

Evaluation of the efficacy of diode laser and the combination of diode laser with 10% strontium chloride in the treatment of dentinal hypersensitivity

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Abstract

Background: Dentinal hypersensitivity (DH) is one of the most commonly encountered dental problems, as a result of exposed dentin that triggers pain or discomfort. There are wide array of treatment options available for it, but none of them is considered ideal till now.

Aim: This randomized clinical trial was designed to assess and compare the efficacy of diode laser alone and a combination of 10% strontium chloride with diode laser for the treatment of dentinal hypersensitivity and also to compare them.

Materials and method: A total of 50 patients with 100 sites each having two contralateral hypersensitive sites (50

for application of diode laser alone and 50 for application of combination of 10% strontium chloride with diode laser) were selected from the outpatient department of Periodontics, Kothiwal Dental College & Research Centre, Moradabad. Blow of air was used as a stimulus. Visual Analogue Scale (VAS) was used for evaluation of response. Assessments were done at baseline, 7th day, 14th day, 30th day and 60th day.

Result: Both the agents showed significant reduction in dentinal hypersensitivity ($p < 0.05$) at all intervals in both the groups when compared with baseline in response to air stimulus. When both the groups were compared, there was no statistically significant difference in 30 minutes ($p >$

0.05) but eventually from 7th day till 60th day there was statistically significant difference between the two groups ($p < 0.05$).

Conclusion: Single application of diode laser alone and combination of 10% strontium chloride with diode laser effectively reduced DH till 2 months of the study period. On comparison, both the agents showed a progressive reduction in dentinal hypersensitivity but combination of 10% strontium chloride with diode laser showed better results than diode laser alone.

Keywords: Dentinal hypersensitivity, 10% strontium chloride (SrCl₂), Visual Analogue Scale (VAS), Diode laser.

Introduction

Pain is an unpleasant sensory and emotional experience but highly beneficial and important as it makes the patient as well as the doctor aware of the underlying pathology. It is often caused by intense or damaging stimuli and is considered to be a distressing feeling. The International Association for the Study of Pain widely used definition which defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage".¹ Such exposure may result from enamel loss by abfraction process, erosion or abrasion and root surface stripping from gingival recession or periodontal treatment. The role of plaque in etiology of dentin hypersensitivity is unknown but it can play an indirect role through effects on periodontal tissues.^{2,3}

Dentinal hypersensitivity is defined as an exaggerated response to a stimulus that usually causes no response in a healthy tooth and also an exaggerated response to a non-harmful stimulus.⁴ Different terms have been used to describe dentin hypersensitivity, a list of which has mentioned below.⁵ These terms are used based on the place of occurrence of hypersensitivity and include:

cervical, root, dentin, cemental, and the terms sensitivity, and hypersensitivity.^{6,7} All of these terms convey the same clinical conception and can be used interchangeably.

1. Dentin Hypersensitivity/Sensitivity
2. Dentinal Hypersensitivity/Sensitivity
3. Cervical Hypersensitivity/Sensitivity
4. Root Hypersensitivity/Sensitivity
5. Cemental Hypersensitivity/Sensitivity

True hypersensitivity can develop due to pulpal inflammation and can present the clinical features of irreversible pulpitis, i.e., severe and persistent pain, as compared with typical short sharp pain of DH. Grossman et al⁸ have suggested different modalities of treatment for dentin hypersensitivity which includes various desensitizing agents like potassium oxalate, strontium chloride, fluoride varnishes, glass ionomer cements, composites, dentin bonding agents.

There are different approaches in treating sensitive teeth. Among these, strontium chloride has been largely used for this purpose. Strontium deposits are produced by an exchange with calcium in the dentin, resulting in recrystallization in the form of strontium apatite complex. This type of precipitation is known to reduce the diameter of open tubules.^{5,8}

A novel therapeutic approach for dentinal hypersensitivity is developed with the advent of laser technology that is increasingly being used in dentistry.⁹ Different types of lasers are used; low output power (low level) lasers which includes He-Ne and diode laser and middle output power lasers (CO₂ laser; Nd:YAG; Er:YAG lasers). The mechanism of reduction of dentin hypersensitivity is different for each other. Diode laser is highly effective in the treatment of dentin hypersensitivity.^{9,10} This laser is able to generate a continuous wave without overheating.

