Comparative evaluation of diode laser and dentin bonding agent in the treatment of dentin hypersensitivity – An in vivo study

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Abstract

Introduction: Dentin hypersensitivity is a very common clinical condition of the teeth, associated with the exposure of the dentin to external environment of the mouth. There is still no promising solution for dentin hypersensitivity due to little knowledge about its etiology and predisposing factors. The purpose of this study was to compare the efficacy of gallium-aluminum-arsenide diode laser (GaAlAs) and dentin bonding agent in the treatment of dentin hypersensitivity.

Materials and Method: Sixty permanent teeth with diagnosis of dentin hypersensitivity were selected from patients reporting the department. The selected teeth were divided into two groups: In group I, teeth were treated with 980 nm GaAlAs laser for 1 min at 30mW and in group II, teeth were treated with dentin bonding agent. Sensitivity was assessed by evaporative stimulus, measured with the criteria proposed by Uchida at baseline and after treatment; immediately, at 15 and at 30 days.

Results: The mean dentin hypersensitivity in both the laser and dentin bonding agent group was 1.9 ± 0.76.After 30 days, the degree of dentin hypersensitivity in Laser treated group (0.90 ± 0.80) was significantly lower than that of Dentin Bonding Agent group (1.40 ± 1.07)($p< 0.05$), thereby showing greater clinical efficacy of diode Laser over Dentin Bonding Agent for the treatment of dentin hypersensitivity.

Conclusion: The dentin bonding agent had less desensitizing efficacy compared with GaAlAs laser. However, the desensitizing effect of the dentin bonding agent still could be considered an effective therapy for treating dentin hypersensitivity.

Keywords: Dentin hypersensitivity (DH); GaAlAs diode laser; Dentin bonding agent.

Key Message: Dentinal hypersensitivity is a global oral health issue and a significant challenge for most dental professionals. With the advent of laser technology and its growing utilization in dentistry, an additional effective therapeutic option with lesser side effects is available for the treatment of dentinal pain.

Introduction

Dentin hypersensitivity is a very common clinical condition that causes considerable discomfort and pain.[(1)] According to Addy et al and a Canadian Consensus Document, dentin hypersensitivity (DH) can be defined 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 pathology." This definition was subsequently modified by the Canadian Board on DH which suggested that "disease" is a more appropriate term than "pathology".[(2,3)] It is better to treat hypersensitivity before the pulpal inflammation eventually becomes an irreversible condition. The difficulty found in treating DH is expressed by the enormous number of techniques and therapeutic alternatives to relieve it. Dentin hypersensitivity can be reduced by blockage of dentinal tubule orifices with resin.[(4)] The dentin bonding agents (DBA) removes the smear layer, etches the dentinal surface and forms deep dentinal resin tags inside the dentinal tubules. It effectively seals the dentinal tubules and prevents DH. However, most of the desensitizing agents are either ineffective or effective for only a short period of time. As a result, the ideal material or technology that is non-irritant to the pulp but is relatively painless and easy to use as well as effective for a long period has yet to be discovered.

Matsumoto et al was the first to apply laser therapy for treating dentin hypersensitivity.[(5)] Different types of laser such as low (He–Ne, diode) and middle output power (CO2, Nd: YAG) lasers have been used for the reduction of DH, although there is little documentation on their efficacy. The GaAlAs laser acts on biostimulation because of the i) increase in production of mitochondrial ATP, ii) increased threshold of the free nerve endings and iii) analgesic effect due to increased β endorphine. The reduction of pain occurs because of the inhibition of the cyclooxygenase enzyme, which suspends the conversion of the arachidonic acid into prostaglandin.[(6)] The laser also increases, the formation of a secondary dentin by the odontoblasts, in process of biostimulation. The GaAlAs laser is easy to apply and presents good results as described in the literature.[(6)] Hence the purpose of this study was to evaluate and compare the clinical efficacy of diode laser and dentin bonding agent in the treatment of dentin hypersensitivity.

Materials and Method

Subjects for this clinical study were selected from the patients visiting the outpatient Department of Conservative Dentistry and Endodontics. The study was

approved by institutional ethics committee and participants were enrolled in the study after obtaining informed consent from each participant. Sixty permanent teeth affected by dentin hypersensitivity were selected from nine patients belonging to the age group of 20-50 years from both genders. The patients were systemically in good medical health as per the past medical history.

