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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF BIOACTIVE GLASS SUBSTANCE CONTAINING-DESENSITIZING DENTIFRICE AND DIODE LASER IN THE MANAGEMENT OF DENTINAL HYPERSENSITIVITY: A RANDOMIZED CONTROLLED, DOUBLE BLIND CLINICAL TRIAL

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ABSTRACT

Dentinal hypersensitivity is a common clinical condition with multifactorial etiology. It is characterized by acute pain due to the exposure of dentin to evaporative, tactile, thermal, chemical, or osmotic stimuli. Severity of dentinal hypersensitivity depends on the interactions among the stimuli and predisposing factors, which include gingival recession, cervical abrasion and periodontal disease. Treatment of dentinal hypersensitivity is aimed at elimination of painful symptoms that can be attained by obliteration of the patent dentinal tubules. Various techniques and materials are available for treatment of dentinal hypersensitivity at home and in office application, which are required to be repeated in order to obtain long term relief and also are time-consuming. Since last decay, lasers and bioactive glass substances have gained popularity in the management of dentinal hypersensitivity. Considering this fact, present study was conducted to evaluate the effects of bioactive glass substance-containing dentifrice (SHY-NM) and diode laser (wavelength 980 nm) on dentinal hypersensitivity when used alone or in combinatins on volunteers suffering from dentinal hypersensitivity using visual analog scale. Based on the observations made in present study, we may conclude that combined application of SHY-NM dentifrice and Diode Laser is highly effective in the management of dentinal hypersensitivity followed by independent application of Diode Laser and SHY-NM dentifrice, with maximum effectivity on day 30 followed by day 7 and 0.

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INTRODUCTION

The term Dentinal hypersensitivity (DH) is used for pain arising from exposed open dentinal tubules, typically in response to various stimuli that cannot be explained from any other forms of dental defects or pathologies (1). The mechanism of DH is explained by a number of mechanisms, namely direct innervations theory (DI), odontoblast receptor theory, and fluid movement/ Brannstrom's hydrodynamic theory. The most widely accepted of these is Brannstrom's hydrodynamics theory, which postulates that on application of a stimulus on dentine, the fluid within the tubules displaced both inward and outward and deforms the nerve endings of pulp-dentine interface and results in pain (2). Incidence of DH ranges from 4 - 74%, may occur at any age, commonly affected age group is 20 - 50 years, females are more prone than males (3,4). Commonly involved teeth are canines and premolars of both arches, commonly affected site is the cervical region of buccal aspects (5). There are a number of predisposing factors that can lead to DH. They are gingival recession, erosion, and abrasion from inefficient brushing, abfraction, parafunctional or occlusal disequilibrium; anatomic predisposition from structural deficiencies in the cementoenamel junction; cavity preparations in vital teeth that expose dentine; or poorly controlled dentinal acid conditioning (6). Various techniques and materials, at home and office applications, have been suggested in the literature for treatment of DH. At home applications include use of desensitizing mouthwashes, dentifrices or tray application foams, anti-inflammatory agents, protein precipitants (formaldehyde, silver nitrate, and strontium chloride), tubule-occluding agents (potassium oxalate, calcium hydroxide, potassium nitrate, and sodium fluoride), while in-office

application includes the varnishes, liners, restorative materials, dentinal adhesive, iontophoresis. However, these methods need repeated applications to obtain long term relief and also are time-consuming (7,8). Commonly used desensitizing dentifrices at home are novamin, vantej, biomim-f, etc,. In the present study, we used SHY-NM dentifrice which contains glycerine, silica, PEG 400, calcium sodium phosphosilicate, cocamido propyl betaine, sodium methyl cocoyl taurate, potassium acesulfame, titanium dioxide and carbomer. Calcium sodium phosphosilicate (CSPS) is an active ingredient of SHY-NM dentifrice. CSPS is a bioactive glass substance, it produces hydroxyapatite-like crystals on the dentinal surface when it comes in contact with saliva and the crystals have a mineral contents comparable to that of bone, enamel, and dentin. These crystals serve as a barrier against oral fluids, thereby halting the progression of DH (9,10).

