinical studies have reported greater reductions in DH when diode laser was combined with fluoride-based desensitizing agents than when either modality was used alone. [4]

Importantly, a clinically relevant in-vivo study by Siddiqui et al. specifically evaluated cuspids and bicuspid and compared nanohydroxyapatite, biosilicate, diode laser and their combinations. All interventions reduced DH, while nanohydroxyapatite combined with laser produced the greatest reduction. [5] This finding is particularly relevant to the present study because the present investigation similarly focuses on hypersensitive cuspids and bicuspid and evaluates the effect of combining nanohydroxyapatite with diode laser. The source document reports this study as one of the closest precedents for the present investigation.

However, evidence is not uniformly supportive of combination therapy. In-vitro and clinical studies have reported that combining a desensitizing agent with laser does not necessarily produce an effect greater than that of the individual modalities. The existing literature

therefore suggests that treatment efficacy may depend on the particular desensitizing material, laser wavelength, power, application protocol, stimulus used for assessment, and duration of follow-up.

This variability provides a rationale for further clinical investigation of different combinations. The present study therefore evaluated and compared the efficacy of diode laser, nanohydroxyapatite, 38% silver diamine fluoride, and their combined application in the management of dentinal hypersensitivity affecting cuspids and bicuspid.

MATERIALS AND METHODS

Study design and setting

This randomized in-vivo clinical study was conducted in the Department of Conservative Dentistry and Endodontics, Regional Dental College, Guwahati, Assam. Institutional ethical clearance was obtained before commencement of the study.

A total of 75 patients with dentinal hypersensitivity involving cuspids or bicuspid were included and randomly allocated into five groups of 15 patients each.

Eligibility criteria

Patients aged 20–50 years with dentinal hypersensitivity involving cuspids or bicuspid were considered eligible. The selected teeth exhibited cervical abrasion or abfraction on the facial surface and demonstrated hypersensitivity to relevant external stimuli. Patients were required to provide consent and comply with follow-up examinations.

Patients with caries, fractures, defective restorations, non-vital teeth, pulpal or periapical pathology, deep caries, large restorations, recent periodontal surgery, orthodontic treatment, or conditions or medications potentially affecting pain perception were excluded. Pregnant and lactating women were also excluded.

Materials

The study used a nanohydroxyapatite desensitizing agent and 38% silver diamine fluoride, together with a diode laser unit and fibre-optic tip. The source document identifies the nanohydroxyapatite agent as being supplied by Group Pharmaceuticals Ltd., Bengaluru, India, and the 38% silver diamine fluoride by Tedequim SRL, Argentina.

Assessment of dentinal hypersensitivity

Before treatment, the selected tooth was isolated using cotton rolls. An air blast was directed onto the exposed dentin from a distance of approximately 1 cm for 10 seconds. The pain response was recorded using the Short-Form McGill Pain Questionnaire. The same stimulus and assessment protocol was used at subsequent evaluations.

Randomization and treatment groups

The participants were randomly allocated to five treatment groups, which were coded during treatment evaluation and statistical analysis to maintain blinding of the evaluation process.

Group	Intervention
A	Nanohydroxyapatite
B	38% silver diamine fluoride
C	Diode laser
D	Nanohydroxyapatite + diode laser
E	38% silver diamine fluoride + diode laser

For Groups A and B, the assigned desensitizing agent was applied to the exposed dentin with an applicator tip and left undisturbed for 15 minutes, after which the patient was instructed to rinse.

For Group C, diode laser irradiation was performed using a power output of 0.2 W, continuous non-contact mode, at a distance of 2–3 mm from the tooth surface, for 120 seconds per site, with two applications to each site.

For Groups D and E, the respective desensitizing agent was applied for 15 minutes followed by diode laser irradiation using the same laser parameters.

Hypersensitivity was reassessed using the same air-blast stimulus on Day 1, Day 7 and Day 14.