Materials and method

The present study was designed as split mouth double blinded randomized clinical trial for a period of 2 months. The details were put before the Institutional Ethics and Review Board, Kothiwal Dental College and Research Centre, Moradabad, and were approved. The protocol of the study was thoroughly explained to the patient and written consent was obtained

Study Population

A total number of 50 subjects (n=50) with a total of 100 hypersensitive teeth (50 on one site and 50 on the opposite site) on the contralateral arch were selected, following the under-mentioned inclusion and exclusion criteria, from the Department of Periodontics and Oral Implantology, Kothiwal Dental College and Research Centre, Moradabad.

Inclusion Criteria

1. Subjects of age group 17-65 years.
2. Dentinal hypersensitivity level of 3 or higher on a visual analogue scale.
3. Dentinal hypersensitivity to air stimulus.
4. Minimum of two hypersensitive teeth in a patient in different quadrants.
5. Any tooth with dentin exposure due to gingival recession or any other kind of wasting disease like attrition, abrasion etc.

Exclusion Criteria

1. Patient with systemic diseases.
2. Pregnant and lactating women.
3. Patient with hypersensitivity to any components of the medication used in the study.
4. Patient undergoing treatment for dentinal hypersensitivity.
5. Clinical evidence of dental caries in the selected tooth or adjacent teeth.

6. Selected tooth with any type of restorations and occlusal overload.

7. Patient with history of periodontal surgery in the preceding 6 months on the hypersensitive tooth.

Armamentarium

The materials used were: (1) Laser equipment- 970 nm (2) 10% strontium chloride. The specification of the diode laser is as follow (1) Type- GaAlAr diode laser: Fona™, Sirona Dental System Germany (2) Wavelength: 970 nm (3) Output power: 0.5W continuous mode (5) Energy: 2.5J (6) Time: 45 seconds and (7) Laser tip diameter: 320µm in diameter (Sirona Dental Company). The solution of 10% strontium chloride was made in the department by diluting 10 grams of strontium chloride in 100 ml of water as directed by the expertise of department of pharmacology and biochemistry.

Procedure

Subject selection was done by using the evaporative stimulus. The affected tooth was isolated with cotton rolls. A blast of air from the same three way syringe at every interval by the same investigator (pressure maintained at 30 psi), was directed onto the affected tooth for 1 second, keeping the nozzle of the syringe perpendicular and 1 cm away from the exposed dentin surface (measured using a metal scale). After application of the stimulus, patient's subjective answer was recorded using the clinical parameter- Visual Analog Scale (VAS) (Figure 1).

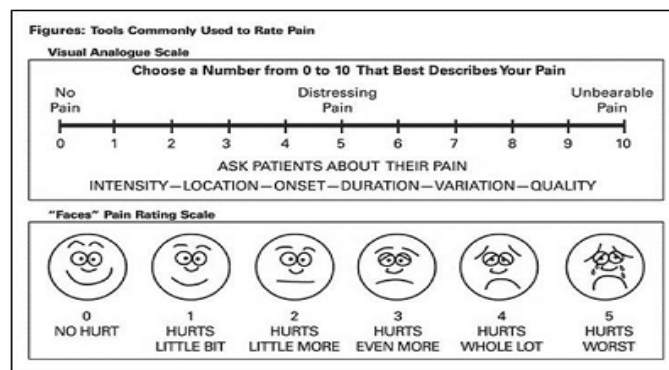


Figure-1: VAS scale

Method applied

Patient with response to stimulus and giving a score of 3 or higher on VAS were selected for the study (Figure 2 and 3). Each patient received professional cleaning and recording of hypersensitivity was done at baseline by the same investigator. Then randomization of the selected site was done using “picking chit method”. According to indication or chit, the hypersensitive tooth was selected.

In the laser group, the selected tooth was subjected to the energy beam of the diode laser for 45 seconds with the above mentioned specification. It was directed to the exposed dentinal surface in a contact mode. The laser tip was moved in a mesial to distal direction and also applied on all the surfaces of the affected tooth.

The contralateral hypersensitive tooth was isolated with cotton and on the affected area 10% strontium chloride was applied, using an applicator tip supragingivally for 3 minutes. It was then washed out with water. After that the same tooth is subjected to the energy beam of diode laser for 45 seconds and the same procedure is repeated (Figure 4 and 5).

