RESEARCH ARTICLE

Efficacy of Diode Laser and Gluma on Post-Preparation Sensitivity: A Randomized Split-Mouth Clinical Study

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ABSTRACT

Objective: This study aimed to compare the efficacy of a 940-nm diode laser and Gluma desensitizer on post-preparation sensitivity of prepared teeth.

Materials and Methods: Twenty patients with 76 teeth participated in the study. For each patient, prepared molar or premolar in one quadrant were individually irradiated by laser. In the symmetrical quadrant, Gluma was applied onto the prepared teeth. No treatment was performed in the control group. Temporary crowns were placed after preparation. Pain response to tactile stimulus was assessed at one day, one week, and two weeks using visual analog scale (VAS). Intergroup comparisons were made with Kruskal Wallis test ($p < 0.05$).

Results: Mean VAS scores of the control group were statistically higher than laser and Gluma groups ($p < 0.017$). The difference between VAS scores of the laser and Gluma groups was statistically insignificant ($p > 0.05$).

Conclusions: A significant reduction in level of sensitivity after both treatments was observed. The reduction of sensitivity with Gluma was not significantly superior to laser. No significant additional reduction occurred in level of sensitivity from the first day to the second week after both treatments.

CLINICAL SIGNIFICANCE

The application of Gluma or a 940-nm diode laser may be considered as effective in reducing sensitivity after tooth preparation without superiority of either method.

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INTRODUCTION

Dentine hypersensitivity is a common symptomatic condition that may occur due to gingival recession, erosion, attrition or crown preparations.[1,2] Particularly, full crown preparations expose the peripheral terminations of 1 to 2 million dentine tubules (30,000–40,000 dentine tubules/mm^2).[2] Previous studies have presented a strong correlation between sensitivity and the number and diameter of exposed dentine tubules.[2,3] Through the exposed tubules, bacterial contamination may irritate pulp tissue or a thermal, tactile or chemical stimulus may induce dentinal fluid flow and activate the nerve response as a painful sensation with Brannstrom's hydrodynamic mechanism.[4] Full crown preparation for vital teeth may cause sharp pain and this may negatively affect a patient's daily routine and perception of treatment. Thus, to reduce the risk of post-preparation sensitivity and irritation to pulp tissue, occluding or sealing of exposed dentin tubules may be necessary. In addition to fabrication of a temporary restoration, several methods have been proposed to reduce post-preparation sensitivity such as using a temporary

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cement with soothing properties, antiseptic agents, desensitizing agents, coating the preparation surface with fluoride or dentin bonding agents or performing a laser treatment.[5]

Desensitizing agents can plug the dentinal tubules and make them less responsive to stimulation by two mechanisms.[6] They can either form a resin seal over the dentinal surface with or without light-curing or precipitate proteins or crystals into and around dentine tubules by rubbing action with a brush or cotton pellet.[5]

A combination product (GLUMA Desensitizer, Heraeus Kulzer GmbH, Wehreim, Germany) with glutaraldehyde and hydroxyethyl methacrylate (HEMA) content, has been promoted for the treatment of dentin hypersensitivity. Glutaraldehyde is a biological fixative, which intrinsically blocks tubular flow where hydroxyethyl methacrylate facilitates infiltration into moist dental hard tissue.[7,8]

The treatment of dentine hypersensitivity has also benefited tremendously from laser technology using the mechanism of ablation of tubule orifices or nerve analgesia.[9] Diode lasers with several wavelengths and low-output power, have been used efficiently for the treatment of dentin hypersensitivity.[9,10] The effect of diode lasers in terms of increased metabolic activity of odontoblasts and obliteration of the dentinal tubules with intensified tertiary dentin production has been reported.[11,12]

Previous studies[10,13,14] associated with laser therapy or dentin desensitizing agents has mostly focused on the treatment of dentin hypersensitivity due to gingival recession or abrasion. However, the efficacy of diode laser on the control of hypersensitivity of prepared teeth in comparison with desensitizing agents has not been studied thus far. Therefore, the aim of this study was to compare the efficacy of a 940-nm diode laser and Gluma desensitizer on post-crown preparation sensitivity of prepared teeth in a two-week post-operative period. The study tested the null hypothesis that the effect of diode laser was not different from that of the desensitizer.