FIGURE 1: Assessment of Preoperative sensitivity



Figure 2: Application of Desensitizing agent using applicator tip



Figure 3: LASER application using fibreoptic tip of diode LASER

Statistical analysis

The study data were entered into Microsoft Excel and analyzed using IBM SPSS. The Results section of the source document reports Friedman two-way ANOVA with post-hoc pairwise analysis for intragroup comparisons and the Kruskal–Wallis test with pairwise post-hoc analysis for intergroup comparisons. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics

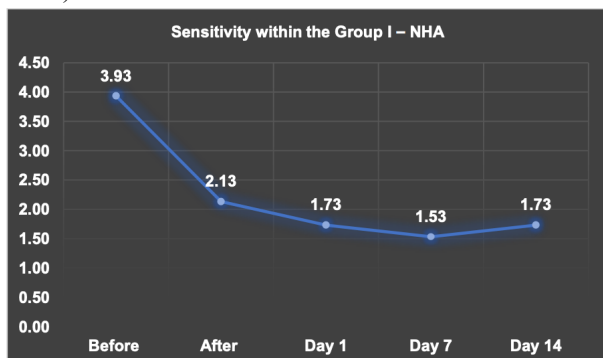
Seventy-five patients were included, with 15 participants in each of the five treatment groups. Baseline hypersensitivity scores were comparable among the groups, with no statistically significant difference ($p = 0.679$). Baseline mean scores ranged from 3.93 ± 1.10 in Group A to 4.33 ± 0.72 in Group D.

Intragroup changes

All five treatment groups demonstrated statistically significant reductions in dentinal hypersensitivity over the observation period.

Group A — Nanohydroxyapatite

The mean hypersensitivity score decreased from 3.93 ± 1.09 at baseline to 2.13 ± 0.91 immediately after treatment, 1.73 ± 0.96 on Day 1, and 1.53 ± 0.83 on Day 7. The Day-14 score was 1.73 ± 0.79 . The overall intragroup difference was statistically significant ($p < 0.001$).



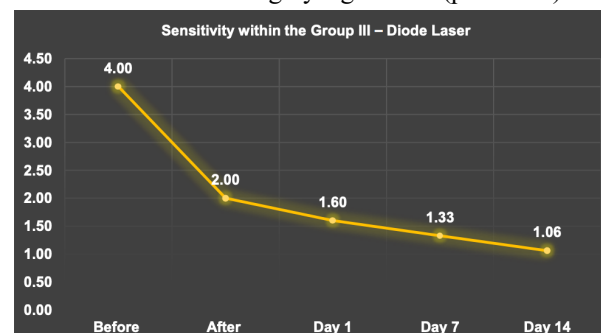
Group B — 38% Silver Diamine Fluoride

The mean score decreased from 3.93 ± 0.88 at baseline to 2.40 ± 0.74 immediately after treatment, followed by 2.00 ± 0.76 on Day 1, 1.60 ± 0.63 on Day 7, and 1.53 ± 0.92 on Day 14. The overall reduction was highly significant ($p < 0.001$).



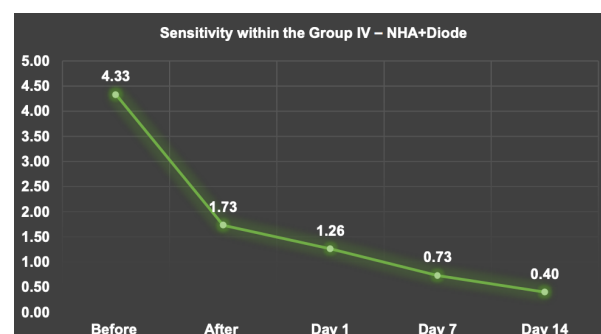
Group C — Diode Laser

The baseline mean score of 4.00 ± 0.85 decreased to 2.00 ± 0.76 immediately after treatment, 1.60 ± 0.63 on Day 1, 1.33 ± 0.82 on Day 7, and 1.07 ± 0.70 on Day 14. The overall reduction was highly significant ($p < 0.001$).