In both cases, hypersensitivity was recorded using the VAS, 30 minutes after the treatment by checking with the air stimulus that was used to measure at the baseline. Then patients were recalled and further recording was done on after 7th, 14th, 30th and 60th day. The response of the subjects were recorded and was done by the first investigator.



Diode Laser



Strontium Chloride



Figure 2: Dentinal hypersensitivity checked by tactile stimulus



Figure 3: Dentinal hypersensitivity checked by air stimulus



Figure 4: 10% SrCl₂ was applied with an applicator tip for 3 mins

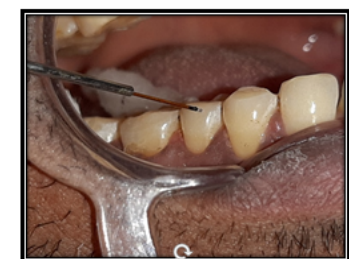


Figure 5: Diode laser was used to treat dentinal hypersensitivity for 45 seconds

Result

The present study was carried out in the department of Periodontics, Kothiwal Dental College and Research Centre, Moradabad to compare the efficacy of diode laser alone and the combination of 10% strontium chloride with diode laser in the treatment of dentinal hypersensitivity. Out of 62 enrolled subjects, 50 could complete the study. The 12 subjects could not complete due to lack of compliance. Out of the 50 subjects, 50% were males of age range 17- 65 years and 50% were females of age 17-65 years (Table 1, Graph 1). The male to female ratio was 1:1.

Table 1: Demographic characteristics of the study population (n=50)

	Min* Age	Max* Age	Mean Age	Male	Female	Percent
Group A	17	65	33.32 ± 11.278	25	25	50.0
Group B	17	65	33.32 ± 11.278	25	25	50.0

*Min- Minimum; *Max- Maximum

With the application of laser alone and in combination of 10% strontium chloride along with diode laser, reduction in hypersensitivity of teeth was observed in maximum subjects. However in 8 subjects, no effect of these procedures was appreciated.

Analysis of efficacy of diode laser in the reduction of dentinal hypersensitivity at different intervals on VAS scale.

The application of diode laser had a beneficial response among the participating subjects in reducing dentinal hypersensitivity. A progressive satisfactory result was observed as evident by the decrease in mean of VAS score of dentinal hypersensitivity from baseline to 2 months (Table 2). While comparing each time intervals (30 minutes, 7th day, 14th day, 30th day and 60th day) with baseline, the decrease in the hypersensitivity was statistically significant ($p < 0.005$).

Table 2: Comparison of mean VAS score at different intervals with that of baseline in Group A

	Test Value = 0			
	t	df	Mean (VAS)	p value
Baseline		49	8.460	
30 min	3.802	49	7.840	.000**
7th day	6.570	49	7.380	.000**
14th day	7.422	49	7.260	.000**
30th day	7.347	49	7.240	.000**
60th day	7.853	49	7.160	.000**

** Significant [$p < 0.005$]

On comparing the VAS score between male and female for evaluation of the efficacy of diode laser in the treatment of dentinal hypersensitivity, there was no

significant difference found as shown in Table 3 and depicted in Graph 1. The gender predilection had no effect in the reduction of hypersensitivity.

