Original Article

Use of High and Low Powers Diode Laser (980nm) in the Treatment of Dentine Hypersensitivity: an in Vivo Comparative Study

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Abstract

Background: Dentine Hypersensitivity (DH) is defined as a short, sharp pain arising from exposed dentine in response to stimuli typically thermal, evaporative, tactile, or osmotic.

Objectives: The study aimed to evaluate and comparethe clinical efficacy of low and high output power of a 980 nm diode laser in the treatment of DH.

Materials and Methods: Twelve teeth with DH were randomly divided into two groups: group A, treated with a high -power diode laser of 1W, and group B, treated with a low-power laser of 500 mW. Sensitive teeth from both groups were subjected to one laser irradiation session using a 980 nm diode laser for duration of 60 seconds. Dentine hypersensitivity was assessed by tactile and thermal stimuli and measured by a visual analog scale (VAS): before treatment, 15 minutes post operatively and one week later. Comparison between different variables by t-Test with the level of significant set at p value of <0.05.

Results: The obtained results for both groups, (before versus after 15 minute of laser sessions) showed a significant reduction in VAS scores (*p*-value < 0.05). The intergroup comparison showed that the reduction in VAS scores was significantly higher in group A. However, when comparing the VAS scores after 15 minutes versus after one week, the mean reduction decreased in the two groups.

Conclusion: A 980 nm diode laser with a high output power of 1W can be used effectively to provide immediate relief in severe cases of DH and is still better after one week.

Key words: Diode laser, Dentine hypersensitivity, Visual analog scale

Introduction

Dentine hypersensitivity (DH) is defined as a short, sharp pain arising from exposed dentine in response to stimuli typically thermal, evaporative, tactile, osmotic, or chemical and which cannot be ascribed to any other form of dental defect or pathology.[1] DH usually affects one out of seven adult patients attending a dental clinic.[2]The prevalence of DH was found to be higher in patients aged 30–40 years and mainly in females.[3]Furthermore, the commonest teeth affected were the upper premolar and molar teeth.[4]

Many theories have been proposed to explain DH. For instance, the hydrodynamic theory, produced by Brännström[5], was adopted more than the odontoblast transducer and direct innervations theories.[1]It considers a pressure change across the dentine that can be generated by certain stimuli, which increase the outward flow of fluid in dentinal tubules, creating a pressure change within the dentine and thus activate intra-dental nerves at the pulp-dentine border or within the dentinal tubules.[6]

The management of DH depends on an adequate diagnosis. That is why it must be distinguished from other causes of sharp dentinal pain. There are two treatment approaches for DH. Either by occluding dentinal tubules that

subsequently blocks the flow of tubular liquid; or by preventing the neural response to a pain stimulus.[3, 6, 7]

Many methods have been used to treat DH, including iontophoresis, root coverage, and desensitizing agents; mainly sodium fluoride.[8]However, these methods have not been proven to achieve satisfactory results in reducing the level of pain.

Because DH is considered an unpleasant disease, patients constantly search for more effective and long-lasting therapies. The development of light amplification by stimulated emission of radiation (laser) applications in dentistry has opened a new gate of treatments.

In 1985, Matsumoto and coworkers used the Nd:YAG laser in the treatment of DH for the first time. After that, studies continued and developed on this issue in the last 10 years.[9]

Research has shown that laser is one of the easiest and most effective ways in desensitization.It has been shown that laser increases the formation of secondary dentine by the odontoblasts. Diode lasers have been used frequently , but there are still no conclusive results on how they occlude dentinal tubules or what suitable time of exposure, power, or wavelengths.) There is need for more studies to confirm the beneficial effects of treatment when comparing different laser parameters.

The aim of this study was to evaluate the effect of diode laser, with different powers (high power 1.0 W and low power 500 mW) on the treatment of DH.

Material and Methods

The study protocol consisted of clinical examination and laser treatment, and was approved by the Ethics Commission of the Institute of Laser, Sudan University of Science and Technology. Patients who were referred to periodontal department at Haj Almardy teaching hospital were considered for the study.

