ORIGINAL RESEARCH

Comparative Evaluation of the Outcome of Diode Laser 810 nm with 8% Arginine and Calcium Carbonate for the Management of Dentinal Hypersensitivity

Saransh Srivastava[1], Himani Sharma[2], Priyanka Tandon[3], Nikita Jain[4], Henna Singh[5], Sahitya Ambesh[6]

Abstract

Aim: To compare and evaluate the adequacy of diode laser 810 nm, and 8% arginine with calcium carbonate (8% ACC) paste form (Pro-Argin™) for the management of dentinal hypersensitivity (DH).

Materials and methods: Sixty-six patients contributing a total of 264 teeth severe hypersensitivity were randomly divided into three groups: group I: (n = 22) treated with 8% ACC paste form, group II: (n = 22) treated with diode laser 810 nm in contact mode, and group III: (n = 22) 8% ACC paste combination with diode laser 810 nm in contact mode. Tactile stimuli response was measured with visual analog scale (VAS) and air blast stimulation was measured by Schiff cold air sensitivity scale (SCASS) baseline, 15 minutes postapplication, 15 and 30 days post-therapy.

Results: Significant reduction was noted in all groups in relation to VAS and SCASS scores (p-value < 0.001) on 15th day and 30th day. However, intergroup comparison revealed that the use of 8% ACC in combination with diode laser 810 nm in contact showed statistically significant decrease in sensitivity (p < 0.001) when compared to 8% ACC form and diode laser alone.

Conclusion: The adjunctive utilization of diode laser 810 nm with 8% ACC shows a promising treatment alternative in alleviating DH.

Clinical significance: Diode laser showed an immediate effect in combination with 8% ACC in the treatment of DH and the application or advising the same in people with DH will help in relieving their symptoms and will lead to better quality of life on a daily basis.

Keywords: Dentin hypersensitivity, Desensitizing toothpaste, Laser, Pro-arginine.

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Introduction

Dentinal hypersensitivity is a common dental clinical condition occurring in permanent teeth, afflicting approximately 15% of the adult population worldwide.[1] It is described as a sharp, short, shooting pain that arises from exposed dentine in response to stimuli, typically evaporative, chemical, tactile, osmotic, or thermal and which cannot be attributed to any other pathology or dental defect.[2]

The most commonly affected areas are the facial surfaces of premolar and canine.[1] When the open dentinal tubules come in contact with any external stimuli including physical pressure, air movement, hot or cold food items it results in discomfort to the patient which varies from minor inconvenience to a very disturbing condition; including emotional stress and chronic irritation. The major etiological factor resulting in the exposure of dentinal tubules is acid erosion of enamel and cementum due to gingival recession or erosion. Other factors that can result in a sensitive tooth include dental defects and diseases, for example, carious tooth, fractured tooth, or periodontal/gingival disease. Therefore, correct diagnosis is crucial in developing and implementing the treatment plan.[3,4]

Occlusion of dentinal tubules and nerve activity blockage which includes nerve desensitization, plugging dentinal tubules, dentin adhesive sealers, protein precipitation, and the use of lasers are the various modalities that are majorly employed in the management and prevention of DH.[5]

In 1985 Matsumoto et al. reported the first utilization of laser (Nd:YAG laser) for the management of DH.[6] Lasers that are used for the management of DH are divided into: low-output (low-level) power lasers [helium–neon (He–Ne, 6 mW) and gallium/aluminum/arsenide (GaAlAs diode lasers, 30–100 mW)], and middle-output power lasers [(Nd:YAG, CO_2, Er:YAG, GaAlAs and Er, Cr:YSGG) (0.3–10 W)].

While the principle of laser is based upon protein coagulation in the exposed dentinal tubules, the 8% ACC technology works by tubular occlusion approach in which the occlusion of the dentinal tubules leads to the cessation of pulpal fluid flow, leading to reduction in DH.[7,8] It is suggested by various studies that, the combination of laser irradiation with specific desensitizing agents could provide additional therapeutic benefit in the management of DH.

