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COMPARATIVE CLINICAL EVALUATION OF EFFICACY OF DIODE LASER AND DENTIN BONDING AGENT ON DENTINAL HYPERSENSITIVITY

Sheth J*., Sanadi RM and Ramteke KR

Department of Periodontics, Y.M.T Dental College and Hospital Mumbai-410210

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ABSTRACT

Background: Dentin sensitivity (DS) or dentinal hypersensitivity (DH) is one of the most commonly encountered clinical problems. It is clinically described as an exaggerated response to application of a stimulus to exposed dentin, regardless of its location.[1,2] It's a painful condition with incidence ranging from 4% to 74%[3,4], occurring higher in females with an age range between 20-40 years. Buccal aspect of cervical area of canines and premolars are most commonly affected. There are various treatment modalities among which Dentin Bonding Agent and lasers are commonly used. The newer bonding agents modify the smear layer and incorporate it in, into the hybrid layer. The laser interaction with the dental pulp causes a photo bio- modulating effect, obliterating the dentinal tubules with the intensification of tertiary dentin production.

Aim: To compare the clinical efficacy of diode laser and seventh generation dentin bonding agent on dentinal hypersensitivity.

Materials and Methods: In a split mouth study, 40 subjects having a complaint of hypersensitivity and having either abrasion, abfraction or gingival recession were randomly allocated into the Diode Laser group 810nmand Seventh generation dentin bonding agent group. Visual Analogue Scale (Woodforde JM and Merskey H, 1972) and Verbal Rating Scale(Uchida *et al* 1980) of each subject were recorded at baseline, immediately, 1 month and 3 months after treatment.

Statistical analysis: Intergroup data was analysed was done using Mann Whitney U test, except for Scratch test which was compared using Independent 't' test.

Results: Intergroup comparison of the two treatment modalities revealed a statistically significant improvement in the clinical parameters for both groups at immediately, 1 month and 3 months. There were reductions in the Visual Analogue Scale and Verbal Rating Scale scores and increase in the scratchometer scores which were statistically significant ($P \leq 0.05$).

Conclusions: Application of 810nm diode laser and seventh generation dentin bonding agent, both are effective treatment strategies in reducing dentin hypersensitivity. However at 3 months diode laser therapy proved more efficacious than dentin bonding agent.

INTRODUCTION

Dentin sensitivity (DS) or dentinal hypersensitivity (DH) is one of the most commonly encountered clinical problems. It is clinically described as an exaggerated response to application of a stimulus to exposed dentin, regardless of its location.[1,2] DH is a painful clinical condition with an incidence ranging from 4% to 74%.[3,4]

It has been stated in the literature that DH develops in two phases: lesion localization and lesion initiation.[5]Several theories have been proposed to explain dentin sensitivity such as the odontoblastic transduction theory, the dentin innervation theory, and the Brannstrom hydrodynamic theory which is most commonly accepted.[6]

There are various aspects of treatment involved based on the mode of administration and based on the mechanism of action, among them are the application of dentin bonding agents and lasers.

Traditionally, resin composites or dentin bonding agents are used as desensitizing agents. The conventional dentin bonding agents (DBA) remove the smear layer, etches the dentinal surface and forms deep dentinal resin tags inside the dentinal tubules. The combined dentin-resin layer (consisting of penetrating resinous tags) has been termed as hybrid layer. It effectively seals the dentinal tubules and prevents dentinal

Corresponding author:* **Sheth J
Department of Periodontics, Y.M.T Dental College and Hospital Mumbai-410210

hypersensitivity.[7] Newer bonding agents modify the smear layer and incorporate it in, into the hybrid layer.[8]

Laser therapy was first introduced as a potential method for treating dentinal sensitivity in mid 1980s.[9] The laser interaction with the dental pulp causes a photo bio- modulating effect, increasing the cellular metabolic activity of the odontoblasts and obliterating the dentinal tubules with the intensification of tertiary dentin production. The lasers used in dentin sensitivity are divided into two groups: low output power laser: helium-neon and gallium/aluminium/arsenide lasers (GaAlAs) and medium output power laser: Neodymium yttrium aluminium-garnet (Nd:YAG) and carbon dioxide(CO_2) lasers.[10]

Hence the present study was conducted to compare the clinical efficacy of diode laser and seventh generation dentin bonding agent on dentinal hypersensitivity.

