

Evaluation of low power diode laser and desensitizer agent as treatment of dentinal hypersensitivity: A clinical study

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Abstract:

Abstract: Dentin hypersensitivity is a widespread and common ailment that is both painful and difficult to treat. Dentin exposure can occur as a result of attrition, abrasion, erosion, abfraction, hypoplastic enamel, gingival recession, defective restorations, improperly formed cemento-enamel junction (CEJ), caries, tooth cracking, trauma, iatrogenic reasons, faulty tooth brushing. A total of thirty patients with age group of above 30 years complaining of hypersensitivity were selected.

Materials and methods: The research participants were divided into three groups: Group A: Teeth treated with low power diode laser irradiation. Group B: Teeth treated with Ormocer based varnish. Group C: Teeth treated with low power diode laser irradiation + Ormocer based varnish. Patients were evaluated by using different stimuli. Cotton rolls were used to isolate the specific teeth and subjected to tactile, air blast tests. Visual analog scale was used to record scores at baseline, 7th, 14th and 30th day.

Results: In Group A, the mean pain scores reduced from 9.3 to 3.2 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically significant in Group A. In Group B, the mean pain scores reduced from 8.6 to 4.00 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically significant in Group B. In Group C, the mean pain scores reduced from 9.00 to 1.00 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically

significant in Group C. The inter-group comparison of change in VAS scores from baseline to different time points. While there was no significant difference between the groups in the mean VAS change from baseline to Day 7, significant differences in mean VAS change from baseline to Day 14 and 30 were noted between the groups. From baseline to Day 30, Group C had the highest mean reduction in VAS score from baseline, followed by Group A and Group B. The differences between all possible pairs were statistically significant.

Conclusion: The results of the current research suggest that all three treatment modalities were effective in reducing dentinal hypersensitivity over time. However, photobiomodulation therapy in combination with ormocer based varnish application demonstrated the most substantial and statistically significant reduction in VAS scores, particularly evident at Day 14 and Day 30.

INTRODUCTION:

Dentin hypersensitivity is a wide spread and common ailment that is both painful and difficult to treat. It is defined as “A short, sharp pain arising from exposed dentin in response to stimuli typically thermal, evaporative, tactile, osmotic or chemical which cannot be ascribed to any form of dental defect or pathology”¹. It is viewed as originating from the underlying exposed dentin after the enamel or root surface cementum has been lost.

The prevalence rate of dentinal hypersensitivity ranges from 2-8% to 74% worldwide². In a questionnaire based epidemiological survey conducted by Goel et al in 2012³ the prevalence of dentin hypersensitivity was 9.1% in North India. Dentin hypersensitivity was found to be more prevalent in females compared to males (69% vs 31% respectively) and more prevalent in the age group of 30-40 years³.

Dentin exposure can occur as a result of attrition, abrasion, erosion, abfraction, hypoplastic enamel, gingival recession, defective restorations, improperly formed cemento-enamel junction (CEJ), caries, tooth cracking, trauma, iatrogenic reasons, faulty tooth brushing. It is perhaps more of a symptom complex rather than a true disease. Besides causing discomfort, this condition may deter a patient from establishing or maintaining adequate oral hygiene procedures which may adversely affect gingival and periodontal health. Thus, the vicious cycle of sensitive teeth leading to reduced plaque control, resulting in establishment of periodontal disease and gingival recession⁴. Plaque accumulation may have a significant role in the genesis

of hypersensitivity⁵. Plaque and its products which invade the dentinal tubules and causes decalcification of peritubular dentin and this eventually enlarges the tubules and leads to dentinal hypersensitivity.

The treatment options include plugging the dentinal tubules to prevent fluid flow or desensitizing the nerves, making it less responsive to stimulation. Several approaches and multiple agents have been explored for treating dentinal hypersensitivity including silver nitrate, corticosteroids, zinc, strontium chloride, formaldehyde, glutaraldehyde, calcium hydroxide, sodium citrate, potassium oxalate, iontophoresis, resin adhesives and fluorides². Besides these chemical agents other methods used for treating hypersensitivity are lasers and light curing varnish. The application of desensitizing agents decreases the intensity of pain through the occlusion of dentinal tubules, depolarization of nerve fibers, increases the formation of tertiary dentin⁶.