Various types of lasers are becoming popular in dentistry, such as low-power HeNe lasers (632.5 nm), diode lasers of various wavelengths (810, 940, 980 nm), and medium-power lasers such as Nd: YAG (1064 nm), CO_2 (10600 nm), Er: YAG (2940 nm) and Er, Cr: YSGG (2780 nm). The interaction of the laser with pulp results in a photobiomodulation effect that further increases the metabolism of odontoblasts and produces tertiary dentin. Diode laser at different wavelengths was first used to treat DH in 1985 and observed effective even in high-grade DH. In our study, we used the diode laser at 980 nm, which was first introduced in 2004 as a possible method for treatment of DH. It is a high-energy laser with low acquisition and maintenance costs and more versatile because of its compact size and due to rapid closure of exposed dentinal tubules. It is also observed to be safe to odontoblasts and pulp tissues. Based on the effects of CSPS and laser on the patent dentinal tubules, the present study was conducted to evaluate the efficacy of CSPS containing-desensitizing dentifrice (SHY-NM) and diode laser (980 nm) in the management of DH when used alone or in combinations in volunteers suffering from DH.

MATERIALS AND METHODS

Sixty (60) volunteers of both sexes having minimum of 20 no. of teeth in oral cavity, complaining of DH were enrolled from the out patient Department, Department of Periodontology and Oral Implantology, Kalka Dental College, Meerut, Uttar Pradesh. Selection criteria were as follows:

Inclusion Criteria

- Age group between 18-50 years of both male and female
- Cooperative, motivated and hygiene conscious patients
- Hypersensitive score of ≥5 in visual analog scale due to gingival recession, cervical abrasion, periodontal disease
- Patient availability till the time of completion of trial

Exclusion Criteria

- Patients on desensitizing treatment
- Patients with orthodontic appliances or bridge
- Patients allergic to desensitizing agent
- Pregnant or lactating mothers
- Smokers
- Presence of any local pathology, e.g, cavities, fractures
- Mobile teeth

Entire procedure was explained to the enrolled volunteers in details. The study protocol was carried out in accordance with the Ethical Standard outlines 1964, declaration of Helsinki as revised in 2008 and was approved by the Institutional Ethical Committee and Research Advisory Committee. Prior to carried out the study, Phase I Periodontal therapy was carried out. Then air spray and cold water-induced DH was assessed at room temperature for all selected volunteers using visual analog scale (VAS)

- Air spray stimulation: The air syringe pressure was used at a pressure of 40-65 psi for 3 seconds keeping 3 mm away and perpendicular to the dentinal surface.
- Cold water stimulation: 1 ml of ice cold water was delivered drop by drop on to the facial /buccal cervical region using a syringe.

The selected volunteers were randomly classified in to four groups by coin toss and treatment provided as follows (Figure 1):

Group I: Sites treated with placebo dentifrice for 2 minutes, regarded as Control.

Group II: Sites treated with SHY-NM for 2 minutes.

Group III: Sites treated with Diode laser (980 nm) at 0.5W in non contact mode for 2 minute.

Group IV: Sites treated with SHY-NM for 2 minutes followed by Diode laser (980 nm) at 0.5W in non contact mode for 2 minute.

The prescribed application was done on day 0 in all the groups. Change in DH was recorded immediately after application on day 0, 7 and 30 by marking the degree of discomfort on VAS having scores from 0 to 10 (Figure 2). Score 0 refers no pain, while score 10 refers extreme pain.

Placebo dentifrice was prepared using the following protocol: 1.2 gm of Tragacanth powder is mixed with 10 ml of water and heat it to get a gel (A). Glycerine (20 gm), sodium lauryl sulphate (10 gm), preservative is mixed with 10 ml of water to get a clear solution (B). Mix Saccharin (50 gm) and Calcium carbonate (14 gm) using mortar and pestle. Then add to the gel of Tragacanth (A) which is further add to the mixture (B). Flavouring agent is added and triturate the entire mixture uniformly to get a paste.

