A comparative evaluation of diode laser, stannous fluoride gel and potassium nitrate gel in the treatment of dentinal hypersensitivity- A clinical study

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Abstract

Background and objectives: The acute, non-spontaneous, short or long lasting nature of pain due to hypersensitivity that appears suddenly on stimulation warrants a therapeutic mode which would bring about a significantly greater, immediate reduction of dentinal hypersensitivity. Lasers may now provide reliable and reproducible treatment for this condition. The present study aimed to compare the efficacy of diode laser with stannous fluoride and potassium nitrate gels in the treatment of dentinal hypersensitivity.

Material and methods: 54 patients with dentinal hypersensitivity, in the age range of 25-45 yrs having 2 adjacent teeth with cervical dentinal hypersensitivity to tactile, thermal and air stimulation were included. The patients were divided equally, randomly into 3 groups: 1) Group A-18 Patients treated with diode laser, 2) Group B- 18 Patients treated with 0.4% stannous fluoride gel, 3) Group C-18 Patients treated with 5% potassium nitrate gel. Each group was treated at baseline; at weekly intervals for two consecutive weeks and at 1, 3 and 6 months, or till the symptoms subsided.

Results: All the three groups showed significant decrease in the DH scores between baseline and 6 months. This was more pronounced in Group A at all time intervals. When the three groups were compared with each other, there was a statistically significant decrease in DH in Group A, which was more than Group B and Group C at week 1.

Conclusion: The 940nm diode laser was not only as efficacious but also brought about an immediate relief as compared to stannous fluoride and potassium nitrate gels in the reduction of dentinal hypersensitivity.

Keywords: Dentine Hypersensitivity; Diode Laser; Potassium Nitrate; Stannous Fluoride.

Introduction

The etiology of DH can stem from multiple sources, such as chemical erosion, traumatic oral hygiene and periodontal disease. The resulting gingival recession, enamel loss, or root surface denudation that exposes the dentinal tubules leads to the transient pain and discomfort elicited by tactile, thermal, or osmotic stimuli.

Various theories have been proposed to explain the actual mechanism. Among these, the hydrodynamic theory has ever been widely accepted. The use of desensitizing agents to reduce neuronal responsiveness to dentinal stimuli also has been investigated extensively. It was reported that potassium-containing dentifrices,[(16)] fluoride-containing medicaments,[(17)] and agents containing 10% strontium chloride[(18)] were partially effective in reducing DH. First-line treatment for DH sufferers often includes an over-the-counter desensitizing dentifrice, typically incorporating either potassium nitrate or stannous fluoride as the key active ingredient.[(19)] Stannous-containing products occlude the dentinal tubules via precipitation of stannous ions in turn blocking the nerve stimulus response20 and have been clinically proven in multiple trials to reduce DH.[(2)] Potassium nitrate products have also been shown to improve tooth sensitivity in many clinical studies,[(22)] with the mechanism of action reported to occur through disruption of the nerve synapses.[(23)]

Recently, affected teeth have been irradiated with different types of lasers like low output power (He–Ne, diode) and middle output power (CO2, Nd: YAG) lasers for the reduction of DH, although there is limited documentation on their efficacy. Diode (Ga Al As) laser is postulated to mediate an analgesic effect by blocking the depolarization of c-fiber afferents25. Most studies are simply before-and-after comparisons, and the lack of direct comparisons and systematic evaluations makes it difficult to determine which of the proposed treatment regimens offers the greatest efficacy for a longer duration with the least adverse effects.

The present study thus was aimed to compare the efficacy of diode laser with stannous fluoride and potassium nitrate gels in the treatment of dentinal hypersensitivity.

Aims and objectives

- To assess the immediate and long term efficacy of diode laser in the treatment of dentinal hypersensitivity.
- To assess the efficacy of 0.4% stannous fluoride gel in the treatment of dentinal hypersensitivity.
- To assess the efficacy of 5% potassium nitrate gel in the treatment of dentinal hypersensitivity.
- To compare the efficacy of diode laser with stannous fluoride and potassium nitrate gels in the treatment of dentinal hypersensitivity.

Materials and Methods

This study was conducted in the Department of Periodontics, Chandra Dental College & Hospital,

Barabanki. It was designed as a single centre, randomized parallel design study conducted over a 6 months period. 54 subjects including 30 males and 24 females in the age range 25-45 years were recruited for the study. Patients were considered suitable for the study if they had sensitive teeth showing abrasion, erosion or recession with exposure of cervical dentin. Each subject's pain inciting stimuli and duration of DH were recorded.

Inclusion Criteria

- Availability for the entire duration of the study
- Patients having at least 2 adjacent teeth with cervical dentinal hypersensitivity to tactile, thermal and air stimulation.

