Comparative evaluation of treatment of noncarious cervical hypersensitivity by a fluoride varnish, a dentin bonding agent, and Er, Cr:YSGG laser: An in vivo study

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Abstract

Context: Dentin hypersensitivity is one of the most common dental problems encountered regularly. This commonly appearing condition is quite difficult to treat satisfactorily, and so, a large number of techniques and therapeutic alternatives constantly are being proposed to relieve it. However, till date, the search for an ideal agent is on. Various laser systems have been discussed as a new treatment option for dentin hypersensitivity. Researchers are claiming good prognosis with lasers. Treatment with soft tissue lasers is being practiced for some time and is well documented. However, the use of Er, Cr:YSGG laser for desensitization purpose is new, and the available data on clinical outcome are limited.

Aims: The purpose of this study was to test and compare the efficacy of a fluoride varnish, a dentin bonding agent, and Er, Cr:YSGG laser in treating noncarious cervical hypersensitivity, in vivo.

Settings and Design: Fifty patients aged between 25 and 55 years complaining of dentinal hypersensitivity who reported to the Department of Conservative Dentistry and Endodontics, Dr. R. Ahmed Dental College and Hospital, Kolkata, participated in this study.

Subjects and Methods: Sensitive teeth in each patient were randomly divided into three treatment groups:
- Group 1 treated with fluoride varnish
- Group 2 treated with dentin bonding agent
- Group 3 treated with Er, Cr: YSGG laser.

Hypersensitivity assessment was done pretreatment, immediately posttreatment, and 1 day, 1, 2, 3, and 4 weeks postoperatively.

Statistical Analysis Used: The data obtained were tabulated and subjected to statistical analysis using the paired and unpaired t-test.

Results: In all the treatment groups, there was significant decrease in mean hypersensitivity scores from pretreatment values after 4 weeks. The posttreatment hypersensitivity scores of Group 3 were minimum for all three test stimuli followed by Group 2 and Group 1, respectively.

Conclusions: All the three treatment agents, namely fluoride varnish, dentin bonding agent, and Er, Cr:YSGG laser, were effective in treating dentin hypersensitivity. Least recurrence in hypersensitivity occurred in the laser-treated group. Even where recurrences did occur, hypersensitivity did not return to pretreatment value and occurred more in those cases exhibiting high pretreatment sensitivity.

Keywords: Dentin bonding agent; Er, Cr:YSGG laser; dentinal hypersensitivity; fluoride varnish

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INTRODUCTION

Dentin hypersensitivity is defined by short, sharp pain arising from exposed dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic, or chemical, which cannot be ascribed to any other form of dental defect or pathology. With increasing life expectancy of the population with a functional natural dentition, dentin hypersensitivity has become a more frequent dental complaint and an increase in requests for treatment thus follows. Clinical studies and questionnaires on dentin hypersensitivity indicate a prevalence of 4%–74%.

As per the hydrodynamic theory proposed by Brannstrom,\textsuperscript{[1]} dentin hypersensitivity occurs due to the movement of the dentinal fluid. An increased outward fluid flow causes a pressure change across dentin, distorting the $A\delta$ fibres by a mechanoreceptor action causing pain.

There may be another process involved. When fluid flow changes the rate in a tubule, there is an electrical discharge called “streaming potential” across the dentin. This may be able to electrically stimulate the nerves.

Topical fluoride varnish is one of the most commonly used agents for treating dentinal hypersensitivity. Adhesive materials such as dentin bonding agents also offer improved and longer-lasting desensitization. However, there effects are somewhat short termed.

Laser systems are being discussed as a new treatment option for dentin hypersensitivity. Researchers are claiming good prognosis with laser. Treatment with soft tissue lasers is being practiced for some time and is well documented. However, the use of Er, Cr: YSGG laser for desensitization purpose is new, and the available data on clinical outcome are limited.

The purpose of this study was in vivo evaluation of the desensitizing effect of Er, Cr: YSGG laser and to compare its efficacy with a fluoride varnish and a dentin bonding agent in treating noncarious cervical hypersensitivity.

SUBJECTS AND METHODS

Fifty patients aged between 25 and 55 years complaining of dentinal hypersensitivity who reported to the Department of Conservative Dentistry and Endodontics, Dr. R. Ahmed Dental College and Hospital, Kolkata, participated in this study. All patients enrolled in this study had a minimum of three hypersensitive teeth per quadrant in at least three quadrants of the mouth.

