THE EFFECTIVENESS OF LASERS IN THE DENTINE HYPERSENSITIVITY TREATMENT

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ABSTRACT

Introduction: Dentine hypersensitivity is a common clinical symptom in dental practice.

It is defined as a specific acute, sharp pain arising from the exposed dentine, most commonly in response to thermal, tactile, chemical and osmotic stimuli which cannot be qualified as any other type of dental pathology. The therapy uses various impregnating agents, toothpaste, gels, solutions and laser therapy.

This review aimed to compare the effectiveness of laser application in resolving dentine hypersensitivity among different desensitizing treatments.

Material and methods: the research was done using PubMed and Google Scholar search engines. The keywords were: laser therapy and dentinal hypersensitivity. Selected articles are written from 2009 through 2019. The articles were divided into three groups: dentinal hypersensitivity after bleaching, after periodontology treatment and unknown etiology. Inclusive criteria were: in all three categories we have works showing results of dentine sensitivity treatment using laser.

New technologies in dentistry, as well as more demanding patients, have brought to an application of new treatment methods in order to improve the quality of our patient's life.

Conclusion: Laser therapy has been proven effective in dentine hypersensitivity treatment of any etiology, immediately after treatment and on the long terms, concerning some dentine coatings providing short-term results. The best therapeutic effect is achieved with the combination of laser with some dentine coatings.

Keywords: laser therapy, dentinal hypersensitivity.

Introduction

"Dentine hypersensitivity is characterized by short and sharp pain occurring in the exposed dentine as a response to thermal, chemical, tactile and osmotic stimuli which cannot be attributed to any other defect in teeth or pathology". [1, 2, 3]

Although sensitivity can appear in any part of the tooth, it is most common to be in the cervical parts of the tooth on the vestibular side and on the surface of the root. [4]

Dentine hypersensitivity is a very common clinical symptom increasing in prevalence over the past few years. [5, 6, 7, 8]

The frequency of the occurrence is from 3 – 57% [4, 9, 10]. When it comes to patients suffering from periodontal disease, the occurrence of dentine hypersensitivity is, then, more common, 72 – 98% . [4, 11] Dentine hypersensitivity most often occurs between the ages of 20 to 50, and it is more common in females than in males. [4, 12]

Different factors can lead to dentine hypersensitivity. Parafunctional habits, toothbrush abrasion and microfractures caused by heavy eccentric occlusal forces belong to predicting factors. [8, 13, 14] Gingival recessions combined with abrasions, dehiscence, fenestrations, frenulum stretch, orthodontic movement, as well as gingival recessions, combined with tooth brushing methods and periodontal diseases, belong to the risk factors for the occurrence of dentine hypersensitivity. [8, 15, 16]

Many agents and approaches to treatment have been used in the prevention and treatment of dentine hypersensitivity. Professionally, the most used agents are fluorides which can reduce hypersensitivity with peripheral occlusion of the tubules and the reduction of fluid movement to/from the pulp. Patients can be prescribed with desensitization pastes with higher fluoride concentration (5000 ppm). Apart from fluoride for tubule occlusion, a large number of pastes also contain potassium salts being known to penetrate deep into dentine tubules and spread along with them to deactivate interdental nerve activity leading to the reduction of the action potential.

Additionally, we should list preparations based on HEMA/glutaraldehyde which occlude the tubules and/or stimulate protein sedimentation within them. After the application of astringents proteins can coagulate not entering the tubules, [17, 18, 19]

In clinical practice, adhesives utilizing polymerization are often used to create a protective barrier within the area of exposed dentine. Their main disadvantage is in the fact that a patient removes them by brushing only a few days after. The restorative procedure with liquid composite is taken into consideration when it comes to major damage, but also with combo glass depending on the size of the defect.

Surgical corrections are indicated in the case when a gingival recession is a cause, and they include covering the root with one of the methods of mucogingival periodontal surgery. Covering the root is not 100% successful in suppressing dentine hypersensitivity so it is often necessary to treat the "remaining" hypersensitivity with one of the listed therapy procedures.

