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Evaluating Diode Laser and 5.0% Potassium Nitrate with 0.62% Sodium Monofluorophosphate Gel in Treatment of Dentinal Hypersensitivity: A Single Blind Randomised Control Trial

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ABSTRACT

Background: Dentinal hypersensitivity (DH) is one of the most common causes of the dental ailment, which affects the quality of life of the individuals. Hence, the present study aimed to assess the efficacy of low-level diode laser and 5% topical potassium nitrate with 0.62% sodium monofluorophosphate gel in the management of this painful hypersensitive condition.

Material and methods: The study was designed as a single-blind randomized controlled trial with three parallel arms. A total of 45 patients under the age group 18-60 years who appeared in the department of Public health dentistry of People's College of Dental Sciences & Research Centre, Bhopal, and local screening camps, with the complaint of DH were enrolled in the study. DH was assessed by mean of both air pressure and tactile stimuli and measured by the Verbal Rating Scale (VRS). The subjects were randomly divided into 3 groups consisting of 15 patients in each group. Group 1 (G1): (15 patients): subjects were treated with 5.0% potassium nitrate with 0.62% sodium monofluorophosphate gel. Group 2 (G2) :(15subjects): subjects were treated with a 980-nm diode laser. Group 3 (G3): (15patients): Patients were treated with placebo gel (Vaseline). Both air and tactile stimuli evaluations were recorded before and after every treatment session, at baseline, immediately after treatment, 15 days after treatment and one month after treatment.

Results: There was a significant decrease in mean values immediately after treatment, **with** an increase in mean of dentinal hypersensitivity 15 days and one month after treatment in all the three groups. However, group 2 showed the least increase in mean DH pain, one month after treatment. Group 1 showed an increase in mean DH pain greater than group 2, 1 month after treatment. Group 3 depicted almost equivalent pain values, 1-month post-treatment and at the baseline.

Conclusion: The results of the study suggested that both the treatment options diode laser and 5% potassium nitrate with 0.62% sodium monofluorophosphate gel are effective in treating dentinal hypersensitivity but the GaAlAs laser showed a very high capability to reduce the Dentinal hypersensitivity a dental ailment for a longer period of time.

Keywords: Dentinal hypersensitivity, Diode laser, Potassium Nitrate, Sodium monofluorophosphate.

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INTRODUCTION

Dentinal hypersensitivity is amongst the commonest dental problem. A dentist encounters in his day to day practice. DH is an exaugurated response to stimuli which normally do not cause any discomfort. According to the Canadian consensus,[1] DH has been described as the "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". Though this pain is localized and of short duration, it makes eating and oral hygiene very difficult. [2] The DH pain differs from the pulpal pain as the latter is usually a dull aching type of pain which is comparatively less localized and last even after removal of stimuli. [3]

The prevalence of Dentinal hypersensitivity has been reported ranging from 4 to 57% in many studies, depending on the population samples studied. [4,5] In patients affected by periodontitis, dentinal hypersensitivity prevalence was even higher, ranging between 60 to 98%.[6] However, the prevalence of DH is likely to increase in the forthcoming years, since now more adults retain teeth in later years of life. This condition may affect patients at any age, due to lifestyle changes consumption of acidic beverages, gastric reflux increase acid attack on enamel results in hypersensitivity and both genders are equally affected.[7] Researches have revealed that this problem befalls in females more frequently than males.[8] Its occurrence is affected by the hygiene of the oral cavity, differences in diet, and the frequency of treatments at dental clinics.[8]

Many theories have tried to explain the producing mechanisms of dentinal hypersensitivities, such as the odontoblastic transduction theory, the neuronal therapy, and the hydrodynamic theory.[7] Presently, however, the hydrodynamic theory proposed by Brännström and his collaborators is the most accepted one.[7] This theory postulates that the dentinal hypersensitivity is determined by the hydrodynamic movement of the fluid that appears in the open tubules of the exposed dentine, this movement activates mechanically the nervous Type A fibres situated at the external extremity of the dentinal tubules or in the interior layer of the pulp. The tubular fluid movement is directly affected by the external temperature, mechanic, chemical or osmotic stimuli. The thermic expansion coefficient of the tubular fluid is almost ten times higher than that of the tubule wall.[9] Thus, the heat applied to the affected dentine determines the expansion of the tubular fluid and the cold determines the contraction of the fluid, both mechanisms cause an excitation of the mechanoreceptors leading to DH.

