Original Article

Comparative Evaluation of the Effects of 5% Sodium Fluoride Varnish and Neodymium-Doped Yttrium Aluminium Garnet (Nd:YAG) laser and their Combined Application on Dentin Hypersensitivity Treatment

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Abstract:

Introduction: Dentin hypersensitivity is one of the most common complications that patients suffer from after periodontal therapies. So far many investigators have used different types of fluoride and laser for treatment of this complication. The aim of this study was to evaluate the effects of 5% sodium fluoride varnish and (Neodymium-Doped Yttrium Aluminium Garnet) Nd:YAG laser and their combined application on dentin hypersensitivity treatment.

Methods: The study is a prospective interventional clinical trial. We selected a group of 9 patients with a total of 60 hypersensitive teeth. Each patient had at least 4 hypersensitive teeth. These 4 teeth were randomly placed in 4 different groups. Group1 didn't receive any treatment. Group2 was treated with 5% sodium fluoride varnish (A Durashield Company product). Group3 was irradiated with Nd: YAG laser (1w, 20Hz, 120s). Group4 was treated by 5% sodium fluoride varnish and Nd: YAG laser combined (same parameters as group3). The assessment of the patients' pain was done with cold air blast test (CAB) and visual analyzing scale (VAS) after stimulation using a probe and cold air. Patients' pain was assessed before and just after treatment, and also 2 hours, 1 week and 2 weeks after treatment. For the assessment of pulp vitality we used the electric pulp test (EPT) at each session. SPSS 11.5 was used to process the results obtained. For the CAB and VAS changes in different groups, two-way repeated-measures ANOVA as well as Post-Hoc-Tukey tests were used. For the comparison of the different treatment groups at each session, one-way ANOVA, Post-Hoc-Tukey and or Mann-Whitney and Kruskal-Wallis tests were used.

Results: VAS and CAB scores didn't show any significant difference between different groups before treatment. Analysis of results obtained with two-way ANOVA test for repeated measures showed significant statistical differences for CAB and VAS scores in all groups between before and after treatment except for CAB score in control group. In the comparison of the fluoride varnish group and laser group alone with fluoride varnish-laser combined group using VAS and CAB scores, we found a significant difference. But we didn't find any significant difference for the comparison between the varnish fluoride group and the laser group using the same score.

Conclusion: The use of 5% sodium fluoride varnish and laser for treatment of dentin hypersensitivity is accompanied by a placebo effect. Although it appears that, if we omit the placebo effect, we had an improvement in all 3 treatment groups. But this improvement was more obvious for the treatment group4 (fluoride –laser) compared to other groups.

Keywords: dentine hypersensitivity; Nd: YAG laser; sodium fluorides

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Introduction

Dentin hypersensitivity is a common complication, manifested by sharp, radiating and rapid onset pains due to reaction of naked dentin to local, thermal, mechanical, touch and osmotic stimuli (1-3). This condition cannot be related to any pathologic trauma (1-3). The prevalence of this condition has been reported to vary between 4-73% in different studies. The third decade of life is the most concerned age range (3). The cause of this complication is the denudation of the dentinal tubules located in the root cervical part to the oral cavity, leading to exposure to different stimuli. One of the most common causes of this complication is periodontal treatments (especially periodontal surgeries). In a study performed on patients that underwent periodontal surgery, the prevalence of dentin hypersensitivity was reported to be 54% (2). The pain and discomfort caused by this condition in addition to reduction of patients' satisfaction for the treatment performed also result in less patients' cooperation regarding respect of hygiene and plaque control (3, 4). Because of the high prevalence of this complication and its adverse effects on patients' hygiene, particularly patients that underwent periodontal treatments, treating this condition is very important.

Several mechanisms have been suggested to explain this pain, between which the hydrodynamic theory has been the most approved by the majority (2, 3). Most of the treatments proposed for this complication are based on this theory, which aim are to seal and close the dentinal tubules. The uses of local fluoride as well as laser irradiation on the sensitive areas are among such treatments.