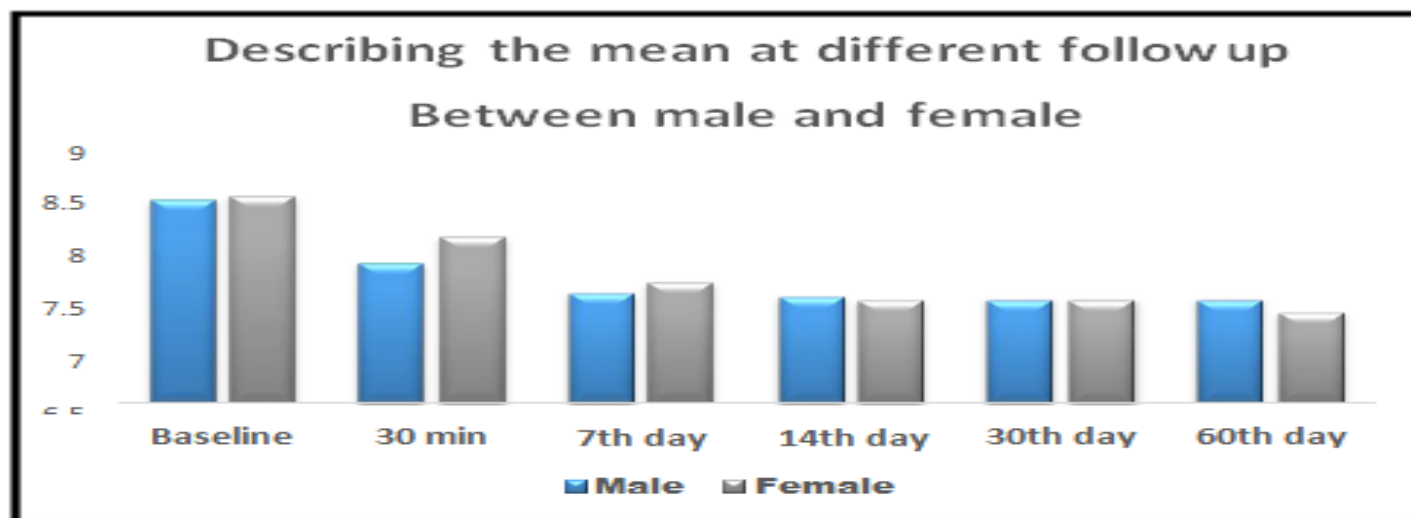
Table 3: Comparison of VAS score between male and female in the diode laser group (Group A)

	Gender	N	Mean	Std. Deviation	Std. Error Mean	p value
Baseline	Male	25	8.44	.768	.154	.674*
	Female	25	8.48	.714	.143	
30 Min	Male	25	7.68	.900	.180	.512*
	Female	25	8.00	.866	.173	
7th Day	Male	25	7.32	.945	.189	.889*
	Female	25	7.44	.870	.174	

14th Day	Male	25	7.24	.926	.185	.909*
	Female	25	7.28	.843	.169	
30th Day	Male	25	7.24	.926	.185	.900*
	Female	25	7.24	.926	.185	
60th Day	Male	25	7.24	.926	.185	.711*
	Female	25	7.08	.909	.182	

*Non significant [p>0.005]

Graph 1: Graphic representation of the mean of VAS score of treatment with diode laser between male and female (Group A)



Analysis of efficacy of combination of 10% strontium chloride and diode laser in the treatment of dental hypersensitivity at different intervals on VAS scale

A definite progressive satisfactory result was observed as seen by the significant decrease in the mean of VAS score in the treatment of dental hypersensitivity from baseline

to 2 months period i.e. 8.460 to 5.740. While comparing each time intervals (30 minutes, 7th day, 14th day, 30th day and 60th day) with baseline, the decrease in the hypersensitivity was statistically significant (p < 0.005) as shown in table 4.

Table 4: Comparison of mean VAS score at different intervals with that of baseline in Group B

	Test Value = 0			
	t	df	Mean (VAS)	p value
Baseline		49	8.460	
30 min	4.913	49	7.580	.000**
7th day	11.229	49	6.260	.000**
14th day	14.396	49	5.840	.000**
30th day	14.107	49	5.820	.000**
60th day	13.597	49	5.740	.000**

****Significant [p < 0.005]**

On comparing the VAS score between male and female for evaluation of efficacy of combination of 10% strontium chloride and diode laser in the treatment of

dentinal hypersensitivity, there was no significant difference found between them as shown in Table 5 and depicted in Graph 2.

