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Original Research

Efficacy of Diode Laser in the Management of Dentin Hypersensitivity Following Periodontal Surgery

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Abstract:

Background: Dentine hypersensitivity is a common clinical condition in patients after periodontal surgery. Laser has been reported to be a better treatment option for this condition than conventional desensitizing agents. The aim of the present study is to evaluate the efficacy of 810 nm diode laser (DL) in reduction of dentine hypersensitivity (DH) in periodontal patients following surgical therapy.

Materials and Methods: Patients with chronic generalized periodontitis who underwent flap surgery and consequently experienced dentin hypersensitivity were randomly selected for the study and divided into 2 groups. Group 1(control group) patients were instructed to use Fluoride containing tooth paste. In Group 2 (test group) patients application of diode laser in non contact mode was carried out. DH was evaluated in all patients using evaporative stimulus (ES) and tactile stimulus (TS) immediately before and after therapy. It was also evaluated on the 2nd, 7th ,14th and 30th days post therapy.

Results: The test and control groups were found to be similar with regard to ES (p=0.648) and TS (p=1.000) at baseline. In the DH evaluation after 15 minutes, TS values had significant reduction in the test group in comparison with the control (p=0.04). Similarly, between 15 and 30 minutes, TS values in the test group showed a significant difference when compared to control (p=0.01). Also, despite the fact that patients in the test group were given a single application of laser at baseline, they experienced a continuous improvement in the measured response to ES (79%) and TS (95%) which lasted for up to 14 days (p=0.002). The difference from baseline through to the end of the study (day 30) for the measured parameters was found to be significantly better for test as compared to control group (p= 0.006 for ES, p= 0.004 for TS).

Conclusion: A significant immediate response was observed with DL which was maintained until day 30. Thus DL can be considered to be a useful adjunct in reducing DH post periodontal surgery.

Key words: Evaporative stimulus, Dentin hypersensitivity, Diode laser, Periodontal flap surgery,Tactile stimulus

Introduction

Dentine hypersensitivity (DH) is a painful response of the tooth to different stimuli such as brushing, acidic diet, occlusal overload, and thermal changes. It is characterized by an acute non-spontaneous, short or long lasting pain that appears suddenly in a specific location, which cannot be attributed to any other dental pathology. It is a highly common complaint of patients (prevalence 4-57%)[1,2] and is easy to diagnose with a routine examination. In patients affected by periodontitis, the prevalence of DH was even higher, i.e., 60-98%.[3] However, there are limited data available in terms of prevalence, intensity, and management of DH following periodontal surgery. This condition is found to affect patients at any age, and both genders are equally affected.[4,5]

Although different theories have been proposed for the DH etiology, it could perhaps be explained by a combination of two theories: The "hydrodynamic theory"[6] and the "neural theory."[7] According to hydrodynamic theory, a stimulus applied to the exposed dentinal tubules increase the flow of tubular fluid, with mechanical deformation of nerves located in the inner ends of the tubules or in the outer layers of the pulp. Type A delta fibers are supposed to be responsible for the dentinal sensitivity activated by the hydrodynamic process. According to neural theory, the release of neuropeptides from the activated nervous terminations subsequently induces a neurogenic inflammation. Following periodontal therapy, increased root sensitivity is encountered due to the removal of 20-50 μm of cementum during scaling and root planning thus exposing the dentinal tubules. Further following surgical therapy, the reduction of a gingival protective barrier either due to surgical excision or shrinkage of tissues, exposes the root surface thereby resulting in DH.[8,9]

The evaluation of DH poses a problem since pain is a highly subjective sensation. Nevertheless, it is possible to classify DH based on patient responses to evaporative and tactile stimuli, and verbal rating scale (VRS) can be used to read the responses.[10]

Multiple treatments have been proposed showing variable results. Conventional therapies for DH are based on the local application of desensitizing agents, either professionally or at home. The most frequently used agents can be classified as protein precipitants, tubule occluding agents, and tubule sealants. According to Grossmann, 1935, an ideal desensitizing agent should be non-irritating to the pulp, not causing pain, easy to apply, having a long-lasting effect, not staining teeth, non-irritating to soft tissues, or periodontal ligament, and economical.[11] However, none of the conventional desensitizing agents satisfied Grossman's criteria for an ideal desensitizing agent.[10]

In the last two decades, the introduction of lasers gave a new lease of life to DH therapy. The laser photobiomodulation action in dental pulp due to the production of large quantities of tertiary dentine is believed to cause physiological obliteration of tubules. The low power lasers (soft lasers) act directly on nerve transmission. Diode lasers gave the best results in clinical trials even in high-grade DH cases, and the gallium aluminum arsenide (Ga-Al-As) diode laser is able to generate a continuous wave without overheating.[12]

Diode laser irradiation has enabled a DH reduction equal to or superior to conventional agents such as potassium nitrate, sodium fluoride, stannous fluoride, and fluoride varnishes.[13-15]

There are very few studies evaluating the efficacy of diode laser in the treatment of DH after periodontal surgery. Hence, the aim of this study is to evaluate the immediate and late efficacy of Ga-Al-As diode lasers for DH management in the post-surgical period of periodontal therapy.