Solutions and varnishes containing fluoride are historically the substances of choice, which provoke the precipitation of crystalline salt on the dentinal tubules surfaces and obstruct them (5). Varnish is one of the fluoride compound forms, which in addition to easy use, is rapidly absorbed by hydroxy apatite crystals and provokes the obstruction of dentinal tubules. This fluoride form was first used in 1991 (3). (Neodymium-Doped Yttrium Aluminium Garnet) Nd:YAG is absorbed by tissues and depending on the power of the ray, it induces physiologic, thermal, abrasive and destructive effects on tissues (1). In this treatment method the obstruction of dentinal tubules is provoked by the photothermal effect of the laser (1).

As previously mentioned, this complication is one of the unwanted and common consequences of periodontal treatments, especially periodontal surgeries. In addition to patient discomfort, treatment prognosis is also jeopardized due to decreased patient cooperation in plaque control. This is why finding a treatment which will be comfortable and in the same time have quick and lasting effect is very important. This study was performed to evaluate and compare the clinical effects of 5% sodium fluoride varnish and Nd: YAG alone and combined to each other in the treatment of dentin hypersensitivity. We Hope that this study will be a positive step in the resolution of this inconvenient complication.

Methods

The study is a prospective interventional clinical trial, on 9 patients with a total of 60 teeth suffering from dentin hypersensitivity. The sampling method was a simple and available one, and the technique used comprises observation and clinical examination. Each patient had to have at least 4 sensitive teeth; not having received any treatments for hypersensitivity in the last 6 months; the sensitive area being without decay; concerned teeth not having undergone RCT (root canal therapy); gingiva and teeth being without inflammation, tartar and plaque, to enter the study. Dental examination was performed via 3 tests:

1- CAB (cold air blast) test: In this test dental stimulation was done via cold air blast from a 3 mm distance and for 1 second, then the clinician with the explanations of the patient on how he has experienced the pain, and taking into account the classification (see table below), attributed the appropriate score. This is an objective test on the patient's pain perception (Figure 1).

2- VAS (visual analyzing scale) test: Via a probe, the

Figure 1. Dental sensitive surface stimulation by cold air blast

tooth is stimulated and the patient is asked to score his pain on a 10cm line. With the explanations that 0 equals absolutely no pain and 10 the more severe pain experienced so far. This is a subjective test and the patient based on his personal experience attributes a score to the pain (Figure 2).

3- EPT (electric pulp test): With this test, the dental vitality is evaluated via the electric pulp test (DIGITEST, Parkell, USA).

After the completion of these 3 tests in the examination, the teeth were randomly divided in 4 groups:

Figure 2. Dental sensitive surface stimulation by sharp probe

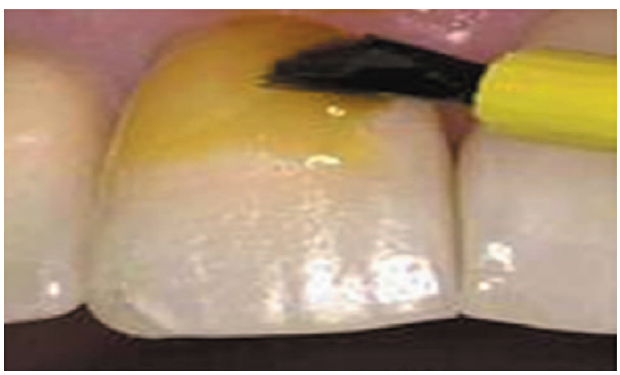

Figure 3. Fluoride varnish application on dental sensitive surface

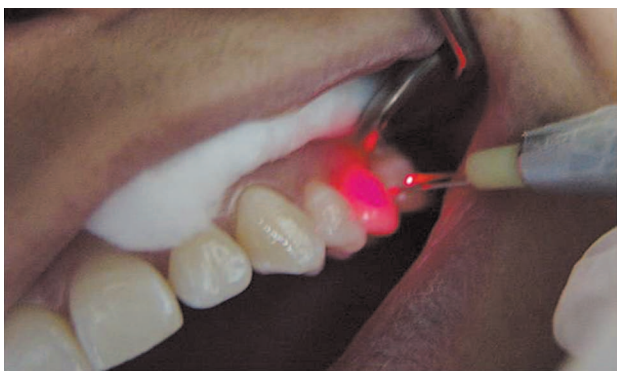

Figure 4. Nd:YAG laser irradiation on dental sensitive surface

Group1: No treatment

Group2: 5% sodium fluoride varnish (Durashield Company) (Figure 3)