Group D — Nanohydroxyapatite + Diode Laser

The baseline mean score was 4.33 ± 0.72 , decreasing to 1.73 ± 0.59 immediately after treatment, 1.27 ± 0.59 on Day 1, 0.73 ± 0.59 on Day 7 and 0.40 ± 0.51 on Day 14. The overall intragroup reduction was highly significant ($p < 0.001$).



Group E — 38% Silver Diamine Fluoride + Diode Laser

Group E demonstrated the lowest final mean sensitivity score. The baseline score of 3.93 ± 0.80 decreased to 1.60 ± 0.63 immediately after treatment, 1.13 ± 0.64 on

Day 1, 0.87 ± 0.74 on Day 7 and 0.33 ± 0.49 on Day 14. The overall intragroup difference was highly significant ($p < 0.001$).



Intergroup comparison

Immediately after treatment, the mean scores were 2.13 ± 0.91 , 2.40 ± 0.74 , 2.00 ± 0.76 , 1.73 ± 0.59 and 1.60 ± 0.63 for Groups A–E, respectively. The overall difference was significant ($p = 0.029$). However, pairwise analysis demonstrated a significant difference only between Groups B and E ($p = 0.046$).

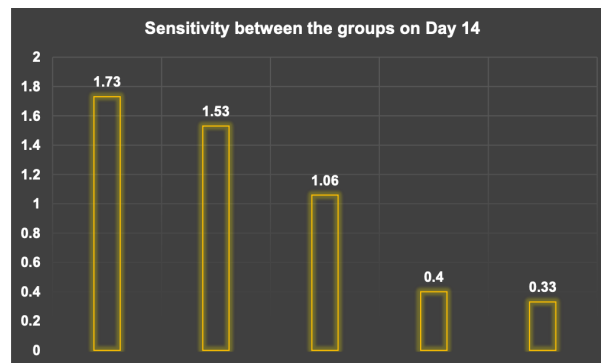
On Day 1, mean scores were 1.73 ± 0.96 , 2.00 ± 0.76 , 1.60 ± 0.63 , 1.27 ± 0.59 and 1.13 ± 0.64 for Groups A–E, respectively. The overall intergroup difference was significant ($p = 0.016$), although the only significant pairwise comparison reported was between Groups B and E ($p = 0.028$).

By Day 7, mean scores were 1.53 ± 0.83 in Group A, 1.60 ± 0.63 in Group B, 1.33 ± 0.82 in Group C, 0.73 ± 0.59 in Group D and 0.87 ± 0.74 in Group E. The overall difference was statistically significant ($p = 0.005$). Groups A and D ($p = 0.043$) and Groups B and D ($p = 0.025$) differed significantly.

At Day 14, the mean scores were:

Group	Treatment	Day-14 mean $\pm$ SD
A	Nanohydroxyapatite	1.73 ± 0.80
B	38% SDF	1.53 ± 0.92
C	Diode laser	1.07 ± 0.70
D	nHA + diode laser	0.40 ± 0.51
E	SDF + diode laser	0.33 ± 0.49

The overall intergroup difference was highly significant ($p < 0.001$). Groups D and E demonstrated significantly lower sensitivity scores than Groups A and B. However, there were no statistically significant differences between C and D, C and E, or D and E.



Thus, the most defensible interpretation of the Day-14 findings is:

nHA + diode laser $\approx$ SDF + diode laser $\approx$ diode laser $>$ nHA and SDF

DISCUSSION

Dentinal hypersensitivity (DH) is a common clinical condition characterized by a short, sharp pain arising from exposed dentin in response to thermal, evaporative, tactile, osmotic, or chemical stimuli. Its multifactorial etiology and the absence of a universally effective treatment modality have resulted in the continued evaluation of both tubule-occluding agents and laser-based approaches for its management. [1–3] The present randomized in vivo clinical study was undertaken to comparatively evaluate the effectiveness of nanohydroxyapatite (nHA), 38% silver diamine fluoride (SDF), diode laser, and their combinations in reducing dentinal hypersensitivity associated with cuspids and bicuspid.