Materials and Methods

A sample of 20 patients in the age group 30-70 years were selected from the outpatient clinic of Department of Periodontics, Pushpagiri College of Dental Sciences, Thiruvalla among patients who reported for their post-surgical periodontal evaluation on the 10th day with a complaint of DH. All these patients were diagnosed with moderate to severe periodontitis[16] for which eventually full mouth periodontal flap surgery was carried out. During the first visit, faulty brushing techniques in all these patients if any were corrected. These patients had very minimal gingival recession and hardly any DH on their first visit but had progressive shrinkage following healing at the time of post-surgical evaluation, and they reported with a complaint of DH with a VRS score of 1, 2, or 3.

The patient exclusion criteria were as follows: (1) Subjects with gross oral pathology or chronic diseases such as gastroesophageal reflux disease, (2) hypersensitive teeth with mobility >1, (3) teeth with extensive and/or defective restorations, suspected pulpitis, caries, cracked enamel, or regressive alterations, (4) subjects with acidic diets, (5) subjects with removable appliances such as removable partial dentures or orthodontic retainers, (6) subjects taking anticonvulsants, antihistamines, antidepressants, sedatives or tranquilizers within 1 month prior to enrolment to the study or if they started taking them during the course of the study, (7) pregnant or lactating women, (8) subjects who were participating in any other clinical study or who used a desensitizing toothpaste within the last 3 months.

Ethical clearance for the study was obtained from the Institutional Ethics Committee, Pushpagiri College of Dental Sciences and signed informed consents were obtained from all the patients after explaining the procedure to them. The study was conducted in accordance with the Helsinki declaration of 1975, as revised in 2008.

DH was recorded for all the teeth in the selected patients at baseline. The selected patients were assigned into a test group and control group of 10 patients each at random.

The test group was treated with Ga-Al-As diode laser on selected teeth. The unit used was Picasso lite diode laser, 7 W with wavelength 810 nm and an inactive fiber. An output power of 0.5 W in a continuous non-contact mode was used for irradiation from a distance of 0.5 mm from the tooth for a period of 60-s.[17,18]

DH was evaluated for one tooth with the maximum sensitivity in each patient after 15 min and 30 min of irradiation followed by days 2,7,14 and 30. Patient responses to evaporative stimulus (ES) and tactile stimulus (TS) were evaluated using the VRS.

VRS: 0- No discomfort; but patient felt the stimulus
1- Slight discomfort; but not painful
2- Painful during application of stimulus
3- Painful during application of stimulus and immediately afterward.

In the control group, patients were instructed to use a fluoride containing toothpaste, and the DH evaluation was done for the tooth with maximum sensitivity.

For eliciting the response to ES, the selected tooth was isolated, and a jet of air applied using a dental syringe from a distance of 1 cm for 1 s and patient responses were recorded using VRS.

Table 1: ES values.

Time interval	Test group		Control group		*P* value
	Median	Mean±SD	Median	Mean±SD	
Baseline	2.00	2.40±0.52	2.00	2.30±0.48	0.648
15 min	1.00	1.10±0.74	2.00	1.60±0.52	0.112
30 min	1.00	1.10±0.74	2.00	1.60±0.52	0.112
2 days	1.00	0.80±0.63	2.00	1.60±0.52	0.010
7 days	1.00	0.70±0.68	1.50	1.50±0.53	0.013
14 days	0.50	0.50±0.53	1.00	1.40±0.52	0.003
30 days	0.00	0.3±0.48	1.00	1.10±0.57	0.006

ES: Evaporative stimulus, SD: Standard deviation

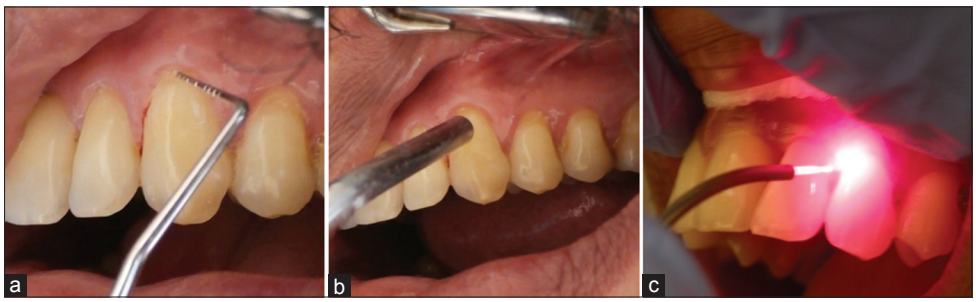

Figure 1: (a) Application of tactile stimulus, (b) application of evaporative stimulus, (c) application of laser.