Group3: Nd: YAG laser (FIDELIS Plus, Fotona Slovenia) (Figure 4)

Group4: 5% sodium fluoride varnish (Durashield) and right after Nd: YAG laser (FIDELIS Plus)

The teeth in groups 3 and 4 received laser treatment. They were completely isolated by cotton rolls and suction. Nd: YAG laser was applied with a power of 1w without cooler, a frequency of 20Hz and a duration of 120 seconds at a distance of 3mm (regulated with an orthodontic wire). The 5% sodium fluoride varnish in groups 2 and 4 was used following the instructions given by the manufacturing factory. After isolation with cotton rolls and suction, varnish was applied 2-3 times on the tooth with the appropriate brush provided in the package. During the treatment, patients eyes were closed and the back of the varnish brush was gently rubbed on the teeth, in order to induce a placebo effect in the patient. After the treatment of group 4, the 3 aforementioned tests were immediately performed by the clinician; this operation took place again 2 hours after. At the end of the treatment session, tooth brushes from GUM Company were given to patients. The following examination sessions took place at 1 and 2 weeks after treatment, which consisted of the 3 same mentioned tests.

The study results were entered in SPSS 11.5 software. In order to determine the difference of the CAB and visual analyzing scale (VAS) changes in the different treatment groups, two-way ANOVA for repeated measures and Post-Hoc-Tukey tests were used. In order to determine the difference in CAB and VAS between different treatment stages in each group and in each treatment group, one-way ANOVA for repeated measures and Willcoxon tests were used. For the comparison of the treatment groups in each treatment stage depending on the necessity, one-way ANOVA test and Post-Hoc-Tukey test and or Kruskal-Wallis test and Mann-Whitney test were used. The changes in CAB and VAS scores are presented in table and chart frames (Chart1 & Chart2). The significant level was set at P=0.05.

Results

After the initial examinations, 9 patients (6 females and 3 males) who had each one at least 4 teeth suffering

Table 1. Pain perception scoring classification

Score	Pain perception
0	Absolutely no pain
1	Non irritating pain
2	Irritating pain which stops when the stimulus stops
3	Irritating pain which doesn't stop when the stimulus stops

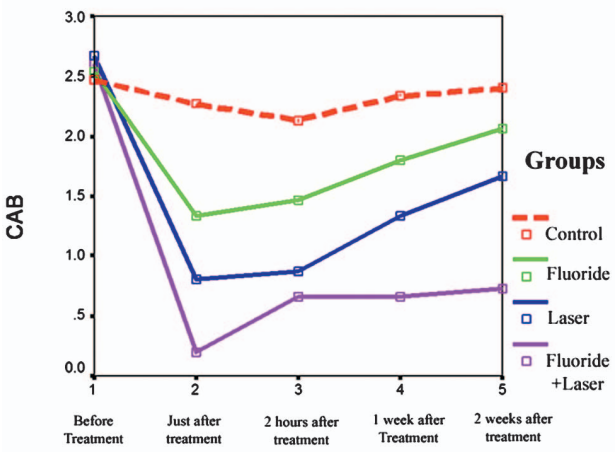

Chart 1. CAB index changes in each one of the treatment groups during the time

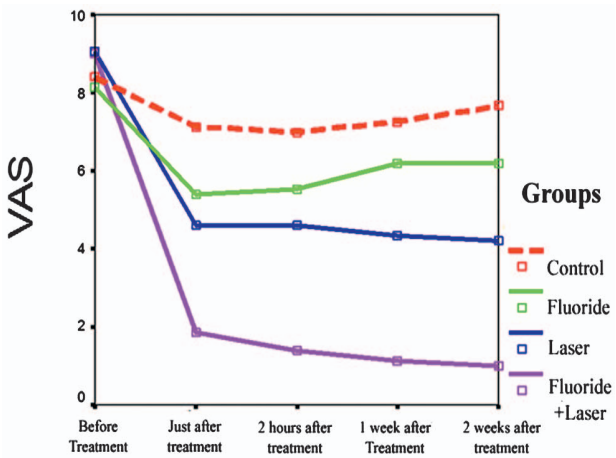

Chart 2. VAS index changes in each one of the treatment groups during the time

from dentin hypersensitivity were selected to participate in the study. Finally the study was performed on 60 sensitive teeth.