A. Inclusion criteria
   i. a history of tooth hypersensitivity to thermal, mechanical, sweet, or sour stimuli on at least three teeth facial surfaces; good physical and mental health; no detrimental oral habits; and a willingness to participate in the study for 1 month.

B. Exclusion criteria
   i. Carious lesion on the selected or neighboring teeth
   ii. Cervical filling on the selected tooth
   iii. Any desensitizing therapy on the selected tooth during the last 6 months
   iv. Periodontal surgery within last 3 months
   v. Nonvital tooth
   vi. Chipped tooth
   vii. Defective restorations
   viii. Cracked tooth syndrome
   ix. Fractured undisplaced cusps
   x. Deep periodontal pockets
   xi. Tender tooth in the same quadrant as the hypersensitive teeth
   xii. Orthodontic appliances
   xiii. Deep dental caries
   xiv. Large restorations showing pulpal response
   xv. Pregnant/lactating females
   xvi. Smokers, alcoholics
   xvii. Patients taking antibiotics/analgesics/anti-inflammatory/antidepressive drugs, patients having cognitive dysfunctions/general communication difficulties.

Study design

The study was performed according to a split-mouth design.

The vitality of all the experimental teeth was ascertained at the beginning and end of the study duration. For 4 weeks before treatment, all patients were enrolled in an oral hygiene program and received oral hygiene instructions on 2–4 appointments as well as professional tooth cleaning according to the individual needs.

Teeth in each patient were randomly divided into three groups:
   • Group 1 treated with fluoride varnish
   • Group 2 treated with dentin bonding agent
   • Group 3 treated with Er, Cr: YSGG laser.

Assessment of dentin hypersensitivity

Baseline assessment was done before any treatment was rendered. A single examiner assessed the patients throughout the study tenure to remove any interexaminer bias.

The teeth were isolated with cotton rolls, and the following stimuli tests were applied.
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A. Tactile test: a sharp dental explorer was passed lightly across the affected area of the tooth, perpendicular to the long axis of the tooth, the test repeated three times before a score

B. Air blast test: a blast of air from a three-way syringe was directed onto the affected area of the tooth at right angles for 3 s from a distance of 2 mm

C. Cold water test: a precooled 1 cc disposable syringe was filled with freshly melted ice-cold water. After isolating the specific tooth, 0.2 ml of the water was slowly expelled from the syringe onto the tooth surface.

For all stimuli tests, patient response was recorded on the following scale:

0 = No significant discomfort or awareness of stimulus
1 = Discomfort, but no severe pain
2 = Severe pain during application of stimulus
3 = Severe pain during and after application of stimulus.

Throughout the study, the stimuli tests were applied in the same order, with a minimum of 5 min gap between the applications of different stimuli.

During testing, the operator’s gloved fingers shielded the neighboring teeth.

After the tests were performed, the teeth with ratings 2 or more for any of the three tests were selected for the study.

Treatment procedure

The teeth to be treated were cleaned with rubber cup and flour of pumice before treatment and then isolated with cotton rolls.

Teeth in Group 1 were treated with fluoride varnish (Fluor Protector; Ivoclar Vivadent) applied over the vestibule areas of the teeth one time weekly for 3 weeks using a microbrush. After application, the patients were explicitly instructed to omit tooth brushing during the following 12 h.

In Group 2, after cleaning the tooth surface with a cotton pellet soaked in distilled water, a conditioner (FROST) was applied to the affected surfaces for 15 s. The teeth were then thoroughly rinsed and dried. The bonding agent (Adper™ Single Bond; 3M ESPE) was applied onto the exposed tooth surface as per the manufacturer’s instructions and cured for 20 s.

In Group 3, after cleaning the tooth surface with a cotton pellet soaked in distilled water, the teeth were irradiated at 2780 nm with Er, Cr: YSGG laser (Waterlase, Biolase Technology) using Z6 tip (600 µm diameter, 6 mm length) at defocus mode. Irradiation was done at an energy level of 0.25 W, 0% of air, and water. The treatment time was 30 s per surface by scanning the cervical part of the tooth. Treatment was performed in small periods with an intervening rest interval.

Immediately after treatment, the hypersensitivity levels of the patient were assessed.

Assessment was again done on day 1 and week 1, 2, 3, and 4 posttreatment.

All patients used a soft toothbrush and toothpaste without any desensitizing agent throughout the study tenure.

The collected data were subjected to statistical analysis as applicable.

RESULTS

In all the treatment groups, there was a significant decrease in the mean hypersensitivity scores from pretreatment values to after 4 weeks.

A stimuli-wise evaluation of hypersensitivity in the three treatment groups before treatment and 1, 2, 3, and 4 weeks after treatment is summarized in Table 1-3, respectively.