Table 2: TS values.

Time interval	Test group		Control group		*P* value
	Median	Mean±SD	Median	Mean±SD	
Baseline*	2.00	2.00	2.00	2.00	1.000
15 min	1.00	0.60±0.52	1.00	1.20±0.63	0.038
30 min	0.00	0.40±0.52	1.00	1.10±0.57	0.014
2 days	0.00	0.20±0.42	1.00	1.00±0.47	0.002
7 days	0.00	0.10±0.32	1.00	0.80±0.42	0.002
14 days	0.00	0.10±0.32	1.00	0.80±0.42	0.002
30 days	0.00	0	1.00	0.60±0.52	0.004

*: p< 0.05 is considered significant, TS: Tactile stimulus, SD: Standard deviation

The TS was applied by scraping the exposed radicular surface of the tooth by means of periodontal probing, and patient responses were recorded using VRS.

The clinical procedure of evaluation of response to ES and TS and the application of laser is shown in Figure 1a-c.

Sample size calculation

The sample size was calculated in order to identify the significance of clinical difference in DH reduction between the test and control groups with 80% power of the test and α = 0.05, two sided. According to this, the estimated sample size to assess the hypothesis was 10 patients per group (total = 20 patients).

Statistical analysis

The relation between the treatment given and the reduction of DH, measured using ES and TS were analyzed. The statistical analyses were done for comparing the effects in the test and control groups at baseline, after 15 min as well as the final outcome. The data were presented as median and range comparing the effects at different follow-up appointments. The significance of difference between test and control group were analyzed using Mann-Whitney test for the comparison at baseline. Friedman test was used for analysis of results across follow-up.

The obtained values for patient responses to ES and TS for the test and control groups are summarized in Tables 1 and 2, respectively.

Results

The study population comprised 12 males and 8 females in the age group, 30-70 years. The treatment was correctly completed by all the patients, and no adverse events were reported by any of them during the entire 30 days study.

The test and control groups were found to be similar with regard to ES ($P = 0.648$) and TS ($P = 1.000$) at baseline. In the DH evaluation after 15 min, we observed a 70% reduction in response to TS (0.60 ± 0.52) in the test group significantly greater than the control group (1.20 ± 0.63) which showed a reduction of 40% ($P = 0.04$). However, the differences were not significant with regard to ES. Between 15 and 30 min, the measured response to TS was 0.60 ± 0.52 at 15 min which reduced to 0.40 ± 0.52 at 30 min in the test group showing a significant difference with 33% reduction in measured values when compared to 8% in the control group where the values reduced from 1.20 ± 0.63 to 1.10 ± 0.57 ($P = 0.01$), but the same was not significant with regard to ES.

Despite the fact that patients in the test group were given a single application of laser at baseline, they experienced a continuous improvement in response to ES (79%) and TS (95%) which lasted for up to 14 days. The reduction in sensitivity was highly significant in the test group when compared to the control, the effect being more evident when eliciting the response to TS ($P = 0.002$). We analyzed the difference from baseline through to the end of the study (day 30) and found that the difference in the measured parameters observed in the test group when compared to the control group was highly significant with regard to the final outcome. (ES values showed 88% reduction in the test group and 52% reduction in the control group [$P = 0.006$] whereas TS values showed 100% reduction in the test group when compared to 70% reduction in sensitivity in the control group [$P = 0.004$]).

Discussion

In this study, the patients who had undergone periodontal surgery were evaluated on the 10th day, and their problem of dentinal hypersensitivity was addressed. The exposure of dentinal tubules after removal of supra and/or subgingival calculus and the removal of diseased cementum from exposed root surfaces is likely to increase the sensitivity experienced in such patients. Hypersensitivity might negatively affect the patient's compliance, especially during the post-surgical weeks. Hence, the availability of treatment that reduces or eliminates DH within a period of 24-48 h would be ideal[11] especially with

regard to patients with dentin sensitivity after periodontal surgical procedures. The diode laser application is believed to act as a rapid, durable, and safe treatment alternative when compared to the traditional topical desensitizing agents.[17]

Since, the DH pain is triggered by the action of thermal or mechanical stimuli on exposed dentinal tubules, the methodology used for assessing the same is based on pulpal response to cool air or tactile stimulation. The VRS was used for evaluation of the patient response to air-blast stimulus and TS since pain is a highly subjective sensation.