Results of pain severity evaluation with the CAB index (Chart1)

The one-way ANOVA test showed that the CAB index had no significant statistical difference in all 4 groups before treatment (P=0.77). The two-way ANOVA test for repeated measures demonstrated that between the different treatment groups after the control of the time stage effect (without consideration to the time stage effect) there was a significant statistical difference (P=0.001) and the interaction effect between the treatment methods and the time stage has also a statistically significant difference (P=0.001).

The result of the one-way ANOVA test for repeated measures for the comparison of the treatment groups separately on the time changes of the CAB index showed that in the control group there was no significant difference between the different stages (P=0.33). But in the fluoride, laser and fluoride-laser groups, between the different stages, with the ANOVA test for repeated measures, a statistical significant difference was seen (P=0.001).

The comparison of CAB index of the different treatment groups in each time stage with the Kruskal-Wallis test, in order to compare the CAB index between different treatment groups except the fluoride-laser group, in the stage right after and one week after treatment showed a statistical significant difference (P=0.001). The two by two comparisons of the groups except the fluoride-laser group, at the 2 hours and 2 weeks after treatment, were performed with the Mann-Whitney test. In the fluoride-laser group, at just after and one week after treatment, with the Kruskal-Wallis test, and at 2 hours and 2 weeks after treatment with the Mann-Whitney test, no statistical significant difference has been seen. The result of the one-way ANOVA test in order to compare the CAB index between different treatment groups at 2 hours and 2 weeks after treatment showed a statistical significant difference (P=0.001). And the two by two comparisons of the groups in these time stages were performed with the Post-Hoc-Tukey test.

Results of pain severity evaluation with the VAS index (Chart2)

The Kruskal-Wallis test for comparison of the VAS index before treatment didn't show any statistical significant difference between the groups (P=0.33). The two-way ANOVA test for repeated measures demonstrated that between the different treatment groups after the control of the time stage effect (without consideration to the time stage effect) there was a significant statistical difference (P=0.001) and the interaction effect between the treatment methods

and the time stage has also a statistically significant difference (P=0.001).

The comparison of VAS index of the different treatment stages for the different treatment groups separately with the two-way ANOVA test for repeated measures in all 4 different treatment groups showed a statistical significant difference (P=0.001). The comparison of VAS index of the different treatment groups in each time stage with the Kruskal-Wallis test, in order to compare the VAS index between the different treatment groups at 2 hours, 1 week and 2 weeks after treatment showed a statistical significant difference (P=0.001).

Results of evaluation of EPT index

The results obtained from this test were analyzed separately for treatment groups with the use of one-way ANOVA for repeated measures. For all 4 groups and for the 5 sessions no statistical significant difference has been seen.

Discussion

The amount of CAB and VAS indexes before treatment didn't show a significant difference, which indicates the similarity and equality of the groups in terms of sensitivity before the treatment, and the random distribution of the teeth in the groups (respectively P=0.77 and P=0.23). Taking into account the VAS index difference in the control group before and after treatment, the existence of a placebo effect in the treatment of these patients is evident, although for the CAB index the difference wasn't significant (P=0.33). It appears that the difference in the results of these indexes is related to the difference in the nature of stimulation performed in those test. The comparison of VAS and CAB indexes in the follow up sessions with before treatment in the fluoride group showed a significant difference in all sessions. Gaffar (1999), Kumar (2005), Ritter (2006) and Merika (2006), also demonstrated the efficacy of fluoride varnish in the treatment of dentin hypersensitivity in their studies (3,6-8).

The comparison of the CAB and VAS indexes in the follow up sessions with before treatment in the laser group showed a significant difference. In many of the studies performed by others, the efficacy of laser in the treatment of dentin hypersensitivity has also been proven, for instance, studies of Kumar (2005) and Poor Samimi (2005) can be mentioned (3,9).