MATERIALS AND METHODS

Patient Selection

Twenty patients (9 males and 11 females) with 76 teeth between the ages of 34 and 72 (mean age: 51.30 ± 12.19 years) participated in this study. Teeth were examined visually and periapical radiographs were made. Inclusion criteria for the study were having one or more molar or premolar tooth for crown preparation in symmetrical quadrants of the maxilla or mandible. Exclusion criteria included carious lesions, mobility, crack, gingival recession, existing crown restorations, previously received desensitizing therapy in the last 6 months, use of desensitizing toothpaste and drugs, pregnancy or smoking. The vitality of the teeth was checked with an electric pulp tester (Denjoy DY310, Hunan, China). Patients were informed about the purpose and the design of the study, and obtained the signed informed consent form from them. The study protocol was approved by Istanbul Medipol University research ethics committee with protocol number: 10840098-47.

Evaluation of Post-Preparation Abutment Sensitivity

After periodontal therapy and stabilization of oral hygiene, tooth preparations were performed by one operator according to the technique described by Schillingburg for metal ceramic crown preparation.[15] In this split-mouth study, each patient's mouth was divided into four quadrants. The selected teeth were randomly assigned to 940-nm diode laser group or Gluma desensitizer group by the lottery method. For each patient, teeth in one quadrant were individually irradiated by diode laser with an optical fiber size of 400 μm, for a total of 60 seconds in three consecutive courses of 20 seconds (Epic 10, Bipolase, San Clemente, USA) using 940-nm continuous wave form with a noncontact mode (2 mm from the surface) at 1 W power. Each tooth was divided into three segments consisting of buccal, lingual, occlusal, and each segment received an irradiation of 20 seconds with 10 seconds of pauses in between.

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TABLE 1. Distribution of the teeth included in the study

	Maxillary Premolars	Mandibular Premolars	Maxillary Molars	Mandibular Molars	Total
Diode Laser	7	7	6	6	26
Gluma	7	8	5	5	25
Control	6	7	6	6	25
Total	20	24	17	17	76

In the symmetrical quadrant, a desensitizer was applied onto the prepared teeth using small cotton pellets according to the manufacturer's instructions and left for 60 seconds. The surface was then dried by air until the fluid film had disappeared and rinsed with water. In one of the quadrants, a randomly selected tooth was defined as control and no treatment was performed. The patients were not aware of what kind of therapy each tooth was receiving. The laser irradiations and application of desensitizer were performed by the same operator. Then, temporary crowns were fabricated with a direct technique and cemented onto the prepared teeth using a non-eugenol temporary cement (Temp Bond NE, Kerr, CA, USA). The effectiveness of both applications was evaluated at three examination periods; 1 day, 1 week, and 2 weeks after the crown preparation and diode laser/Gluma application. The temporary crowns were removed at each examination period and temporarily cemented between appointments. Each abutment received a tactile stimulus of an explorer through the finishing line circumferentially and the preparation surface mesio-distally and buccolingually by the same examiner who was not aware of the type of treatment.[16]

After each stimulus, patients were asked to mark the intensity of sensitivity on a 100 mm visual analog scale using (VAS).

A minimum clinically significant difference in VAS scores was determined at 0.6.[17,18] A power analysis was done to determine the number of specimens required in each experimental subgroup. For the evaluated parameter, a 0.8 power and 0.05 alpha error probability, the minimum number of patients required to conduct this study was determined as 20.

Statistical Analysis

The data obtained in the study was assessed using Statistical Package for Social Sciences (SPSS 22, IBM Corp., Turkey) program. Intergroup comparisons were made with a Kruskal Wallis test, and a Mann Whitney U test with Bonferroni correction was used for the determination of the group causing a difference. Friedman test was used for the in-group 1st, 7th, and 14th day comparisons of the parameters. Significance was evaluated at a level of $p < 0.05$.