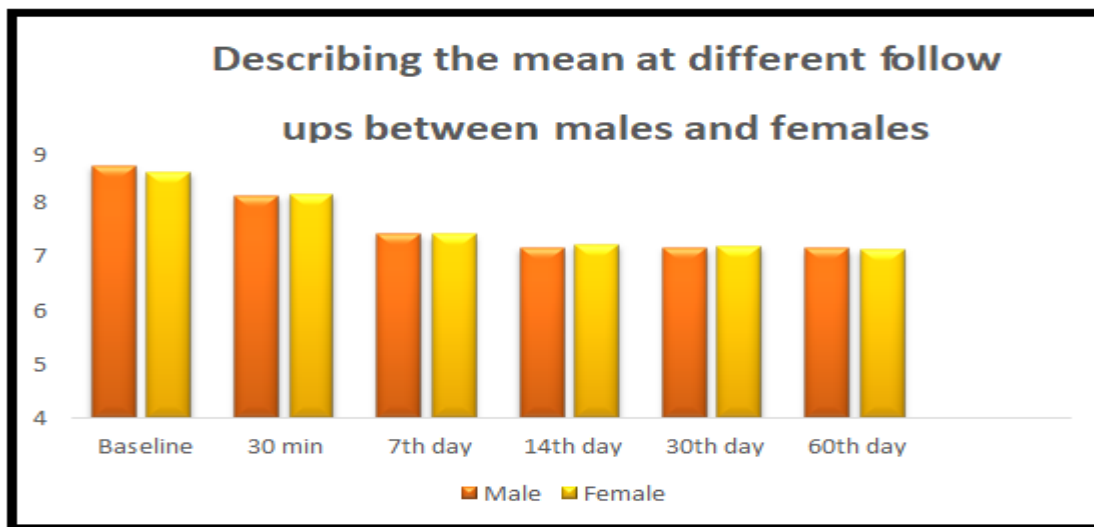
Table 5: Comparison of VAS score between male and female in the combination of 10% strontium chloride and diode laser group (Group B)

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean	p value
Baseline	Male	25	8.56	.768	.154	.699**
	Female	25	8.36	.700	.140	
30 min	Male	25	7.56	1.158	.232	.617**
	Female	25	7.60	.913	.183	
7th days	Male	25	6.28	1.308	.262	.520**
	Female	25	6.24	1.052	.210	
14th day	Male	25	5.80	1.225	.245	.353**
	Female	25	5.88	.881	.176	
30th day	Male	25	5.80	1.225	.245	.533**
	Female	25	5.84	.987	.197	
60th day	Male	25	5.76	1.268	.254	.955**
	Female	25	5.72	1.173	.235	

**Non significant [p > 0.005]

Graph 2: Graphic representation of the mean of VAS score with application of combination of 10%



Strontium chloride with diode laser between male and female

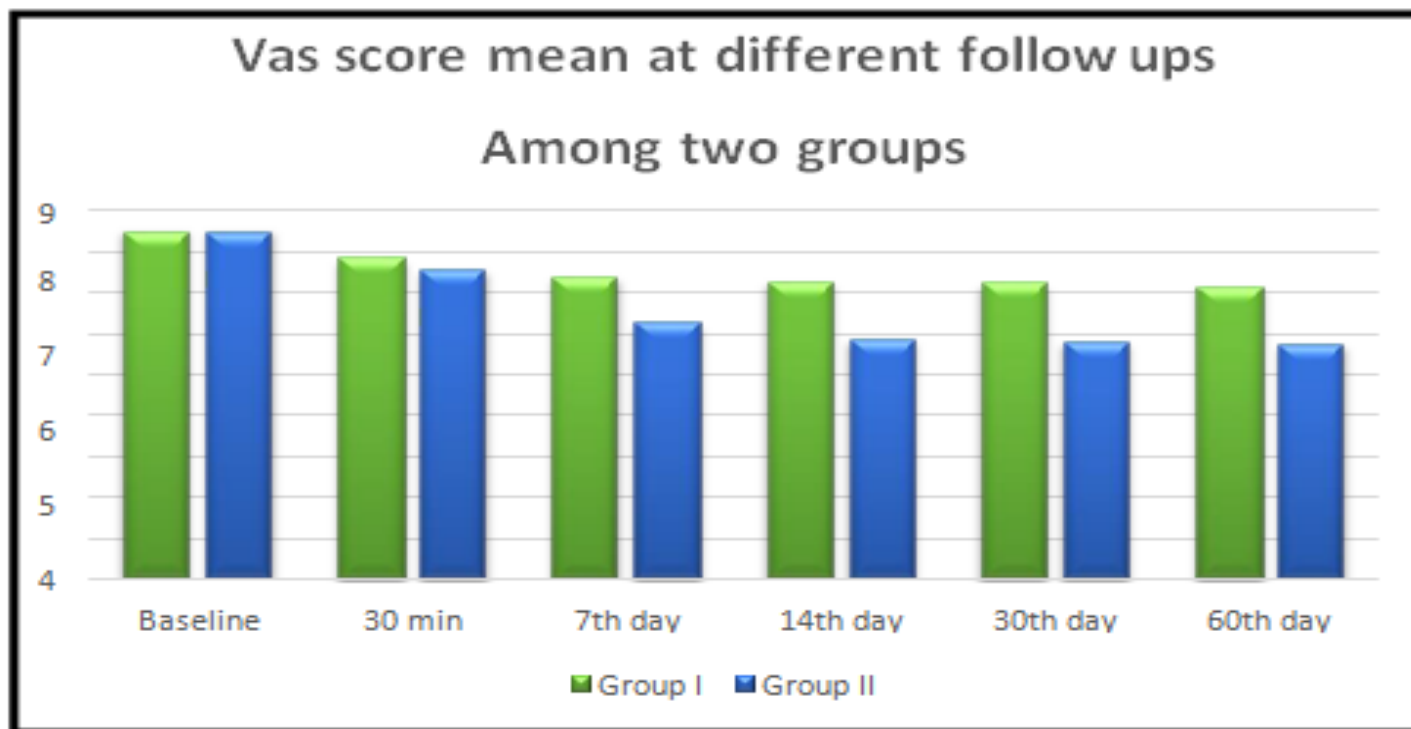
On comparing both the groups (Group A and Group B) at different follow up intervals, there was no statistically significant difference till 30 minutes but from 7th day till 60th day, there was a marked statistically significant difference between both the groups as shown in Table 6 and depicted in Graph 4