Patient Selection: Detailed case history was taken for all the patients followed by clinical examination. After arriving at a diagnosis of dentin hypersensitivity, standard IOPA radiograph was taken for each affected tooth to rule out caries or any other pathology. The vitality of all the experimental teeth was evaluated at the beginning and at the end of the trial by means of an electric pulp tester. Inclusion Criteria of the study were systemically healthy patients with bilaterally hypersensitive teeth present, whose probable etiologic factors included abrasion, gingival recession, parafunctional habits and frequent ingestion of acidic food. Tooth with caries, fracture, defective restoration or periapical pathology were excluded from the study. All the patients were enrolled in an oral hygiene programme four weeks before treatment. Oral hygiene instructions were given and professional tooth cleaning was done according to the individual needs.

Evaluation of Dentin Hypersensitivity: DH was assessed by an evaporative stimulus. A strong air-blast from a three way dental syringe was directed to the exposed cervical area for 1 second at a distance of 1 cm and at right angle to the buccal surface of the assigned teeth, whilst adjacent teeth were isolated with cotton rolls(Fig. 1A). Air stimulus time was controlled and the distance was measured by a UNC-15 periodontal probe. All stimuli were applied by one operator in the same dental chair with the same equipment yielding similar air pressure and air temperature each time.

Table 1: Degree of Dentin Hypersensitivity (Uchida et al 1980)[7]

Degree	Sensitivity
0	Without significant discomfort.
1	Discomfort with mild pain.
2	Sharp pain solely during the application of stimulus.
3	Sharp pain during the application of stimulus and continues after its removal.

Data was standardized by scoring the degree of hypersensitivity for each tooth before treatment according to the criteria proposed by Uchida et al (1980)[7] which establish four degrees for hypersensitivity depending on patient's response to stimulation (Table 1).

Fig. 1A: Evaporative stimulus application; B: Dentin Bonding Agent application (Group II), C: GaAlAs laser application (Group I)

In this split-mouth study, for each patient, selected teeth were randomly assigned to GaAlAs diode laser group **(Group I)** or dentin bonding agent group **(Group II)** by the flip coin method. For each patient, all the affected teeth on one side of the arch were treated with the GaAlAs Diode Laser (Denlase-980/7, China Daheng Group, Inc.) and the Single component, self-etch dentin bonding agent (Bond Plus SE, Medicept U.K) was applied on the remaining teeth on the other side of the arch. In both the groups, prophylaxis of the region was done with rubber cup, when possible; if prophylaxis was not possible due to sensitivity, a slightly wet cotton ball was used. In laser group, the affected sensitive teeth were lased with the GaAlAs laser perpendicular to the tooth surface for 1min in a continuous, non-contact mode and using a fibre diameter of 400 microns at 30 mW by scanning the cervical part in an overlapping pattern under relative cotton roll isolation (Fig. 1C).[4,5] Similarly, application of the single component, self-etch dentin bonding agent (Bond Plus SE, Medicept U.K) was done by scrubbing the agent on the tooth surface for 20 seconds. It was applied in two layers & light cured for 10 seconds (Fig. 1B). All the patients used a soft toothbrush and toothpaste without any anti-hypersensitivity agent during the study period. In addition, subjects were instructed not to use any mouth rinse and/ or fluoride products during the study. The effectiveness of both treatments was assessed at three different time points (immediately after treatment, after 15 days and after 30 days of the treatment). Data were analyzed for descriptive and inferential statistics using statistical software R-3.0.0. A *p* value of 0.05 was considered as significant.

Results

Mean age of study participants was 33.11 ± 11.83 years. The demographic details of patients are presented in Table 2.

Table 2: Demographic characteristics of study participants (n=9)

	Category	n (%)
Gender	Male	4 (44.44)
	Female	5 (55.56)
Occupation	House wife	2 (22.23)
	Nurse	1 (11.11)
	Student	4 (44.44)
	Employee	1 (11.11)
	Government officer	1 (11.11)

Baseline matching was done as per the dentin hypersensitivity scores in both the study groups. It is evident from the **Fig. 2** showing identical distribution in both the study groups.