RESULTS

All of the 20 participants completed the study in a period of 5 months. Table 1 presents the distribution of the teeth included in the study.

There were statistically significant differences between first day VAS scores of the teeth (p:0.001; $p < 0.01$) (Table 2). Regarding the first day, the mean VAS score of the control group was statistically higher than the diode laser (p:0.001) and desensitizing agent (p:0.001) groups ($p < 0.017$). The difference between VAS scores of the 940-nm diode laser and Gluma desensitizer groups was statistically insignificant (p:0.763; $p > 0.05$).

The differences between first week VAS scores of the teeth were statistically significant (p:0.028; $p < 0.05$) (Table 2). Regarding the first week, mean VAS score of the control group was statistically higher than diode laser (p:0.013) and Gluma desensitizer (p:0.011) groups ($p < 0.017$). The difference between VAS scores of the diode laser and desensitizing agent groups was statistically insignificant (p:0.993; $p > 0.05$).

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TABLE 2. Mean VAS values and standard deviations (SD) of the teeth at first day, first week, and second week of diode laser and Gluma application

	Diode laser		Gluma		Control		
	Range	Mean ± SD (Median)	Range	Mean ± SD (Median)	Range	Mean ± SD (Median)	[1]p
1st day	0–8	1.29 ± 2.24 (0)	0–4	0.75 ± 1.08 (0)	0–6	2.35 ± 1.42 (2)	0.001**
1st week	0–6	1.57 ± 2.04 (1)	0–4	1.21 ± 1.23 (1)	0–7	2.50 ± 1.82 (2)	0.028*
2nd week	0–7	1.36 ± 2.02 (0.5)	0–4	0.96 ± 1.23 (0.5)	0–7	2.50 ± 2.09 (2)	0.011*
[2]p	0.389		0.180		0.595		

There were statistically significant differences between second week VAS scores of the teeth (p:0.011; $p < 0.05$) (Table 2). Regarding the second week, VAS score of the control group was statistically higher than diode laser (p:0.016) and desensitizing agent (p:0.004) groups ($p < 0.017$). The difference between VAS scores of the diode laser and Gluma desensitizer groups was statistically insignificant (p:0.785; $p > 0.05$).

Regarding the control group without any treatment, and diode laser and Gluma desensitizer groups, the difference between the first day, first week, and second week VAS scores was statistically insignificant ($p > 0.05$).

DISCUSSION

This clinical study evaluated the efficacy of a diode laser and Gluma desensitizer on post-preparation sensitivity. The results revealed that both modalities resulted in relief where one's effect was not superior to the other. The null hypothesis stating that the effect of diode laser was not different from that of the desensitizer was accepted.

The perception of sensitivity is subjective and it is difficult to quantify the amount of sensitivity. In previous studies, VAS was used to evaluate the response to the irritant due to its simplicity and sensitivity in discrimination between treatment modalities.[16,18] Bodian and colleagues.[19] considered VAS as reliable since the amount of pain in one patient can be measured multiple times and individually compared. For the assessment of dentine sensitivity, tactile stimulation performed with a sharp explorer was preferred to thermal stimulus because of its consistent and repeatable feature. The effect of an air blast as a thermal stimulus was considered unknown and possibly variable.[20]

The application of Gluma to the prepared dentine surface has been recommended anecdotally and also in the literature to reduce post-preparation sensitivity.[21–23] In their in vitro study, Schüpbach and colleagues.[24] displayed multiple transverse septa that occurred in the lumen of the dentinal tubules in contact with the tubular walls down to a depth of 200 μm under both scanning electron microscopy (SEM) and confocal laser scanning microscopy after Gluma application. They assumed that the flow of dentinal fluid was influenced by septum formation. In addition, with its high water solubility, HEMA might have promoted penetration of glutaraldehyde into the tubules where glutaraldehyde leaded to fixing of serum proteins in dentinal fluid and occluded the tubules.[24,25]