Lasers have emerged as an effective treatment option for dentin hypersensitivity. Low power diode lasers (0.8W, 980 nm) are effective because they cause narrowing or occlusion of dentinal tubules by coagulating the proteins in the fluid within the tubules and promote healing by the formation of reparative dentin, a process that naturally reduces sensitivity over time⁷. Admira protect is a light cured ormocer based technology which occludes the dentinal tubules by the formation of resin tags⁸. Admira Protect varnish is composed of a unique blend of materials like OrmoCer (Organically Modified Ceramics) comprises inorganic-organic co-polymers and inorganic silinated filler particles that bind to dentin offering high biocompatibility, stability, and adhesion to dental tissues, fluoride included to promote remineralization of the tooth enamel and dentin helps in reduce the permeability of the dentin, adhesive monomers enhance the bonding of the varnish to the tooth surface, photoinitiators ensure that the varnish hardens quickly and effectively, forming a robust protective layer when light source is exposed⁹.

Materials and methods:

The study was conducted on patients reported to the outpatient department of Periodontics and Implantology, Drs Sudha & Nageswara Rao Siddartha Institute of Dental Sciences Chinnaoutpalli, Gannavaram. A total of thirty patients with age group of above 30 years complaining of hypersensitivity were selected. The research participants were divided into three groups:

Group A: Teeth treated with low power diode laser irradiation.

Group B: Teeth treated with Ormocer based varnish.

Group C: Teeth treated with low power diode laser irradiation + Ormocer based varnish.

Inclusion criteria:

1. Participants within age group of 30-60 years irrespective of gender.
2. History of tooth hypersensitivity to thermal, mechanical, sweet/sour stimuli for at least three teeth.
3. Teeth with gingival recession, abrasion are included.
4. Systemically healthy patients.

Exclusion criteria:

1. Active carious lesions.
2. Usage of anti-inflammatory drugs/analgesics at the time of recruitment.
3. Participants using desensitizing agents.
4. Pregnant and lactating women.

Procedure:

Patients who fulfilled the inclusion criteria were evaluated by using different stimuli. Cotton rolls were used to isolate the specific teeth and subjected to tactile, air blast tests.

Tactile test: A sharp dental explorer no-17/23 was passed lightly across the affected area of the tooth perpendicular to the long axis of the tooth.

Air blast test: The nozzle tip of an air syringe was kept about 1-2 cm away from the isolated tooth and then a blast of air was directed on the tooth for one second.

Visual analog scale (**VAS- Hayes and Patterson in 1921**) was used to record scores:

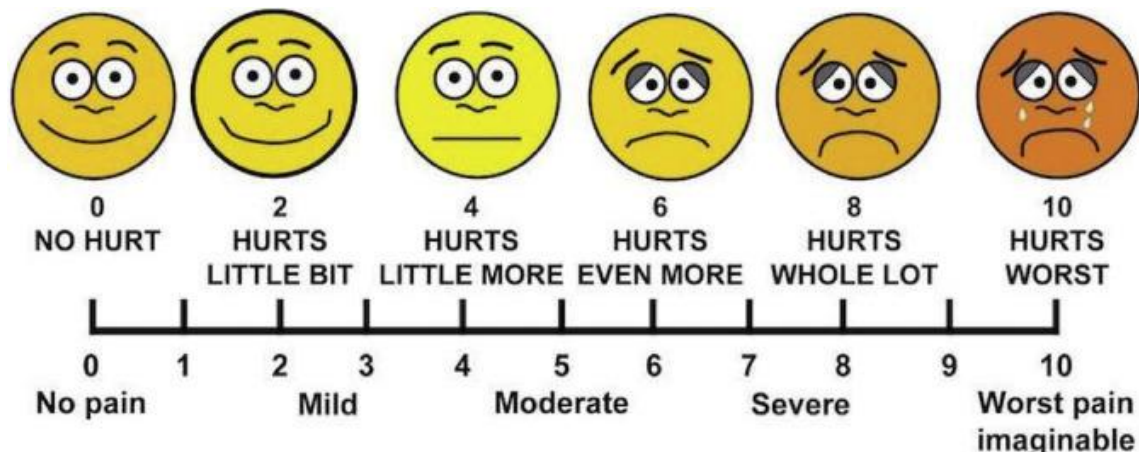
0: No pain

1-3: Mild pain

4-6: Moderate pain

7-9: Severe pain

10: Worst pain



Throughout the study, the stimuli tests were applied in the same order with a minimum of five-minute gap between the applications of different stimuli.