MATERIAL AND METHODS

In this split mouth clinical study, 40 subjects having a complaint of hypersensitivity and having either abrasion, abfraction or gingival recession were randomly allocated and divided into the following groups:

- ***Site A:*** Diode laser application at 0.5W for 2minutes (Zolar Photon©)
- ***Site B:*** Application of seventh generation dentin bonding agent. (Medicept© BOND plus SE)

The clinical parameters assessed were: Simplified Oral Hygiene Index, Scratchometer score, Visual Analogue Scale, Verbal Rating Scale. The latter three parameters were recorded at baseline, immediately, 1 month and 3 months period.

Subjects in the age group of 18 to 50 years having a complaint of dentinal hypersensitivity with atleast one tooth in two quadrants in the same arch, with good oral hygiene (Simplified Oral Hygiene Index score ≤1.3, 1964) and having non-carious cervical lesions that is abrasion, abfraction or gingival recession were included.

Teeth with fluorosis or hypocalcification, Carious teeth, fractured teeth, pulpal pathology. Teeth with defective restoration and facets. Subjects with a history of using any desensitizing agents in the past six months, on stress or pain medication, undergoing orthodontic treatment, pregnant or lactating females, on oral contraceptive pills, with any systemic disease and subjects not willing to participate in the study were excluded.

Ethical clearance was obtained from the institutional ethical committee. A detailed case history and informed written consent of the subjects participating in the study was obtained.Oral hygiene instructions were given to all the subjects and brushing technique demonstrated. For each of the subjects, the initial hypersensitivity pattern was evaluated with three stimuli: Tactile stimulus using a scratchometer, Air blast using an air syringe, Thermal stimulus using cold water test.

Scratchometer unit

Figure 1

After each stimulus, degree of hypersensitivity was determined according to the Visual Analogue Scale (VAS) and Verbal Rating Scale (VRS) with a time interval of 5minutes after application of each stimuli. Oral prophylaxis of the region was done prior to the therapy using rubber cup. Immediately after prophylaxis of the test teeth, site A was isolated and subjected to 810 nm diode laser at 0.5W, continuous wave for 2 minutes.

Site A treated by using diode laser

Tactile stimulus test

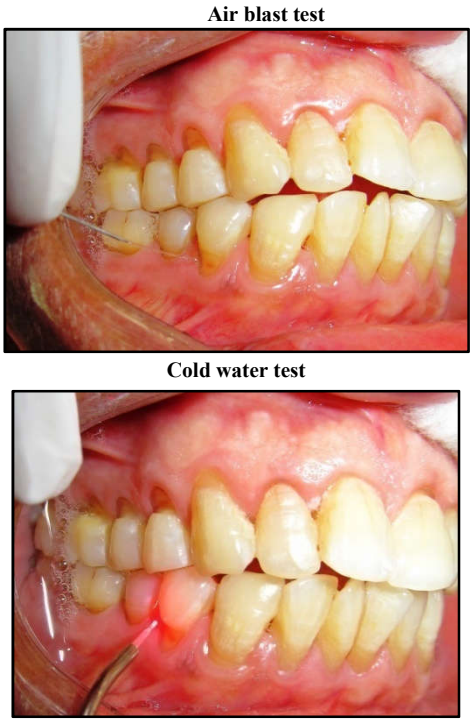

Figure 2 showing use of scratchometer for tactile stimulus, air blast test by using air syringe and for thermal stimulus using cold water.

Site B was isolated and two coats of seventh generation dentin bonding agent, were applied and light cured, as per manufacturer's instructions.