The application of Nd:YAG, Er;Cr:YSGG, and diode lasers have been presented as alternatives to desensitizing agents for the treatment of hypersensitivity. The effectiveness of diode lasers with wavelengths in the range of 635 to 830 nm, and dosages in the range of 2 to 10 J/cm on hypersensitivity were evaluated.[9,10] These lasers control sensitivity either by occluding dentinal tubules or reducing the pulpal nerve's pain threshold.[9] Diode

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lasers are relatively less absorbed by dental hard tissues therefore detection of any perceivable structural changes in dentin tubule morphology created by diode laser may not be always anticipated.[26] However, laser energy reaches the pulp via dental hard tissues. In a SEM study, Gholami and colleagues.[27] evaluated the occluding effects of lasers on dentinal tubules and reported that a diode laser with an 810 nm wavelength and one-second irradiation duration in non-contact mode caused a mild, irregular melting in peritubular melting. Therefore, it was assumed that diode laser functions by depressing the nervous signal transmission of afferent C-fibers.[28]

In the literature, there were different irradiation durations used in clinical studies to control the cervical hypersensitivity starting from 60 seconds to 2 minutes.[13,29,30] Since the dentin surface used for laser application was intentionally formed by preparation and, therefore, might contain higher number of dentin tubules with wider orifices compared to dentin surfaces formed by recession, the 60 seconds irradiation was applied in three consecutive courses of 20 seconds and 10 seconds of pauses were given in between to protect the pulp tissue.

The effect of Gluma and a diode laser on post-preparation sensitivity of a prepared vital dentin surface has not been previously studied, and thus no comparative study is available. Therefore, the results of the present study were compared with previous studies regarding hypersensitivity due to gingival recession or abrasion.[10,13,14]

Femiano and colleagues.[31] compared the desensitizing efficacy of 2% sodium fluoride solution, diode laser, and Gluma in cervical dentin hypersensitivity in 262 teeth of 24 subjects immediately after treatment, and after 1 month, and 6 months using VAS where the results showed a significant reduction in sensitivity for teeth applied diode laser and Gluma in accordance with this study.

When the results at different time intervals were evaluated, for both treatments, a 48% reduction in VAS scores was detected one day after the tooth preparation, which could be interpreted as immediate relief as reported by previous studies.[13,14] The slightly higher VAS scores at the end of first week, may be attributed to hypothetical bacterial contamination during try-in of a metal substructure. A lower pain threshold associated with increased inflammatory mediator synthesis was reported in bacterial contamination.[32]

The effect of gender on the perception of sensitivity or individual differences may be taken into consideration during interpretation of the slightly lower VAS scores at the end of second week.[16] In this study, relief in post-preparation sensitivity was evaluated after a period of two weeks, which was considered to be the maximum duration of time for a crown fabrication under normal conditions. Therefore, those short-term results should be validated by long-term clinical follow-up studies of hypersensitivity after cementation.

It may be noted that the mean age in this study was high and post-preparation sensitivity is most prone in younger teeth. This fact should also be taken into consideration while interpreting the results. The use of a non-eugenol temporary cement was preferred for temporary crown cementation order to eliminate the sedative effect of eugenol and to assess the effect of laser and Gluma application on sensitivity, alone.

This short-term study, with both a diode laser and Gluma desensitizer resulted in a significant decrease in post-preparation sensitivity and may be beneficial in terms of patient's comfort without causing any side effects. In this sense, factors such as clinical equipment, economy, patient cooperation, time efficiency of application, and clinician's preference to the technique may affect the motivation of which treatment should be used.[9,33] Nonetheless, multicenter long-term clinical trials with a higher number of eligible patients should be conducted to confirm the present results.

CONCLUSION

Within the limitations of this study, following conclusions were drawn:

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There was a reduction in level of sensitivity after both treatments.

The reduction of sensitivity with Gluma desensitizer was not significantly superior to a 940-nm diode laser.

No significant additional reduction occurred in level of sensitivity from the first day to the second week after both treatments.

DISCLOSURE

The authors do not have any financial interest in the companies whose products are included in this article.

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