After these stimuli tests were performed, the patients with $VAS \geq 2$ for one of the tests were chosen for the study.

EXPERIMENTAL DESIGN:

The study is a randomized controlled clinical trial. In each patient the treatment protocol i.e., diode laser, admira protect varnish and diode laser + admira protect varnish was randomly allocated using slip method. Assessment of various stimuli was done by the investigator and treatment assignment of different treatment modalities was done.

Group A: Cotton rolls were used to isolate the teeth and dried. Scaling and root planing was performed followed by, low power diode laser was irradiated at a wavelength of 940 nm under relative isolation with a fixed power of 0.5W for 60 seconds in a continuous mode and in non-contact mode.

Group B: Cotton rolls were used to isolate the teeth and dried. Scaling and root planing was performed followed by, application of admira protect varnish with disposable brush evenly on all dentin surfaces to be treated and allow to act for 20 s. Then disperse the varnish with a faint air jet and light-cure with a conventional polymerization for 10 s. Apply a second layer of varnish, disperse it with a faint air-jet and light cure for 10 s.

Group C: Cotton rolls were used to isolate the teeth and dried. Scaling and root planing was performed followed by, the respective teeth will receive both laser irradiation (0.5W, 940 nm) and ormocer based varnish.

Patients were recalled after 7th, 14th day and final evaluation was done on 30th day. If the stimuli test scores remained the same or even increased the treatment procedure was repeated.

Post-operative instructions:

Patients were instructed to maintain good oral hygiene, avoid acidic foods like citrus fruits, low pH beverages, wines, curd etc., throughout the study period.

All scores are compared at 7th, 14th and 30th day with baseline scores.

RESULTS:

Data was compiled using Microsoft excel software and statistical analysis was done using IBM Statistical Package for Social Science (SPSS) version 20 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Repeated measures analysis of variance was used for comparison of the VAS scores within each of the three study groups with the change in time at baseline, 7th, 14th and 30th day. One way analysis of variance (ANOVA) was done to inter-group comparisons of VAS scores at baseline, 7th, 14th and 30th day for all the three study groups. Multiple bar charts were used for data presentation. The level of significance was set at $p \leq 0.05$ for all the statistical tests.

Evaluation of patient discomfort (VAS) at day 1, 7, 14 and 30.

Intra group comparison:

In **Group A**, the mean pain scores reduced from 9.3 to 3.2 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically significant in Group A. (Table 1).

In **Group B**, the mean pain scores reduced from 8.6 to 4.00 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically significant in Group B. (Table 2).

In **Group C**, the mean pain scores reduced from 9.00 to 1.00 from day 1 to 30, which was noted that the differences between all possible time point pairs were statistically significant in Group C. (Table 3).

Inter group comparison:

The mean VAS score **at baseline** in the Group A was 9.3, Group B was 8.6 and Group C was 9.00 shows no statistical significance. **(Table 4, Graph 1)**

The mean VAS score **at Day 7** in the Group A was 7.1, Group B was 6.6 and Group C was 6.7 shows no statistical significance. **(Table 5, Graph 2)**

The mean VAS score **at Day 14** in the Group A was 6.3, Group B was 5.4 and Group C was 4.00 shows statistical significance. **(Table 6, Graph 3)**

The mean VAS score **at Day 30** in the Group A was 3.2, Group B was 4.00 and Group C was 1.00 shows statistical significance. **(Table 7, Graph 4)**

The inter-group comparison of change in VAS scores from baseline to different time points. While there was no significant difference between the groups in the mean VAS change from **baseline to Day 7**, significant differences in mean VAS change from baseline to Day 14 and 30 were noted between the groups. **(Table 8, Graph 5).**

From **baseline to Day 30**, Group C had the highest mean reduction in VAS score from baseline, followed by Group A and Group B. The differences between all possible pairs were statistically significant **(Graph 5).**

Table 1: Comparison of the VAS scores at baseline between the three study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					A	10		
B		8.60	.843	.267	8.00	9.20		
C	10	9.00	.816	.258	8.42	9.58		