There is no significant difference in the before treatment values obtained by tactile stimuli for all the three groups at $P = 0.05$.

After 1 week, the effect of laser is significantly better than bonding agent ($t = 3.63, P < 0.001$) and also that of varnish ($t = 3.12, P < 0.01$). Between bonding agent and varnish, there is no significant difference.

After 2 weeks, no significant difference is present between bonding agent and varnish. The effect of laser is significantly better than varnish ($t = 2.44, P < 0.02$). Difference between laser and bonding agent is not significant at $P = 0.05$, but it is significant at 10% level ($P = 0.10$).

After 3 weeks, the mean hypersensitivity scores in the varnish-treated group are significantly higher than both of laser and bonding agent. Laser and bonding agent do not differ significantly.

After 4 weeks also the mean hypersensitivity in the varnish treated group remained higher than the other two.

From Table 2, we see that there is no significant difference in the before treatment values obtained by air blast stimuli for all the three groups at $P = 0.05$.

At all other time intervals, the mean hypersensitivity score in the varnish-treated group is highest compared to laser- and bonding agent-treated groups.
At all stages, the mean value of varnish-treated group is significantly higher than laser-treated group at \( P = 0.05 \). Further, the difference in mean hypersensitivity scores between bonding agent- and varnish-treated groups is significant after 3 and 4 weeks. On 1-week and 2-week period also, the differences though not significant at 5% level are significant at 9% and 10% levels, respectively.

There is no significant difference between the laser and bonding agent-treated groups. However, after 1 week period, \( P = 0.053 \), i.e., almost equal to \( P = 0.05 \), can be considered statistically significant.

Between laser- and bonding agent-treated groups, there is no significant difference at 2 and 3 weeks postoperatively. On the
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Table 4: Hypersensitivity scores of the three treatment groups before and 4 weeks after treatment obtained by tactile test

| Groups | Pretreatment Mean | SD | After 4 weeks Mean | SD | t  | P     |
|--------|------------------|----|-------------------|----|----|-------|
| 1      | 2.03             | 0.6| 0.45              | 0.62| 39.076| <0.001|
| 2      | 2.0              | 0.61| 0.227             | 0.507| 27.36| <0.001|
| 3      | 1.88             | 0.63| 0.147             | 0.355| 29.35| <0.001|

SD: Standard deviation

Table 5: Hypersensitivity scores of the three treatment groups before and 4 weeks after treatment obtained by air blast test

| Groups | Pretreatment Mean | SD | After 4 weeks Mean | SD | t  | P     |
|--------|------------------|----|-------------------|----|----|-------|
| 1      | 2.04             | 0.6| 0.53              | 0.62| 28.724| <0.001|
| 2      | 2.03             | 0.63| 0.28              | 0.56 | 31.58| <0.001|
| 3      | 2.11             | 0.58| 0.21              | 0.41 | 41.601| <0.001|

SD: Standard deviation

Table 6: Hypersensitivity scores of the three treatment groups before and 4 weeks after treatment obtained by cold water test

| Groups | Pretreatment Mean | SD | After 4 weeks Mean | SD | t  | P     |
|--------|------------------|----|-------------------|----|----|-------|
| 1      | 2.307            | 0.463| 0.60              | 0.655| 26.06| <0.001|
| 2      | 2.24             | 0.429| 0.413             | 0.615| 29.84| <0.001|
| 3      | 2.227            | 0.42| 0.24              | 0.429| 40.55| <0.001|

SD: Standard deviation

1st week, the difference is just statistically significant (t = 1.95, P = 0.051). On the 4th week, the difference is statistically significant at 1% level (t = 2.82, P < 0.01).

Between varnish and laser, the mean hypersensitivity scores in varnish-treated group are significantly higher than laser-treated groups at 1, 2, 3, and 4 weeks postoperatively.

Between bonding agent- and varnish-treated groups, the difference in mean hypersensitivity scores at the 3rd and 4th postoperative week is statistically significant.

The mean hypersensitivity scores of each treatment group elicited by different stimuli tests before treatment and 4 weeks after treatment were subjected to statistical analysis by paired t-test and are tabulated in Tables 4-6.

On evaluation, it can be found that there is significant decrease in mean hypersensitivity scores in each of the three treatment groups between pretreatment and 4 weeks posttreatment values as obtained by the three test stimuli [Tables 4-6].