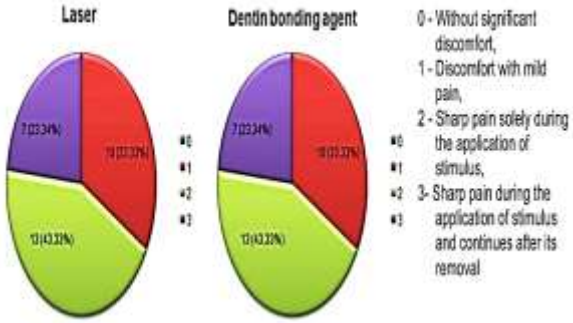

Fig. 2: Pie diagram showing the distribution of teeth according to the degree of dentin hypersensitivity in Group I (Diode Laser) and Group II (Dentin Bonding Agent) before treatment

Table 3: Comparison of mean dentin hypersensitivity between study groups at baseline and different follow-up visit

Time interval	Laser (Group I) (n=30)	Dentin bonding agent (Group II) (n=30)	*P*
Baseline	1.9 ± 0.76	1.9 ± 0.76	0.90
Immediate	1.20 ± 0.92	1.10 ± 0.96	0.07
After 15 days	1.03 ± 0.93	1.33 ± 0.96	0.05
After 30 days	0.90 ± 0.80	1.40 ± 1.07	0.04

The intergroup comparison at three time points was performed to evaluate the statistical significance of difference in tooth sensitivity (Table 3). Both immediately after the treatment and after 15 days, the difference in the mean sensitivity of laser group and DBA group was statistically insignificant. However, after 30 days, the difference in the mean sensitivity of laser group and DBA group was statistically significant as indicated by p-value of 0.04 ($p < 0.05$) (Table 3). In the Laser group, the mean dentin hypersensitivity reduced from 1.9 to 0.9 after 30 days, showing the reduction of 52%. For Dentin Bonding Agent group, the mean hypersensitivity reduced from 1.9 to 1.4 after 30 days, resulting into a sensitivity reduction of 26%. To determine which time point contributed to significance, a Pair-wise analysis of sensitivity at different time points was performed using Wilcoxon signed rank test. It showed that there was statistically significant lowering of sensitivity immediately after treatment in both the groups when compared with pre-treatment (p = 0.001). Further, the lowering continued to be significant as compared to pre-treatment sensitivity in both the groups as indicated by $p< 0.05$. However, the difference of sensitivity between the post-treatment time points was mainly contributed by lowering of score immediately after the treatment.

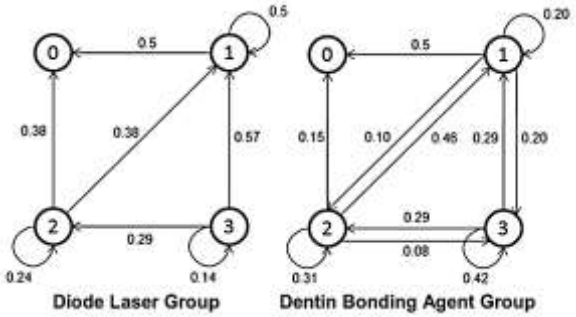

Fig. 3: Schematic showing the transition probabilities of sensitivity post-treatment as compared to pre-treatment

Diode laser provided relief even in cases of severe dentin hypersensitivity as the maximum probability was 0.57 corresponding to pre- and post-treatment sensitivity of 3 and 1 respectively (Fig. 3). Hence in diode laser group, likelihood of transition from higher sensitivity (score 3) to lower sensitivity (score1) was the highest; while the likelihood of high sensitivity teeth remaining the same after treatment was the lowest as indicated by the non-zero probability of 0.14. Similarly, in the Dentin bonding agent group, maximum probability (0.5) was corresponding to pre- and post-treatment sensitivity of 1 and 0 respectively, followed by 0.46 corresponding to pre- and post-treatment of 2 and 1 respectively. While the likelihood of higher sensitivity (score 3) remaining the same was 0.42, indicating its lower clinical efficacy in severe (score 3) and moderate (score 2) dentin hypersensitivity (Fig. 3).

Discussion

Dentin hypersensitivity is a largely explored topic in dentistry, with many researches for efficient new methods for its treatment. However, ideal treatment for DH does not exist, even in case of combination of

different protocols. Dentin bonding agent may be considered as a gold standard and used for investigating the efficacy of professionally applied topical desensitizing agents.[8] In present clinical study, Single component, self etch dentin bonding agent (Bond Plus SE, Medicept U.K.) was used instead of total etch procedure to prevent the collapse of collagen network. Additionally, the self-etching primers need no etching, rinsing and drying, so that the risk of over-etching and over-drying of the dentin is eliminated. They are simple to apply in clinical situations, and reduce the technique sensitivity of the bonding procedure.[9,10] However, the disadvantage of dentin bonding agent is that the loss of occluded resin from physical force such as brushing would result in less effectiveness.[4] To overcome this disadvantage laser was introduced for DH treatment. The present clinical study has therefore focused on comparing the conventional treatment modality of dentin bonding agent as supported by literature with newly introduced treatment with laser. Most of the studies on dentin hypersensitivity have used 780nm, 830nm, 900nm wavelength. Hence we used 980 nm wavelength GaAlAs diode laser to evaluate its effect.

