International Journal of Scientific Research and Management (IJSRM)
||Volume||5||Issue||09||Pages||6983-6990||2017||
Website: www.ijsrm.in ISSN (e): 2321-3418
Index Copernicus value (2015): 57.47 DOI: 10.18535/ijsrm/v5i9.08

Effectiveness of laser therapy over topical desensitising agents in the treatment of dentinal hypersensitivity- A systematic review

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ABSTRACT:

AIM: To analyze the available scientific evidence on the effectiveness of laser therapy compared to the topical desensitizing agents in the treatment of dentinal hypersensitivity.

Materials and methods: A broad literature search was performed using both electronic database and hand search. The databases like COCHRANECENTRAL, MEDLINE, GOOGLE SCHOLAR, EBSCO HOST, PROQUEST were used for online data search and hand search was performed in the central library of the institute to identify the relevant articles. Articles that satisfied the inclusion criteria with description of randomized clinical trials comparing lasers versus topical desensitising agents in the treatment of dentinal hypersensitivity were included. These included studies were subjected to critical analysis following the Cochrane Collaboration tool for evaluating the risk of bias. **Results:** The initial search resulted in 65 articles; however, 21 of these articles were excluded because they were duplicates and then 20 articles were excluded as they were not clinical trials. After analyzing the full text from 24 clinical trials, 17 were excluded because they did not fulfill all the selection criteria. Our final review included 7 studies. Of these 7 studies 1 study used Nd:YAG laser system, 4 studies used GaALAS laser, one study used Er:YAG laser and one study used both CO2 and Er:YAG laser. Among the seven studies 5 studies reported that the lasers alone or in combination with topical desensitising agents are superior over topical desensitising agents used alone. Remaining 2 studies reported that both lasers and topical desensitising agents were equally effective in reducing dentinal hypersensitivity. **Conclusion:** With the constraints of limited available literature lasers alone or in combination with topical desensitising agents showed promising results than topical desensitising agent alone and this desensitizing efficacy of lasers was immediate and long lasting.

Key words: Lasers, laser therapy, topical desensitising agents, effectiveness, dentinal hypersensitivity, systematic review

Introduction

Dentine hypersensitivity is a common oral complaint characterized by 'short, sharp pain arising from exposed dentin 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. Dentine exposure may result from enamel loss by attrition, abrasion, erosion, abfraction and root surface stripping from gingival recession or periodontal treatment. Various mechanisms have been so far defined for producing dentinal hypersensitivity. The hydrodynamic theory is the most reliable among all. According to this, movement of fluid with in the exposed dentinal tubules is responsible for stimulation of pulpal mechanoreceptors[1].

Conceptually, treatment of dentinal hypersensitivity aims either to suppress the nerve impulse by direct neurological interaction or blocking of hydrodynamic mechanism by mechanical blockage of the tubules [2]. The ideal desensitising agents as listed by Grossman should not irritate or endanger the integrity of the pulp, should be relatively painless on application or shortly afterwards, should be easily applied, rapid in action and permanently effective and should not discolour tooth structure. To date, no such agent has been discovered and there is no 'gold standard' for assessing new treatment[3].

Several treatment methods have been tried to reduce dentinal hypersensitivity, ranging from home-use, over the counter products such as desensitizing mouthwashes, dentifrices or tray application forms to in-office application products such as varnishes, liners, restorative material, dentinal adhesives, iontophoresis procedures. Most of these agents tried and tested have the disadvantage of delayed action and multiple applications. None of them has provided a long term relief [4, 5].

A review of the literature shows a great number of treatment modalities for dentinal hypersensitivity, and this suggests that none of the treatments are totally effective. Currently, there is no desensitizing agent that is considered ideal for managing this complex sensorial condition [6]. Various studies showed that lasers can be used in the effective management of dentinal hypersensitivity. Four types of lasers (Nd:YAG laser, Er:YAG laser, CO2 laser and GaALAS laser) are commonly used in the treatment of dentine hypersensitivity, and their effectiveness ranges from 5.2% to 100%, depending on the laser type and parameters used. With the advent of laser technology and its growing utilization in dentistry, the use of the laser may open up new dimensions in the treatment of dentine hypersensitivity. The mechanism behind the laser's effect on dentine hypersensitivity is thought to be laser-induced occlusion, narrowing of dentinal tubules, or direct nerve analgesia[7].