Therefore, the objective of this study was to compare the effectiveness of diode laser 810 nm alone and in combination with 8% ACC in the management of DH.

[1,2]Department of Periodontology, School of Dental Sciences, Sharda University, Greater Noida, Uttar Pradesh, India

[3]Department of Periodontology, ITS Dental College, Greater Noida, Uttar Pradesh, India

[4–6]Private Practitioner

Corresponding Author: Saransh Srivastava, Department of Periodontology, School of Dental Sciences, Sharda University, Greater Noida, Uttar Pradesh, India, Phone: +91 9999409408, e-mail: srnsh92@gmail.com

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Materials and Methods

Study Design

A single-center, double-blinded prospective clinical study was conducted in the Department of Periodontology with 66 subjects (n = 264 teeth) including 36 males and 30 females within the age range of 25–55 years. The randomization was done using envelope method. Subjects were involved in the study based upon the following criteria.

Inclusion Criteria

Systemically healthy subjects with an age of 25–55 years, with at least two hypersensitive anterior teeth demonstrating gingival recession/cervical abrasion less than 1 mm in depth, which did not involve or require any restoration prior to the procedure and no history of desensitizing dentifrice use in last 3 months.

Exclusion Criteria

Patients with advanced periodontal disease or history of periodontal disease treatment, gross oral pathology, chronic disease, or DH teeth with more than grade I mobility and with presented systemic conditions, lactating or pregnant females, subjects who had participated in a desensitizing dentifrice study or any other clinical study or using desensitizing dentifrice in the last 3 months, were not involved in the study.

Tactile Hypersensitivity Measurement Using VAS

By using light manual pressure with sharp dental explorer, tactile hypersensitivity was evaluated at the cementoenamel junction in mesiodistal direction on the selected tooth. According to VAS, the patients were asked to point out a value from 0 (pain absence) to 10 (intolerable pain) that represented their pain level on the basis of patient's subjective answer for the assessment of DH.[9] Patients who reported 8 and above VAS score at the baseline were included.

Sensitivity Assessment by Air Blast Using SCASS

Sensitivity was assessed using air component of dental air/water syringe connected to an air compressor. The air blast (60 ± 5 psi) was directed perpendicularly at the tooth surface from a distance of 3 mm at 20–25°C temperature for 5 seconds. Schiff cold air sensitivity scale with score of 2 or 3 was involved in the study.

Treatment Procedure

Subjects (n = 66 subjects) contributing 264 teeth, were then randomly assigned to one of the three treatment groups, each consisting of 88 teeth. Phase I therapy was completed and oral hygiene instructions were given to every patient prior to the procedure.

Group I: 8% ACC-containing Toothpaste

Selected teeth were isolated with cotton rolls and 8% ACC containing toothpaste [Pro-Argin™ Technology, Colgate Sensitive Pro-Relief® Desensitizing Paste, Colgate-Palmolive (India) Ltd., Mumbai, India] was applied with a cotton pellet onto the intended site and left in place for 1 minute.

Group II: GaAlAs Diode Laser

Selected teeth were treated with GaAlAs diode laser (Picasso+, AMD Lasers, Utah) in continuous mode (810 nm, 1 W). Energy per application was 19 J, laser beam was directed perpendicular to the tooth surface in continuous emission form at three points: two cervical points (one mesiobuccal and one distobuccal) and one apical point for 1 minute and a total of 3 minutes per tooth.

Group III: GaAlAs Diode Laser + 8% ACC-containing Toothpaste

The 8% ACC paste was applied on selected tooth surface for at least 1 minute and then the teeth were irradiated with diode laser in the same way as done in group II.

The assessment of DH scores was done with VAS and SCASS on baseline (prior to application) and postapplication, that is, at 15 minutes, 15th and 30th day. Patients were instructed to refrain from the use of other mouthwashes or desensitizing toothpaste during the trial and advised to continue their normal oral hygiene practices using their usual toothpaste with normal brush twice a day.