A range of therapies have been devised to alleviate this condition.[10,11]Most of the desensitizing methods in use, attempt to inhibit the pain by either sealing the dentinal tubules with coating mechanisms or by altering the tubules contents through coagulation, protein precipitation, or creation of insoluble calcium complexes.[12] Potassium nitrate reduces dentinal sensory nerve activity due to the depolarizing activity of the K+ ions. Recently, a laser has been used as a new treatment method for DH. [13] Researches have shown that when laser application on hypersensitive teeth, impossibly melts the dentinal surface with occlusion of open dentinal tubules.[14] Several types of laser have been utilized to treat hypersensitive dentine. Low-level laser therapy has been suggested as a new method in the treatment of dentinal hypersensitivity. The low-level laser therapy is different from other laser treatment modalities since, within the dental pulp, it changes the neural transmission network rather than melting the exposed dentine surfaces[15].

The aim of this study was to assess the effectiveness of low-level diode laser and 5% topical potassium nitrate+0.62% sodium monofluorophosphate gel in the treatment of Dentinal hypersensitivity in order to evaluate the possibilities of this device in the management of this painful condition, a susceptible state of teeth for a prolonged period for the symptomatic relief.

MATERIAL AND METHOD

This study was conducted in the Department of Public Health Dentistry, People's College of Dental Sciences & Research Centre, Bhopal (M.P), ethical clearance was obtained from the concerned Ethical Committee of the institute. A single-blind, randomized clinical trial was conducted to compare the efficacy of Gallium-aluminum-Arsenicum (GaAIAs) diode laser and topical 5.0% potassium

nitrate with 0.62% sodium monofluorophosphate gel in the treatment of dentinal hypersensitivity among susceptible individuals. The dentinal hypersensitivity of the subjects was evaluated using VRS scale, at baseline, immediately after treatment,15 days after treatment and one month after treatment using tactile and cold air methods.

Selection of target population:

The target population for the study were individuals with the complaint of dentinal hypersensitivity, visiting Outpatient Department of People's College of Dental Sciences & Research Centre, Bhopal and various local screening camps or outreach programs.

Only those individuals satisfying the inclusion and exclusion criteria were invited to take part in the study

The inclusion criteria:

1. The subject between the age of 18-60 years;

2. The subject is in good general health.

3. Sensitive teeth are showing attrition, abrasion, erosion, or recession with exposure of cervical dentin.

4. The subject is a regular user of toothpaste and a toothbrush.

5. The subject should exhibit dentinal hypersensitivity and exhibit discomfort by, the two test stimuli used were tactile and cold air method, which were as follows:

- Identifying the hypersensitive teeth with a straight probe/explorer used cervically on each tooth anterior to the second molars.
- Ten minutes later, the tooth response to cold air was assessed using standard dental air syringe at a pressure of 20°C ± 3°C at 60-65 psi directed perpendicular to the exposed hypersensitive tooth.

6. The subject should be willing to participate in the study.

The exclusion criteria:

The patients were excluded from the study if they;

1. Administering analgesic, anti-inflammatory or anti-depressive drugs
2. Individuals with eating disorders,
3. Pregnant individuals
4. Individuals are undergoing orthodontic therapy.
5. Individuals with cognitive dysfunctions or general communication difficulties.
6. Individuals subjected to periodontal surgery within the past three months,
7. Individuals with congenital tooth crown defects,
8. Individuals with multiple carious lesions
9. Individuals with restored or fractured teeth,
10. Individuals with non-vital or symptoms of pulp damage
11. Individuals have undertaken any anti-hypersensitive therapy within the last 30 days

Study sample:

As the study was related to individuals with dental hypersensitivity and absence of sampling frame, a convenient and judgment type of sampling was carried out. Male and female patients between 18-60 years of age who full fill all criteria were selected for the study. A total of 45 subjects were thus included to participate in the study post a pilot study on 18 subjects. The sample size was calculated based on the power of the study taken as 80% (constant= 7.9).[16]

Study Protocol:

Written consent was taken from the individuals selected for the study after informing the entire study procedure to them. From the time of selection, until the end of the study, standardized oral hygiene was established by asking the subjects to follow prescribed, oral hygiene instructions. During the study period, all the subjects were instructed to brush their teeth regularly two times a day with non-desensitizing and non fluoridated toothpaste at home.

Instruments and measures used:

The data was collected through a dental clinical examination, mouth mirror, explorer or straight probe, standard air syringe from the dental unit, 5.0% potassium nitrate with 0.62% sodium monofluorophosphate gel, Diode Laser, Laser

protecting eyewear, Vaseline, Gloves, mask, saliva ejector.