The five treatment groups were comparable at baseline, with no statistically significant difference in hypersensitivity scores ($p=0.679$). This baseline comparability is important because differences in the initial severity of hypersensitivity could influence the magnitude of subsequent pain reduction. The absence of a significant baseline difference therefore provides reasonable support that the changes observed during follow-up were predominantly associated with the respective treatment interventions rather than substantial differences in pretreatment sensitivity between the groups. The present study assessed sensitivity using a standardized evaporative air stimulus and the Short-Form McGill Pain Questionnaire at baseline, immediately after treatment, and on Days 1, 7, and 14. All five treatment groups demonstrated statistically significant reductions in hypersensitivity scores over the observation period ($p<0.001$ for each group), indicating that nHA, SDF, diode laser, and both combination protocols were effective in reducing dentinal hypersensitivity within the 14-day follow-up period. However, the magnitude and temporal pattern of

reduction differed among the treatment groups. Nanohydroxyapatite reduced the mean hypersensitivity score from 3.93 at baseline to 1.73 at Day 14, whereas SDF reduced the score from 3.93 to 1.53. Diode laser produced a greater reduction, from 4.00 at baseline to 1.07 at Day 14. The combination groups demonstrated the lowest mean Day-14 scores, with the nHA + diode laser group decreasing from 4.33 to 0.40 and the SDF + diode laser group from 3.93 to 0.33. These findings indicate a greater numerical reduction with laser-containing protocols compared with the topical desensitizing agents used alone.

The reduction observed with nHA may be attributed primarily to its tubule-occluding and remineralizing properties. Hydroxyapatite-based materials can deposit mineral within and over exposed dentinal tubules, thereby reducing dentinal permeability and limiting dentinal fluid movement. According to the hydrodynamic theory of dentinal hypersensitivity, fluid movement within exposed dentinal tubules can stimulate pulpal mechanoreceptors and produce the characteristic short, sharp pain associated with DH. [2,3] Therefore, reduction of dentinal permeability represents an important therapeutic approach. Previous clinical studies have reported beneficial effects of nHA-containing formulations in reducing dentinal hypersensitivity. Vano et al. demonstrated significant reduction in dentinal hypersensitivity following the use of an nHA-containing toothpaste in a double-blind randomized controlled trial, while Amaechi et al. reported significant improvement following eight weeks of treatment with an nHA-containing toothpaste. [4,5] Polyakova et al. also demonstrated significant reductions in dentinal hypersensitivity with hydroxyapatite-containing formulations. [6] The present findings are therefore consistent with the available clinical evidence supporting nHA as a useful desensitizing agent.

The relatively moderate reduction observed with nHA in the present study may be related to the treatment protocol and duration of observation. Unlike studies evaluating nHA-containing dentifrices over several weeks, the present investigation involved a professionally applied desensitizing agent during a single treatment session, followed by a short 14-day observation period. Consequently, the results should be interpreted specifically in relation to the clinical application protocol used in this study rather than generalized to all nHA formulations or long-term home-use dentifrices. Recent evidence suggests that the effectiveness of desensitizing agents may vary according to formulation, frequency of application, and duration of follow-up. [5,18]

Silver diamine fluoride also produced a statistically significant reduction in dentinal hypersensitivity, with

the mean score decreasing from 3.93 at baseline to 1.53 at Day 14. The desensitizing effect of SDF may be associated with the formation of mineral-rich precipitates and reduction in dentinal permeability, thereby limiting fluid movement through exposed dentinal tubules. The fluoride component can promote mineral deposition, while silver ions can interact with dentinal components and contribute to tubule occlusion. [15] The clinical effectiveness of 38% SDF in reducing dentinal hypersensitivity has been supported by recent evidence. Chan et al. reported significant reductions in hypersensitivity following professionally applied 38% SDF, while a 2024 systematic review concluded that there is clinical evidence supporting the use of SDF for reducing dentine hypersensitivity. [14,15] The present findings are therefore consistent with the emerging evidence supporting SDF as an effective in-office desensitizing agent.