Statistical Analysis

Data were summarized as mean ± standard deviation. Groups were compared by one factor repeated measures analysis of variance (ANOVA) and the significance of mean difference between the groups (periods) was done by Tukey's *post hoc* test considering subject as a random effect and time as a fixed effect. Groups were also compared by Student's t-test. A two-tailed p-value <0.05 was considered statistically significant. Analyses were performed on STATISTICA 7.1 software (StatSoft Inc., USA).

Results

Sixty-six subjects (n = 264 teeth) were evaluated in the study. No patient reported any adverse side effects on soft and hard tissues during the course of the study. When baseline mean value

Table 1: Comparison of VAS between groups

VAS dependent variable	*Comparison between groups*		*Mean difference*	*Standard error*	*Significant*	*ANOVA*
Baseline vs immediate (after 15 minutes of application)	Group I	Group II	–0.87	0.060	0.025	F = 12.754 Significant = 0.000
	Group I	Group III	–3.00	0.057	0.000	
	Group II	Group III	–2.20	0.041	0.022	
Baseline vs 15th day	Group I	Group II	–1.02	0.118	0.000	F = 76.625 Significant = 0.000
	Group I	Group III	–3.06	0.112	0.000	
	Group II	Group III	–2.02	0.045	0.032	
Baseline vs 30th day	Group I	Group II	–0.41	0.23	0.000	F = 135.312 Significant = 0.000
	Group I	Group III	–3.05	0.24	0.000	
	Group II	Group III	–2.65	0.73	0.000	

(8.4 ± 0.48) in terms of VAS score (Table 1) was compared with immediate (15 minutes post-treatment) (6.46 ± 0.46), 15th day (4.4 ± 0.56), and 30th day (2.4 ±1.92) postoperative scores, the statistical analysis demonstrated reduction in DH. Similarly, for SCASS score, when the baseline mean value (2.6 ± 0.4.8) was compared with immediate (15 minutes post-treatment) (1.93 ± 0.03), 15th day (1.6 ± 0.32), and 30th day (0.93 ± 0.38) postoperative scores, they demonstrated reduction in DH (Table 2).

Visual Analog Scale Score Analysis

During intergroup comparison, group III mean value (3.44 ± 1.23) and group II mean value (4.26 ± 0.73) reported statistically significant reduction in DH at all time intervals when compared with group I mean value (7.66 ± 0.52). Also, group III demonstrated significantly better results than group II at all time intervals (Fig. 1).

Schiff Cold Air Sensitivity Scale Score Analysis

Fifteen minutes after application, SCASS scores show no statistically significant difference between group II mean value (1.8 ± 0.74) and group III mean value (1.8 ± 0.4) when compared to group I mean value (2.2 ± 0.4) (Fig. 2).

When comparing the efficacy of three regimens, a higher decrease of DH was registered in group III (1.13 ± 0.57), followed by group II (1.2 ± 0.48) and group I (2.13 ± 0.24) over the period of 30 days.

Discussion

The present study was conducted to investigate the efficacy of the combination of diode laser and 8% ACC-containing toothpaste in reducing DH. The results showed a significant reduction of DH when compared to diode laser and 8% ACC alone over a period of 30 days postapplication.

The hydrodynamic theory proposed by Brännström is the most widely accepted theory describing the mechanism of DH. A simple clinical method for diagnosing DH includes the use of exploratory probe on the exposed dentin or evaporative or air blast method examining all the areas of teeth during which the patient complains of hypersensitivity and pain.[9] Visual analog scale and SCASS are the methods for the evaluation of hypersensitivity as they are easily understood by patients and are sensitive in differentiating among the effects of various treatment modalities, therefore, suitable for evaluating the response.[10]

It is observed in various clinical studies that teeth with DH report a significantly greater number of patent dentinal tubules per millimeter and an increased mean diameter per tubule than control teeth suggesting that the patients with wider tubules have increased dentinal fluid movement and thus increased pain response.[11,12]

In intergroup comparison, on the basis of VAS score analysis group III with mean value (3.44 ± 1.23), group II and group III showed better reduction of DH in comparison to baseline mean value (8.4 ± 0.48).