**DISCUSSION**

In the present study, hypersensitivity was assessed by three stimuli tests – tactile test, air blast test, and cold water test. Assessment was done pretreatment, immediately posttreatment, and 1 day, 1, 2, 3, and 4 weeks postoperatively. For all stimuli tests, patient response was recorded on a 4-point scale. Several investigators suggest that visual analog score was more sensitive in discriminating between various treatments and changes in pain intensity. However, the problem of visual analog score is the wide range of grading from 0 to 10 that produce much confusion to the patients who cannot report the accurate score. However, the old quantization method score seems to be clinically easier and more accurate as the grade range from 0 to 3 makes the patient’s choice easier and hence is used in this study.[2]

In all the treatment groups involved in the present study, there is a significant decrease in sensitivity scores measured after 4 weeks from pretreatment values.

In Group 1, the action of sodium fluoride varnish can be attributed to the reaction that occurs between sodium fluoride and calcium ions of the dentinal fluid, leading to the formation of calcium fluoride crystals, which are deposited onto the opening of the dentinal tubules. However, some amount of hypersensitivity returned after 4 weeks in Group 1. This can be attributed to the fact that the precipitate is slowly soluble in the saliva and is removed by mechanical and chemical factors, such as brushing, food, acidic beverages, and acid from dental plaque. Hence, they provide only transient relief or require repeated application.[3]

Results obtained in Group 2 also show a reduction in hypersensitivity scores after 4 weeks in the present study. Desensitisation occurs in Group 2 due to the high wettability of the dentin bonding agents, which allows good penetration of the bonding agent into the tubules and sealing after curing.

However, the posttreatment hypersensitivity scores of Group 3 are minimum for all three test stimuli followed by Group 2 and Group 1, respectively.

The following mechanisms may be responsible for the effect of Er, Cr:YSGG laser:

The high absorption of Er, Cr: YSGG laser emission wavelength (2.78 μm) in water may result in the deposition of insoluble salts from the exposed tubules by the evaporation of dentinal fluid. Thus, it could be suggested that this deposition is responsible for the obturation of the dentinal tubules, reducing dentinal hypersensitivity. Scanning electron microscope (SEM) analysis showed that Er, Cr:YSGG laser irradiation caused melting of the peritubular dentin with a somewhat irregular pattern and reduced mean tubular entrance diameter by up to approximately 50%.[4]
Another possible mechanism of Er, Cr:YSGG laser on the dentinal hypersensitivity is its effect on the neural receptor transient receptor potential vanilloid type 1 (TRPV1) which is known to be stimulated by heat. Reports in dentistry suggested that the Er, Cr:YSGG laser may assist in local anesthesia on a short-term basis. Thermal-sensitive transient receptor potential channels (TRPs) in the dental sensory nerves may serve as tooth pain sensors,\textsuperscript{[5]} and research suggests that Er, Cr:YSGG laser has analgesic properties via TRPV1 inhibition.\textsuperscript{[6]}

The high bactericidal potential of Er, Cr:YSGG laser is also important since bacteria have the ability to lower pain threshold in sensitive teeth as a result of increased inflammatory mediators’ synthesis. Er, Cr:YSGG laser irradiation at 0.25 W without water spray reduced microorganisms on dentin surfaces without signs of carbonization or melting.\textsuperscript{[7]}

In the present study, the teeth were irradiated at 2780 nm with Er, Cr: YSGG laser using Z6 tip at defocus mode. Irradiation was done at an energy level of 0.25 W, 0% of air, and water. The treatment time was 30 s per surface by scanning the cervical part of the tooth. Treatment was performed in small periods with an intervening rest interval.

Since it has been reported that the exogenous water has a greater effect than endogenous water on dentin ablation, in the present study, Er, Cr:YSGG laser was used without water.

Carbonization occurred even at 0.5 W when Er, Cr:YSGG laser was used without water.\textsuperscript{[8]} Therefore, the energy setting of the present study was lower than the threshold for carbonization, melting, and surface roughness.

Further, to prevent intrapulpal temperature rise, laser irradiation was applied in separate periods.\textsuperscript{[9]}

In the present study, the return in sensitivity was more in the varnish-treated group compared to bonding agent- and laser-treated groups, but it did not return to baseline scores. Sensitivity also recurred in bonding agent-treated group more than that of laser-treated group, but to a lesser degree. Even in the laser-treated group, some sensitivity did recur, especially in cases with high initial scores, but never to baseline level.

**CONCLUSION**

Hence, within the limitations of the present study, it can be said that Er, Cr:YSGG laser does provide a new, effective alternative for the treatment of dentinal hypersensitivity, and further, long-term clinical trials should be conducted to evaluate their efficacy.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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