All patients attending the clinic during the study period, aged 24-30 years suffering from DH due to tooth wear or gingival recession, were

considered for the study. Exclusion criteria were for patients suffering from teeth with carious lesions or defective restoration, active periodontal disease, periodontal surgery within the previous six months, using analgesics or anti-inflammatory drugs, pregnancy, and lactation. Further, the patients should not have received any desensitizer agents for the previous two months.

Participation in the study was voluntary and those who agreed, after being informed about the study objectives, signed a written consent.

Clinical Evaluation

At the first visit, full mouth scaling and root planning were performed. The patients were instructed to brush their teeth with non-desensitizing dentifrices throughout the study.

Clinical testing included teeth exposed to both tactile stimuli by scratching the suspected tooth with the tip of a dental probe and thermal stimulation by the application of a jet of air using a dental air unit syringe perpendicular to the tooth surface for Three seconds. The adjacent teeth were isolated with cotton rolls to prevent false-positive results. Then the patient was asked to determine the level of pain based on VAS scale from 0 to 10.[12] The range of the pain on VAS was evaluated according to the standard assessment[10, 11] as 0 (no pain), 1-3 (mild), 4-6 (moderate), 7-9 (severe), and 10 (worst pain).

Then using a split-mouth design, the side of the mouth was selected randomly by tossing coin, to one of the following treatment group; group A or group B. Twelve teeth were included in the study, so each group of treatment method contained six teeth.

Laser Treatment

Laser session was conducted at AlModather Dental Clinic, Khartoum. Laser treatment was performed by diode laser-Quick Lase (810+980 nm) - United Kingdom. After the first VAS measurement, the involved teeth were randomly divided into two experimental groups, namely group A and group B.

Group (A) was treated by the diode laser with a high power of 1.0 W in continuous emission mode, glass fiber 400µm in diameter, the selected wavelength was 980 nm, and the exposure time was 60 seconds in non-contact

mode on the exposed dentine. Group (B) was treated with the same parameters as Group (A), except the power was changed to 500 mW.

Both groups were subjected to one session of laser for the treatment of DH. The VAS measurements were performed again after 15 minutes of laser treatment, and after one week.

Data was analyzed using SPSS ver26. Descriptive analysis was performed using the mean ± standard deviation (SD) for numerical variables. A comparison between the study groups was analyzed by a paired sample T-test. For all statistical tests, P value < 0.05 was considered statistically significant.

Results

We started with 22 teethes diagnosed with DH. They received laser treatment, and the pain level was measured after 15 minutes, which showed a clear decrease in pain level. However, a few of them defaulted and we left with only 12 teeth, on them, we completed the study and followed up after a week.

The mean and standard deviation (SD) results of the VAS scores for group A are shown in Table1. It shows a significant reduction in VAS after one week of laser treatment (p value = 0.001), and after 15 minutes (p = 0.007).

Table1. Comparison between Means and Standard deviations of VAS scale for Group A before laser treatment, after 15 minutes and after one week.

Comparison	Mean	SD	*P* value
Before laser versus after 15 min	1.5	0.837	0.007
Before laser versus after one week	1.667	0.516	0.001
After 15 min versus after one week	0.167	0.753	0.611

Table 2 shows the VAS reading for group B for each time point of the therapeutic protocol. There was no significance when comparing the VAS scale before applying the laser versus after 15 minutes (*p* value = 0.141) and the VAS after 15 minutes versus after one week of treatment (*p* value = 0.328). However, there is a significant reduction in *p* value in the VAS scale before laser versus after one week (*p* value = 0.007).

Table 2: Comparison between Means and Standard deviations of VAS scale for Group B before laser treatment, after 15 minutes and after one week

Comparison	Mean	SD	*P* value
Before laser versus after 15 min	0.833	1.169	0.141
Before laser versus after one week	1.5	0.753	0.007
After 15 min versus after one week	0.667	1.095	0.328

The comparison between *p* values for both groups from tables (1) and (2) shows a significant result in the *p* values before laser versus after one week, with group A having a significant reduction.