All the data has been recorded by a trained clinician who has not been the part of study. Blinded data were unfolded and analysed statistically.

RESULTS

The efficacy of SHY-NM dentifrice and diode laser in the management of DH was measured by evaluating the response of patients to air pressure and cold water on VAS.

Response to air pressure on VAS score: **Group I**: On day 0, the mean VAS score was found to be 5.87 ± 0.74, which was reduced to 5.67 ± 0.62 on day 7 and further reduced to 5.00 ± 0.66 on day 30. The VAS score was reduced by 0.20 ± 0.09 on day 7 compared to that of day 0, which was statistically not significant ($p = 0.31$).

Table 1. Mean VAS score in response to Air pressure at various time points in different groups

Group	Day	Mean VAS score ± SD	Difference in VAS score ± SD			p value		
			Day 0 to 7	Day 0 to 30	Day 7 to 30	Day 0 to 7	Day 0 to 30	Day 7 to 30
I	0	5.87 ± 0.74 (5-7)	0.20 ± 0.09	0.87± 0.17	0.87± 0.17	0.31^{ns}	0.008**	0.03*
	7	5.67 ± 0.62 (5-7)						
	30	5.0 ± 0.66 (4-6)						
II	0	6.67 ± 0.49 (6-7)	0.67 ± 0.14	2.20 ± 0.27	1.53 ± 0.19	0.03*	0.002**	0.006**
	7	0.600 ± 0.66 (5-7)						
	30	4.47 ± 0.64 (4-6)						
III	0	7.93 ± 0.70 (7-9)	2.13 ± 0.29	3.60 ± 0.76	1.37 ± 0.25	0.002**	<0.01**	0.01**
	7	5.80 ± 1.15 (4-8)						
	30	4.33 ± 0.82 (3-5)						
IV	0	8.53 ± 0.64 (7-9)	3.53 ± 0.35	5.87 ± 0.44	2.33 ± 0.30	<0.01**	<0.01**	0.001***
	7	5.00 ± 0.85 (4-6)						
	30	2.67 ± 0.72 (2-4)						

ns: not significant, *: Significant,**: highly significant, ***: very highly significant

Table 2. Mean VAS score in response to Cold water at various time points in different groups

Group	Day	Mean VAS score ± SD	Difference in VAS score ± SD			p value		
			Day 0 to 7	Day 0 to 30	Day 7 to30	Day 0 to 7	Day 0 to 30	Day 7 to30
I	0	5.73 ± 0.71 (5-7)	0.20 ± 0.11	0.86 ± 0.14	0.66 ± 0.12	0.38^{ns}	0.005**	0.02*
	7	5.53 ± 0.52 (5-6)						
	30	4.87 ± 0.64 (4-6)						
II	0	6.53 ± 0.52 (6-7)	0.66 ± 0.10	2.13 ± 0.31	1.47 ± 0.20	0.03*	<0.01**	0.002**
	7	5.87 ± 0.74 (5-7)						
	30	4.40 ± 0.51 (4-5)						
III	0	7.80 ± 0.68 (7-9)	2.13 ± 0.24	3.67 ± 0.41	1.54 ± 0.37	<0.01**	<0.01**	0.004**
	7	5.67 ± 1.05 (4-8)						
	30	4.13 ± 0.74 (3-5)						
IV	0	8.40 ± 0.63 (7-9)	3.60 ± 0.30	5.87 ± 0.48	2.27 ± 0.23	<0.01**	<0.01**	<0.01**
	7	4.80 ± 0.78 (4-6)						
	30	2.53± 0.74 (2-4)						