Table 6: Comparison of VAS score between diode laser alone (Group A) and combination of 10% strontium chloride and diode laser (Group B) at different follow ups

Time	Group	Mean	Mean Difference	Std. Deviation	Std. Error Mean	t	df	Std. Error Difference	95% Confidence Interval of the Difference		p value
									Lower	Upper	
Baseline	A	8.46		.734	.104						
	B	8.46	0.000	.734	.104	0.000	98	.147	-.291	.291	1.000*
30 Mins	A	7.84		.889	.126						
	B	7.58	.260	1.032	.146	1.350	95.897	.193	-.122	.642	.180*
7th Day	A	7.38		.901	.127						
	B	6.26	1.120	1.175	.166	5.349	91.830	.209	.704	1.536	.000**
14th Day	A	7.26		.876	.124						
	B	5.84	1.420	1.057	.149	7.314	94.751	.194	1.035	1.805	.000**
30th Day	A	7.24		.916	.130						
	B	5.82	1.420	1.101	.156	7.011	94.868	.203	1.018	1.822	.000**
60th Day	A	7.16		.912	.129						
	B	5.74	1.420	1.209	.171	6.631	91.107	.214	.995	1.845	.000**

*Non significant [p>0.005]; **Significant [p<0.005]

Graph 3: Graphic representation of the mean of VAS score at different follow ups between the diode laser group (Group A) and the combination of 10% strontium chloride and diode laser group (Group B)



Thus the study finds that both the agents were having satisfactory and comparable results in reducing dentinal hypersensitivity. But it was proven that combination of 10% strontium chloride and diode laser (Group B) had significantly better result than the diode laser alone (Group A).

Discussion

A commonly occurring, easily diagnosed and frequently observed dental problem which is still on the lookout for a treatment that can provide rapid and permanent relief is “Dentinal Hypersensitivity” (DH)- a problem which is often discussed but difficult to understand and manage. Literature has reported few studies on the use of 10% strontium chloride, most of them being in vitro.^{14,15} Very few studies were done showing the effectiveness of 10% strontium chloride in the treatment of dentinal hypersensitivity, so a dire need of it was felt. Since, diode laser emerged as a promising treatment modality in DH, a comparative evaluation of 10% strontium chloride and

diode laser in the treatment of dentinal hypersensitivity. Along with comparative evaluation, individual efficacy of diode laser at different intervals was also felt to be considered.

In this study, the age of the selected subjects ranged between 17- 65 years of age. For the selection of a particular sensitive tooth, it was exposed to air stimulus by one examiner and its response was recorded on VAS scale. To observe distinct change in scores, subjects were selected only if the sensitive tooth had a VAS score of 3 or more in response to air stimulus, as it was recommended to test products or clinical procedures in vivo.^{16,17,18}

Sensitivity to air stimulus was evaluated by a direct blast of air from three way syringe. The nozzle of three way syringe was kept perpendicular and 1 cm away from the exposed dentinal surface (measured by use of a metal scale). This was done to maintain uniformity and to avoid desiccating the dentin surface.¹⁹