Laser was firstly used in the treatment of dentine hypersensitivity by Matsumoto et al in 1985. Since then, many studies have been published examining the effectiveness of laser therapy used in the treatment of dentine hypersensitivity. [20, 21]

It was proven that the combination of laser therapy application and desensitizing agents provides the best results in the treatment of dentine hypersensitivity. [22]

This paper aims to show the results of dentine hypersensitivity treatment with the use of laser alone or in combination with various impregnating agents.

Material and methods

Computer research was used to examine articles published within two databases (PubMed and Google Scholar). Different combinations of keywords were used while researching: laser therapy and dentine hypersensitivity. Papers were published in the period from 2009 to 2019.

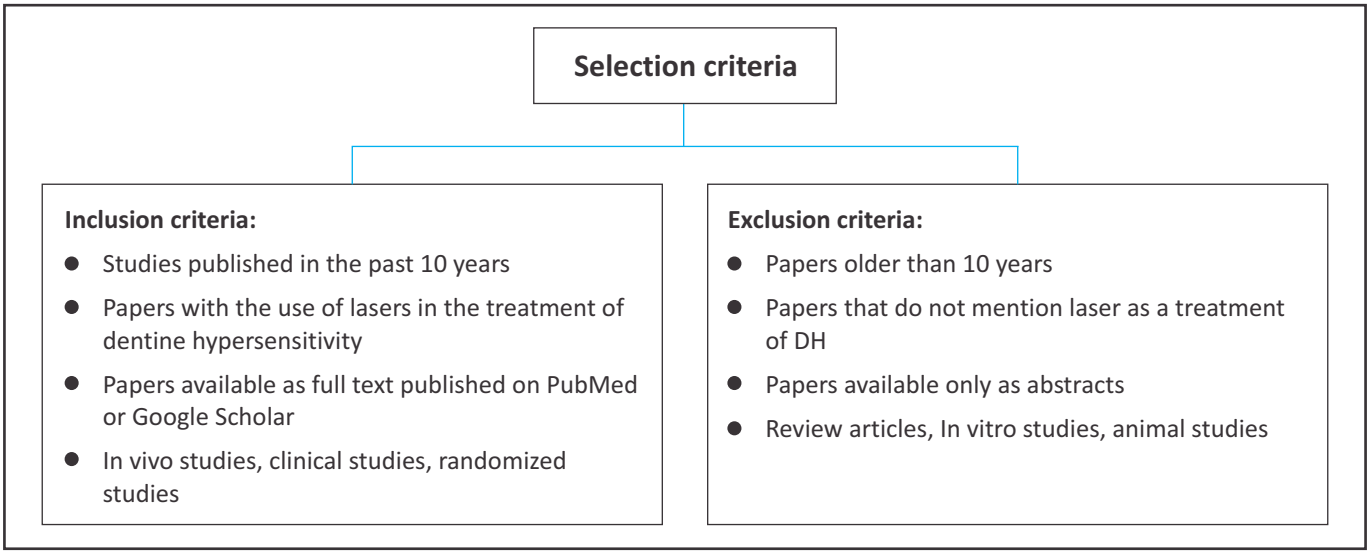

Image 1. Selection criteria

Papers were grouped into three categories: treatment of dentine hypersensitivity after teeth bleaching, after periodontal therapy and treatment of dentine hypersensitivity of unknown etiology.

The inclusion criteria and exclusion criteria based on which papers were selected are shown in schema (**Image 1**).

Results

Of 209 examined papers, 41 papers were selected according to the inclusion criteria, and 168 papers were eliminated according to the exclusion criteria (**Table 1**). Of those papers, 11 are from the group treatment of dentine hypersensitivity as a result of periodontal therapy, 6 papers are from the group treatment of dentine hypersensitivity as a result of teeth bleaching, and 24 papers are from the group treatment of dentine hypersensitivity of unknown etiology (**Table 2**).