Site B treated by using dentin bonding agent

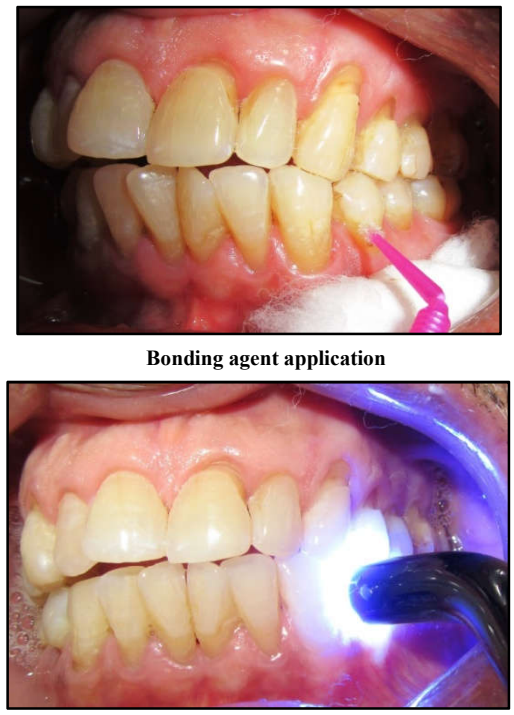

Figure 3 after using of scratchometer for tactile stimulus, air blast test by using air syringe, for thermal stimulus using cold water, application of bonding agent and cured by light cure gun.

Data obtained was tabulated and subjected to statistical analysis. Different subgroups were compared using Mann Whitney U test, Independent't' test, Kruskall Wallis ANOVA, repeated measures (Parametric) ANOVA. The p value were calculated.

RESULTS

There was no attrition in the sample size of the study.

Scratchometer Score

On mean reduction comparison between both groups it was seen that there was a statistically significant difference from baseline to 1 month (p=0.028), baseline to 3 months (p= 0.001), immediately to 3 months (p=0.004) and 1 month to 3 months (p=0.001). However there was no statistically significant difference observed between baseline to immediately (p=0.073) and immediately to 1 month (p=0.414). (Table no.1)

Tactile stimulus test

On mean reduction comparison between both groups for tactile VAS scores it was seen that there was a statistically significant difference from immediately to 1 month (p=0.009), immediately to 3 months (p=0.044). However there was no statistically significant difference observed between baseline to immediately (p=0.810), baseline to 1 month (p=0.175), baseline to 3 months (p= 0.139) and 1 month to 3 months (p= 0.723). (Table no.2)

On mean reduction comparison between both groups for tactile VRS scores it was seen that there was a no statistically significant difference from baseline to immediately (p=0.638), baseline to 1 month (p=0.239), baseline to 3 months (p=0.064), immediately to 1 month (p=0.323), immediately to 3 months (p=0.094), 1 month to 3 months (p=0.312). (Table no.3)

Air blast test

On mean reduction comparison between both groups for air blast VAS scores it was seen that there was a statistically significant difference from baseline to 1 month (p=0.006), baseline to 3 months (p=0.003), immediately to 1 month (p=0.038), immediately to 3 months (p=0.043). However there was no statistically significant difference observed between baseline to immediately (p=0.060) and 1 month to 3 months (p=0.437). (Table no.4)

On mean reduction comparison between both groups for air blast VRS scores it was seen that there was a statistically significant difference from baseline to 3 months (p=0.017), immediately to 1 month (p=0.012), immediately to 3 months (p=0.000) and 1 month to 3 months (p=0.000) However there was no statistically significant difference observed between baseline to immediately (p=0.282) and baseline to 1 month (p=.0.876). (Table no.5)

Cold water test

On mean reduction comparison between both groups for cold water VAS scores it was seen that there was a statistically significant difference from baseline to 3 months (p=0.029). However there was no statistically significant difference observed between baseline to immediately (p=0.184) and baseline to 1 month (p=0.127), immediately to 1 month (p=0.662), immediately to 3 months (p=0.161) and 1 month to 3 months (p=0.190). (Table no.6)

Table 1 Intergroup Comparison of Diode Laser and DBA groups with Scratchometer scores at baseline and 3 months.

