Effectiveness of fluoride varnish, diode laser, and their combination in treatment of dentin hypersensitivity: A randomized split-mouth clinical trial

Akanksha Jain, Jyoti Rao, Neha Pal, Alok Singh

Abstract:
Background: Dentin hypersensitivity is a common dental problem with no permanent cure and predictable prognosis. Aim: The aim of this study was to evaluate the effectiveness of fluoride varnish (sodium fluoride [NaF]), diode laser, and the combination of NaF and diode laser in the treatment of dentin hypersensitivity. Settings and Design: This was a randomized split-mouth clinical trial. Materials and Methods: Sixty patients aged 20–60 years suffering from dentin hypersensitivity to air-blast, cold, and tactile stimulation were selected. Sensory teeth were allotted to Group 1 – NaF varnish application alone, Group 2 – 810-nm gallium–aluminum–arsenide laser (GaAlAs) diode laser (0.5 W) irradiation alone, and Group 3 – NaF varnish application, followed by diode laser irradiation. VAS score was recorded at baseline, 1 week, 2 weeks, 1 month, 3 months, and 6 months. Results: A statistically significant reduction in dentin hypersensitivity was observed in all the three groups, from the baseline to the 1st, 3rd, and 6th-month follow-ups (P < 0.05). Group 2 and Group 3 demonstrated a significantly higher reduction (P < 0.05) in dentin hypersensitivity for all the stimuli as opposed to Group 1 at all follow-up intervals. However, no statistically significant difference (P > 0.05) was present between Group 2 and Group 3 at all follow-ups. Conclusion: Diode laser is significantly more effective than fluoride varnish alone in the treatment of dentin hypersensitivity over a period of 6 months.

Key words: Dentin sensitivity, fluoride, laser, varnish

INTRODUCTION

Dentin hypersensitivity is a common clinical problem encountered in dentistry. Sensory stimuli do not yield any response in healthy teeth but lead to exaggerated response in hypersensitive teeth. An international workshop defines this condition as: “Dentin hypersensitivity is characterized by short, sharp pain arising from stimulated dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other dental defect or pathology.”

Enamel can be worn off by attrition, abrasive toothbrushing, and erosion from acidic diet and parafunctional habits. The root surfaces of teeth can be exposed by gingival recession and periodontal disease. Dentin abrades 25 times, whereas cementum abrades 35 times more easily than enamel. The most accepted theory for hypersensitivity is the hydrodynamic theory. This theory attributes the movement of dentinal fluid in either direction within the dentinal tubules on application of an external stimulus. This excites the pulp’s mechanoreceptors in turn and results in hypersensitivity, perceived as pain by the patient.

Dentin hypersensitivity can range from slight discomfort to extreme pain depending on the individual’s pain perception and tolerance. A variety of desensitizing agents have been recommended to reduce dentin hypersensitivity, which include nerve-desensitizing agents, protein-precipitating agents, dentin adhesive sealers, agents plugging dentinal tubules, and homeopathic agents.

Sodium fluoride (NaF) was first proposed as a desensitizing agent by Lukomsky. Fluoride varnish was also favored by Porto et al. due to its ease of use and potential for patient compliance.

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to its ease of application and immediate action. In 1985, lasers were introduced as a potential desensitizing tool. The working parameters such as wavelength and the power density of the laser and the optical properties of the target tissue can lead to different tissue reactions. Kimura et al. reported an effectiveness varying from 5.2% to 100% depending on the laser parameters being used. The combination of lasers with chemical substances such as fluorides presents as an additional therapeutic option. In various clinical studies, the effectiveness of more than 20% has been found over the laser treatment alone.

Dentin hypersensitivity has been the topic of research since the past decade. Many treatment modalities that obliterate the dentinal tubules are available; however, till date, no consensus regarding the most efficient method for treating dentin hypersensitivity has been published. Effective therapeutic options that provide long-lasting relief with a predictable prognosis are being explored even today. Thus, this study aimed to evaluate the effectiveness of the 810-nm diode laser alone and in combination with 5% NaF varnish in the treatment of dentin hypersensitivity.