The major advantage of using the split-mouth design is that subjects serve as their own controls, thus this design may be more efficient than designs with between subject comparisons.Plaque accumulation plays an important role in the etiology of dentin hypersensitivity.[8] Hence proper oral hygiene was maintained throughout the procedure.To prevent confounding bias, all the patients used a soft toothbrush and non-desensitising toothpaste during the study period.

Evaporative stimulus is a more reproducible method than tactile stimulation for assessing DH.[11] Also using a probe on the cervical lesion to elicit a response potentially damages the dentin bonding agent coating.[12] In addition, there are difficulties involved in tactile stimulation such as accurately scratching the surface using the same force and direction in the same previously tested location.[5]

Various studies for treatment effectiveness of GaAlAs laser used 30 mW power in a continuous mode for 0.5 – 3 min.[5] These studies showed diode laser effectiveness from 58.5 – 100%.[5] There are no absolute scientific proofs of which would be the most adequate wavelength, as well as timing of application, quantity of joules to be applied, number of applications and the interval between them.[13] Diode laser with settings of 2.0 W and 980-nm sealed exposed dentin tubules effectively without causing significant morphological alterations of the pulp and odontoblasts (Ying Liu et al 2013).[14] Hence diode laser with 980 nm at 30 mW for 1 minute in a continuous non contact mode was used in the present study.

There was significant lowering of dentin hypersensitivity immediately after treatment in the Diode laser group when compared with pre-treatment. Further, the lowering continued to be significant as compared to pre-treatment sensitivity in both the groups. These results were in accordance with the study by Tasanee Tengrungsun et al (2008),[4] Sicilia et al (2009)[15] and Hasan Guney Yilmaz et al (2011).[16] Also there is statistically significant lowering of dentin hypersensitivity immediately after treatment in the Dentin bonding agent group when compared with pre-treatment. These results were in accordance with the studies by Aparna S (2010)[17] and Tasanee Tengrungsun et al (2008).[4] This significant decrease in dentin hypersensitivity score after laser therapy might be due to biostimulation and interference with neural transmission in the dental pulp.[4,6,18] Similarly the significant decrease in dentin hypersensitivity score after dentin bonding agent therapy might be due to occlusion of dentinal tubules due to formation of resin tags.[4] However, the difference of dentin hypersensitivity between the post-treatment time points was statistically insignificant in both the groups. In other words, the overall significance obtained in Friedman test was mainly contributed by lowering of score immediately after the treatment.

The slight increase in dentin hypersensitivity in the dentin bonding agent group as compared to immediate effect might be due to the loss of occluded resin from physical force such as brushing in spite of giving proper oral hygiene instructions to the patient. This results in a loss of treatment efficiency over time.[4] Whereas the slight decrease in dentin hypersensitivity in diode laser group after 30 days as compared to the immediate effect might be due to formation of tertiary dentin after 30 days.[19] Further, after 30 days, the mean degree of dentin hypersensitivity in Laser treated group was significantly lower than that of Dentin Bonding Agent group, thereby showing the effectiveness of GaAlAs laser over Dentin Bonding Agent.

The desensitizing effects of both GaAlAs laser and dentin bonding agent treatments in this study provided a significant relief in sharp painful condition. Nevertheless, the GaAlAs laser inspite of its high cost could be clinically advantageous method to reduce dentin hypersensitivity due to its rapid clinical effectivity with no adverse reactions observed. As such the laser treatment could be suitable for routine clinical management of dentin hypersensitivity. It would be interesting to study the long term effects of laser treatment in reducing dentin hypersensitivity so as to improve the quality of life of the patients.

Conclusion

Within the limitations of the present study, it may be concluded that

1. A significant reduction of dentin hypersensitivity was observed immediately after treatment in the diode laser and dentin bonding agent groups when compared with pre-treatment.