One way analysis of variance; $p \leq 0.05$ considered statistically significant

Table 2: Comparison of the VAS scores at Day 7 between the three study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					A	10		
B	10	6.60	.516	.163	6.23	6.97		
C	10	6.70	.823	.260	6.11	7.29		

One way analysis of variance; $p \leq 0.05$ considered statistically significant

Table 3: Comparison of the VAS scores at Day 14 between the three study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					A	10		
B	10	5.40	.516	.163	5.03	5.77		
C	10	4.00	.816	.258	3.42	4.58		

One way analysis of variance; $p \leq 0.05$ considered statistically significant

Table 4: Comparison of the VAS scores at Day 30 between the three study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					A	10		
B	10	4.00	.667	.211	3.52	4.48		
C	10	1.00	.667	.211	.52	1.48		

One way analysis of variance; $p \leq 0.05$ considered statistically significant

Table 5: Intra-group comparison of VAS scores with time in Group A

Time	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					Baseline	10		
Day 7	10	7.10	.738	.233	6.57	7.63		
Day 14	10	6.30	.949	.300	5.62	6.98		
Day 30	10	3.20	.632	.200	2.75	3.65		

Repeated measures analysis of variance; $p \leq 0.05$ considered statistically significant; * denotes significance.

Table 6: Intra-group comparison of VAS scores with time in Group B

Time	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					Baseline	10		
Day 7	10	6.60	.516	.163	6.23	6.97		
Day 14	10	5.40	.516	.163	5.03	5.77		
Day 30	10	4.00	.667	.211	3.52	4.48		

Repeated measures analysis of variance; $p \leq 0.05$ considered statistically significant; * denotes significance

Table 7: Intra-group comparison of VAS scores with time in Group C

Time	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
					Baseline	10		
Day 7	10	6.70	.823	.260	6.11	7.29		
Day 14	10	4.00	.816	.258	3.42	4.58		
Day 30	10	1.00	.667	.211	.52	1.48		

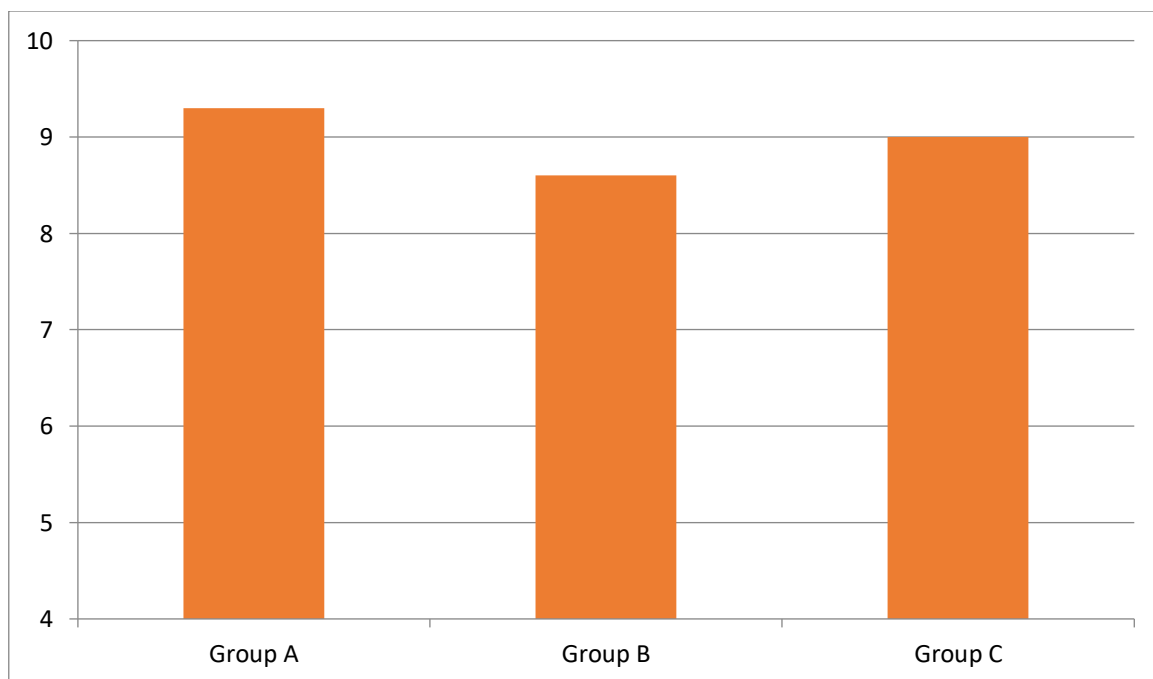
Repeated measures analysis of variance; $p \leq 0.05$ considered statistically significant; * denotes significance