Papers are grouped in tables and represented according to authors, year of publication, number of patients included in the study, treatment and specifications, number of visits, scales that were used for pain objectification and results (**Table 3, 4, 5**).

Database	PubMed	Google Scholar	Total
Total of examined papers	126	83	209
Papers older than 10 years	67	32	99
Papers that do not use laser	10	8	18
Review articles	11	12	23
In vitro studies	8	7	15
Only abstracts	5	8	13
Included papers	26	15	41

Table 1.
Overview of bibliography and paper selection

	Unknown etiologies	Result of periodontal therapy	Result of teeth bleaching	Total
Dentine sensitivity	24	11	6	41

Table 2.
Dentine sensitivity by categories

Author, year, reference number	Number of patients	Treatment and specifications	Number of visits	Pain objectification scale	Results
1. Chuan-Hang Yu, Yu-Chao Chang, 2013 (23)	20 patients	Er: YAG laser, 60mJ/pulse, a repetition rate of 2Hz, with water irrigation.	1	VAS (0-100mm)	Er: YAG laser desensitizing treatment can effectively reduce hypersensitivity of cervically exposed dentine.
2. Maura et al. 2019 (24)	60 patients	I. Desensitise KF 2% FGM Potassium nitrate and sodium fluoride 2% II. Clinpro XT Varnish 3M ESPE III. GaAlAs laser, 808nm	4	VAS (0-10)	A significant reduction of dentine hypersensitivity has been achieved in all three groups. There was no statistically significant difference in the reduction of dentine hypersensitivity between these three groups.
3. Yilmaz HG, Bayindir H, 2014 (25)	20 patients (60 teeth)	I.Er,Cr: YSGG laser at 0,25W II. Er, Cr: YSGG laser at 0,5W III. Placebo	1	VAS (0-10)	Both groups with the laser have shown an effective reduction of dentine hypersensitivity concerning the placebo group. However, the group treated with the 0.5 W power laser has shown better results.
4. Aghanashini et al, 2018 (26)	17 patients (40 teeth)	I. Diode laser 980nm wavelength, 320 nm core diameter optic fiber, 0,5 W output power, the 30s II. Fluor protector varnish (by Ivoclar Vivadent)	1	VAS (0-10)	Both diode laser and fluor protectors have proven effective in the treatment of dentine hypersensitivity. Diode laser, however, achieves long-term protection.
5. Umberto et al, 2012 (27)	10 patients (115 teeth)	I. 1,25%NaF, 60s II. Diode Laser GaAlAs (980nm) III. NaF gel at diode laser, the same parameters, the 60s	3	NRS (0-10)	The diode laser has proven effective in the treatment of dentine hypersensitivity, either alone, or when it is used with NaF gel, concerning group I.
6. Baba Z et al, 2018 (28)	12 patients (54 teeth)	I. Nd: YAG laser II. MI-varnish™ treatment layer	4	VAS (0-100)	Evident reduction of dentine hypersensitivity in both groups. Statistically, there is no significant difference between the two treated groups.
7. Dantas EM, Amorim FK, Nobrega FJ, Dantas PM, 2016 (29)	86 teeth	I. Fluoride varnish II. Diode laser (GaAlAs 980nm)	4	VAS (0-10)	Even though both groups displayed good results in the treatment of dentine hypersensitivity, in a short time, however, fluoride was more effective.
8. Suri I, Singh P, Shakir QJ, Shetty A, Bapat R, Thakur R 2016 (30)	30 patients (20 teeth)	I. 5% NaF II. Diode Laser (980nm GaAlAs) III. Group I + Group II IV. Placebo	1	VAS (0-10)	Although reduction of dentine hypersensitivity was achieved in all groups, 5% NaF in combination with diode laser has shown the best results.
9. Yaghini J, Mogharehabed A, Safavi N, 2015 (31)	40 patients	I. Laser toothbrush II. Non-laser toothbrush	4	VAS (0-10)	Even though both groups have shown a reduction of dentine hypersensitivity, the first group has had better results.
10. Mogharehabed A, Khatami H, Abdi Zamharir Z, et al, 2012 (32)	9 patients (60 teeth)	I. Placebo II. 5% sodium fluoride varnish III. Nd: YAG laser(1W,20Hz,120s) IV. Group II + Group III	1	VAS (0-10)	The effectiveness of 5% sodium fluoride and a laser in the treatment of dentine hypersensitivity has proven far more effective than in the placebo group. The group that was treated with the combination of NaF and laser has shown the best results.
11. Machado et al. 2019 (33)	1 patient (2 teeth)	I. Nd: YAG laser, 1060nm II. Glumma desensitizer	1	VAS (0-10)	The effectiveness has been proven in both groups equally.
12. Praveen R, Thakur S, Kirthiga M, Narmatha M 2018 (34)	23 patients (50 teeth)	I. Glutaraldehyde-based topical desensitizing agent II. Low-level diode laser (904 nm), GaAlAs	3	VAS (0-10)	A significant reduction of pain has been proven in both groups after a three-month evaluation period.