Clinical trials have supported different approaches for the treatment of dentinal tubules, but the results are contradictory. Therefore, controlled randomized studies of the effectiveness of desensitizing agents are important and much needed [8]. Some randomized controlled trials had demonstrated greater efficacy of lasers over topical desensitising agent in treating dentinal hypersensitivity [9, 10], while others suggested that there was no significant difference between laser therapy and topical desensitising agent [11, 12].

The purpose of this study was to systematically evaluate existing evidence to verify whether laser therapy provided a better performance compared to other desensitising agents for treating dentine hypersensitivity

Materials and methods

Focused question: Is laser therapy more effective than topical desensitizing agents in the treatment of dentinal hypersensitivity?

Search process: A broad literature search was performed using both electronic database and hand search in library. The important databases like MEDLINE, GOOGLE SCHOLAR, COCHRANE CENTRAL, EBSCO HOST, PROQUEST were used for online data search. Search strategy was based on the following terms: dentine sensitivity, dentinal sensitivity, dentin hypersensitivity, dentinal hypersensitivity, lasers and randomized clinical trials or combination of these words according to Boolean search. A comparison of different searches was done to delete the repeated studies. Then abstracts of all available articles were examined. All studies, which appeared to meet the inclusion criteria, were obtained in the full text format and was subjected to validity assessment. Application of the Cochrane Collaboration tool for evaluating the risk of bias was done. Then selected articles were grouped into high risk bias and low risk bias articles.

Inclusion criteria: Randomized clinical trials were included when they had a trial group with any type of laser and control group that received topical desensitizing agents, with duration of 8 weeks and patients having at least two or more hypersensitive teeth

Exclusion criteria: The studies that had confusing data or probable errors, editorials letters, case reports, reviews, were all excluded. Studies without control groups

Types of outcome measures: The outcome measures assessed were VAS scores, VRS scores, the criteria proposed by Uchida et al and An arbitrary pain scale in 4 degrees

Results

Figure 1 summarised the details of the study selection process and the reasons for exclusion. The initial search resulted in 65 articles; however, 21 of these articles were excluded because they were duplicates and then 20 articles were excluded as they were not clinical trials. After analyzing the full text from 24 clinical trials, 17 were excluded (Table1) because they did not fulfill all the selection criteria[13-29]. Our final review included 7 articles [9-12,30,31,32]. Demographic details and General characteristics of included studies were described in table 2,3 & 4.

Risk of bias of included studies:

The included studies were subjected to critical analysis following the Cochrane Collaboration tool for evaluating the risk of bias, and we classified three articles as having a low risk of bias and four articles as having a high risk of bias. Table 5 shows the domain in which the trails were judged to have the high risk of bias.

Description of studies

Studies included in this systematic review compared the efficacy of lasers alone or in combination with the topical desensitizing agent versus topical desensitising agents in the treatment of dentine hypersensitivity. Of these seven studies one study used Nd:YAG laser system, four studies used GaALAS laser, one study used Er:YAG laser and one study used both CO2 and Er:YAG laser.

Nd:YAG laser versus control group: Lopes AO et al reported that Nd:YAG laser combined with Gluma Desensitizer, showed a significant reduction in hypersensitivity at first time of evaluation (immediately after treatment), whereas in the Nd:YAG group and Gluma Desensitizer group from the 2 evaluation (1 week) . In all the three groups even after 6 months of treatment there was no increase in pain. So it was concluded that Nd:YAG laser combined with Gluma Desensitizer (both applied together) is an effective treatment strategy that has immediate and long lasting effects.

GaALAS laser versus control group: Flecha OD et al reported that both GaALAS lasers and cyanoacrylate glue reduced the dentinal hypersensitivity and there was no significant difference in the reduction of dentinal hypersensitivity between the two groups. So it was concluded that cyanoacrylate glue is as effective as GaALAS laser.