**MATERIALS AND METHODS**

In this split-mouth, double-blind, randomized control trial, sixty systemically healthy controls aged 20–60 years visiting the outpatient department of periodontics and fulfilling the inclusion criteria were selected for the study. Inclusion criteria:

1. The presence of a minimum of two teeth, hypersensitive to tactile, cold, or air stimulation corresponding to 4 cm and above on the Visual Analog Scale (VAS) in three quadrants
2. Willingness to provide written informed consent for being included in the study.

Patients who had received any professional treatment with desensitizing agents during the past 6 months; patients with a history of antibiotics, anti-inflammatory drug, or immunosuppressive drug therapy in the past 6 months; patients who underwent periodontal treatment in the past 6 months; patients with history of any systemic disease or allergy to fluorides; pregnant or lactating women; smokers; and chronic alcoholics were excluded from the study. The teeth having carious lesions, extensive restorations, endodontic treatment on the selected teeth, teeth diagnosed to have cracked tooth syndrome, vertical fracture, and pulpitis were also excluded from the study.

The study was approved by the institution’s ethical committee and review board and was conducted in accordance with the Helsinki Declaration as revised in 2013.

In each patient, hypersensitive teeth in three different quadrants were randomly assigned to one of the three treatment groups by a lottery method. In Group 1, NaF varnish application was done, in Group 2, diode laser application, and in Group 3, NaF varnish, followed by diode laser application, was done. A total of 626 teeth were evaluated for dentin hypersensitivity, of which 207 teeth were treated with NaF varnish, 207 teeth were treated with diode laser, and 212 teeth were treated with the combination of NaF and diode laser.

**Clinical parameter used for recording hypersensitivity score**

VAS score for each stimulus was recorded before each treatment session (at baseline, 1 week, and 2 weeks), followed by VAS score recording at 1 month, 3 months, and 6 months. The following stimuli were used for the assessment of dentin hypersensitivity with a 5-min gap between each stimulus.

**Air-blast stimulus**

Three-way syringe attached to the dental chair was used, kept at a distance of 0.5 cm, and perpendicular to the tooth surface for 1 s per tooth at room temperature.

**Cold stimulus**

A precooled 2-ml disposable syringe was filled with freshly melted ice-cold water. After isolating the specific tooth, 0.5 ml of the water was slowly expelled from the syringe on the tooth surface.

**Tactile stimulus**

The University of North Carolina-15 probe tip was moved back and forth in contact on the buccal tooth surface.

Adjacent teeth were covered with the operator’s fingers and or cotton rolls while dentin stimulation. A single operator evaluated all teeth for hypersensitivity while other operators performed all the treatments assigned.

In each patient, periodontal therapy consisting of full-mouth scaling and root planing using hand instruments and ultrasonic scaler, followed by oral hygiene instructions, was given. Dentin hypersensitivity was assessed and recorded for the three stimuli (air blast, cold, and tactile) before initiating any hypersensitivity treatment. After recording the baseline dentin hypersensitivity scores, hypersensitive teeth in different quadrants were assigned to one of the three treatment groups:

**Group 1 (sodium fluoride varnish application)**

Hypersensitive teeth in the selected quadrant were treated by application of NaF varnish (Fluoritop SR Varnish containing 50-mg NaF equivalent to 22,600 ppm of fluoride, ICPA, India) for 2 min using a disposable applicator tip [Figure 1].

**Group 2 (diode laser application)**

Hypersensitive teeth in the selected quadrant were irradiated using GaAlAs diode laser: 810 nm (Picasso, AMD lasers, Dentsply International Co., United States), power 0.5 W continuous emission form. Each tooth was irradiated for 2 min in noncontact mode with the laser beam directed perpendicular to the buccal surface of the tooth [Figure 2].