Table 8: Inter-group comparison of change in VAS scores from baseline to different time points

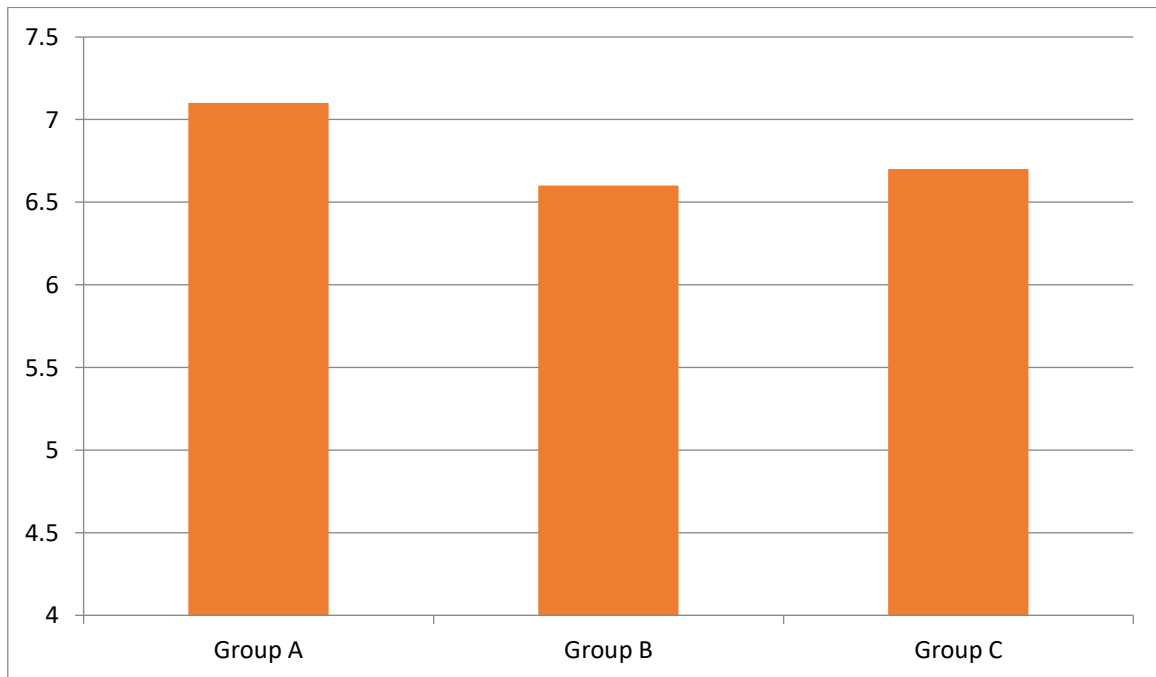
Time	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
						Baseline to Day 7	A		
B	10	2.00	.667	.211	1.52	2.48			
C	10	2.30	.483	.153	1.95	2.65			
Baseline to Day 14	A	10	3.00	.943	.298	2.33	3.67	16.71	<0.001*
B	10	3.20	.789	.249	2.64	3.76			
C	10	5.00	.816	.258	4.42	5.58			
Baseline to Day 30	A	10	6.10	.738	.233	5.57	6.63	25.04	<0.001*
B	10	4.60	1.350	.427	3.63	5.57			
C	10	8.00	1.054	.333	7.25	8.75			

One way analysis of variance; $p \leq 0.05$ considered statistically significant; * denotes significance