Dilsiz A et al reported that test group (GaAlAs laser+ desensitizer toothpaste) significantly redeced the dentinal hypersensitivity compared to the control group (desensitizer toothpaste) in all the follow up periods. So it was concluded that GaALAS laser combined with desensitising tooth paste had a significantly greater efficacy in treating dentin hypersensitivity

Vieira et al reported that both GaAlAs laser and a 3% potassium oxalate gel groups showed reduction in dentinal hypersensitivity. However, there was no significant difference in the reduction of dentinal hypersensitivity among the two groups. So it was concluded that both treatments were equally effective.

Sicilia et al reported that after 15 minutes of treatment GaALAS laser group showed three times greater reduction in dentinal hypersensitivity than the 10% potassium nitrate bio adhesive gel group. After 14 days, this effect was even greater and lasted until day 60. The authors concluded that GaALAS laser had a significantly greater immediate and long-lasting response in treating dentin hypersensitivity.

Er:YAG laser , CO2 laser versus control group: Ipci et al reported that of CO2 lasers and Er:YAG laser alone and in combination with topical sodium fluoride significantly reduced dentine hypersensitivity compared to the sodium fluoride group. However those four treatments did not differ significantly from each other. So it was concluded that both the CO2 and Er:YAG lasers had promising potential in treating dentine hypersensitivity. But the combination of lasers with NaF gel did not show greater efficacy compared to either laser used alone.

Er:YAG laser versus control group: Schwarz et al reported that dentinal hypersensitivity was reduced in both Er:YAG laser group and Dentin Protector group immediately and 1week after the treatment. But dentinal hypersensitivity was increased after 2 months and 6 months in Dentin Protector group, whereas the effect of Er:YAG lasers remained at same level that was achieved immedietly after treatment. The authors concluded that Er:YAG lasers desensitising efficacy was more durable than Dentin Protector that maintained even 6 months following the initial irradiation.

Among the seven studies five studies[9,10.30,31.32] reported that the lasers alone or in combination with topical desensitising agents were superior over topical desensitising agents. Among these five studies three studies[9,10,31] reported the efficacy of combined effect of lasers and topical desensitising agents, of which two studies[9,10] reported that the combination of laser and topical de sensitizing agent showed greater efficacy whereas one study[31] reported that combination of laser and topical de sensitizing agent did not show greater efficacy compared to laser used alone. Remaining two studies[11,12] reported that both lasers and topicaldesensitising agents were equally effective in reducing dentinal hypersensitivity.

Safety of lasers: In our systematic review, none of the laser treated patients in the seven included studies showed secondary effects, which confirms the safety of lasers in the treatment of dentinal hypersensitivity.

Figure 1: Flow chart showing analysis of articles

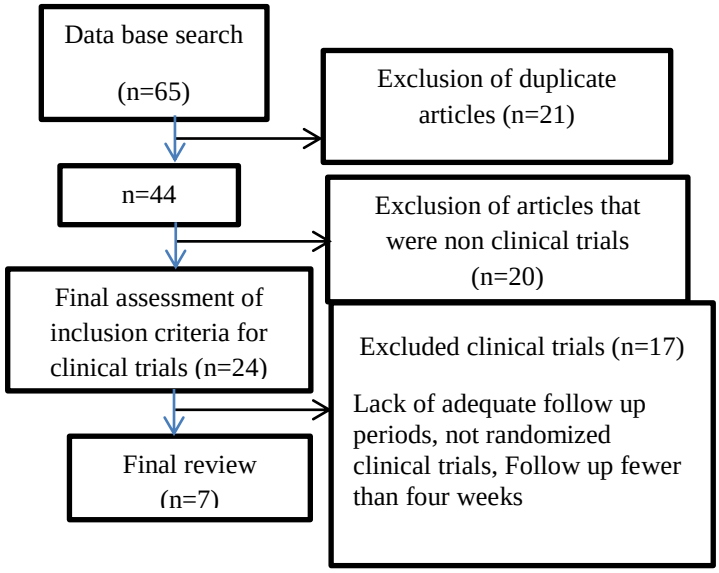

Table 1: Articles excluded from the study

Author name	Title of article	Reason for exclusion
Tailor A et al 2014[13]	To compare and evaluate the efficacy of bifluorid 12, Diode laser and their combined effect in treatment of Dentinal hypersensitivity- clinical study	Follow up for fewer than 8 weeks
Talesara K et al 2012 [14]	Evaluation of potassium binoxalate gel and Nd:YAG laser in the management of dentinal hypersensitivity: a split-mouth clinical and ESEM study	Not a randomised controlled trial.
Orhan K et al 2011[15]	Low-level laser therapy of dentin hypersensitivity: a short-term clinical trial	Follow up for fewer than 8 weeks
Yilmaz HG et al 2011[16]	Clinical evaluation of Er,Cr:YSGG and GaAlAs laser therapy for treating dentine hypersensitivity: A randomized controlled clinical trial	Control group was not a topical desensitising agent