ns: not significant, *: significant, **: highly significant

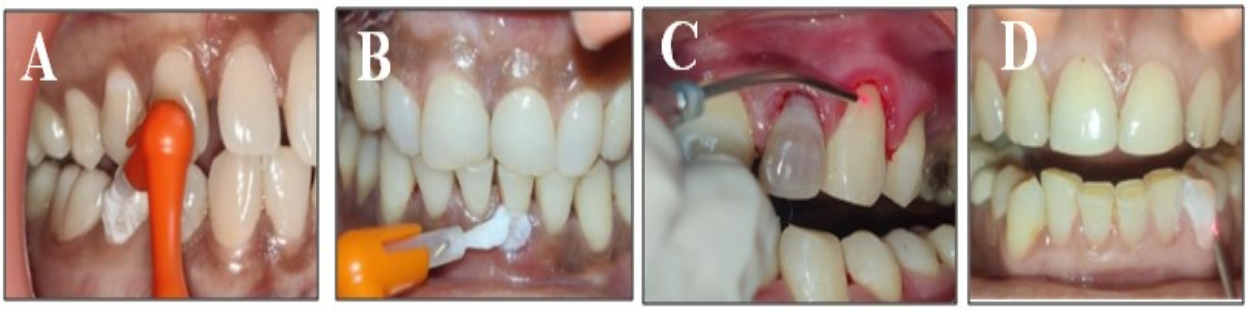

Figure 1. Hypersensitive sites treated with different treatment modalities. A. Control sites treated with placebo dentifrice using an applicator tip (group I); B. sites treated with SHY-NM dentrifrice (group II); C. sites treated with Diode laser (980 nm) at 0.5W in non contact mode (group III) and D. sites combinely treated with SHY-NM dentrifrice followed by Diode laser(group IV)

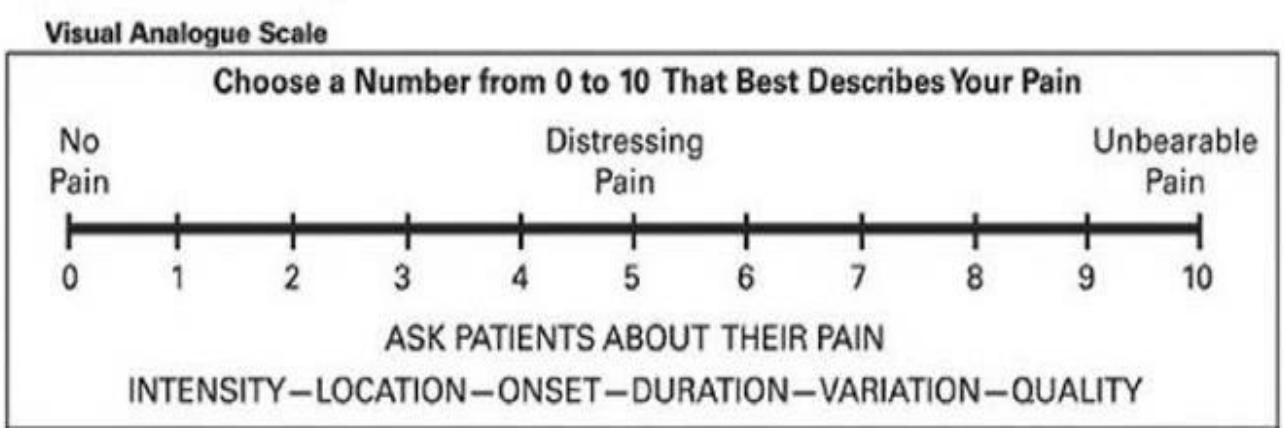

Figure 2. Visual Analog Scale indented with scores from 0 to 10. Score 0 refers to no pain while score 10 refers to extreme pain.

The VAS score was reduced by 0.87 ± 0.17 on day 30 compared to that of day 0, which was found to be statistically highly significant (p = 0.008). The difference in reduction from day 7 to 30 was found to be 0.67 ± 0.14, which was statistically significant (p = 0.03), as shown in Table 1.

Group II: As shown in Table 1, on day 0, the mean VAS score was found to be 6.67 ± 0.49, which was reduced to 6.00 ± 0.66 on day 7 and further reduced to 4.47 ± 0.64 on day 30. The VAS score was reduced by 0.67 ± 0.14 on day 7 compared to that of day 0, which was statistically significant (p = 0.03). The VAS score was reduced by 2.20 ± 1.53 on day 30 compared to that of day 0, which was found to be statistically highly significant (p = 0.002). The difference in reduction from day 7 to 30 was found to be 1.53 ± 0.19, which was statistically highly significant (p = 0.006).