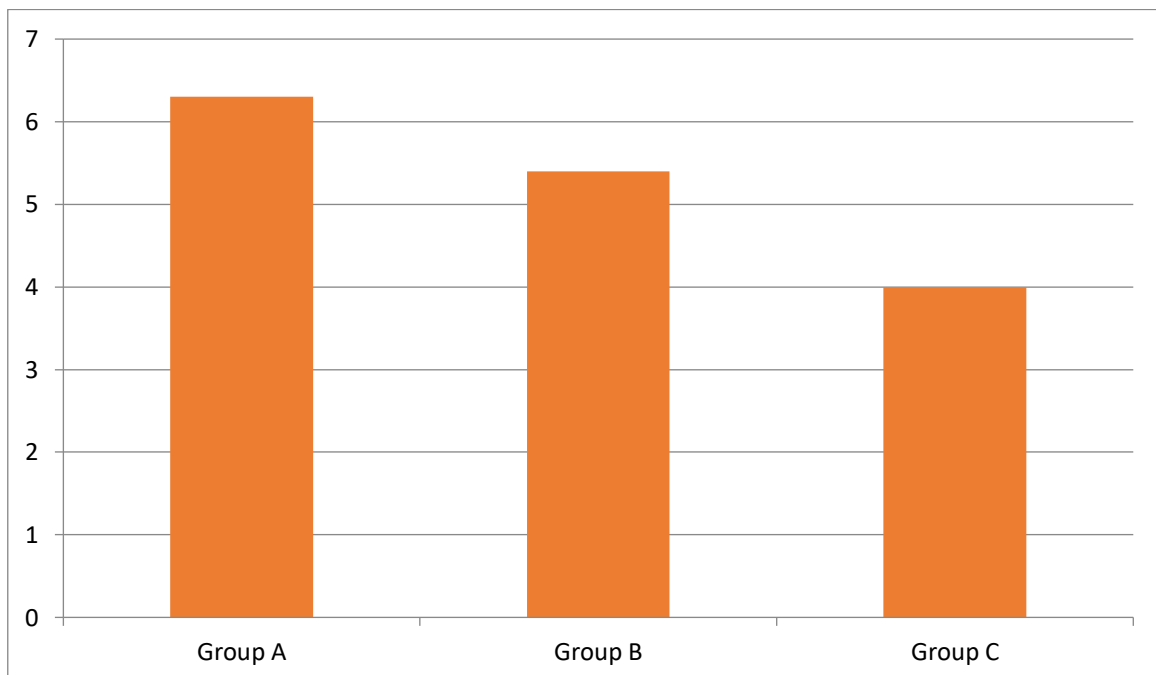
Graph 1: Comparison of the VAS scores at baseline between the three study groups



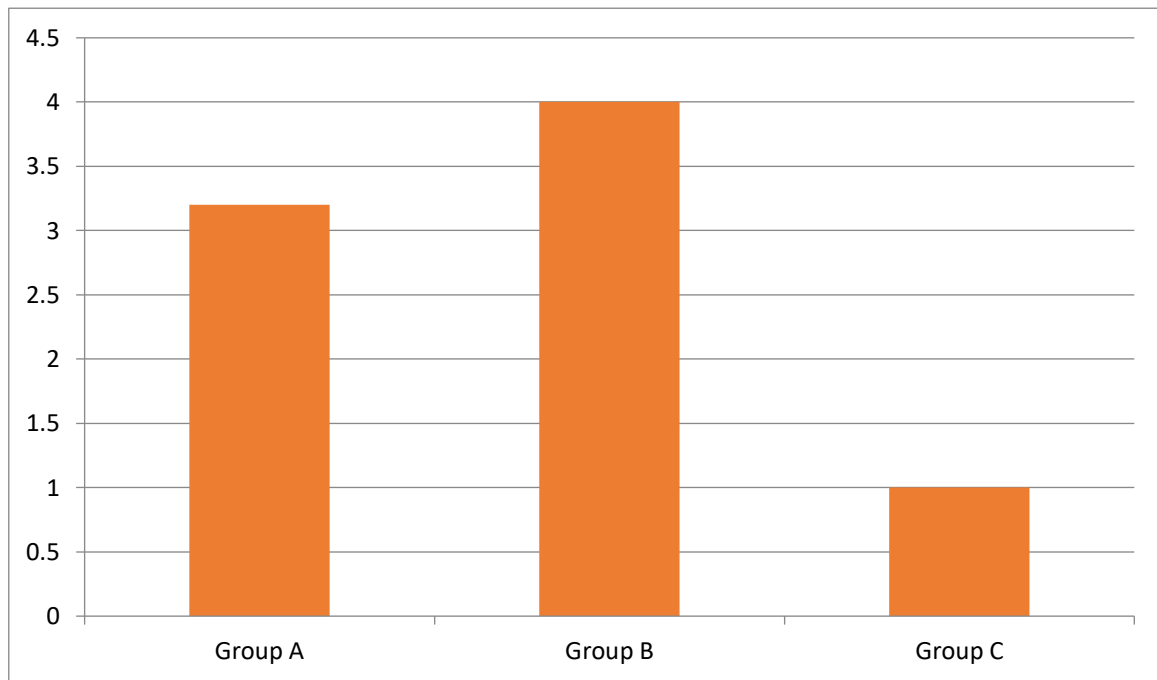
Graph 2: Comparison of the VAS scores at Day 7 between the three study groups