Pesevska S 2010[17]	Dentinal hypersensitivity following scaling and root planing: comparison of low-level laser and topical fluoride treatment	Follow up for fewer than 8 weeks
Kara C et al 2009[18]	Comparative Evaluation of Nd:YAG Laser and Fluoride Varnish for the Treatment of Dentinal Hypersensitivity	Follow up for fewer than 8 weeks
Tengrungsun T et al 2008[19]	Comparative study in desensitizing efficacy using the GaAlAs laser and dentin bonding agent	Follow up for fewer than 8 weeks
Birang R et al 2007[20]	Comparative evaluation of the effects of Nd:YAG and Er:YAG laser in hypersensitivity treatment	Control group was not topical agent
Kumar NG et al 2005[21]	Short-Term Assessment of the Nd:YAG Laser With and Without Sodium Fluoride Varnish in the Treatment of Dentin Hypersensitivity – A Clinical and Scanning Electron Microscopy Study	Follow up for fewer than 8 weeks
Ladalardo TGP et al 2004[22]	Laser Therapy in the Treatment of Dentine Hypersensitivity	Control group was not a topical desensitising agent
Ciaramicoli MT et al 2003[23]	Treatment of Cervical Dentin Hypersensitivity Using Neodymium: Yttrium–Aluminum–Garnet Laser. Clinical Evaluation	Control group was not a topical desensitising agent
Corona SAM et al 2003[24]	Clinical evaluation of low-level laser therapy and fluoride varnish for treating cervical dentinal hypersensitivity	Follow up for fewer than 8 weeks
Marsilio A et al 2003[25]	Effect of the Clinical Application of the GaAlAs Laser in the Treatment of Dentine Hypersensitivity	Control group was not a topical desensitising agent
Lier BB et al 2002[26]	Treatment of dentin hypersensitivity by Nd:YAG laser	Control group was not a topical desensitising agent
Moritz A et al 1996[27]	Long-Term Effects of C02 Laser Irradiation on Treatment of Hypersensitive Dental Necks: Results of an in Vivo Study	Not a randomized study
Gutknecht N et al 1997 [28]	Treatment of Hypersensitive Teeth Using Nd:YAG laser: A Comparison of the Use of Various Settings in an in Vivo Study	Not a randomized study
Gerschman JA et al 1994 [29]	Low level laser therapy for dentinal tooth hypersensitivity	Control group was not a topical desensitising agent

Table 2: Demographic and clinical characteristics of the studies included in the review

Author	Age	Men	Women	No. of subjects	No.of teeth	Clinical characteristics for inclusion
Lopes AO	-	-	-	24	33	Sensitive teeth showing tooth wear or gingival recession with exposure of cervical dentin.
Flecha OD	12-60	15	47	62	434	pain in response to stimulus caused by the air jet
Dilsiz A	16-48	6	7	13	52	Miller's Class I or Class II recessions and clinically elicitable DH
Vieira AHM	24-68	7	23	30	164	Moderate to severe DH
Sicilia A	19-70	18	27	45	-	DH associated with chronic periodontitis,
Ipci SD	23-62	21	29	50	420	clinically elicitable DH
Schwarz F	23-56	14	16	30	104	Patients with hypersensitive and caries-free teeth.

