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Full Length Research Paper

Role of 810 nm and 980 nm diode laser in treatment of dentinal hypersensitivity: A literature review

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Abstract

Laser therapy was first introduced as a potential method for treating dentinal hypersensitivity (DH) in the mid-1980s Various types of laser used in treatment like low power lasers He-Ne (632.5 nm), diode lasers with various wavelengths 810, 940,980 nm and medium power lasers as Nd:YAG (1064nm), CO2 10600 Er:YAG (2940nm) and Er,Cr:YSGG (2780nm). He-Ne (632.5 nm) and diode lasers have analgic effect. Objectives: To appraise the efficiency of different techniques by using diode lasers 810 and 980 nm alone or in a combination with different desensitizing agents in management and treatment of dentinal hypersensitivity Data:138 articles are included then according to exclusion criteria, 46 articles are included, after specific exclusion criteria and evaluation of the articles, they become 35 articles, from the 35 articles there were 5 systematic review articles 22 in vivo study and 8 in vitro study. Sources: A thorough search of Literature was performed through Pubmed databases. Words used in the search: diode lasers and hypersensitivity, diode lasers in treatment dental hypersensitivity, dentinal hypersensitivity, and low power lasers. Conclusions: 810 and 980 diode lasers are effective in treatment of dentinal hypersensitivity, diode lasers with different wavelengths alone or with desensitizing materials are efficient.

Keywords: Diode Lasers, Dentinal hypersensitivity, low power lasers

INTRODUCTION

Dentinal hypersensitivity (DH) is characterized by a non-spontaneous, an acute short or long-lasting pain originating from exposure of the dentinal tubules or dentine to the thermal, chemical, mechanical, or osmotic stimuli, which cannot be attributed to any other dental pathology dentinal hypersensitivity is a quite common problem. Que et al., pointed out a prevalence of dentinal hypersensitivity varying between 2–8% and 74 % (Addy M (2000).

In patients affected by periodontitis, DH prevalence was even higher ranging between 60 to 98%, this condition may affect patients at any age, and both genders are equally affected. Others terms or definitions used to describe dentinal hypersensitivity have been created by substituting the word dentinal, adding site descriptors, such as cervical or root, and combining this with either hypersensitivity or sensitivity (Addy, 2002). The etiology of dentinal hypersensitivity remains unknown, but the most common accepted theory is the fluid movements/hydrodynamic theory proposed by Braennstrom and Astroem, which involves that the movements of fluids of the tubules. These movements of the fluids are direct reactions of thermal, chemical, osmotic, and mechanical stimuli (Bader et al., 2014). The odontoblastic processes are indeed rounded by dentinal fluid coming from the pulp complex, which forms 22% of the dentinal volume (Cummins 2010), and some studies reported that sensitive dentine contain 8 times more tubules, but also wider tubules, than not the sensitive teeth (Dilsiz et al.,2010), (Dilsiz et al.,2010). Another great problem related to dentinal hypersensitivity is its evaluation, since pain is a highly subjective sensation. Nevertheless, it is possible to classify the dentine hypersensitivity according to Matsumoto's criteria and visual analogue scale (Femiano et al., 2013).

In this classification, three degrees of dentine hypersensitivity are recognized: grade 1 mild discomfort/pain, grade 2 moderate pains, and grade moderate moderate pains, and grade 3 characterized by intense and unbearable pain. To obtain a conclusive

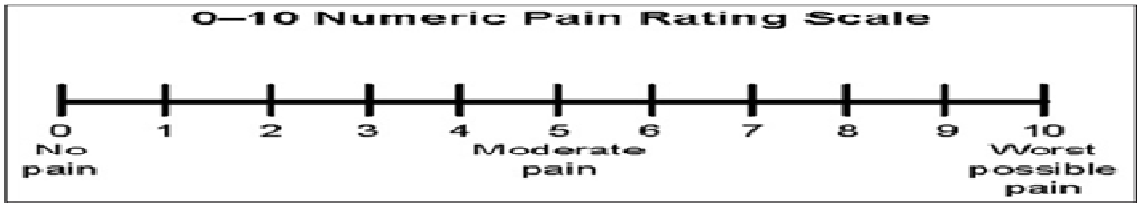

Figure1: Visual analogue scale (VAS)

diagnosis of dentinal hypersensitivity, first carefully evaluate, investigate and compare among the other teeth, in order to eliminate other possible causes of pain, which could lead to confusion. A good clinical history is essential and questions asked by the professional may help to collect important information that will help in treatment.