Table 2: Comparison of SCASS score between groups

SCA dependent variable	*Comparison between groups*		*Mean difference*	*Standard error*	*Significant*	*ANOVA*
Baseline vs immediate (after 15 minutes of application)	Group I	Group II	–0.82	0.160	0.000	F = 30.754 Significant = 0.000
	Group I	Group III	–1.086	0.157	0.000	
	Group II	Group III	–0.245	0.141	0.156	
Baseline vs 15th day	Group I	Group II	–1.056	0.118	0.000	F = 68.625 Significant = 0.000
	Group I	Group III	–1.456	0.112	0.000	
	Group II	Group III	–0.364	0.145	0.030	
Baseline vs 30th day	Group I	Group II	–1.226	0.123	0.000	F = 116.312 Significant = 0.000
	Group I	Group III	–1.589	0.124	0.000	
	Group II	Group III	–0.635	0.173	0.000	

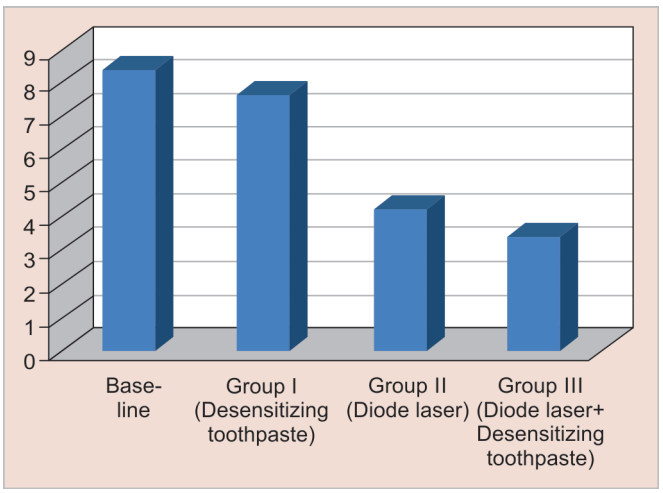

Fig. 1: Visual analog scale interpretation

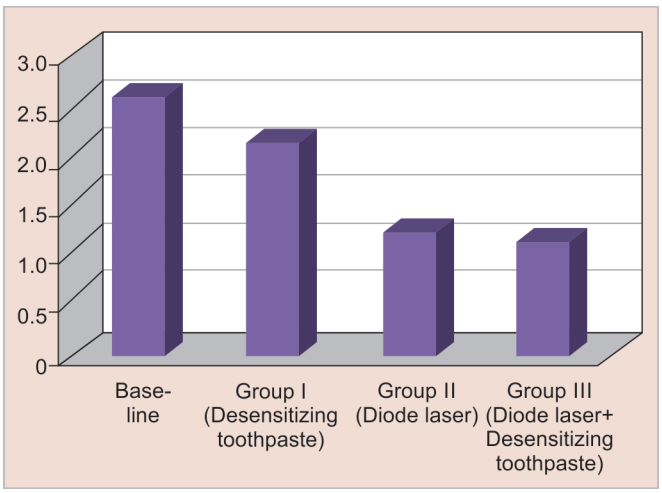

Fig. 2: Schiff cold air sensitivity scale interpretation

Akin to group II (4.26 ± 0.73) and group III indicate better reduction in DH treatment as compared to group I mean value (7.66 ± 0.52).

Similarly, on the basis of SCASS score analysis, group III mean value (1.13 ± 0.57), group II and group I also showed reduction in DH compared to baseline (2.6 ± 0.48) and alike in group II (1.2 ± 0.48) and group III indicate better reduction in DH as compared to group I (2.13 ± 0.24).