Author, year, reference number	Number of patients	Treatment and specifications	Number of visits	Pain objectification scale	Results
13. Ozlem K, Esad GM, Ayse A, Aslihan U 2019 (35)	17 patients (100 teeth)	I. Glumma desensitizer (GCA), II. Nd: YAG laser III. I+II IV: Er, Cr: YSGG laser V. IV+I	5	VAS (0-10)	Dentine hypersensitivity has been significantly reduced in all groups. Er, Cr: YSGG laser with or without GCA has proven the most effective in the treatment of dentine hypersensitivity.
14. Bal MV, Keskiner I, Sazer U, Acikel C, Saygun I 2015 (36)	21 patients (156 teeth)	I. Placebo II. Low-level laser (685nm) III. Desensitizing paste (DP) 8% arginine-calcium carbonate IV. Laser followed by DP (LLL+DP) V. DP followed by laser (DP+LLL)	1	VAS (0-10)	The application of either LLL or DP has proven effective in the treatment of dentine hypersensitivity. However, their combination has not provided an improved effect.
15. Moosavi H, Maleknejad F, Sharifi M, 2015 (37)	31 patients (62 teeth)	I. Low-power red laser (630nm) II. Placebo	1	VAS (0-10)	A significantly better reduction of dentine hypersensitivity in the group treated with the laser than in the placebo group.
16. Genovesi A, Sachero E, Lorenzi C 2010 (38)	15 patients	I. Er:YAG(2940nm)+fluoride gel II. Placebo III. Er: YAG lasers IV. Fluoride gel+placebo	1	VAS (0-10)	A statistically significant difference between groups I and II has been proven. There was no statistically significant difference between groups III and IV. Er: YAG has proven the most effective in the treatment of dentine hypersensitivity.
17. Mobadder et al, 2019 (39)	184 patients	Diode laser (980nm)	1	VAS (0-10)	Postoperative pain has reduced significantly. So, this treatment can be considered safe with a long-term effect.
18. Soares ML, Porciúncula GB, Lucena MI et al, 2016 (40)	23 patients (89 teeth)	I. Placebo II. 2% neutral fluoride gel ,60s III. Nd: YAG laser (1, 10Hz, the 60s) IV. GaAlAs laser (40mW,4J/cm², the 60s)	1	VAS (0-10)	All treatments have momentarily alleviated dentine hypersensitivity, but the results achieved in the group with a laser have shown significantly better results.
19. Lopes AO, Aranha AC 2013. (41)	24 patients (33 teeth)	I. Glumma II. Nd: YAG Laser III. I+II	1	VAS (0-10)	All treatments have proven effective in the treatment of dentine hypersensitivity, but the combination of laser and Glumma has given better long-term results.
20. Lopes AO, Eduardo C de P, Aranha AC 2015 (42)	27 patients (55 teeth)	I. Glumma II. Low-power laser (810nm) III. Low-power laser (810nm) IV. I+II V. I+III	1 1 3 3 3	VAS (0-10)	All groups have shown a reduction of dentine hypersensitivity. The Glumma group had a momentary alleviation, and the combination of glumma with the lasers has given even better results.
21. Gojkov-Vukelic et al, 2016 (4)	18 patients	Low-power diode laser (980nm)	3	VAS (0-10)	Significant effectiveness of laser has been proven in all patients.
22. Hashim et al, 2014 (43)	5 patients (14 teeth)	I. Diode laser (810nm) the 30s II. Diode laser (810nm) 1min	2	VAS (0-10)	The diode laser is effective in the treatment of dentine hypersensitivity.
23. Aranha AC, Pimenta LA, Marchi GM 2009 (44)	101 teeth	I. Glumma Desensitizer II. Seal & Protect (SP) III. Oxa-gel (OG) IV. Fluoride V. Low-intensity laser LILT (660nm)	1 1 1 1 3	VAS (0-10)	After 6 months all treatments have proven effective in the treatment of dentine hypersensitivity, without statistically significant difference between them.
24. Bilichodmath R, Kumar RV, Bilichodmath S, Sameera U 2018 (45)	8 patients (200 teeth)	I. 0.4% stannous fluoride gel II.0.4% stannous fluoride+ diode laser (810nm, non-contact mode) III. Laser only IV. 0.4% stannous fluoride + diode laser (contact mode)	1	VAS (0-10)	All groups have shown a significant reduction of dentine hypersensitivity. however, groups treated with the combination of 0.4% SnF2 and diode laser (both contact and non-contact mode) have shown better results concerning the groups treated with 0.4% SnF2 and laser separately.