Methods used to assess dental hypersensitivity

Tactile method : [17]

The tactile method consisted of running an explorer or straight probe cervically on the hypersensitive tooth and recording the patient's perception of discomfort from a score of 0-3 in the Verbal Rating Scale (VRS).

***Airblast Stimulation*:** [9,18]

This method was to be performed two minutes after the tactile scoring procedure by means of a standard air syringe from the dental unit. The test tooth was isolated and cold air from a dental unit air syringe at 20°C ± 3°C at 60-65 psi directed perpendicular to the exposed hypersensitive tooth surface was applied for 1 second. The discomfort of the patient was recorded on a score of 0-3 as described for tactile method.

The patients' reactions to the stimuli were recorded before and after the treatment, at baseline, immediately after treatment, 15 days after treatment and 1 month after treatment. Before the desensitizing procedure, teeth surface was carefully cleaned with water, rinsed and gently dried with cotton pellet.

Treatment Procedure:

The study was a randomized control trial with single-blind technique. The subjects were randomly divided into 3 groups consisting of 15 patients in each group.

1. **Group 1 (G1):** (15 patients): subjects were treated with **5.0% potassium nitrate + 0.62% sodium monofluorophosphate gel** which was applied for 90 seconds on the tooth.
2. **Group 2 (G2)** :(15 subjects): In this group subjects were treated with a 980-nm **diode laser** (GaAlAs) (**Doctor- Smile, Italy**) performing with an output power of 0.2 W, in a continuous mode, using 350micron diameter fibre. Each site received one application of infrared laser beam for 20 seconds.
3. **Group 3 (G3):** (15subjects): Treatment was done with placebo gel **(Vaseline)**

The response of the subjects to cold air blast was assessed by a short blast of 1-second duration at a distance of 0.5 cm for each tooth. Both air and tactile stimuli evaluations were performed before and after every treatment session, at baseline, immediately after treatment, 15 days after treatment and 1 month after treatment.

Reliability:

There was an interval of ten minutes between each of the testing methods. All three testing methods were carried out by a single examiner. Intra-examiner calibration for the tactile and cold air methods was carried out on 18 subjects with dental hypersensitivity and was calibrated to be 95%.

Blinding:

The present study employed a single blinding procedure to eliminate bias. The statistician was blinded.

Data Analysis:

Data presentation and statistical analysis were performed on a personal computer using the Statistical Package for Social Sciences (SPSS, version 17) software for Windows 7. The ANOVA and chi-square test were used to analyze the data. The level of significance was considered at $P<0.05$.

RESULTS

Table 1: Comparison of mean dentinal hypersensitivity scores at different time intervals in between groups 1,2 and 3.

Time interval	Groups	N**	Mean	Std. Deviation	F value	P value
Baseline	Gel	30	1.87	0.571		
	Laser	30	1.97	0.490	0.249	0.780
	Placebo	30	1.90	0.607		
	Total	90	1.91	0.554		
Immediately	Gel	30	0.13	0.346		
	Laser	30	0.17	0.461	89.774	0.001*
	Placebo	30	1.67	0.661		
	Total	90	0.66	0.876		
15day	Gel	30	0.50	0.509		
	Laser	30	0.10	0.305	11.560	0.001*
	Placebo	30	1.90	0.607		
	Total	90	0.83	0.915		
1 month	Gel	30	0.63	0.556		
	Laser	30	0.43	0.568		
	Placebo	30	1.83	0.648	49.062	0.001*
	Total	90	0.97	0.854		

Note: * P<0.05

**N= Number of methods used to calculate the dentinal Hypersensitivity (N= 30 by totalling 15 scores from tactile stimuli and 15 scores from air blast stimulus in each group of 15 patients)

Graph 1: Comparison of mean dentinal hypersensitivity at different time intervals in between groups 1,2 and 3.