Laser therapy was first introduced as a potential method for treating dentinal hypersensitivity (DH) in the mid-1980s (Gerschman et al., (1994) .Various types of laser used in treatment like low power lasers He-Ne (632.5 nm), diode lasers with various wavelengths 810, 940,980 nm and medium power lasers as Nd:YAG (1064nm), $CO(10600)_2$, Er:YAG (2940nm) and Er,Cr:YSGG (2780nm). He-Ne (632.5 nm) and diode lasers have analgic effect; they can have effect alone or with combination with desensitizing agents.

The desensitizing effect of the middle output-power lasers (Nd:YAG, CO_2, and Er:YAG) is thought to be related to the occlusion or narrowing of the dentinal tubules. According to hydrodynamic theory, such occlusion could mediate stimulus transmission from the dental surface to the pulp. Only the Nd:YAG laser at 1064 nm seems to have an additional analgesic effect, probably because the irradiation can temporally alter the ending of the sensory axons. The use of dental lasers has been cited as a possible new treatment option for dentinal hypersensitivity, and has become a subject of intensive research in recent decades.

Low-level laser therapy (LLLT) is a sensitizing method that shows promise. This treatment induces alterations within the net of nerve transmission of the dental pulp, instead of altering the exposed dentinal surface, as in most other types of treatment.18 LLLT has been used for dentinal hypersensitivity since the 1980s. Studies using the GaAlAs laser showed dentinal hypersensitivity reduction in the range of 60–98%.

The explanation for the immediate reduction in DH when a low-power diode laser with an infrared wavelength is used is based on physiological experiments that demonstrated that when light acts on the cell membrane, it allows greater passage and consequent increase in Ca2+, Na2+, and K+ ions. Consequently, the endorphin system and the action potential of neural cells increase, and at the same time, the depolarization of C fiber afferents is blocked, not allowing the pain information to reach the central nervous system. Nd: YAG, Er; Cr: YSGG, and CO_2 lasers, have ability to melt peri tubular dentin, can occlude dentinal tubules partially or totally and therefore reduce patients' hypersensitivity symptoms.

Aim of the study

To appraise and assess the efficiency of different techniques by using diode lasers 810 and 980 nm alone or in a combination with different desensitizing agents in management and treatment of dentinal hypersensitivity

MATERIALS AND METHODS

A thorough search of Literature was performed through Pubmed databases. Words used in the search: diode lasers and hypersensitivity, diode lasers in treatment dental hypersensitivity, dentinal hypersensitivity, low power lasers.

Inclusion Criteria:
Articles from 2003 to 2016.
Articles in English were only accepted.
In vivo study only.
Articles related to 810 and 980 nm diode lasers.

Exclusion Criteria:
Articles before 2003.
Articles that not related to the literature.
Articles with confusing data and errors.
In vitro study and systematic review.

138 articles are included then according to exclusion criteria, 46 articles are included, after specific exclusion criteria and evaluation of the articles, they become 35 articles. Regarding to exclusion criteria as some titles are not related to the title of literature and discuss other issues, from the 35 articles there were 5 systematic review articles 22 in vivo studies and 8 in vitro studies. Then after exclude 12 articles from 22 in vivo studies, 10 articles are discussed in vivo studies related to different wavelengths of diode lasers alone or in combination with desensitizing agents. So I will conduct a systematic review of 810 and 980 diode lasers in treatment or reduction dentine hypersensitivity.