Although both topical agents produced significant reductions in sensitivity, diode laser demonstrated a greater numerical reduction during the observation period. The mean hypersensitivity score in the diode laser group decreased from 4.00 at baseline to 2.00 immediately after treatment, followed by 1.60 on Day 1, 1.33 on Day 7, and 1.07 on Day 14. This progressive reduction suggests that the clinical benefit of laser therapy was maintained and continued to increase during the follow-up period. Earlier clinical studies have reported significant reductions in dentinal hypersensitivity following laser application. Ladalardo et al. demonstrated the effectiveness of laser therapy in reducing dentinal hypersensitivity, while Corona et al. reported beneficial effects of low-level laser therapy in the management of cervical dentinal hypersensitivity. [9,10] Moosavi et al. similarly demonstrated significant reduction in dentinal hypersensitivity following diode laser irradiation. [12]

The findings of the present study are also consistent with recent evidence syntheses evaluating laser therapy. Chen et al., in a 2025 systematic review and meta-analysis, evaluated lasers in comparison with topical desensitizing agents and reported that both approaches can reduce dentinal hypersensitivity, although the magnitude of benefit varies according to treatment modality and clinical outcome. [16] Javed et al., in a 2025 umbrella review incorporating 25 systematic reviews, reported that laser therapy, either alone or combined with desensitizing agents, was consistently associated with short-term reductions in DH-related pain; however, results were less consistent when lasers were compared directly with other desensitizing agents, and methodological limitations were present across the existing evidence base. [17] The present finding that

diode laser produced a greater numerical reduction than nHA or SDF monotherapy is therefore compatible with the broader evidence, while not establishing universal superiority of laser therapy.

The clinical effect of diode laser may be explained by its potential influence on both dentinal and neural components of hypersensitivity. Laser irradiation may reduce dentinal permeability through modification or partial sealing of dentinal tubules and may additionally influence neural transmission and excitability, thereby reducing pain perception. [2,9,11] The progressive reduction observed in the present diode laser group may therefore reflect persistence of these effects beyond the immediate post-treatment period. However, the precise biological mechanism cannot be established from the present clinical study because dentinal tubule morphology, permeability, or pulpal neural activity was not directly evaluated.

An important finding of the present study was the performance of the combination treatment groups. Both nHA + diode laser and SDF + diode laser demonstrated greater numerical reductions in hypersensitivity than their respective monotherapies. The nHA + diode laser group showed a reduction from 4.33 at baseline to 0.40 at Day 14, whereas the SDF + diode laser group decreased from 3.93 to 0.33. At Day 14, the combination groups demonstrated significantly lower hypersensitivity scores than the topical-agent groups. Specifically, the nHA + diode laser group was significantly different from nHA alone ($p < 0.001$) and SDF alone ($p = 0.005$), while the SDF + diode laser group was significantly different from nHA alone ($p < 0.001$) and SDF alone ($p = 0.002$).

The improved performance of the combination groups may be explained by the complementary actions of the two treatment approaches. The topical desensitizing agents primarily act through reduction of dentinal permeability and tubule occlusion, whereas diode laser may additionally influence dentinal structure and neural responsiveness. [2,9,11] Combining these approaches may therefore provide both a reduction in fluid movement through exposed dentinal tubules and an alteration of pain transmission. The present clinical findings are compatible with this interpretation, although the proposed mechanisms were not directly investigated in the study and should consequently be regarded as plausible explanations rather than mechanisms demonstrated experimentally.