Table 3. Presentation of 24 cases of dentine hypersensitivity included in the study, as a result of unknown etiology

Author, year, reference number	Number of patients	Treatment and specifications	Number of visits	Pain objectification scale	Results
1. Dilsiz A, Aydin T, Emrem G 2010 (46)	13 patients (52 teeth)	I. GaAlAs Diode laser (808nm) + desensitizer toothpaste II. Desensitizer toothpaste	3	VAS (0-10)	GaAlAs diode laser + desensitizer toothpaste has proven a bigger degree of desensitization than the control group.
2. George VT et al, 2016 (47)	20 patients	I. Ga-Al-As Diode laser (810 nm) II. Fluoride containing toothpaste	1	VRS (0-10)	After 30 days, effectiveness in the treatment of dentine hypersensitivity was significantly better in the group that was treated with a laser.
3. Sicilia A, Cuesta-Frechoso S, Suarez A, 2009 (48)	45 patients	I. Diode laser (810nm) + placebo gel II. Placebo laser + 10% potassium nitrate bio adhesive gel III. Placebo laser + placebo gel	1	VRS (0-10)	Diode laser in combination with 10% potassium nitrate bio adhesive gel has proven effectiveness in the treatment of dentine hypersensitivity. Diode laser alone has proven effective concerning the placebo effect.
4. Guney Yilmaz H, Kurtulmus-Yilmaz S, 2011 (49)	48 patients (244 teeth)	I. GaAlAs laser (810nm, 500mW, 60s, 8,5J/cm²) II. Placebo laser III. NaF varnish IV. Placebo NaF varnish	1	VAS (0-10)	Both GaAlAs laser and NaF have proven effective in the treatment of dentine hypersensitivity concerning placebo groups, without any significant statistical difference between them.
5. García-Delaney C, Abad-Sánchez D, Arnabat 2017 (50)	30 patients (120 teeth)	I. Laser (660nm) II. No laser activation	1	VAS (0-100)	A significant statistical difference has been proven in the sensitivity between groups with laser activation and no laser activation, and the laser in the first group has proven significantly more effective.
6. Pesevska S, Nakova M, Ivanovski K, 2010 (51)	30 teeth	I. Low-Level Diode laser (630-670nm) II. Topical Fluoride Varnish (Fluor Protector)	3	VRS (0-10)	The reduction of dentine hypersensitivity was significantly better in the group with a laser concerning fluor protector.
7. Raut CP, Sethi KS, Kohale B, Mamajiwala A, 2018 (52)	30 patients (99 teeth)	I. Laser without activation II. Laser AlGaInAs (940nm) +0,4%SnF2 III. Only laser	4	VRS (0-10)	Only laser or in combination with 0,4%SnF2 is effective in the treatment of dentine hypersensitivity. A significant reduction of dentine hypersensitivity was in groups II and III concerning the control group I, but there was no significant difference in the reduction of dentine hypersensitivity between groups II and III.
8. Clavijo EMA, Clavijo VRG 2009 (53)	28 teeth	I. PO 3%/Baseline; potassium oxalate 3% (OxaGel®, Kota) II. Laser/Baseline; Low-level diode laser	1	VAS (0-10)	It has been proven the both PO and laser are effective in the reduction of dentine hypersensitivity. However, the laser still provided better results.
9. Doshi S, Jain S, Hegde R, 2014 (54)	30 patients	I. GaAlAs laser (200-660nm) II. Placebo (laser without activation)	1	VRS, VAS (0-10)	A statistically more significant reduction of dentine hypersensitivity has been achieved in the first group.
10. Tabibdzadeh et al, 2018 (55)	8 patients (62 teeth)	Diode laser (980nm)	3	VAS (0-10)	Statistically significant results have been achieved after the treatment concerning the VAS scale.
11. Etemadi A, Sadeghi M, Dadjou MH 2011 (56)	40 patients	I. Low-level laser (660nm) II. Placebo (non-activated laser)	3	VAS (0-10)	Dentine hypersensitivity in the group with a laser has been reduced after the first treatment, which speaks in favour of the effectiveness of the laser in the treatment of dentine hypersensitivity.