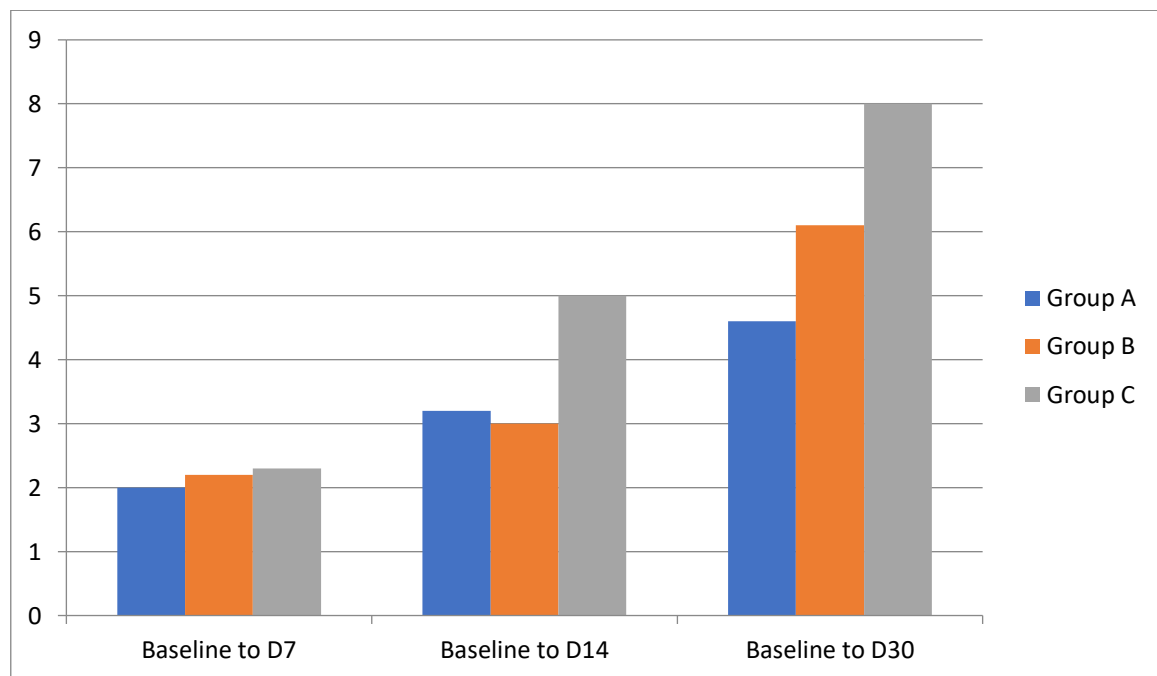
Graph 3: Comparison of the VAS scores at Day 14 between the three study groups



Graph 4: Comparison of the VAS scores at Day 30 between the three study groups



Graph 5: Inter-group comparison of change in VAS scores from baseline to different time points



CONCLUSION

The results of the current research suggest that all three treatment modalities were effective in reducing dentinal hypersensitivity over time. However, photobiomodulation therapy in combination with ormocer based varnish application demonstrated the most substantial and statistically significant reduction in VAS scores, particularly evident at Day 14 and Day 30. This suggests that the treatment protocol used in Group C may be more effective for long-term management of dentinal hypersensitivity compared to the other two groups.

The following conclusions can be drawn from the present study:

1. All the treatment modalities showed significant reduction in the sensitivity to all the test stimuli when compared to baseline scores.
2. Ormocer based varnish application group required more repeated dose when compared to photobiomodulation therapy group for each of the two test stimuli at the end of the study period.
3. The teeth with a higher baseline sensitivity score required a repeat dose.