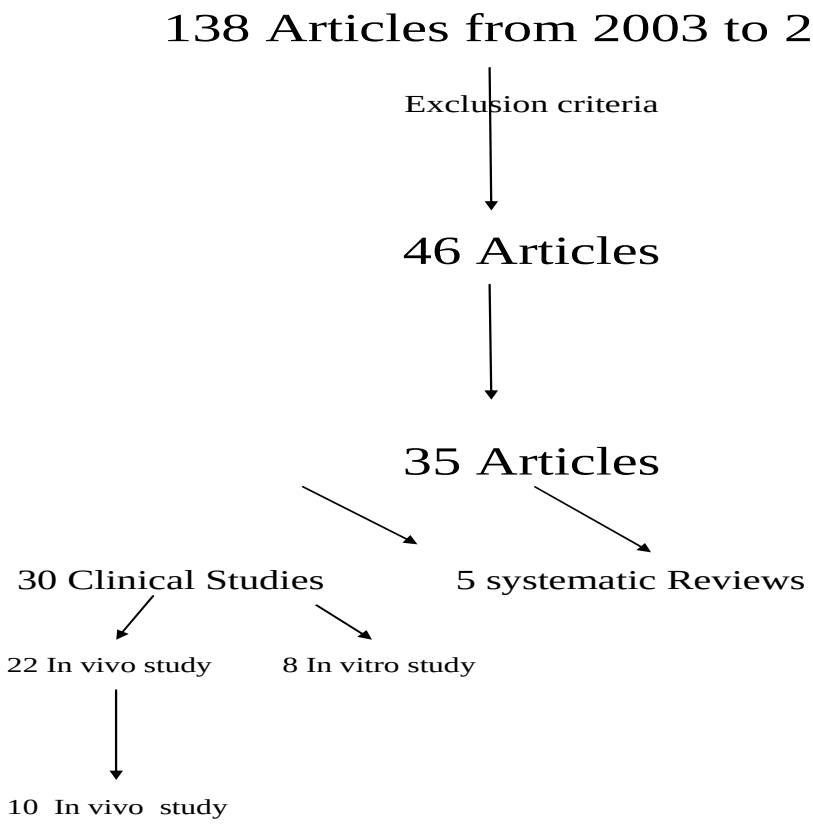

Figure2: Articles from 2003 to 2016

Literature review

Diode lasers provide an abundance of available wavelengths in the visible and infrared spectrum. Near infrared (NIR) lasers are characterized by a high absorption in chromophores found in soft tissue. The wavelength of a laser determines its level of absorption and interaction with the tissue. The absorption coefficient is a measure of the level of absorption that occurs in a specific tissue by a specific wavelength. A high absorption coefficient means that less energy is needed to get the same local heating effect (J Clin Periodontol. 2009).

Diode laser 980 nm

An innovative 980-nm diode wavelength laser was introduced, which was first reported on 2004. It is a high-energy laser, with low purchase and maintenance costs, as well as greater versatility because of its compact size.

In vivo study was done by Umberto et al., to discuss the efficacy of a diode Gallium Aluminum Arsenide laser alone and in combination with topical sodium fluoride gel (NaF) in the treatment of dentine hypersensitivity, this study was done on 10 patients and in total of 115 teeth and classified to three groups first group with GaAlAs laser 980 nm. Each site received three applications of one minute each once a week for three weeks, second group was treated by 1.25% of NaF applied for 60 seconds on tooth surface, then the last group was treated by NaF gel was left on tooth surface for 60 seconds before the irradiation with diode laser 980 nm; in this way, the laser system could favor the permanence of desensitizer for a longer time than when it was used alone.

Umberto et al., found that the GaAlAs laser showed a very high capability to improve immediately the dentinal hypersensitivity related pain, both alone and even better in combination with NaF gel. On the other hand, the sole gel results, even if positive, cannot equalize the performances of laser in the immediate. Finally they concluded that combination between laser and desensitizing material achieve the best results.

Suri et al., discuss the effect of diode laser 980nm alone and in combination with NaF in reduction of dentinal hypersensitivity, they found that diode laser 980 nm in combination with NaF reduce dentinal hypersensitivity but NaF alone is better, it was in vivo study that patients classified in to four groups group 1 was control group, group 2 (NaF) treated by 5% NaF varnish, Group 3 treated with 980 nm DL, and Group 4 treated with both 5% NaF varnish and 980 nm DL (combination group).

Figure 3: Diode laser 980 nm

Diode laser 810 nm

A randomized, double-blind, controlled, clinical study was done by Yilmaz et al., to compare Low Level Laser Therapy with topical fluoride application in the treatment of dentine hypersensitivity that occurred following scaling and root planning. Patients were classified in to four groups as group one treated by gallium aluminum arsenide GaAlAs, second group were treated by NaF, third group with placebo laser and finally group four treated by placebo sodium fluoride (NaF).