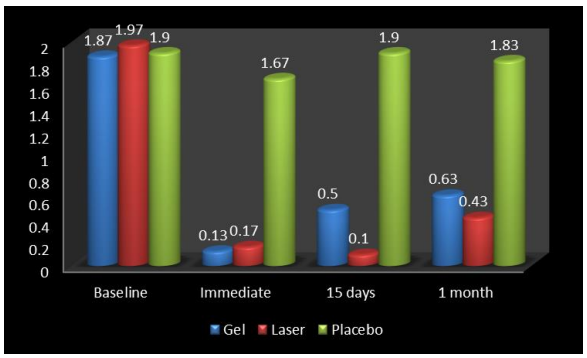

Table 1 and graph 1 shows ANOVA results for **Comparison of mean dentinal hypersensitivity at different time intervals in between groups 1, 2 and 3**. At baseline, the mean values for gel, laser and placebo groups were 1.87, 1.97 and 1.90, respectively. There was a significant decrease in mean values immediately after the treatment in first two groups, the values being 0.13 in 1st group and 0.17 in 2nd group, whereas the 3rd group does not show any reduction in dentinal hypersensitivity after treatment. There was an increase in mean values in the first two groups, the values being 0.50 and 0.10, respectively, for the two groups at a 15-day interval. Similarly, it was found that there was an increase in dentinal hypersensitivity at 1-month interval after treatment with the values being 0.63 in the 1st group and 0.43 in the 2nd group.

Table 2: Dentinal hypersensitivity severity at baseline in groups 1,2 and 3.

Groups	N	No pain n (%)	Mild Pain n(%)	Moderate Pain n(%)	Severe Pain n(%)
Gel	30	0(0.00)	7(38.9)	20(32.3)	3(30.0)
Laser	30	0(0.00)	4(22.2)	23(37.1)	3(30.0)
Placebo	30	0(0.00)	7(38.9)	19(30.6)	4(40.0)
Chi-square value	1.619				
df value	4				
P value	0.805				

Graph 2: Dentinal hypersensitivity severity at baseline in groups 1,2 and 3.

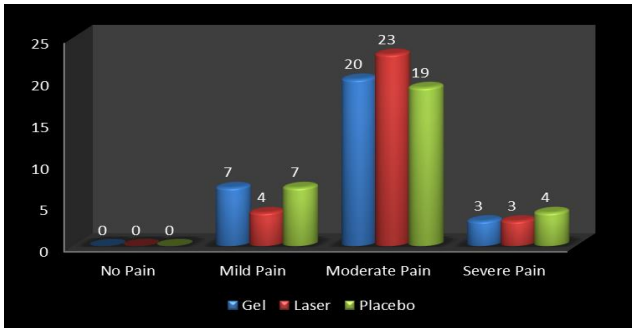

Table 2 and graph 2 shows chi-square values expressing **Dentinal hypersensitivity severity at baseline in groups 1,2 and 3**. According to the readings, the subjects reporting with dentinal hypersensitivity at baseline were 38.9%, 22.2% and 38.9% indicating mild sensation for the three groups, respectively. The gel group reported 32.3%, laser group 37.1%, and placebo group reported 30.6 % subjects with moderate pain. And finally, 30.0% for gel and laser groups and 40.0% for the placebo group were encountered with severe dentinal hypersensitivity.

Table 3: Dentinal hypersensitivity severity immediately after treatment in groups 1,2 and 3.

Groups	N	No pain n(%)	Mild Pain n(%)	Moderate Pain n(%)	Severe Pain n(%)
Gel	30	26(50.0)	4(20.0)	0(0.0)	0(0.0)
Laser	30	26(50.0)	3(15.0)	1(6.7)	0(0.0)
Placebo	30	0(00.0)	13(65.0)	14(93.3)	3(100)
Chi-square value	65.50				
df value	6				
P value	0.001				

Note : * P <0.05

Graph 3: Dentinal hypersensitivity severity immediately after treatment in groups 1,2 and 3.

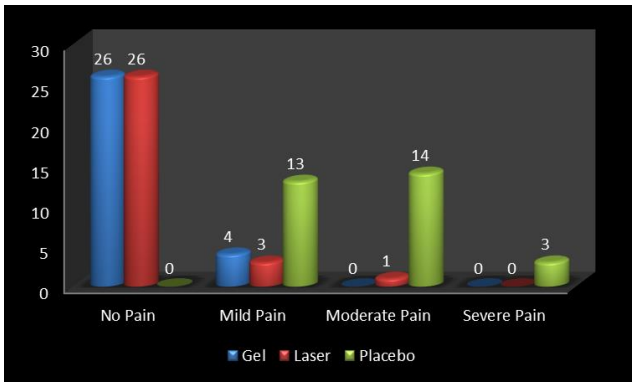

Table 3 and graph 3 shows chi-square results **Dentinal hypersensitivity severity immediately after treatment in groups 1,2 and 3.** Just after treatment 50.0% subjects reported with no pain in first two groups. The patients who reported with mild main after treatment were 20.0% in the gel group, 15.0% in the laser group and 65.0% in the placebo group. Looking forward at the scores 6.7% of the subjects reported with moderate pain in laser group and increased severity of pain was observed in only placebo group showing 100% of subjects suffering from severe pain and sensitivity of tooth even after treatment.