For long term evaluation of hypersensitive response by both lasers and varnish larger sample size and long term follow up periods are required to validate the effectiveness of both desensitizing agents.

DISCUSSION

The Canadian Advisory Board on Dentin Hypersensitivity in 2003 defined hypersensitivity as “Pain derived from exposed dentin in response to chemical, thermal, tactile or osmotic stimuli which cannot be explained as arising from any other dental defect or disease.”⁴⁰ Dentin hypersensitivity may exert negative effect on the quality of a person’s life especially with regards to dietary selection, maintaining optimal dental hygiene and its underlying present esthetic concerns. Different terms have been used to describe dentin hypersensitivity (**Davari AR et al 2013**)⁵¹.

PREDISPOSING FACTORS FOR DENTIN HYPERSENSITIVITY

- Gingival recession caused by overzealous brushing/improper brushing, periodontal disease and related periodontal conditions and aging.
- Abrasion due to use of abrasive agents/improper brushing technique.

- Erosion caused by consumption of acidic foods and beverages with $\text{pH} \leq 5.5$ (Carbonated drinks, fruit juices).
- Abfraction caused by compressive and tensile forces can be generated in the cervical area due to eccentric loading.
- Periodontal treatment procedures such as scaling and root planing can cause dentinal tubule exposure.
- Poor oral hygiene causes periodontal tissue destruction/supporting bone loss and root exposure.

In the first phase, dentinal tubules are exposed due to loss of enamel by attrition, abrasion, erosion, abfraction and gingival recession along with the loss of cementum on the root surface of canines and premolars in the buccal surfaces. It was noticed that not all the exposed dentin is sensitive. However, their calcified smear layer as compared to non-sensitive dentin is thin and this leads to an increase in the fluid movement and consequently the pain response.

In the second phase, for the exposed dentin to be sensitized, the tubular plugs and the smear layer are removed and consequently, dentinal tubules and pulp are exposed to the external environment. Plug and smear layer on the surface of exposed dentin are composed of elements of protein and sediments which are derived from salivary calcium phosphates seal the dentinal tubules inconsistently and transiently. The mechanical factors are not the only key factors in the removal of smear layer and when they are accompanied with acidic foods or carbonated drinks they lead to the removal of smear layer and this leads to an increase in the fluid movement and consequently the pain response.

Torres CR and Silva TM (2014)²⁸ stated that application of Admira Protect shows a longer-lasting effect in reducing hypersensitive response for both tactile and evaporative stimuli. The present study shows the similar results reported by Ravishankar P et al²¹, Maity S et al¹⁵ observed that admira protect varnish significantly reduces the postoperative pain when compared to baseline. **Dilsiz A (2010)**⁴⁰ in a study to assess the hypersensitive response of teeth with Class I or Class II gingival recession in which GaAlAs diode laser irradiated at 808 nm, 100 mW, 25 seconds for three sessions alone and in conjunction with desensitizer tooth paste resulted in decreased hypersensitive response which was evaluated by visual analog scale scores. This study shows the similar results to the present study in decreasing the hypersensitive response through combined approach. **Sicilia A (2009)**⁴⁰ in a study to document the duration

of hypersensitivity response after the application of 810 nm diode laser and 10% potassium nitrate gel and concluded that teeth treated either with diode laser and gel showed significantly decrease the hypersensitive response more pronounced after 14 days and continued upto 60 days. This study is in contradictory to the present study as both the treatment procedures shows the decrease in hypersensitive response in a similar fashion. **Schwarz F (2002)** in a study to evaluate the desensitizing effect of dentin protector and Er:YAG laser irradiated at 80 mJ, 3 Hz on cervically exposed dentin. The teeth irradiated with laser is effective in reducing the hypersensitive dentin and maintained over a longer duration than with dentin protector.

The results of the current study clearly demonstrated significantly decrease in the hypersensitive response, VAS scores in the photobiomodulation group combined with ormocer based varnish application followed by laser irradiation and least response shown with ormocer based varnish application.

Limitations of the study

The highly subjective nature of the condition makes it extremely difficult to evaluate DH objectively. The potential limitation of studying treatment responses to DH is subjective assessment of hypersensitivity scores that obviously lacks standardized measurability.

Conflict of interest - None

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