Low-level lasers can act directly on the pulp nerve terminals causing analgesia by means of depressed nerve transmission of stimuli and may occlude dentinal tubules by increasing the cellular metabolic activity of odontoblasts that promote tertiary dentine production.[19] The rapid desensitizing effect of laser therapy observed in the study may be attributed to a mechanism through which diode laser can induce changes in neural transmission networks within the pulp (depressed nerve transmission), rather than alterations in the exposed dentine surface. In addition, laser therapy may stimulate the normal physiological cellular functions. The laser would stimulate the production of sclerotic dentine, thus promoting the internal obliteration of dentinal tubules; and this is in accordance with the study done on dental pulps in teeth carried out by Matsumoto *et al*.[20] The laser application may contribute to the repair of the dentine – Pulp complex, preserving the pulp vitality; which may explain the maintained immediate effect and late effects of laser therapy.

Several studies evaluated the sole effect of a diode laser in treatment of DH. Matsumoto *et al*., 1985 showed 85% improvement in laser-treated teeth,[21] whereas Aun *et al*., 1989 reported 98% success.[22] Yamaguchi *et al*., 1990 and Gerschman *et al*., 1994 also demonstrated a significant result in laser-treated group.[13,23] Brugnera *et al*., 2001 could find an immediate analgesic effect using diode laser.[24]

The combination of different types of lasers with desensitizing agents like sodium fluoride and stannous fluoride has been reported to enhance treatment effectiveness by more than 20% over that of laser alone.[25-27] A systematic review of literature which compared the effectiveness of laser therapy and topical desensitizing agents by HE *et al*. indicated the likelihood that laser therapy has a slight clinical advantage over topical medicaments in the treatment of DH.[28] However, some earlier studies have indicated that laser treatment seems to be transient and the sensitivity returns in time, but the mechanism of recurrence is unknown.[29]

The low-intensity lasers have also shown variable results in several studies. A decrease in dentinal hypersensitivity was reported in a clinical trial after application of red (660 nm) and infrared (830 nm) lasers for 114 s on hypersensitive teeth.[15] The red laser showed a greater degree of desensitization in subjects aged 25-35 years when compared to the infrared laser. This age group also showed a higher rate of desensitization compared with subjects 35-45 years of age who may be more prone to regressive or atrophic changes in the dentin-pulp complex as a result of the physiological aging process. Consequently, the infrared laser was found to be ineffective in subjects who were 35-45 years of age. The desensitization produced may be due to removal of the nociceptive potential of pulp nerve fibers. The red laser (660 nm) was also compared with the light-emitting diode and a placebo in six sessions,[30] with similar results among all treatments at 15 days and better results for the laser at 60 days. The results of this study suggest that two sessions may be sufficient for reducing dentinal hypersensitivity. Conversely, another study[31] compared the effect of a light-cured composite resin (placebo) with a Ga-Al-As diode laser (670 nm) in six applications with a 48-72 h interval between applications. After 8 weeks, pain reduction was observed with both treatments, even though no significant differences were found between them. A similar study done by Lizarelli *et al*.,[32] also found no difference between the infrared laser and light-emitting diode, but both produced more reduction in dentin sensitivity compared with placebo indicating the importance of the number of applications. The mechanism of sensitivity reduction is believed to be due to the production of reactionary dentin through a physiological nonaggressive pathway.

Previous studies have reported an absence of significant pulp damage or thermal alterations after laser irradiation of the radicular surface.[12,21] In our study, none of the 10 lasers treated patients showed secondary effects which confirm the safety of this type of treatment. However, inappropriate laser use should be avoided, and the practitioner must be thorough with the security and efficacy documentation of the laser protocol applied. Among the strengths of this study are the 4 weeks observation period and the multiple evaluation times which made it possible to detect any relapse in hypersensitivity within the 4 weeks.

According to this study, the diode laser treatment shows better results with regard to the cost-benefit characteristic as well as the longevity of treatment, when compared to conventional forms of treatment. However, long-term studies using larger samples are necessary to confirm the durability of the therapeutic effect of the treatment with lasers when compared to conventional forms of treatment. The rapidity and durability of laser treatment observed in our study shall be further corroborated using histological or SEM studies.

Conclusion

Within the limits of this study, the application of diode laser has shown efficacy in rapid DH reduction as well as the stability of results when compared to the control group in the post-surgical period of periodontal therapy. The effect was

apparent at 15 and 30 min; at 2 weeks and it remained stable until day 30. Owing to its rapid action and stability of results, diode laser can be considered a useful tool for DH reduction in periodontal patients as a potential adjunct to conventional periodontal therapy. These results have to be confirmed using larger samples of patients and by longer follow-up periods (e.g.: 3 and 6 months) for obtaining more credible results.

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