Group III: On day 0, the response on VAS score was found to be 7.93 ± 0.70, which was reduced to 5.80 ± 1.15 on day 7 and further reduced to 4.33 ± 0.82 on day 30. The VAS score was reduced by 2.13 ± 0.29 on day 7 compared to that of day 0, which was statistically highly significant (p = 0.002). The VAS score was reduced by 3.60 ± 0.76 on day 30 compared to that of day 0, which was found to be statistically highly significant (p≤0.01). The difference in reduction from day 7 to 30 was found to be 1.37 ± 0.25, which was statistically significant. (p = 0.013), as shown in Table 1.

Group IV: On day 0, the response on VAS score was found to be 8.53 ± 0.64, which was reduced to 5.00 ± 0.85 on day 7 and further reduced to 2.67 ± 0.72 on day 30. The VAS score was reduced by 3.53 ± 0.35 on day 7 compared to that of day 0, which was statistically very highly significant. (p≤0.01). The VAS score was reduced by 5.87 ± 0.44 on day 30 compared to that of day 0, which was statistically very highly significant. (p≤0.01). The difference in reduction from day 7 to 30 was found to be 2.33 ± 0.30, which was statistically very highly significant (p≤0.001), as shown in Table 1.

The response to air pressure on VAS score for Group I and Group II was compared using ANOVA test and found to be statistically significant (p = 0.02). The difference in between Group I and Group III was found to be statistically highly significant (p = 0.002), while the differences in between Group I and Group IV, Group II and Group III, Group II and Group IV, Group III and Group IV were found to be statistically highly significant (p≤0.01).

Response to cold water on VAS score

Group I: On day 0, the response on VAS score was found to be 5.73 ± 0.71, which was reduced to 5.53 ± 0.52 on day 7 and further reduced to 4.87 ± 0.64 on day 30.The VAS score was reduced by 0.20 ± 0.11 on day 7 compared to that of day 0, which was statistically not significant (p = 0.38). The VAS score was reduced by 0.86 ± 0.14 on day 30 compared to that of day 0, which was found to be statistically highly significant (p = 0.005). The difference in reduction from day 7 to 30 was found to be 0.66 ± 0.12, which was statistically significant. (p = 0.02), as shown in Table 2.

Group II: On day 0, the response on VAS score was found to be 6.53 ± 0.52, which was reduced to 5.87 ± 0.74 on day 7 and further reduced to 4.40 ± 0.51 on day 30. The VAS score was reduced by 0.66 ± 0.10 on day 7 compared to that of day 0, which was statistically significant (p = 0.03). The VAS score was reduced by 2.13 ± 0.31 on day 30 compared to that of day 0, which was found to be statistically highly significant (p≤0.01). The difference in reduction from day 7 to 30 was found to be 1.47 ± 0.20, which was statistically highly significant (p = 0.002), as shown in Table 2.

Group III: On day 0, the response on VAS score was found to be 7.80 ± 0.68, which was reduced to 5.67 ± 1.05 on day 7 and further reduced to 4.13 ± 0.74 on day 30. The VAS score was reduced by 3.60 ± 0.30 on day 7 compared to that of day 0, which was statistically highly significant (p≤0.01). The VAS score was reduced by 3.67 ± 0.41 on day 30 compared to that of day 0, which was found to be statistically highly significant (p≤0.01). The difference in reduction from day 7 to 30 was found to be 1.54 ± 0.37, which was statistically highly significant. (p = 0.004), as shown in Table 2.

Group IV: On day 0, the response on VAS score was found to be 8.40 ± 0.63, which was reduced to 4.80 ± 0.78 on day 7 and further reduced to 2.53 ± 0.74 on day 30. The VAS score was reduced by 3.60 ± 0.30 on day 7 compared to that of day 0, which was statistically highly significant (p≤0.01). The VAS score was reduced by 5.87 ± 0.48 on day 30 compared to that of day 0, which was found to be statistically highly significant (p≤0.01). The difference in reduction from day 7 to 30 was found to be 2.27 ± 0.23, which was statistically highly significant (p≤0.01), as shown in Table 2.