Table 3: General characteristics of the included studies

Study	Lasers group	Intervention group	Pain-provoking stimulus	Outcomes	Follow up period
Lopes AO	Nd:YAG laser	Gluma desensitizer	Application of air using a dental syringe for 3 sec, 2mm away from and perpendicular to the root	VAS scores	Baseline, immediately after treatment, 1week, 1, 3, 6 months
Flecha OD	GaAlAS laser	Cyanoacrylate	Air jet at a distance of 3-4mm for 4 sec. Cold spray with cotton swab for 4 sec	VAS scores	Baseline, 24hrs after treatment, 1,3, 6 months
Dilsiz A	GaAlAS laser	Sensodyne F desensitising tooth paste.	Air blast of 60 pounds per square inch at 22c derived from dental syringe for 1 sec	VAS scores	Baseline,30 min after treatment, 15 days, 1, 2months
Vieira AHM	GaALAS laser	3% potassium oxalate gel	Manual pressure. Air blast with air syringe for 1 sec	VAS scores	Baseline, after treatment, 3months
Sicilia A	GaALAS laser	.NK10% gel	Dental syringe from a distance of 1 cm for 1 s. Scraping the exposed radicular surface by periodontal probing	VRS scale and a scale of 0–5 points	Baseline, 15 and 30 min. 2, 4, 7, 14, 30 and 60 days after laser application
Ipci	CO2 / Er:YAG laser	2% sodium fluoride	An air syringe of the dental unit , and a 1-sec cold air blast 2 mm from the site	criteria by Uchida	Before treatment, 1 week, 1 month, 6 month
Schwarz F et al.[32]	Er:YAG laser	Dentin protector	A 3-s air blast at a distance of 2 mm from each site	Arbitrary pain scale 4 Degrees	Baseline, 1-week 2-week, 6-months

Table 4: Laser parameters of final reviewed studies

Study	Laser parameter	wavelength	Power output	Energy	frequency	Irradiation time	Energy density
Lopes AO et al. [9]	Nd:YAG laser	NR	1.5 W	100 mJ	10 HZ	15sec 4 times	83.3 Jcm-2
Flecha OD et al. [12]	GaAlAS laser	795 nm	120 mW	NR	NR	8 sec	2.88 Jcm-2
Dilsiz A et al.[10]	GaAlAS laser	808nm	100 mW	2.5 J	NR	25 sec	2 Jcm2
Vieira AHM et al.[11]	GaALAS laser	660 nm	30 mW	NR	NR	120 sec	4 Jcm2
Sicilia A et al. [30]	GaALAS laser	810nm	1.5-2.5 mW	NR	NR	1min	NR
Ipci SD et al. [31]	CO2 / Er:YAG Laser	CO2 : 10.6 µm Er:YAG 2.94 µm	CO2 :1w Er:YAG : 60 mJ	NR	CO2 :NR Er:YAG : 30 Hz	CO2 : 10 sec Er:YAG : 10 sec	NR
Schwarz F et al.[32]	Er:YAG laser	NR	NR	80 mJ	3HZ	2min	NR

Table 5: Studies having high risk of bias

Improper Concealment	1 Study	Dilsiz A et al
Improper blinding	1 Study	Lopes AO et al
Improper Concealment and Improper blinding	2 Studies	Ipci SD et al. Schwarz et al

Discussion

Numerous agents have been used in the management of dentinal hypersensitivity termed as desensitizing agents. Grossman suggested a number of requirements for these agents: Therapy for dentinal hypersensitivity should be non-irritant to the pulp, relatively painless on application, easily carried out, rapid in action, effective for long period, and without staining effects. These agents include desensitizing toothpastes and gels containing salts of potassium, strontium, oxalates and fluorides, various varnishes, restorative materials, gels, iontophoresis, lasers, etc. Most of these agents were tried and tested but they have the disadvantage of delayed action and multiple applications. None of them has provided a long term relief. It has been shown in various studies that lasers can be used in the effective management of DH[14].

Numerous studies had been reported the effectiveness of laser therapy for treating dentine hypersensitivity[9,12,14,30,31]. Till today the acceptance of this technology by clinicians is still limited, not only because of its low cost-effectiveness and its unclear mechanism of action, but also the potential thermal effects may induce thermal damage to temperature-sensitive pulpal tissues[33]. Holland et al. suggested that a randomized, blinded and controlled trial was the gold standard for determining efficacy[34]. Therefore, it is necessary to provide evidence-based medicine of laser therapy in the treatment of dentine hypersensitivity.

This systematic review was designed to compare the effectiveness of laser therapy with that of topical desensitising agents in the treatment of dentine hypersensitivity. A mean duration of 8 weeks has been recommended for dentinal hypersensitivity studies, which is an average time taken by the desensitizing agent to reach its peak action. So in this study we included Studies with a mean duration of 8 weeks[14].