**Group 3 (sodium fluoride varnish + diode laser application)**

Hypersensitive teeth in the selected quadrant were treated by application of fluoride varnish for 2 min, followed by irradiation treatment using 810-nm GaAlAs diode laser, power 0.5 W continuous emission form. Each tooth was irradiated for 2 min in noncontact mode with the laser beam directed perpendicular to the buccal surface of the tooth [Figure 3]. All patients were instructed not to eat for 1 h following each session and to resume toothbrushing after 12 h.
for pairwise comparisons on the different combinations of related groups. The Kruskal–Wallis test was used to compare the three treatments at each time interval for each stimulus. Post hoc Mann–Whitney U-test with Bonferroni adjustment was used for pairwise comparisons.

RESULTS

Sixty patients (33 females and 27 males) with a mean age of 36 years were evaluated for 6 months. In the present study, there were no statistically significant differences in the dentin hypersensitivity score between the three treatment groups with regard to air-blast, cold, and tactile stimuli at baseline examination ($P \geq 0.05$) that ensured that randomization of the treatment groups was successful [Table 1]. On intragroup comparison, all the three treatment modalities (Group 1, Group 2, and Group 3) lead to a statistically significant reduction ($P \leq 0.05$) in dentin hypersensitivity from the baseline to the 1st, 3rd, and 6th months for all the three stimuli – air blast, cold, and tactile [Table 2].

On intergroup comparison, there was a significantly higher reduction ($P < 0.05$) in dentin hypersensitivity in Group 2 and Group 3 for all the three stimuli – air blast, cold, and tactile [Table 3] when compared to Group 1 at the 1st, 3rd, and 6th-month follow-up intervals. Group 3 leads to higher reduction in dentin hypersensitivity using air-blast, cold, and tactile stimuli when compared to Group 2 after dentin stimulation using air-blast, cold, and tactile stimuli; however, the difference between the two treatment groups was not statistically significant at the follow-up intervals ($P > 0.05$) [Table 3].

DISCUSSION

The prevalence of dentin hypersensitivity varies between 3% and 57% in the general population. Root instrumentation during periodontal therapy may lead to cementum removal which explains the higher frequency of dentin hypersensitivity (60%–98%) in periodontitis patients. Split-mouth study design was used in the present study to facilitate the comparison of the three treatment methods under similar and standardized conditions. The patients who underwent treatment with desensitizing agents or periodontal treatment during the past 6 months were excluded to prevent any manipulation of the results due to the past desensitizing procedure.

According to the results obtained, on intragroup comparison, a statistically significant reduction in hypersensitivity was observed from the baseline to the 1st, 3rd, and 6th months for all the stimuli in the three groups. The relief in hypersensitivity in Group 1 can be explained by the prolonged contact time of fluoride with the tooth surface due to the sticky consistency of varnish. The varnish dries rapidly leaving behind a thin, transparent coating. There is a deposition of calcium fluoride (CaF$_2$) crystals on the tooth surface which blocks the patent dentinal tubules. The relief in hypersensitivity in Group 2 and Group 3 can be explained by the secondary dentin formation through stimulation of odontoblasts after laser irradiation. This occludes the dentinal tubules and reduces the dentinal fluid.
In the present study, there was a significantly higher reduction in dentin hypersensitivity in Group 2 and Group 3 for all the three stimuli when compared to Group 1 at all follow-up intervals. The action of the varnish in occluding the dentinal tubules is comparatively short-lived due to small crystal size of CaF$_2$ (about 0.05 μm) that precipitates formed on the outer dentin surface and its tendency to be removed during toothbrushing. The precipitate may be removed over time due to the presence of saliva or factors such as acid from dental biofilm, food, and acid beverages.[16] This might lead to reopening of the patent dentinal tubules and thus triggering hypersensitivity. However, the relief after the use of low-level diode laser is due to depressed nerve transmission within the dental pulp along with the internal obliteration of dentinal tubules. The secondary dentin formed is not affected by mechanical forces. There is no reopening of the patent dentinal tubules which helps in maintaining the desensitizing effect.

Similar results were obtained in previous studies, according to which diode laser whether used alone or combined with fluoride varnish was significantly more effective than fluoride varnish alone ($P < 0.05$).[19-23] However, the present results were in contrast to the results observed by Corona et al. and Dantas et al., who reported no significant difference between diode laser and fluoride varnish in reducing hypersensitivity ($P > 0.05$).