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	37.25 ±7.642	64.40 ±8.366	62.25 ±8.854	58.20 ±9.422	27.15± 8.1	25± 8.038	20.95± 8.735	2.15± 2.413	6.20± 3.443	4.05± 2.736
DBA	38.75 ±7.299	62.80 ±6.881	60 ±6.389	23.35 ±7.350	24.05± 7.096	21.25±6. 849	14.60± 8.104	2.80± 4.386	9.45± 5.974	6.65± 3.906
P value	0.372	0.353	0.196	0.012*	0.073#	0.028*	0.001**	0.414#	0.004**	0.001**

Table 2 Intergroup Comparison of Diode Laser and DBA groups with Tactile VAS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	6.95 ±0.783	3.03 ±0.698	3.10 ±0.672	3.78 ±0.800	3.93± 1.047	3.85± 1.051	3.18± 1.13	0.08± 0.267	0.75± 0.630	0.68± 0.656
DBA	7.13 ±0.686	3.25 ±0.494	3.58 ±0.675	4.30 ±0.723	3.88± 0.791	3.55± 0.904	2.83± 0.958	0.33± 0.526	1.05± 0.677	0.73±0.599
P value	0.291	1.000	0.002*	0.003*	0.810#	0.175#	0.139#	0.009*	0.044*	0.723#

Table 3 Intergroup Comparison of Diode Laser and DBA groups with Tactile VRS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	2.35 ±0.483	0.53 ±0.506	0.50 ±0.506	0.78 ±0.423	1.83±0.636	1.85±0.580	1.58±0.636	0.03±0.577	0.25±0.588	0.28±0.554
DBA	2.48 ±0.506	0.73 ±0.506	0.80 ±0.464	1.20 ±0.608	1.75± 0.776	1.68±0.730	1.28±0.784	0.08±0.267	0.48±0.599	0.40±0.545
P value	0.262	0.081	0.007*	0.001*	0.638#	0.239#	0.064#	0.323#	0.094#	0.312#

Table 4 Intergroup Comparison of Diode Laser and DBA groups with Air Blast VAS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	6.95 ±0.597	2.93± 0.730	3.03 ±0.733	3.53 ±0.784	4.03±1.025	3.93±1.023	3.43±1.059	0.10±0.304	0.60±0.632	0.50±0.641
DBA	7.13 ±0.516	3.48± 0.554	3.78 ±0.620	4.38 ±0.667	3.65±0.700	3.35±0.802	2.75±0.899	0.30±0.516	0.90±0.672	0.60±0.496
P value	0.165	0.000*	0.000*	0.000*	0.060#	0.006**	0.003**	0.038*	0.043*	0.437#

Table 5 Intergroup Comparison of Diode Laser and DBA groups with Air Blast VRS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	2.33 ±0.474	0.83 ±0.385	0.88 ±0.335	0.93 ±0.267	1.50±0.641	1.45±0.639	1.40±0.591	0.05±0.221	0.10±0.379	0.05±0.316
DBA	2.45 ±0.504	0.78 ±0.530	1.03 ±0.530	1.43 ±0.594	1.68±0.797	1.43±0.781	1.03±0.768	0.25±0.439	0.65±0.483	0.40±0.496
P value	0.257	0.631	0.135	0.000*	0.282#	0.876#	0.017*	0.012*	0.000**	0.000**

(P value≤ 0.05 is significant,*-significant, **- highly significant, #- not significant)

Table 6 Intergroup Comparison of Diode Laser and DBA groups with Cold Water VAS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	7.25 ±0.670	3.20± 0.608	3.40 ±0.545	3.80 ±0.723	4.05±0.876	3.85±0.864	3.45±0.986	0.20±0.405	0.60±0.709	0.40±0.591
DBA	7.25 ±0.588	3.45± 0.552	3.70 ±0.648	4.28 ±0.716	3.80±0.791	3.55±0.876	2.98±0.920	0.25±0.494	0.83±0.712	0.58±0.594
P value	1.000	0.058	0.028*	0.004*	0.184#	0.127#	0.029*	0.662#	0.161#	0.190#