The responses to cold water on VAS score for Group I and Group III, Group II and Group III, Group I and Group IV, Group II and IV, Group III and IV were compared using ANOVA test and found to be statistically highly significant (p≤0.01), while the difference in between, Group I and Group II was found to be statistically significant (p = 0.02).

DISCUSSION

DH is a common clinical condition with multifactorial etiology. It is characterized by acute pain due to the exposure of dentin to evaporative, tactile, thermal, chemical, or osmotic stimuli. The predisposing factors are gingival recession, cervical abrasion and periodontal disease. Severity of DH depends on the interactions among the predisposing factors and stimuli. The treatment of DH is aimed at to eliminate the painful symptoms, which can be attained by obliteration of the patent dentinal tubules. Various techniques and materials have been suggested in the literature for treatment of DH, at home and in-office applications. In the present study, CSPS-containing dentifrice (SHY-NM dentifrice) was used in the treatment of DH. As soon as, CSPS comes in contact with saliva, it produces hydroxyapatite like crystals on the dentinal surface. These crystals later serve as a barrier against oral fluids, thereby halting the progression of dentinal hypersensitivity (SHY-NM and Diode). We have compared the effect of SHY-NM dentifrice on DH with the effect of diode laser in the management of DH. Interaction of laser with pulp results in photobiomodulation, which raises the metabolic activity of odontoblasts and produces tertiary dentin that further obliterates the patent dentinal tubules (11). We have selected the wavelength of 980 nm, because of its quick sealing action on the exposed dentinal tubules and also safe to odontoblasts and pulp tissues (12). The response to an air pressure and cold water stimulation in terms of DH was

determined in all the patients using a VAS. All the patients have been asked to define the level of pain using VAS score, ranging from 0 to 10, where 0 represents no pain and 10 is the most painfull situation, as described by Kashyap *et al*., in 2012 (13). The present study was conducted on Sixty (60) volunteers of both sexes with a score of ≥5 in VAS were included in the study. To avoid to received the false observations, subjects with carious, fractures, orthodontic appliances or bridge, mobile teeth, on desensitizing agent or having any allergy to desensitizing agent were excluded from the study. To prevent the bias in observation, we conducted the study in a double blind way. The applications of the prescribed procedures were done by a clinician (PM) and Score on VAS was recorded by another clinician (VV). Finally handed over the unfolded findings for statistical analysis.

The enrolled subjects (n= 60) were randomly divided into four groups i.e. group I (self-prepared placebo dentifrice, control group), group II (SHY-NM dentifrice), group III (Diode laser at wavelength of 980 nm at 0.5W) and group IV (application of SHY-NM followed by Diode laser of 0.5W at 980 nm). Minimal reduction in DH was observed in group I on all the days of evaluation. Statistically significant reduction in DH was observed with the application of SHY-NM dentifrice (group II), which is in accordance with the previous findings (13,14), and may be due to the barrier effect of hydroxyapatite like crystals that forms over the exposed dentine when CSPS comes in contact with saliva. Compared to Group I and II, application of Diode Laser was found to be more effective (Group III), which may be due to the production of tertiary dentine that in turn obliterates the dentinal tubules (15,16). Our findings are in accordance with the previous observations (12, 17, 19). Compared to all the groups, application of SHY-NM dentifrice followed by diode laser (Group IV) was found to be highly effective. This may be due to the synergistic effect of diode laser and SHY-NM dentifrice, which is in accordance with the observations made previously (19, 20, 21). Considering the sample size in the present study, further studies are required with larger sample size.

CONCLUSION

On the basis of inference drawn from the findings within the limitation of present study, we may conclude that combined application of SHY-NM dentifrice and Diode Laser is highly effective in the management of dentinal hypersensitivity followed by independent application of Diode Laser and SHY-NM dentifrice, with maximum effectivity on day 30 followed by day 7 and 0.

Conflicts of Interest: Nil

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