In the present study, Group 3 reported a higher reduction in dentin hypersensitivity using air-blast, cold, and tactile stimuli when compared to Group 2; however, no significant difference was observed between the two groups at any follow-up interval. Similar findings were observed by Tailor et al., who evaluated the efficacy of a 808 nm diode laser with topical fluoride (6% NaF and 6% CaF$_2$) in the reduction of dentin hypersensitivity.

According to the results of some studies, lasers work in harmony with desensitizing agents.[24-27] They help in prolonging the contact of the desensitizer agent on the tooth surface. However, a direct comparison with the results of the present study cannot be made due to the differences in the fluoride treatment and the emission wavelength of the diode laser used.

Regardless of the methodology employed, different patients have different pain threshold which might obscure the results of the study and reduce the reliability of the results obtained.[28] This was a major limitation of the present study. Although the adjacent teeth were isolated using cotton rolls and operator’s fingers, the use of rubber dam may have resulted in more precise measurements. Oral prophylaxis was not repeated after baseline evaluation of dentin hypersensitivity till the end of 6 months. The presence of supragingival deposits could have altered the dentin hypersensitivity. Although a single examiner performed dentin stimulation using air-blast, cold, and tactile stimuli, variations in the pressure of the tactile stimulus, pressure of the air from the three-way dental syringe for air-blast stimulus, and temperature variation of freshly melted ice-cold water could not be avoided and could have affected the results. Other limitations included a lack of placebo-controlled design.

**CONCLUSION**

It can be concluded that both fluoride varnish and diode laser are effective in treating dentin hypersensitivity. However, diode laser used alone and in combination with fluoride varnish is significantly more effective than fluoride varnish alone in the treatment of dentin hypersensitivity.

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### Table 3: Intergroup comparison of dentin hypersensitivity using Mann–Whitney U-test at follow-up intervals

| Stimuli    | Comparison groups | Baseline | 1st week | 2nd week | 1st month | 3rd month | 6th month |
|------------|-------------------|----------|----------|----------|-----------|-----------|-----------|
| Air blast  | Group 1 versus Group 2 | 1759.50  | 979.50   | 485.00   | 382.50    | 67.00     | 0.00      |
|            | P                  | 0.27     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 1 versus Group 3 | 1723.00  | 939.50   | 488.50   | 310.00    | 37.50     | 0.00      |
|            | P                  | 0.22     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 2 versus Group 3 | 1697.50  | 1789.50  | 1748.00  | 1689.50   | 1746.50   | 1763.50   |
|            | P                  | 0.19     | 0.31    | 0.26     | 0.18      | 0.26      | 0.28      |
| Cold       | Group 1 versus Group 2 | 1779.00  | 1048.00  | 433.50   | 426.00    | 132.00    | 75.50     |
|            | P                  | 0.30     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 1 versus Group 3 | 1658.00  | 1061.50  | 446.00   | 421.00    | 134.50    | 75.50     |
|            | P                  | 0.15     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 2 versus 3    | 1667.50  | 1795.50  | 1777.50  | 1771.00   | 1729.50   | 1757.00   |
|            | P                  | 0.16     | 0.32    | 0.30     | 0.29      | 0.23      | 0.27      |
| Tactile    | Group 1 versus Group 2 | 1614.50  | 739.50   | 355.00   | 323.50    | 95.00     | 7.00      |
|            | P                  | 0.13     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 1 versus Group 3 | 1735.50  | 732.50   | 411.00   | 330.50    | 71.00     | 21.00     |
|            | P                  | 0.28     | 0.00    | 0.00     | 0.00      | 0.00      | 0.00      |
|            | Group 2 versus Group 3 | 1675.00  | 1872.50  | 1782.00  | 1777.50   | 1707.50   | 1691.00   |
|            | P                  | 0.16     | 0.30    | 0.30     | 0.29      | 0.17      | 0.16      |

*P < 0.05 (statistically significant difference between two groups). P – Level of significance

### Conflicts of interest

There are no conflicts of interest.

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