Kleinberg suggested that ACC forms a cationic complex which readily binds with the negatively charged dentinal surface along with the dentinal tubules. Also, due to alkalinity of the ACC, saliva and/or dentinal fluid eases the precipitation of phosphate and calcium which forms the plugs to seal the dentinal tubules.[13]

The results of the present study were in accordance with Nathoo et al.[14] and Kapferer et al.,[15] who demonstrated that 8% ACC is successful in relieving DH, thus, suggesting the potency of 8% ACC in the management of DH. In which Nathoo et al.[14] found that relative to the benchmark desensitizing toothpaste (2% potassium nitrate and 1450 ppm fluoride) and the control toothpaste groups (1450 ppm fluoride), the 8.0% arginine toothpaste group exhibited statistically significant ($p < 0.05$) reductions in DH on both tactile and air blast hypersensitivity scores immediately after direct application. Reductions in sensitivity for the 8.0% arginine toothpaste compared to the benchmark desensitizing toothpaste and control toothpaste were 161.2 and 180.2% (tactile), and 59.8 and 58.0% (air blast). Relative to the benchmark desensitizing toothpaste and control toothpaste groups, the 8.0% arginine group exhibited statistically significant ($p < 0.05$) reductions in sensitivity after the subsequent 3 days of twice-daily regular tooth brushing of 147.1 and 181.2% (tactile), and 70.1 and 70.9% (air blast) and Kapferer et al.[15] did the study in which in-office application of 8% ACC showed statistically significant difference in air blast ($p = 0.001$) and tactile ($p = 0.047$) hypersensitivity reduction over time (12 weeks) when compared with control paste (calcium carbonate).

Rezazadeh et al.[16] in their study illustrated the efficiency of diode laser 810 nm in the management of DH and showed its immediate analgesic effect. When laser interacts with dental pulp, it shows photo-biomodulating effect which leads to the obliteration of dentinal tubules with an increased production of tertiary dentine. It also improves the cellular metabolic activity of the odontoblasts and preserves the pulpal vitality. Laser interferes with transmission of nerve signals to the central nervous system, resulting in pain relief due to blockage of the nerve signals. The blockage of dentinal tubules by laser also impedes the internal communication of the pulp with external oral fluids resulting in prolonged state of analgesia in 97% of the cases.[17]

According to George et al.,[18] the efficacy of the lasers (diode laser 810 nm) was found to be increased when it was applied in conjunction with desensitizing toothpaste containing 8% ACC (mean tubule diameter = 0.28 μm) than when it was used alone (mean tubule diameter = 0.51 μm). The results of the present study are in accordance with the aforesaid study.

Both the groups, that is, group II and group III, demonstrated higher score in immediate pain reduction especially at air stimulation when compared to group I. This may be attributed to depressed nerve transmission resulted due to melting of dentinal tubules giving immediate relief.[19]

When the VAS and SCASS scores of the three groups in the present study were compared, a statistically significant reduction in DH was observed in group III (laser + 8% ACC). This group registered the highest reduction, in particular for SCASS scores. Therefore, it can be stated that the combination of laser with desensitizing agent, that is, 8% ACC showed better performance in relieving DH due to the greater occlusion of the dentinal tubules.

Within the limitation of present study, it can be stated that the diode laser 810 nm along with 8% ACC demonstrated statistically significant improvement and immediate relief in acute DH-related pain. The present study had a short-term follow-up as the aim was to determine which agents are able to reduce the patient's acute complaint of DH on a single application. However, studies with larger sample sizes and longer follow-ups should be conducted in order to identify the agents responsible for long-term relief from DH. Moreover, laser being a newer modality of treatment while 8% ACC is readily present in toothpaste, the former warrants future randomized control studies to establish its role in the treatment of DH.

Conclusion

Lasers are an effective modality in treating DH by affecting tubule occlusion.

Desensitizing toothpaste containing 8% ACC has been found to significantly occlude dentinal tubules, but when used in conjunction with a diode laser 810 nm it has been found to be the most effective.

Lasers have been found to be more effective in occluding dentinal tubules when used as a stand-alone modality even more than when the desensitizing toothpaste was used alone.

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