Low level laser therapy was performed with GaAlAs diode laser (with continuous emission (810nm) on non-contact mode (2mm from the surface). The laser device was used with the following parameters: output power of 500mW, irradiation time of 60sec, and 3.5cm2 area of active tip resulting in an energy density of 8.5J/cm2. In the placebo laser group, the same GaAlAs laser without laser emission was used. GaAlAs laser was applied by scanning the cervical part in an overlapping pattern. In the NaF varnish group the light yellow varnish was applied with a disposable brush at the cervical region of both the buccal and lingual surfaces strictly. All active and placebo treatments were performed only at the first visit, by the same clinician.

Both the GaAlAs laser and NaF varnish treatments resulted in a significant decrease in the VAS scores immediately after treatments that was maintained through-out the study compared to the baseline scores However, in the NaF group, there was a significant increase in the mean degree of VAS scores at 3 and 6 months com-pared to at 1 week and 1 month.

Yilmaz et al., had suggested that GaAlAs diode laser application could be suitable for routine clinical treatment of dentinal hypersensitivity because of the rapid and long-term clinical effectiveness without ad-verse reactions.

Another study was done by Yilmaz et al., to compare the efficiency and assess the effect of two different wavelengths of lasers diode laser 810 nm and Er,Cr:YSGG 2780 nm, so it was double clinical study , patients were classified to 3 groups, first control group, second group patients treated by diode laser 810nm, and finally patients treated by Er,Cr:YSGG 2780 nm. Finally, it was concluded that gallium Aluminum Arsenide diode laser 810 nm irradiation seem to be suitable for the treatment for Dentinal Hypersensitivity, due to the rapid and 3-months clinical effectiveness without adverse reactions.

Hashi et al., found that diode laser (810 nm) provided a decrease in cervical dentine hypersensitivity and the therapeutic immediate and late effects of the diode laser 810 nm with 60 seconds exposure duration were greater than those of the 810 nm with 30 seconds exposure duration. An in vivo study was done to study the effect of the clinical application of the diode laser (810 nm) in the treatment of dentine hypersensitivity with two duration time, first group 30 seconds exposure duration group and the other 60 seconds exposure duration group, as there is significant reduction of dentine sensitivity occurred along all times measured during the two treatment sessions in both groups treated with 30 seconds exposure duration and 60 seconds exposure duration. .

An in vivo study was done by Sicilia et al., on 45 patients to evaluate the immediate efficacy in the