Exclusion Criteria

Patients with any of the following:

- Any professional desensitizing treatment in the last 6 months;
- Chronic use of any anti-inflammatory or psychotropic drugs;
- Pregnancy, allergic manifestations, idiosyncrasies to various products;
- Regurgitation, acid rich diets;
- Orthodontic treatment, periodontal surgeries in the last 3 months;
- Congenital tooth crown defects;
- Restored, non-vital or fractured teeth;
- Teeth with pulpal defects.

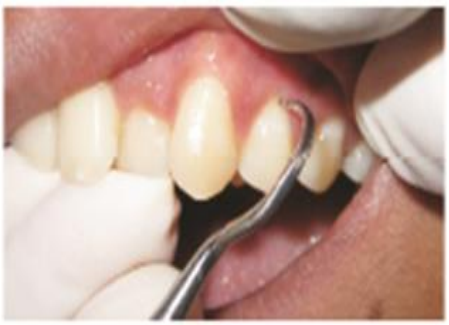


Fig. 1: Evaluation of Dentinal hypersensitivity by Tactile Method

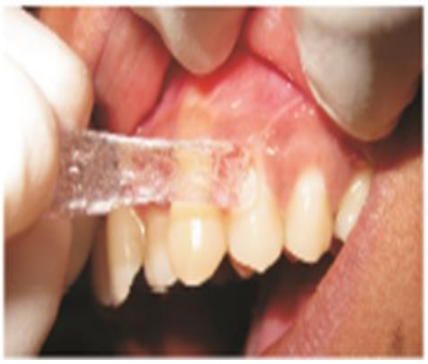


Fig. 2: Applications of Ice Stick to evaluate Dentinal hypersensitivity (Thermal Stimulation)

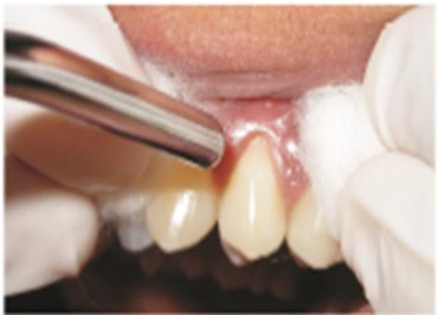


Fig. 3: Applications of Air Jet to evaluate Dentinal hypersensitivity (Air blast stimulation)

Dentinal hypersensitivity was assessed by,

- Tactile method: Mechanical stimulation with a No.23 dental explorer drawn across the cervical area of each tooth at an approximated constant force. (Fig. 1)
- Air blast stimulation: A blast of air from a three way syringe connected to an air compressor at a pressure of 60 psi under room temperature of about 20–25° C. This air jet, lasting for 3 s at a distance of 1 cm from the tooth surface (Fig. 3)
- Thermal stimulation: An ice stick was applied to the facial and lingual surface of the tooth to be assessed. (Fig. 2)

A time gap of 10 minutes was given between the application of each stimulus. Evaluation of DH was based on the patient's subjective answer, using the Visual Analog Scale94. Ordinal values from 0 to 10 located at the opposite ends of this scale represent "pain absence" (value 0) and "intolerable pain" (value 10). The patients were asked to indicate a value from 0 to 10 that best represented their pain level.

From the moment of selection, the subjects were instructed to use a soft bristle toothbrush and adequate brushing instructions were given.

To determine the efficacy of therapy on DH pain, the following approach was used:

- Excellent—DH reached value 0, meant absence of pain.
- Good—DH reached value 1, 2, or 3, meant light pain.
- Unsatisfactory—DH reached value 4, 5, or 6 meant moderate pain and 7, 8, or 9 meant strong pain; even then the pain was tolerated.
- Bad—Final DH was higher than the initial pain and the pain was not tolerated.

The subjects were divided equally, randomly consecutively into 3 groups;

- Group A-18 subjects treated with diode laser
- Group B-18 subjects treated with 0.4% stannous fluoride gel
- Group C-18 subjects treated with 5% potassium nitrate gel.

For Group A, which was considered as the test group, the tooth was gently dried with a cotton roll

before applying diode laser. Ga Al As-diode laser (Ezlase)* with 940nm wavelength was used as per the manufacturer's instructions in a pulsed, defocused operation mode. Both the operator and the subjects used appropriate protective eyewear during the laser application (Fig. 4). The power was set at 1.2-1.5W with pulse duration 0.20 seconds and a pulse interval of 0.20 seconds (Fig. 6). The exposure time per application was 15 seconds. Energy per application was 19 J.

Diode laser (DL) was applied perpendicular to the long axis of the tooth at a distance of 10-12 mm point by point (Fig. 7). Four points of application were chosen on each tooth. Three points on the vestibular surface of the incisor and canine teeth and one point on the lingual surface. In the premolar and molars application was done at 2 points on the vestibular surface and 2 points on the lingual surface66 (Fig. 5).