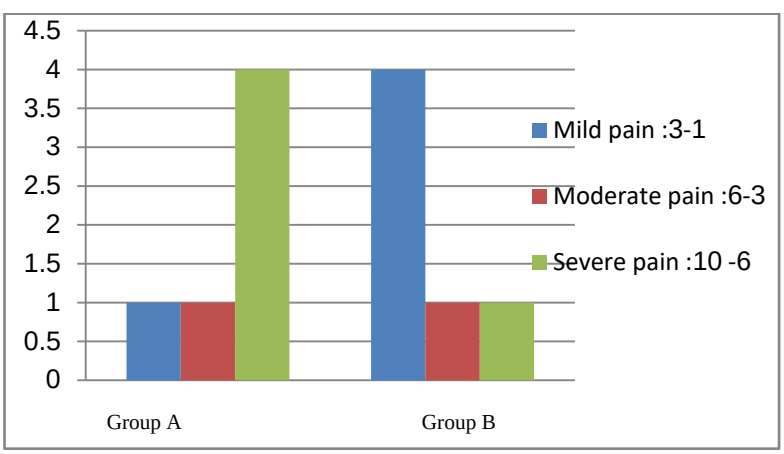

Figure.1. Numbers of teeth have readings of VAS scale before laser in both groups

Figure (1) shows the number of teeth that had a VAS scale, ranging from mild to severe in groups A and B.

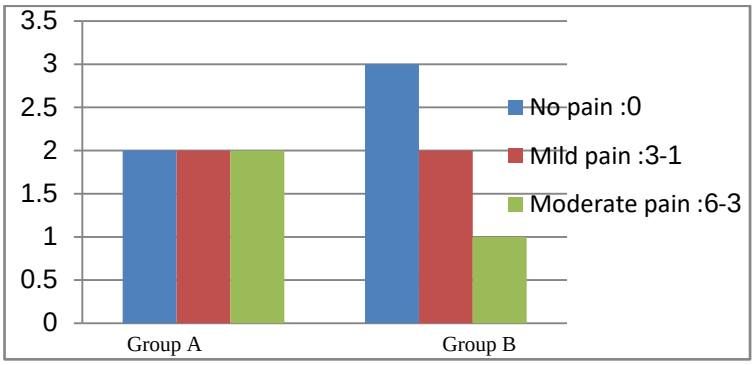

Figure.2: Numbers of teeth have readings of VAS scale after 15 minutes in both groups.

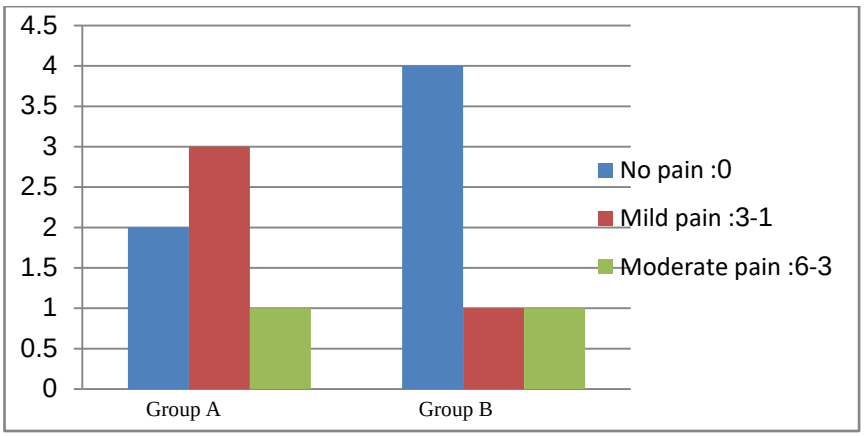

Figure 3: Numbers of teeth have readings of VAS scale after one week in both groups.

Figures (2) and (3) show the VAS with a severe mark was impaired in both groups after 15 minutes of laser treatment and after one week as well.