Also in the comparison of the CAB and VAS indexes in the follow up sessions with before treatment in the fluoride-laser group showed a significant difference for both tests. Kumar (2005) in his clinical trial found a dramatic reduction in the VAS and CAB indexes after the use of fluoride-laser combined (3). Therefor, based on the results of this study, it is clear that fluoride varnish, Nd: YAG laser and the combination of fluoride varnish and laser, all three are able to improve the dentin hypersensitivity condition. In different studies, such as Lin & Lan (1999), Kumar (2005) and Hsu P.J (2006), the closure or narrowing of the dentinal tubules following the use of these methods was proven via electronic microscope (3, 10, 11). When generally comparing the treatment groups and the control group using the CAB and VAS indexes, all three treatment groups had a significant difference with the control group. In the comparison of each group with the control group for the different sessions separately using the VAS index, and of the laser and fluoride-laser groups with the control group using the CAB index, for all sessions after treatment a significant difference has been seen. The difference between the CAB index of the fluoride varnish group and the control group alone just after and 2 hours after treatment was significant. The evaluation of the results of the CAB index in the fluoride varnish group compared to the control group showed recurrence of sensitivity to cold air blast after day 7.

Like we also mentioned before, the difference in type of stimulation used can be the factor for the differences in the results for the VAS and CAB indexes in the fluoride varnish group after day 7. In the general comparison of the fluoride-laser group based on CAB and VAS indexes with the two fluoride varnish and laser groups, the severity of the sensitivity was significantly less. In the microscopic studies performed, the obstruction of the dentinal tubules was also better and more in the fluoride-laser group compared to the laser group or the fluoride varnish group (3, 10, 11). The comparison of the different sessions separately of the fluoride varnish group and the laser group distinctively with the fluoride-laser group using the CAB and VAS indexes showed a significant difference for all sessions after treatment, which imply more improvement for the fluoride-laser group. In the general comparison of the fluoride varnish group with the laser group using the CAB and VAS indexes no significant difference has been found. And when

separately comparing the different sessions of these two groups using the CAB index, for no session was a significant difference shown. But in the comparison of the different sessions separately using the VAS index for these two mentioned groups, only for the sessions just after and 2 hours after treatment was the difference not significant, and the sensitivity severity of the laser group to the probe was significantly less than the fluoride varnish group at 1 and 2 weeks after treatment.

In his own study Kumar reached a significant difference in the comparison between these two groups (fluoride varnish with laser) at 2 hours after treatment, and asserted that the laser was more efficacious. But before performing the treatment, he etched the teeth with 1% citric acid. Actually, he evaluated the effect of these treatment methods on the maximum amount of dentin hypersensitivity (open and enlarged tubules resulting from etch). It seems that in more severe dentin hypersensitivity (etched dentin) laser has more sealing potential compared to fluoride varnish, and this could be the explanation for the differences between this study and Kumar's one (3). The general evaluation of the CAB and VAS indexes in the comparison of two by two of the groups showed that the improvement process of the hypersensitivity was significantly more in the fluoride-laser group than in the fluoride varnish and laser groups. The execution of the electric pulp test (EPT) in each session showed the non dangerous nature of laser for teeth. The non dangerous nature of laser therapy for the pulp was previously proved by numerous studies, such as: White (1994) and Poor Samimi (2005)…(9, 12). In several clinical and microscopic trials like Lin & Lan (1999), Kumar (2005), Poor Samimi (2005), Yaghini (2006) and Dilsiz (2009), the positive effect of Nd: YAG laser on the reduction of dentin hypersensitivity via the melting and closure of the dentinal tubules, was shown (3, 9, 11, 13, 14). The electronic microscopic assessment performed also demonstrated that combining fluoride varnish and Nd: YAG laser, through simultaneous melting of fluoride varnish and dentin (into the dentinal tubules) and their crystallization together results in the formation of a seal resistant to acid and mechanical blows (tooth brushing) (3, 10, 11).

Our clinical findings coming from two CAB and VAS tests also showed a better combined treatment effect of fluoride and laser till 14 days after treatment, which is in adequation with the results obtained by the studies mentioned above.

Conclusion

The clinical findings of this study showed that the combined used of fluoride varnish and Nd: YAG laser, results in dramatic and significant reduction in the severity of dental hypersensitivity. The therapeutic effect of this combination is better than the application of laser alone or fluoride varnish alone.

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