Figure 4: Diode Laser 810 nm

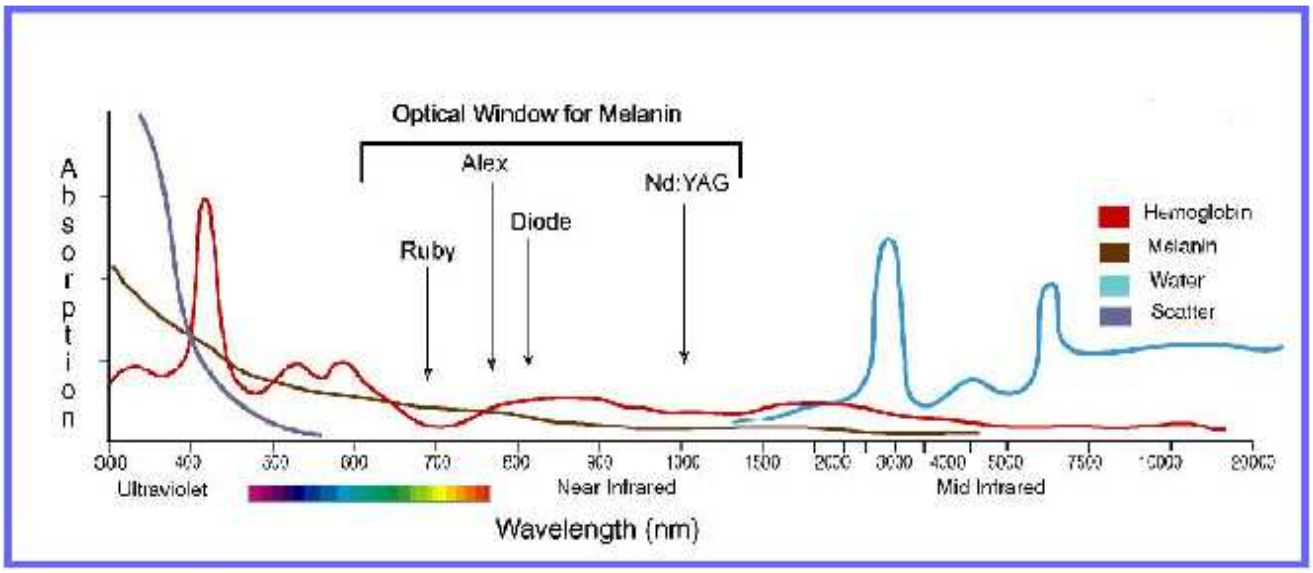

Figure 5: Chromophores and peak absorption of different lasers

reduction of dentine hypersensitivity (DH) when applying an 810nm diode laser (DL), and a 10% potassium nitrate bio adhesive gel (NK10%).Patients were classified to three groups as test group (15 patients): treatment with

dental Laser and placebo gel, second group positive control group (15 patients): treatment with placebo laser and NK potassium nitrate 10% gel and finally placebo group (15 patients): treatment with placebo laser and placebo gel. The test group was treated using a dental laser with a wavelength of 810nm and an inactive fibre not initiated, at an output power of 1.5–2.5mW, for 1min or 60 seconds. While a placebo laser was used with the rest of the patients (positive control and placebo groups).

Dental Laser can be considered a useful tool for dentinal hypersensitivity reduction in populations of a similar nature, as for instance, patients in periodontal practices.NK10% gel proved to be effective in the immediate treatment of dentinal hypersensitivity DH.

Dilsiz et al., found that diode laser 810 nm have ability to reduce dentinal hypersensitivity by study done to evaluate the effect of diode laser 810 nm on dentinal hypersensitivity as patients classified to 4 groups, first group treated with Er:YAG, second one with Nd:YAG, third control group and last group with diode laser 810, parameters were power 100 mW, and time 20s, but parameters were insufficient , power in continuous or pulsed, contact or non contact mode.

According to Lopes et al., the combination of protocols is an interesting alternative in the treatment of cervical dentin hypersensitivity was concluded in study done to evaluate the effect of low-power laser and a desensitizing agent on dentin hypersensitivity, so in vivo study with 5 groups as group 1: Gluma Desensitizer, group 2: low-power laser (at low dose three vestibular points and one apical point of irradiation: 30 mW, 10 J/cm^2, 9 s per point with wavelength of 810 nm), three sessions were performed with an interval of 72 h between them; Group 3: low-power laser at high dose (application at one cervical and one apical point: 100 mW, 90 J/cm^2, 11 s per point with wavelength of 810 nm), three sessions were performed with an interval of 72 h between irradiations; Group 4: low-power laser at low dose and gluma Desensitizer; and Group 5: low-power laser at high dose + Gluma Desensitizer

A double blind controlled trial study was done by Femiano et al., to study the diode laser in association to sodium fluoride vs Gluma desensitizer on t reatment of cervical dentin hypersensitivity. Four groups were classified as group 1 were treated with sodium fluoride NaF applied with a cotton swab for 60 seconds, repeated three times at weekly intervals, group 2 were treated with a diode laser with these parameters: 0.2 W in continuous emission using a fiber of 320 µm diameter, at a minimum distance from the tooth of 0.5 cm and not more than 1.0 cm, kept perpendicular to the tooth and performing rapid movements apical-coronal and mesio-distal in order to treat the whole surface of the tooth.

Each affected site received three applications of 1 minute each once at weekly intervals, group 3 were treated using both NaF and diode laser at the same parameters and times of G-2. The NaF was left on the tooth surface for 60 seconds before the laser irradiation and finally Group 4 were treated using a colorless, aromatic fluid containing 36.1% 2-hydroxyethylmethacrylate and 5.1% glutaral-dehyde (HEMA-G) in purified water (Gluma desensitizer applied with a micro brush for 60 seconds and repeated three times at weekly intervals.