Table 4. Presentation of 11 cases of dentine hypersensitivity, as a result of periodontal therapy

Author, year, reference number	Number of patients	Treatment and specifications	Number of visits	Pain objectification scale	Results
1. Kossatz S, Dalanhol AP, Cunha T, 2011 (57)	30 patients	I. Light-activated (470nm) II. Laser diodes (830nm) III. Non-activated	2	VAS (0-4)	Treatment in group I has proven most effective.
2. Moosavi H, Arjmand N, 2016 (58)	66 patients	I. Placebo II. LLLRL Diode laser (660nm) III. LLIL Diode laser (810)	1	VAS (0-10)	810 nm LLIL was more effective in the treatment of dentine hypersensitivity than 660nm laser. Both lasers have shown a significant pain reduction concerning the placebo group.
3. De Al meida Farhat et al, 2014 (59)	16 patients	I. LED II. LED-laser (300Mw/CCM²)	2	VRS (0-10)	The LED laser has proven ineffective in the treatment of dentine hypersensitivity after teeth bleaching.
4. De Alencar CM, De Paula B, Lamartine JNA 2018 (60)	25 patients	I. GPLACEBO: Glaser with no laser activation (placebo effect), after the teeth bleaching treatment, 5000ppm fluor preparation applied after 5 min II. GLASER-LLLT Glaser (808nm)	4	VAS (0-10)	Significant pain reduction after teeth bleaching treatment in the group treated with Glaser concerning Gplacebo.
5. de Almeida LC, Costa CA, Riehl H, dos Santos PH 2012 (61)	40 patients	I. Home bleaching with 10% carbamide peroxide, 4h/d II. 35% hydrogen peroxide, 10 min III. Quartz-tungsten-halogen light irradiation, 10mins IV. LED/laser light irradiation, 10min	3	VAS (0-10)	All of the techniques have led to sensitivity, only the Laser light irradiation technique has had a minimal sensitivity as a consequence, which speaks in favour of the fact that the laser as a treatment of choice in the therapy of dentine hypersensitivity reduction can be used for the process of teeth bleaching as well.
6. Martin J, Eduardo F, Valeria B, Andrea W, 2013, (62)	88 patients	I. H2O2 15% + TiO2 + light II. H2O2 35% + light III. H2O2 35%	3	VAS (0-10)	The sensitivity after treatment was the same in all three groups immediately after the treatment.