On mean reduction comparison between both groups for cold water VRS scores it was seen that there was a statistically significant difference from baseline to 3 months (p=0.000). immediately to 1 month (p=0.021), immediately to 3months (p=0.000) and 1 month to 3 months (p=0.000). However there was no statistically significant difference observed between baseline to immediately (p=0.413) and baseline to 1 month (p=0.090). (Table no.7)

Table 7 Intergroup Comparison of Diode Laser and DBA groups with Cold Water VRS scores at baseline and 3 months

Groups	Baseline	Immed-iately	1month	3months	Change from baseline to immedi-ately	Change from baseline to 1month	Change from baseline to 3months	Change from immedia-tely to 1month	Change from immedia-tely to 3months	Change from 1month to 3months
Laser	2.65 ±0.483	1 ±0.000	1 ±0.000	1 ±0.000	1.65±0.483	1.65±0.483	1.65±0.483	0.00±0.000	0.00±0.000	0.00±0.000
DBA	2.63 ±0.490	1.08 ±0.35	1.20 ±0.464	1.53 ±0.554	1.55±0.597	1.43±0.675	1.10±0.709	0.13±0.335	0.45±0.504	0.33±0.474
P value	0.819	0.179	0.008*	0.000*	0.413#	0.090#	0.000**	0.021*	0.000**	0.000**

(P value≤ 0.05 is significant,*-significant, **- highly significant, #- not significant)

DISCUSSION

Tooth hypersensitivity or precisely dentin sensitivity is a true pain syndrome clinically described as an exaggerated response to a non-noxious stimuli.[165] It consists of short, sharp pain that occurs when a stimulus reaches exposed dentin. Typically, no other pathology can be found for the pain associated with dentinal hypersensitivity.[11,12]

A wide variety of agents have been used for the treatment of dentinal hypersensitivity which helps in reducing the dentinal tubule fluid movement or directed towards reducing the functional diameter of the tubules, so as to limit fluid movement. Depending on the severity of the sensitivity, two treatment options are available: at-home desensitizing agents for mild sensitivity and professional treatment for moderate to severe sensitivity.[13]

Sealing the dentinal tubules with a bonding agent or adhesive material has also been suggested to create long lasting blockage of dentin hypersensitivity.[14]

GaAlAs laser is thought to act by affecting the neural transmission in the dentinal tubules.[15] It has also been proposed that lasers coagulate the proteins inside the dentinal tubules and block the movement of fluid.[16] Diode lasers gave the best results in clinical trials even in high grade DH cases and the gallium aluminium arsenide (Ga-Al-As) diode laser is able to generate a continuous wave without overheating.[17] Both lasers and dentin bonding agent has been shown as an effective modality of treatment for treating dentinal hypersensitivity (Tengrungsun T and Sangkla W2008).[18] However, the long term results of application of both the agents has not been addressed much in the literature.

Hence, this split mouth study was conducted to compare and evaluate the clinical efficacy of diode laser and seventh generation dentin bonding agent on dentin hypersensitivity. The bonding agent used was a seventh generation bonding system as it uses the smear layer as a bonding substrate. The acidic primer demineralises the smear layer and the top of the underlying dentin surface. The acidic primer also infiltrates the exposed collagen along with the hydrophilic monomers, which then copolymerize. Because the etched surface is not rinsed, the demineralized smear layer is incorporated into the hybrid layer.[19]

The acidic primer and adhesive monomers also infiltrate collagen fibers as the primer decalcifies the inorganic component in dentin to the same depth, which should minimize voids, potential leakage and sensitivity.[19]

The order of application of stimulus is also important as given by Clark and Troullos. They have advised that least disturbing stimulus should be used first, with the most disturbing stimulus to be used at last so that each stimulus does not interfere with the other stimuli used in measuring procedure. So in the present study tactile stimulus, least disturbing stimulus was used first, followed by air blast and then cold water, with 5 minutes gap in between these test stimuli.[20]

The above mentioned procedure was done under aseptic condition and was standardized as much as possible, the same dental unit, the same period for testing, the same sequence of application of stimuli and the same auxiliary personnel were used.