Table 4: Dentinal hypersensitivity severity 15 days after treatment in groups 1,2 and 3.

Groups	N	No pain n(%)	Mild Pain n(%)	Moderate Pain n(%)	Severe Pain n(%)
Gel	30	15(35.7)	15(60.0)	0(0.00)	0(0.00)
Laser	30	27(64.3)	3(12.0)	0(0.00)	0(0.00)
Placebo	30	0(0.00)	7(28.0)	19(100)	4(100.)
Chi-square value	81.103				
df value	6				
P value	0.001*				

Note: * P <0.05

Graph 4: Dentinal hypersensitivity severity 15 days after treatment in groups 1,2& 3.

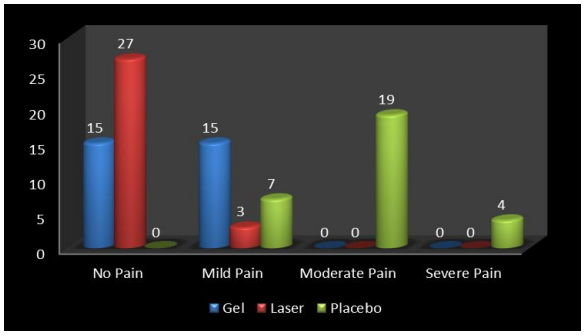

Table 4 and graph 4 shows chi-square results for **Dentinal hypersensitivity severity 15 days after treatment in groups 1,2 and 3.** The subjects reporting with no pain 15 days after treatment were 35.7% in the gel group and 64.3% in the laser group. Those who reported with mild pain were 60.0% in the first group, 12.0 % in the second group and 28.0% in the third group. The dentinal hypersensitivity was found to be 100% in the placebo group in individuals reporting with both moderate and severe pain and sensitivity of the tooth.

Table 5: Dentinal hypersensitivity severity one month after treatment in groups 1,2 and 3.

Groups	N	No pain n(%)	Mild Pain n(%)	Moderate Pain n(%)	Severe Pain n(%)
Gel	30	12(40.0)	17(45.9)	1(5.3)	0(00.0)
Laser	30	18(60.0)	11(29.7)	1(5.3)	0(00.0)
Placebo	30	0(00.0)	9(24.3)	17(89.5)	4(100.0)
Chi-square value	54.558				
df value	6				
P value	0.001*				

Note *P<0.05

Graph 5: Dentinal hypersensitivity severity one month after treatment in groups 1,2 and 3.

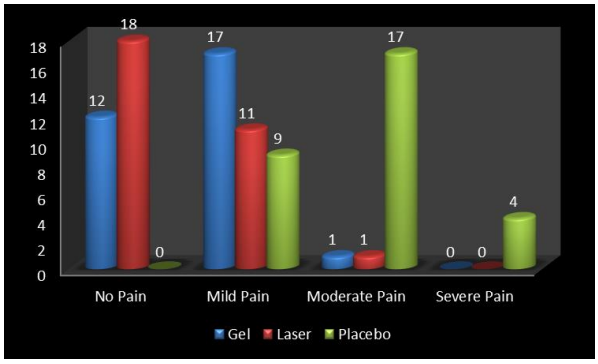

Table 5 and graph 5 shows chi-square results for **Dentinal hypersensitivity severity 1 month after treatment in groups 1,2 and 3.** On 1 month clinical evaluation after treatment the subjects who reported with no pain were 40.0% in the gel group and 60.0% in the laser group. The subjects who were encountered with mild pain were 45.9%, 29.7% and 24.3% respectively for three groups. Furthermore, the subjects who reported with moderate pain were 5.3% in gel and laser groups, and 89.5% in the placebo group. The more severe painful condition was found with 100% subjects in the placebo group.