Previous investigations have also reported favorable outcomes with combined laser and desensitizing treatments. Suri et al. reported that diode laser combined with 5% sodium fluoride varnish produced a greater desensitizing effect than either treatment alone. [8] More

recently, Jaindesarda et al. compared nano-hydroxyapatite dentifrice, diode laser, and their combination in a randomized clinical trial and reported the greatest and most sustained reduction in dentinal hypersensitivity with the combined treatment. [19] This recent clinical evidence is particularly relevant to the present findings because it evaluates the same general treatment concept of combining nHA with diode laser. However, laboratory and clinical evidence regarding the additional benefit of combination therapy is not uniform. Some studies have reported that combined treatment does not provide a statistically significant advantage over laser alone, indicating that the effect may depend on the type of desensitizing material, laser parameters, application protocol, and follow-up duration. [16,17]

The intergroup findings at different evaluation periods provide further insight into the relative clinical performance of the treatment modalities. Immediately after treatment, a statistically significant difference was observed among the five groups ($p = 0.029$). The lowest mean scores were observed in the combination groups, although pairwise analysis demonstrated a statistically significant difference only between SDF and SDF + diode laser ($p = 0.046$). On Day 1, the overall intergroup difference remained statistically significant ($p = 0.016$), with the significant pairwise difference again involving SDF and SDF + diode laser ($p = 0.028$). By Day 7, the overall difference increased in significance ($p = 0.005$), with statistically significant differences between nHA and nHA + diode laser ($p = 0.043$) and between SDF and nHA + diode laser ($p = 0.025$). At Day 14, a highly significant overall difference was observed among the groups ($p < 0.001$). The combination groups demonstrated the lowest mean hypersensitivity scores, followed by diode laser, while nHA and SDF showed comparatively higher scores.

At Day 14, the numerical pattern was therefore:

Group D $\approx$ Group E $\approx$ Group C > Group B/A

in terms of reduction in hypersensitivity, with lower scores representing better clinical response. Importantly, however, the pairwise comparisons did not demonstrate statistically significant differences between Group C and either combination group, nor between Group D and Group E. Therefore, although the combination groups demonstrated the lowest numerical scores, the present study does not establish that either combination protocol is statistically superior to diode laser alone. Rather, the findings demonstrate that the combination protocols were significantly more effective than the topical-agent monotherapies at the later follow-up. This distinction between numerical and statistical superiority is important when interpreting the clinical relevance of the results.

The finding that the nHA + diode laser group demonstrated a very low Day-14 hypersensitivity score is noteworthy in view of the recent randomized clinical trial by Jaindesarda et al. [19] In that study, the combination of nHA dentifrice and diode laser produced the greatest overall reduction in DH compared with the individual modalities, supporting the potential benefit of combining a mineral-based desensitizing approach with laser therapy. [19] However, differences in study design, laser parameters, nHA formulation, sample size, sensitivity assessment, and follow-up duration must be considered when comparing the two studies. The consistency in the direction of effect nevertheless provides clinical support for further investigation of combined nHA and diode laser therapy.

The findings regarding the combination of SDF and diode laser are also relevant because relatively limited clinical evidence is available regarding this specific combination. The 2024 systematic review of SDF for dentinal hypersensitivity indicated that evidence supporting SDF is increasing, but that clinical studies remain heterogeneous and evidence regarding combinations with other treatment modalities is limited. [15] Thus, the present findings provide additional clinical information regarding the potential role of diode laser as an adjunct to SDF, although the absence of a significant difference between SDF + laser and laser alone indicates that the incremental benefit of adding SDF to laser cannot be established from the present data. The present results should also be interpreted in the context of the heterogeneity of laser therapy protocols reported in the literature. Laser wavelength, power output, irradiation mode, exposure time, number of applications, and contact versus non-contact application can all influence clinical outcomes. [16,17] The present study employed a diode laser at 0.2 W in continuous non-contact mode, with application for 120 seconds per site and two applications to each site. Therefore, the observed results should be interpreted specifically in relation to this treatment protocol rather than extrapolated to diode lasers in general. Recent evidence syntheses have emphasized the need for standardized laser protocols and outcome measures to facilitate meaningful comparison between clinical studies. [16,17] From a clinical perspective, the findings indicate that both conventional desensitizing agents and diode laser therapy can be considered effective approaches for the management of dentinal hypersensitivity. The greater numerical reduction observed with diode laser and the still lower numerical scores in the combination groups suggest potential clinical advantages of laser-containing protocols. Combination therapy may be particularly useful when a clinician wishes to combine the

permeability-reducing effects of a topical desensitizing agent with the effects produced by laser irradiation. Nevertheless, treatment selection should also consider factors such as availability and cost of laser equipment, operator training, treatment time, material characteristics, esthetic considerations, and patient-specific factors.