Another study done by Dilsiz et al., in vivo study as patients classified into two groups: the first group, which received treatment with desensitizer toothpaste and diode laser 810 nm, and the second group, treated with desensitizer toothpaste. Teeth in the test group received laser therapy for three sessions. Parameters of group 2 were irradiated at 100 mW for 25 sec, with continuous-emission, noncontact mode but not mentioned in mm, perpendicular to the surface, with the scanning movements on the region of exposed root surfaces. Significant reduction of dentinal hypersensitivity occurred during the three treatment sessions in the test group, Dilsiz et al., conclude that diode laser 810 can reduce dentinal hypersensitivity.

RESULTS

980 nm and 810 diode lasers are effective in reduce or treatment of dentinal hypersensitivity alone or in combination with desensitizing agents. Diodes lasers and in combination with desensitizing materials are very efficient and precise than treatment done by diode lasers alone, there is no effect on the pulp tissue as the temperature does not exceed the threshold temperature (5.5 C).

DISCUSSION

The study of Zach and Cohen defined the temperature thresholds at which can irreversible or reversible pulp damage occurred. When Temperature rises above 5.5℃ resulted in an unacceptable degree of pulpal necrosis. Below this temperature only mild and reversible pulpitis occurred, while below 2.5℃ no histological changes to the pulpal tissue could be seen.

Across the various laser treatment groups, temperature changes at the level of the dental pulp were generally less than 1.5℃, and thus no deleterious effects would be expected clinically. However, as these measurements were conducted on teeth sectioned in half, the situation in vivo may show changes of lesser magnitude due to increased heat sinking from dentine and the cooling effect of blood flow.

Sgolastra et al., found that lasers are efficient in reduce dentinal hypersensitivity without damage to the pulp and without adverse effect.

Also Bader et al., found that lasers play an important role in reduce or treatment dentinal hypersensitivity.

Table 1: Summary of articles that mentioned in the study

Study	Wavelength	Number of groups	Mode of application	Conclusion
Umberto R et al.,	980 nm	3 groups, no control group	Alone and in combination	Combination between laser and desensitizing material achieve the best results
Suri I et al.,	980 nm	4 groups, with control group	Alone and in combination	Diode laser 980 nm in combination with NaF reduce dentinal hypersensitivity but NaF alone is better
Yilmaz HG et al .,	810 nm	4 groups, no control group	Laser alone	Diode laser application could be suitable for routine clinical treatment of dentinal hypersensitivity because of the rapid and long-term clinical effectiveness without ad-verse reactions.
Yilmaz HG et al .,	810 nm	3 groups, there is control group	Laser alone	Diode laser 810 nm irradiation seem to be suitable for the treatment for Dentinal Hypersensitivity
Hashim NT et al.,	810 nm	2 groups, no control group	Alone	that diode laser (810 nm) provided a decrease in cervical dentine hypersensitivity and the therapeutic immediate and late effects of the diode laser 810 nm with 60 seconds exposure duration were greater than those of the 810 nm with 30 seconds exposure duration.
Sicilia A et al	810 nm	3 groups, no control group	Alone and in combination	Dental Laser can be considered a useful tool for dentinal hypersensitivity
Dilsiz A et al	810 nm	4 groups, with control group	Alone	diode laser 810 nm have ability to reduce dentinal hypersensitivity
Lopes et al	810 nm	5 groups, no control group	Alone and combination	Efficient in treatment of cervical dentin hypersensitivity
Femiano F et al.,	810 nm	4 groups, no control group	Alone and combination	use of the laser diode in association with the NaF effectively reduced CDH
Dilsiz A et al.,	810 nm	2 groups, no control group	Alone	diode laser 810 can reduce dentinal hypersensitivity.

CONCLUSION

810 and 980 diode lasers are effective in treatment and reduce of dentinal hypersensitivity, diode lasers with different wavelengths alone or with desensitizing materials are efficient, and there is no effect on the pulp tissue as the temperature does not exceed the threshold temperature. Lasers treatment is more comfortable and faster than traditional dentinal hypersensitivity treatment, since the time consuming procedures such as isolation of operation field and repeated applications were eliminated.

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