For Stannous fluoride (group B)[Sentim-SF] and Potassium nitrate gel (group C) [Sensodent-K] , which were taken as positive control groups, tubes were provided to the subjects with appropriate instructions i. e. to be applied at home twice a day for 2 weeks. The patients were asked to apply the gels with a toothbrush leaving it on for one minute, brush and then were asked to expectorate.

Each group was recalled at weekly intervals for two consecutive weeks and at 1, 3 and 6 months. Hypersensitivity scores were recorded before and after therapy using Visual Analog Scale at all follow-up visits.

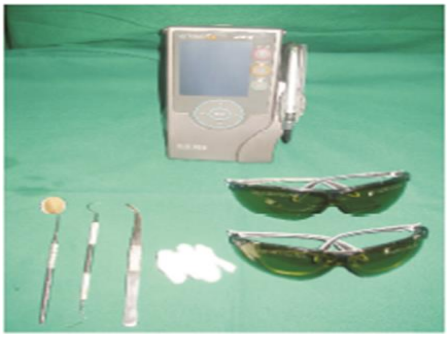


Fig. 4: Diode Laser with protective Eye Wear

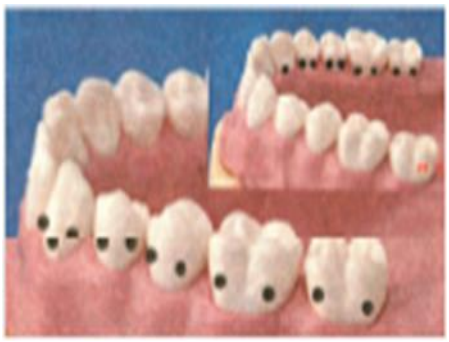


Fig. 5: Systemic representation of areas of application of Diode Laser

Fig. 6: Power Settings for Diode Laser

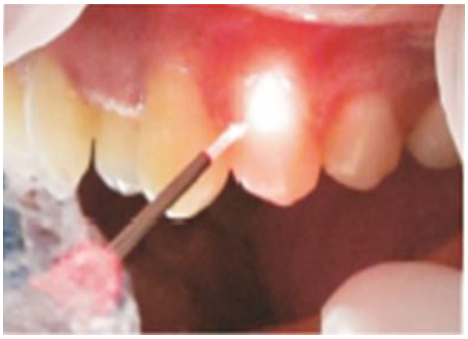


Fig. 7: Applications of Dental Laser on tooth

The collected data was subjected to statistical procedures like

- Mann-Whitney U-test,
- Kruskal-Wallis ANOVA test by ranks,
- Wilcoxon-matched pair test by ranks.

The significance level adopted was 5% (p=0.05) for all tests.

This randomized parallel prospective study was conducted to assess the immediate and long term efficacy of diode laser in the treatment of dentinal hypersensitivity, to assess the effects of 0.4% stannous fluoride gel in the treatment of dentinal hypersensitivity, to assess the effects of 5% potassium nitrate gel in the treatment of dentinal hypersensitivity and to compare the efficacy of diode laser with stannous fluoride and potassium nitrate gels in the treatment of dentinal hypersensitivity. A total of 66 subjects entered the study of which 12 were lost to follow-up.

When the three groups were compared with each other, there was a statistically significant decrease in DH in Group A, which was more than Group B and Group C at week 1.

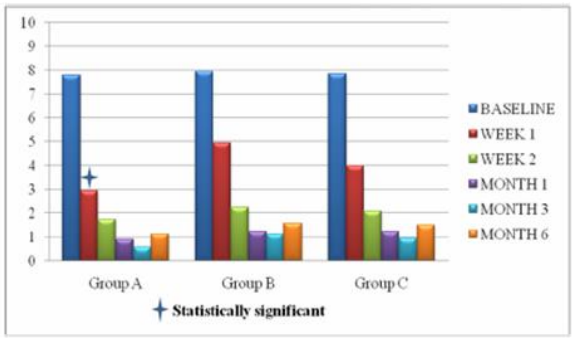
Comparing the desensitizing treatments, the statistical analysis revealed significant differences between the periods of examination. Statistically significant differences were observed immediately after the treatment in Group A when compared to Group B and Group C.

Results

Comparing the desensitizing treatments, the statistical analysis revealed significant differences between the periods of examination. Statistically significant differences were observed immediately after the treatment in Group a when compared to Group B and Group C. (Table 3, Graph 1.)