In this systematic review, seven trials met the rigorous inclusion criteria. Four types of lasers were involved in these studies, including Nd:YAG laser, GaALAs laser, CO2 laser and Er:YAG laser.

One study was reported on the clinical effect of Nd:YAG laser. In this study Lopes AO et al[9] concluded that association of Nd:YAG and Gluma desensitizer is an effective treatment strategy that has immediate and long lasting effects. Nd:YAG laser had been reported to be successful in treating dentine hypersensitivity and was probably because of its thermal effect leading to the occlusion of dentinal tubules as well as the potential pulpal analgesia[35]. But in a study conducted by Lier BB et al it was concluded that the effect of treatment of hypersensitive teeth with Nd:YAG laser is not different from placebo and this observed effects seem to last for at least 16weeks[26].

The desensitising effectiveness of Er:YAG lasers had been demonstrated in two trials[31,32]. Schwarz *et al* [32]concluded that Er:YAG lasers desensitising efficacy was more durable

than Dentin Protector that maintained even 6 months following the initial irradiation. Ipci et al[31] concluded that Er:YAG lasers had promising potential in treating dentine hypersensitivity. The mechanism of action of Er:YAG laser treatment for hypersensitivity remains unclear, its thermomechanical ablation mechanism and its high absorption by water may lead to a decrease in dentinal fluid movements by evaporating the superficial layers of dentinal fluid and it also acts by effecting the pulpal nerves. Furthermore, the potential anti-bacterial characteristic may be also contributed to the desensitising effects [27, 31].

The desensitising effectiveness of CO_2 lasers had been demonstrated in one trial. Ipci et al[31] demonstrated that CO2 lasers have promising potential for desensitizing hypersensitive teeth and stated that the combination of lasers with NaF gel did not show greater efficacy. The mechanism of action of CO_2 laser for the treatment for hypersensitivity is due to the melted areas around the exposed dentinal tubules resulted in smaller tubule orifices, and a significantly greater percentage of tubular occlusion[36].

GaALAs laser's desensitising efficacy was demonstrated in four trials. Flecha OD *et al* [12] concluded that cyanoacrylate glue is as effective as GaALAS laser. Dilsiz A *et al*[10] *concluded* that GaALAS laser combined with desensitising tooth paste had a significantly greater effect for treating dentin hypersensitivity. Vieira *et al*[11] concluded that there was no significant difference in the desensitising effects of a GaAlAs laser and a 3% potassium oxalate gel. One high-quality trial conducted by Sicilia *et al*[30] conclude that GaALAS laser had a significantly greater immediate response for treating dentin hypersensitivity. The effect had become obvious at 15 min, and it remained stable until 2 months. In conclusion, this study confirmed that GaALAS laser brought about rapid reduction and long-term duration of desensitising effect. The mechanism of GaALAs laser on hypersensitivity was different from other types of lasers. This type of low output power lasers mediate an analgesic effect related to depressed nerve transmission. According to experiments using the diode laser at 830 nm, this effect is caused by blocking the depolarization of C-fiber afferents. They cause the dentin-pulp complex to respond to the irradiation with the obliteration of the dentinal tubules by means of a specific biological mechanism. The laser interaction with the dental pulp causes a photo bio-modulating effect, increasing the cellular metabolic activity of the odontoblasts and obliterating the dentinal tubules with the intensification of tertiary dentin production[15].

Although this systematic review indicates a slight clinical advantage over topical desensitizing agents, clinicians must do a comprehensive evaluation regarding case selection and cost effectiveness of lasers before choosing them as treatment option for dentinal hypersensitivity. In addition still there is a need to get high quality evidence. Further studies are required to adopt standard study procedures like adequate sample size, randomization and blinding

Conclusion

With the constraints of limited available literature lasers alone or in combination with topical desensitising agents showed promising results than topical desensitising agent alone and this desensitizing efficacy of lasers was immediate and long lasting.

Scope for future studies

As both of the quantity and quality of the literature are limited, the above conclusions need to be verified by rigorously designed, randomized, controlled clinical trials that involve a significant number of subjects

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