Table 5. Presentation of 6 cases of dentine hypersensitivity, as a result of teeth, bleaching

Discussion

With this review paper we tried to consolidate the results of published papers that examined the effectiveness of lasers in the treatment of dentine hypersensitivity, as a result of periodontal therapy, dentine hypersensitivity as a result of teeth bleaching and as a result of unknown etiology. The majority of authors addressed the treatment of dentine hypersensitivity of unknown etiology.

Treatments of used choice were Er:YAG laser of various wave lengths [25, 27, 37, 40, 41]; desensitisation agent KF2% FGMO; Potassium nitrate and sodium fluoride 2% [26, 34]; Glass ionomers – ClinPro XT Varnish 26; Photo laser, low power diode laser GaA1As 808nm [26] and 940nm [36, 49, 50, 55] and 980nm [29, 31, 42, 45]; Fluor irrigation [31, 54]; Diode laser 980nm [28, 32, 48, 58]; Fluor protect [28]; 1,25% NaF [29, 52]; 5% NaF [29, 32]; NaF gel in combination with diode laser 980nm [29, 32]; Nd:YAG 1060nm [30, 34, 35, 37, 42, 43]; dentine varnish [30]; laser toothbrushes [33]; combination of Nd:YAG and 5% sodium fluoride varnish [34]; Glumma [35, 37, 43, 44, 47]; Glutaraldehyde topical gel [36]; combination Er:YAG plus Glumma [37]; low power laser at wave lengths 685nm [38], 630 [39], 660nm [47, 53, 54, 57, 59, 61]; 2% fluor gel [42, 47]; Nd:YAG laser plus Glumma [43]; diode laser 810nm [46, 44, 51, 52, 61]; Seal protect [47]; Oxa gel [47]; 0,4% SnF2 [48]; 0,4% SnF2 plus diode laser 980nm [48]; toothpaste for sensitive teeth [49, 50].

Treatment of dentine hypersensitivity of unknown etiology

In the treatment of dentine hypersensitivity of unknown etiology, after examination and analysis of 24 papers, all authors mention that there was a statistically significant difference in the reduction of pain in teeth treated with some choice of the treatments concerning the teeth or groups that were treated by a placebo.

In the papers using only laser, a significant reduction of dentine hypersensitivity was achieved after the evaluation period. However, high power lasers provided better results in a shorter period. That difference was lost on long-term basis. In the papers using teeth laser and others using some of desensitizing agents, either varnish, coating or gels, immediately after intervention there was no statistically significant difference between laser and various desensitizing agents, but on the long-term basis after the period of evaluation teeth treated with laser still showed a positive therapeutic effect, whereas it disappeared in teeth treated with some of desensitizing agents.

The best therapeutic effect immediately after, as well as in control examinations period, proved to be a combination of a laser and some dentine coating in the treatment of dentine hypersensitivity.

Treatment of dentine hypersensitivity as a result of periodontal therapy

In the treatment of dentine hypersensitivity as a result of periodontal therapy, after examining and analysing 11 papers, it can be concluded that results are statistically significantly better in teeth treated with laser.

Treatment of dentine hypersensitivity as a result of teeth bleaching

In the treatment of dentine hypersensitivity as a result of teeth bleaching, after examining and analysing 6 papers, in all of them, treated with laser and treated with fluorine, there was a reduction of dentine hypersensitivity concerning the placebo groups. Better and long-term results have been achieved in teeth treated with laser. This speaks in favour of the effectiveness of laser in the treatment of dentine hypersensitivity and this etiology.

Both diode lasers and high-power lasers were used in the papers. Undefined was which of those two groups of lasers is more effective, and this could be the subject of some further research.

Conclusion

Laser therapy has been proven effective in the treatment of dentine hypersensitivity of any etiology, immediately after treatment as well as on long-term basis, concerning some dentine coatings providing short-term results. The best therapeutic effect is achieved with the combination of laser with some dentine coatings.

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