Table: 3 Comparison of different time intervals in Group

Group	Time	Mean	Std.Dv.	Mean Diff	SD Diff	T-Value	Z-Value	P-Value
Group A	Baseline	7.7778	1.1144					
	Week 1	2.9444	1.3921	4.8333	1.4246	0.0000	3.7236	0.0002
	Baseline	7.7778	1.1144					
	Week 2	1.7222	1.5265	6.0556	1.1618	0.0000	3.7236	0.0002
	Baseline	7.7778	1.1144					
	Month 1	0.8889	1.2783	6.8889	1.0786	0.0000	3.7236	0.0002
	Baseline	7.7778	1.1144					
	Month 3	0.5556	0.6157	7.2222	1.3528	0.0000	3.7236	0.0002
	Baseline	7.7778	1.1144					
	Month 6	1.1111	0.5830	6.6667	0.9701	0.0000	3.7236	0.0002
	Week 1	2.9444	1.3921					
	Week 2	1.7222	1.5265	1.2222	1.0603	0.0000	3.1798	0.0015
	Week 1	2.9444	1.3921					
	Month 1	0.8889	1.2783	2.0556	0.9984	0.0000	3.6214	0.0003
	Week 1	2.9444	1.3921					
	Month 3	0.5556	0.6157	2.3889	1.3779	0.0000	3.6214	0.0003
	Week 1	2.9444	1.3921					
	Month 6	1.1111	0.583	1.8333	1.3827	0.0000	3.5162	0.0004
	Week 2	1.7222	1.5265					
	Month 1	0.8889	1.2783	0.8333	0.8575	5.0000	2.8304	0.0047
	Week 2	1.7222	1.5265					
	Month 3	0.5556	0.6157	1.1666	1.6891	20.0000	2.6746	0.0075
	Week 2	1.7222	1.5265					
	Month 6	1.1111	0.5830	0.6111	1.4200	26.0000	1.6636	0.0962
	Month 1	0.8889	1.2783					
	Month 3	0.5556	0.6157	0.3333	1.4552	25.0000	0.7113	0.4769
	Month 1	0.8889	1.2783					
	Month 6	1.1111	0.5830	0.2222	1.2154	16.5000	1.467	0.1424
	Month 3	0.5556	0.6157					
	Month 6	1.1111	0.5830	0.5556	0.6157	0.0000	2.6656	0.0077



Graph 1: Comparison of the overall sensitivity scores (0-10 intensity scale) from baseline t all time intervals in the three group

Discussion

In the present study, a visual analog scale (VAS) was used to assess DH because it is easily understood by patients, it is sensitive in discriminating among the effects of various types of treatments, and it thus is suitable for evaluating the response.[100] DH was assessed at all time intervals recording the patient's subjective perception to their individual pain inciting stimuli.

The scores initially showed a mean pain intensity response of grade 8 corresponding to maximum pain in the quantitative numeric pain intensity scale, described as the response-based assessment.[101] This was supported by evaluation of the subjects 'to rely upon changes in neural transmission networks within the dental pulp causing depressed nerve transmission, rather than alterations in the exposed dentine surface, as observed with other treatment modalities.

When the VAS scores of the three groups were compared, the laser group showed a statistically significant reduction in DH in the first week itself. The faster desensitizing effect of laser therapy observed in the conducted research may be attributed to depressed nerve transmission. Moreover, besides the immediate analgesic effect, the laser therapy if used within the

correct parameters may stimulate the normal physiological cellular functions. Therefore, at subsequent appointments, the pulpal tissue would be less injured and inflamed and the laser would stimulate the production of sclerotic dentin, thus promoting the internal obliteration of dentinal tubules.[68]

Traditional DH treatment is based on the application of desensitizing substances, which reduce or eliminate pain and are capable of stimulating the formation of dentine, which obliterates the dentinal tubules exposed to the oral environment.[12] According to the literature, conventional treatment with potassium salts and stannous fluoride have demonstrated a significant reduction of DH in a few weeks.[121] However, because the elicitation of pain in DH patients is acute, the availability of a treatment that reduces or eliminates DH within a period of 24–48 h, or even earlier, would be ideal.

Since DH has been touted as a recurrent phenomenon, it would be prudent to evaluate the therapeutic agents for a much longer duration. The clinical results described above may seem impressive, even to the degree of doubts. However, laser therapy is no panacea and should only be used within the limits of its own merits. Correct diagnosis, proper treatment technique and treatment intervals plus sufficient dosage are all essential to obtain good results.

Summary & Conclusion

From the present study, the following conclusions can be drawn:

- The 940nm diode laser brought about a statistically significant reduction of dentinalhypersensitivity immediately, i.e. at the first week itself, this was maintained even at6 months.
- 0.4% stannous fluoride gel was effective in the treatment of DH.
- 5% potassium nitrate gel was effective in reducing DH.
- Diode laser was not only as efficacious but also brought about an immediate relief ascompared to stannous fluoride and potassium nitrate gels in the reduction of dentinalhypersensitivity

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