DISCUSSION

There is no ideal treatment for permanent cure of dentinal hypersensitivity. Clinicians have been looking forward to symptomatic relief their patients, by giving the best treatment possible for this common dental ailment. Earlier, the dentist used to prescribe a topical desensitizing agent for treating this painful condition [13,19-21], but the effects were short term. With the advancement of technology, lasers are the more effective longer span, a treatment modality for DH. [22-27]

According to the results of the present study, there was a significant decrease in dentinal hypersensitivity immediately after treatment with 5% potassium nitrate and 0.62% sodium monofluorophosphate gel. This effect was due to the combined effect of Potassium nitrate and sodium monofluorophosphate. The decrease of the sensory nerve impulse by potassium nitrate is probably due to an increase in extracellular potassium ion concentration. After the initial depolarization, there is a sustained depolarization of the conducting nerves. In this case, the stimuli cause hydrodynamic fluid shifts, but the nerves do not fire because they are inexcitable, which in turn produces a desensitizing effect.[28-30] The dentinal tubule occluding effect of Potassium Nitrate has been verified by James JM et al. [30] Additionally monofluorophosphate interacts with enamel to form fluoride hydroxyapatite without calcium, which occludes the tubules, accompanied by an increase in the degree of mineralization, to produce a desensitizing effect.[31] However, there was an increase in dentinal hypersensitivity 15 days and one month after treatment probably because reapplication of gel is required for the longer desensitizing effect.

Those subjects who received laser treatment with a 980-nm diode laser (GaAlAs) performed with an output power of 0.2 W, in a continuous mode, using 350micron diameter fibre also showed a significant decrease in dentinal hypersensitivity immediately after treatment. This analgesic effect of low-level laser therapy is due to an interruption in nerve transmission, as detailed by Asnaashari M et al.[13] Gojkov-Vukelic M et al. confirmed that 980 nm diode laser at 2 W of power for 60 seconds is safe and effective in treating cervical DH.[32]Marwan El Mobadder demonstrated the effectiveness of 980nm diode laser in combination with graphite paste to decrease the DH pain immediately after one application and once within six months followup. [33] Conversely in our study, there was an increase in mean of dentinal hypersensitivity 15 days and 1 month after treatment, which indicates the need for reapplication of a laser beam on the affected teeth, in-between, for prolonged desensitizing effect.

The Vaseline group did not show any significant decrease in dentinal hypersensitivity since it was a placebo used as a control in the study, and its desensitizing effect has not been reported until now. The control group helps to compare the subjective data of individuals and to interpret them in an objective manner. Statistical insignificance in the control group was evaluated as objective results were obtained in the test groups.

When calculated in percentage, the severity of dentinal hypersensitivity, immediately after treatment in groups 1 and 2 showed 50.0% subjects with no pain which indicated that 5% potassium nitrate with 0.62% sodium monofluorophosphate gel and diode lasers are an effective treatment modality for immediate pain relief for mild to moderate dentinal hypersensitivity cases. Contrarily placebo group showed 100% of patients suffering from severe pain even after treatment proving the ineffectiveness of the treatment being given to the group 3 patients.

Looking forward 15 days after treatment, the patients who reported with no pain were 35.7% in gel group and 64.3% in laser group which gives a clue that laser has more lasting effect than gel been used in the study.

On final examination after 1 month of treatment, the patients who reported with no pain were 40.0% in gel group and 60.0% in laser group thus proving that laser is a superior treatment option for treating dentinal hypersensitivity than potassium nitrate with sodium monofluorophosphate gel for a longer lasting effect. This fact was also proved by Romeo Umberto et al. [34] who reported that the laser-induced superficial melting permits to keep longer the tubules occlusion than by NaF gel emphasizing the reduction of DH-related pain. Many other researchers have demonstrated similar results to prove the effectiveness of diode laser in curing DH. In the studies done by Aun et al.[35], Matsumoto et

al.[36], Kumazaki et al. [37] and Yamaguchi et al.[38] , the success rate was 98%, 85%, 62.2% and 60% in laser-treated groups for DH.

The limitations of the study were that the follow up of the participants was done only for a month which was too short to conclude the duration of effectiveness of the different treatment modalities being tested. The duration of action, along with the synergistic effect, also needs to be evaluated. Secondly, the treatment was given only once, and hence longer desensitizing effect could not be achieved in patients with moderate to severe dentinal hypersensitivity. And lastly, the sample size was small. Further studies are recommended to generalize the findings of this study.

CONCLUSION

Dentinal hypersensitivity a common and annoying dental ailment with no permanent treatment modality, the results of the current study concludes that both the treatment options diode laser and 5% potassium nitrate with 0.62% sodium monofluorophosphate gel are effective in treating dentinal hypersensitivity, but the GaAlAs laser showed a very high capability to diminish the Dentinal hypersensitivity ailment for an elongated period of time.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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