The use of tactile stimulus was done using a scratchometer which was used for dentin sensitivity by Kleinberg[21] in 1990. In the present study at 3 months there was significant reduction of score in DBA group as compared to laser showing recurrence of sensitivity higher in DBA group compared to laser. This was the first study to compare the scratchometer scores following use of DBA and diode laser in the treatment of hypersensitivity.

In the tactile stimulus test, it was observed that the difference in the VAS and VRS scores were statistically non-significant at baseline and immediately, however it was statistically significant at 1 month and 3 months in both the groups with higher scores in the DBA group, indicating greater recurrence of sensitivity in the DBA group. These findings were similar with the study conducted by Mittal R *et al* (2014). At 3 months evaluation, nerve analgesia effect must have ended thereby resulting in recurrence of dentinal hypersensitivity. Also in the DBA group the recurrence of sensitivity was significantly greater at 3 months as reported by Brahmbhatt N *et al* probably as a result of loss or wear of the occluding layer.[22]

The air blast test was used for evaluation of dentin sensitivity since 1967 by Brannstrom *et al*.[23] This is the first study assesing air blast test to compare diode laser v/s DBA application together at different time intervals and it was observed for VAS scale that there was no statistically significant difference at baseline, however there was statistical significant reduction immediately, 1 month and 3 months post

treatment. For VRS scores there was no statistically significant difference at baseline, immediately and 1month, however there was statistically significant difference at 3months for both the groups.

Cold water is an effective hydrodynamic stimuli because of difference in thermal conductivity and coefficients of expansions or contraction of dentinal fluids and dentin. This mismatch of volumetric changes produces negative intrapulpal and presumably intradental pressures that displace mechanoreceptors and cause pain. In the present study cold water was used because application of water stream is almost purely a thermal stimuli and there is no pressure application.[24] This is the first study that has compared the cold water test for both diode laser and DBA groups at different time intervals and it was observed that there was no statistically significant difference at baseline and immediately, however it was statistically significant at 1month and 3 months for both VAS and VRS scores in both the groups.

On comparison of both the treatment modalities it was observed that both diode laser and dentin bonding agent are effective in reducing dentinal hypersensitivity. However there was greater recurrence in sensitivity in all the parameters assessed in the DBA group as compared to diode laser. Hence diode laser is more effective in reducing dentinal hypersensitivity which is accordance with the studies conducted by Femiano *et al*(2013)[25] and He S *et al*(2011)[26], whereas in the studies conducted by Lopes A *et al* (2015)[27], Orhan K *et al*(2011)[28], Aranha A *et al* (2009)[29] it was concluded that both the treatment modes had shown similar effectiveness in reducing dentinal hypersensitivity.

The results of the present study were in contrast with the study conducted by Tengrungsun T and Sangkla W (2008)[18] which concluded better effectiveness of dentin bonding agent over diode laser in reducing dentinal hypersensitivity. The present study showed that dentin bonding agent was an effective treatment modality in reducing dentinal hypersensitivity. This is in accordance with the studies conducted by CRG Torres *et al* (2014)[30], Gibson M *et al* (2013)[31], Ishihata S *et al* (2012)[32], Diode laser was also seen in the present study to be an effective treatment modality in reducing dentinal hypersensitivity. This was similar to the studies conducted by George VT *et al* (2016)[33], Jain PR *et al* (2015)[34], Merh A *et al* (2015)[35], Mittal R *et al* (2014)[36], Doshi S *et al* (2014)[37].

Although, an effort was made to eliminate subjectivity using quantitative stimulation, it was realized that all measurements were still based upon subjective response.

In the present study, a reduction in hypersensitivity was observed for both the groups i.e. Diode laser and the DBA group. Both the groups showed significant reduction in hypersensitivity immediately and post application and maintained almost the same level at 1 month. Both the groups showed recurrence at 3 months for both the VAS and the VRS scales, however recurrence was seen significantly greater in the dentin bonding agent group as compared to diode laser group.

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