Discussion

DH can be attributed to either exposed dentine due to removal of the enamel covering the crown, or denudation of the root surface which is associated with gingival recession.[13] Morphological studies demonstrate a larger number and wider tubules of hypersensitive teeth when compared to non-sensitive teeth.[14] Therefore, all treatments aim at sealing or narrowing the tubules. Several studies have demonstrated that laser can be used in the treatment of DH because it has an analgesic and photo-bio modulating effect on dentinal tubules, also it promotes dentine closure by coagulation or precipitation of insoluble calcium complexes.[15] Laser can be used with low

(He-Ne, Diode lasers) or middle (CO_2, Nd:YAGlasers) output power ,with or without a desensitizing agent.[16]The result of treatment may vary from one type of laser to another. It has been found that diode laser seals the dentinal tubule rapidly without any damage to the odontoblast or pulp tissue.[17, 18]

In this study, the age range of the patients was 24-30 years, most of them were females, which is in contrast with the study conducted by Chitra et al, where most of patients were males.[19]

This clinical trial involved an evaluation of the effectiveness of using two different laser powers (low and high). A significant reduction in pain was observed. Furthermore, teeth that presented with sharp stimulated pain before laser treatment showed an immediate decrease in pain sensation after 15 minutes of the first session of diode laser (980 nm) in both groups. This benefit was sustained even after one week after initial irradiation. The Group treated with high power laser (1W) showed the best results.

Our results were in agreement with the results of FelicoFemio who used laser with different powers (5W and 0.2W) used separately or in combination. He found that high power diode laser recorded a better immediate improvement (57%) compared to lower laser (49%), with the preference for combination technique (60%).[20]Narges Naghsh et al. concluded that application of 810 and 980-nm diode lasers with high power (1W) for 30 seconds was effective in decreasing pain in patients with DH, with no significant difference between these two wavelengths.[21]

On the other hand, our results were not in agreement with the observation of Lopes et al , who did not find significant differences in the level of pain when comparing the Nd:YAG laser to a low intensity laser ,using high and low doses, and desensitizing agent.[22]

Desensitization can be referred to as a mechanism through which high power induces a photo-thermal effect that melts the hard tissue on the surface, with the smear layer occluding the tubules. Therefore, laser blocks the movement of the fluids in the dentinal tubules, which causes DH pain.[5]

Marwan El Mobadder et al. concluded from vivo and vitro studies that a diode laser with 1W power provided significant pain reduction immediately

and over 6 months follow up period, especially when laser was coupled with graphite paste.[23]Literature showed the superiority of Nd:YAGusing in treatment of DH when compared with other types of laser or desensitizing agents. Nd:YAG laser seals dentinal tubules by dissolving and re-solidifying the hydroxyapatite crystals in dentine.[15]

The group treated with low laser power in the present study also showed a reduction in DH. Oliveira Lopes explained the reduction in DH by using a low-power diode laser with an infrared wavelength based on the fact that light acts on the cell membrane, allowing greater passage and a subsequent increase in Ca^{2+}, Na^{2+}, and K^{+} ions. As a result, the endorphin system and the action potential of neural cells increase. In addition, the depolarization of C fiber afferents is blocked, thereby not allowing the pain information to reach the central nervous system.[24] The long-lasting effect of low-power lasers can be attributed to the formation of a layer of tertiary dentine.

The decrease in DH by low power diode laser agrees with the results obtained by Ana Lucia Marsilio et al. who found immediate reduction in DH treated by low power (15mW), even after 60 days of follow up ,without any effect of the different energies they used ($3J/cm^2$ and $5J/cm^2$).[25]Rakesh Mittal concluded that a medium-power 0.5W GaAlAs diode laser causes both nerve analgesia and partial occlusion of dentinal tubules.[26]

In the current study, there was a significant difference between before and after 15 minutes irradiation. We attributed the reason to the immediate analgesia through which diode laser depress nerve transmission through blocking depolarization in afferent fibers within the pulp tissue.[27]

Conclusion

The immediate and late therapeutic effects of the diode laser 980 nm with 60 seconds exposure duration and 1W power were greater than those of the 980 nm with 5mW.

It can be concluded that the laser parameters (980 nm wavelength, at 0.5W power or 1W power, and for duration of 1 minute) that have been used in

this study were safe, and no adverse effects were observed on irradiated teeth and adjacent tissue.

Further long-term studies with larger sample sizes are needed. This can confirm precisely which output power is more effective in treating dentine hypersensitivity for long treatment duration.

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