After patients were selected, oral prophylaxis was carried out first to make the tooth surface plaque free so that the treatment of dentinal hypersensitivity could be carried out properly. The role of plaque in the etiology of dentinal hypersensitivity is unknown but it can play an indirect role through effects on periodontal tissues.^{2,3} Patients were taught rolling technique of brushing so that the predisposing factor like faulty tooth brushing could be removed. This was followed by randomization which could have been carried out in many different ways but picking chit method was chosen as it was easy to perform and could be carried out anywhere without the need of any instrument. Baseline records were taken on VAS scale by use of the air stimulus. The response of individuals at baseline were almost similar for both diode laser and combination of 10% strontium chloride and diode laser and were statistically insignificant (Table 2 and Table 5). This shows that the same standard of pre-treatment hypersensitivity were obtained and there was no bias in selection of the cases in the two groups. 10% strontium chloride was applied for 3 minutes as used previously by Suri et al²⁰ where they concluded that 3 minutes were considered to be the sufficient time for crystals precipitation.

Ananthakrishna et al²¹ have concluded that strontium deposits are produced by an exchange with calcium in the dentin resulting in recrystallization in the form of strontium apatite complex. This type of precipitation is known to reduce the diameter of open tubules and the precipitation occurs during 3 minutes after the application of the strontium chloride. For the control site, diode laser at 970 nm was used as the efficacy of diode laser at this wavelength for reduction of DH has also been shown in some studies.^{22,23,24}

Results showed that single application of diode laser alone and combination of 10% strontium chloride with diode

laser effectively and statistically significantly reduced dentinal hypersensitivity at each intervals (30 mins, 7th day, 30th day and 60th day) when compared with baseline (Tables 2 and 5). On comparison combination of 10% strontium chloride and diode laser showed significantly better result than the diode laser alone (Table 6, Graph 3).

Although 10% strontium chloride and diode laser present distinct modes of action but in the present study, both of them together as a combination have shown a splendid response among the participating subjects in reducing dentinal hypersensitivity.

When the comparison of mean of VAS scores at different intervals from baseline was done in Group B, there was a statistically significant difference ($p < 0.05$) (Table 4). There was a continuous decrease in the dentinal hypersensitivity from baseline to 2 months as represented numerically by reduction of VAS score from 8.460 to 5.740

This implies that when combination was used as a treatment option, it was more effective with time even after single application in reducing dentinal hypersensitivity. It was also seen that there was no difference in the mean of VAS score between males and females when the laser alone and the combination of 10% strontium chloride with diode laser was applied for the treatment of dentinal hypersensitivity (Table 5).

Based on the neural theory, the effect of diode laser is caused by blocking the depolarization of C-fibres afferent.¹¹ Diode laser has enabled a dentin hypersensitivity reduction equal or superior to conventional treatment of using desensitizing agents like potassium nitrate, strontium chloride, potassium oxalate, sodium fluoride.^{11,12}

As the laser acts by reducing the depolarization of nerve fibres, giving immediate response and the strontium chloride reduces hypersensitivity by recrystallization

giving a more permanent relief, a combination of the two techniques may be expected to give an instant as well as prolonged relief.^{12,13}

Although 10% strontium chloride and diode laser present distinct mode of action but in the present study, the efficacy of combination showed a splendid result as compared to the diode laser alone. Both the treatments showed almost similar effects on reduction of dentinal hypersensitivity till 30 minutes. Eventually with time, a statistically significant difference ($p < 0.05$) was marked on 7th day, 14th day, 30th day and 60th day when both the treatment methods were compared to see the reduction of dentinal hypersensitivity (Table 6). There was a definite marked difference of the mean of VAS score between both Group A and Group B on 7th day (7.38 and 6.26 respectively); 14th day (7.26 and 5.84 respectively); 30th day (7.24 and 5.82 respectively) and 60th day (7.16 and 5.74 respectively).

Conclusion

Single application of diode laser (970 nm, 0.5 W, continuous mode) is effective in reduction of dentinal hypersensitivity and it is maintained till 2 months of the study period. Single application of 10% strontium chloride along with diode laser reduces dentinal hypersensitivity effectively and gradually till 2 months. On comparison, both the agents were effective in reduction of dentinal hypersensitivity but combination of 10% strontium chloride with diode laser showed better results than diode laser alone.

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