The present study has several limitations. First, the sample size was relatively small, with 15 participants in each treatment group, which may have limited the ability to detect smaller differences between groups. Second, the follow-up period was limited to 14 days. Consequently, the study cannot establish the long-term durability of the observed desensitizing effects or determine whether sensitivity may recur after the observation period. This is particularly relevant because recent evidence suggests that the effectiveness of desensitizing agents may change over longer follow-up periods. [18] Third, sensitivity was assessed using an evaporative air stimulus and a patient-reported pain assessment. Although these are clinically relevant measures, additional stimuli such as tactile or thermal stimulation could have provided a more comprehensive assessment of treatment response. Fourth, the study did not include an untreated or placebo control group; therefore, the contribution of spontaneous variation in hypersensitivity or nonspecific treatment effects cannot be completely excluded. Fifth, the study did not include scanning electron microscopy, dentinal permeability testing, or other laboratory assessments that could have directly demonstrated changes in dentinal tubule patency. Finally, although the study groups were coded during data collection and analysis, the nature of the clinical interventions makes complete participant and operator blinding difficult.

Despite these limitations, the present study provides clinically relevant comparative information by evaluating nHA, 38% SDF, diode laser, and two combination protocols within the same clinical investigation and using a standardized assessment approach. The statistically significant reduction observed within every treatment group indicates that all five interventions were beneficial in reducing dentinal hypersensitivity during the 14-day observation period. Among the individual modalities, diode laser demonstrated a greater numerical reduction than either nHA or SDF. The combination protocols produced the lowest numerical hypersensitivity scores and were significantly better than the topical desensitizing agents alone at Day 14; however, neither combination demonstrated a statistically significant advantage over diode laser alone. These findings are broadly consistent with contemporary evidence supporting both topical

desensitizing agents and laser therapy as clinically useful approaches to DH management. [4–19]

Overall, the present study suggests that diode laser therapy may provide an effective approach for reducing dentinal hypersensitivity, while its combination with nHA or SDF may provide additional numerical reduction compared with topical treatment alone. However, the absence of a significant difference between the combination groups and diode laser alone indicates that the present results should not be interpreted as demonstrating a definitive additive or synergistic effect. Larger randomized controlled trials with longer follow-up periods, standardized laser parameters, multiple sensitivity stimuli, and objective assessment of dentinal tubule changes are required to determine whether the apparent advantage of combination treatment is sustained and clinically meaningful.

CONCLUSION

Within the limitations of the present study, it can be concluded that diode laser-containing treatment protocols are effective approaches for dentinal hypersensitivity, with combination therapy demonstrating an enhanced clinical response compared with nHA or SDF used alone. The findings are consistent with contemporary literature suggesting that laser-based approaches can provide meaningful desensitization, while also highlighting the continuing uncertainty regarding the superiority of one modality over another. The present study provides clinically relevant evidence for the use of diode laser, particularly in combination with topical desensitizing agents, but larger studies with longer follow-up are required before combination therapy can be considered definitively superior or synergistic.

Clinical significance

In summary, the clinical significance of the present study is that all evaluated modalities can provide meaningful reduction in dentinal hypersensitivity, diode laser demonstrated the best performance among the individual therapies, and combination treatment produced the lowest numerical sensitivity scores and was superior to topical desensitizing agents alone. However, the present evidence does not demonstrate a statistically significant advantage of combination therapy over diode laser alone.

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