2. The difference of dentin hypersensitivity between the post-treatment time points was statistically insignificant in both the groups. The overall effect obtained was mainly contributed by lowering of score immediately after the treatment.
3. Further, it is evident that after 30 days, the mean degree of dentin hypersensitivity in Laser treated group was significantly lower than that of Dentin Bonding Agent group, thereby showing the greater clinical efficacy of Diode Laser over Dentin Bonding Agent.

References

1. Pol D G., Jonnala J., Chute M., Gunjikar T., Pol S D. Current strategy in the management of dentinal hypersensitivity. Journal of Indian Dental Association 2011 june; 5(6):746-749.
2. Lin YH, Gillam DG. The Prevalence of Root Sensitivity following Periodontal Therapy: A Systematic Review. International Journal of Dentistry. Volume 2012, Article ID 407023,12 pages.
3. Porto IC, Andrade AK, Montes MA. Diagnosis and treatment of dentinal hypersensitivity. J Oral Sci. 2009 Sep;51(3):323-32.
4. Tengrungsun T, Sangkla W. Comparative study in desensitizing efficacy using the GaAlAs laser and dentin bonding agent. J Dent. 2008 Jun;36(6):392-5.
5. Koukichi Matsumotoa, Yuichi Kimurab. Laser Therapy of Dentin Hypersensitivity. J Oral Laser Application 2007;7:7-25.
6. YUI, Karen Cristina Kazue. Low level laser therapy for dentine hypersensitivity. Cienc Odontol Bras 2003 out./dez.;6(4):17-24.
7. Uchida A, Wakano Y, Fukuyama O, Miki T, Iwayama Y, Okada H. Controlled clinical evaluation of a 10% strontium chloride dentifrice in treatment of dentin hypersensitivity following periodontal surgery. J Periodontol. 1980 Oct;51(10):578-81.
8. Sethna GD, Prabhuji ML, Karthikeyan BV. Comparison of two different forms of varnishes in the treatment of dentine hypersensitivity: a subject-blind randomised clinical study. Oral Health Prev Dent. 2011;9(2):143-50.
9. Vinaychandra, R. Self-etch Adhesives: Simple, Easier. but is it Better? J. Int Oral Health 2010 Aug;2(2):85-91.
10. SL, Türkün. Clinical evaluation of a self-etching and a one-bottle adhesive system at two years. J Dent. 2003 Nov;31(8):527-34.
11. Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Lasers for the treatment of dentin hypersensitivity: a meta-analysis. J Dent Res. 2013 Jun;92(6):492-9.
12. Gibson M[1], Sharif MO, Smith A, Saini P, Brunton PA.A practice based randomised controlled trial of the efficacy of three interventions to reduce dentinal hypersensitivity. J Dent. 2013 Aug;41(8):668-74.
13. Gentile LC[1], Greghi SL. Clinical evaluation of dentin hypersensitivity treatment with the low intensity Gallium-Aluminum-Arsenide laser - AsGaAl. J Appl Oral Sci. 2004 Dec;12(4):267-72.
14. Liu Y, Gao J, Gao Y, Xu S, Zhan X, Wu B. In vitro study of dentin hypersensitivity treated by 980-nm diode laser. J Lasers Med Sci. 2013 Summer;4(3):111-9.
15. Sicilia A, Cuesta-Frechoso S, Suárez A, Angulo J, Pordomingo A, De Juan P. Immediate efficacy of diode laser application in the treatment of dentine hypersensitivity in periodontal maintenance patients: a randomized clinical trial. J Clin Periodontol 2009;36:650–660.
16. Yilmaz HG, Kurtulmus-Yilmaz S, Cengiz E, Bayindir H, Aykac Y. Clinical evaluation of Er,Cr: YSGG and GaAlAs laser therapy for treating dentine hypersensitivity: A randomized controlled clinical trial. J Dent. 2011 Mar;39(3):249-54.
17. Aparna S, Setty S, Thakur S. Comparative efficacy of two treatment modalities for dentinal hypersensitivity: a clinical trial. Indian J Dent Res. 2010 Oct-Dec;21(4):544-8.
18. Miglani S, Aggarwal V, Ahuja B. Dentin hypersensitivity: Recent trends in management. J Conserv Dent. 2010 Oct;13(4):218-24.
19. Tate Y, Yoshiba K, Yoshiba N, Iwaku M, Okiji T, Ohshima H. Odontoblast responses to GaAlAs laser irradiation in rat molars: an experimental study using heat-shock protein-25 immunohistochemistry. Eur J Oral Sci. 2006 Feb;114(1):50-7.