 REVIEW ARTICLE

Treatment of dentin hypersensitivity with laser: systematic review

Tratamento da hipersensibilidade dentinária com laser: revisão sistemática

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ABSTRACT

BACKGROUND AND OBJECTIVES: Dentin hypersensitivity is an exacerbated response to a stimulus, causing acute and short-term pain. Over the years, several treatments for dentin hypersensitivity have emerged, including laser therapy. Thus, the objective of this work was to carry out a review about the available devices and the existing procedures of laser therapy in the treatment of dentin hypersensitivity.
CONTENTS: A systematic review of studies published from 2016 to 2020 was carried out through bibliographic search in the electronic databases Pubmed and the *Biblioteca Virtual em Saúde* – (Virtual Health Library), using the following descriptors: "Laser" And "Dentin Hypersensitivity". Of the total of 51 articles found in the search, 14 were eligible for a review. There was an evaluation of the possible risks of bias for each of the articles included.
CONCLUSION: As a result, a variety of devices available on the market and different protocols that prove to be effective for the treatment of dentin hypersensitivity when compared to the initial pain situation (baseline) were found. When laser treatment is compared with other existing therapies, it's not so clear which would be the most effective, due to the wide variety of study methodologies. However, an association of therapies that act in the two mechanisms of pain interception (neural and blocker) seems to be an appropriate conduct in the control of dentin hypersensitivity, and this combination can happen through physical methods (High and low intensity laser) and chemical (neural and blocker agents).

Keywords: Dentin desensitizing agents, Dentin sensitivity, Lasers.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A hipersensibilidade dentinária é uma resposta exacerbada a um estímulo, causando dor aguda e de curta duração. Ao longo dos anos, diversos tratamentos para a hipersensibilidade dentinária têm surgido, incluindo a laserterapia. O objetivo foi realizar uma revisão acerca dos aparelhos disponíveis e dos protocolos do tratamento da hipersensibilidade dentinária com laser.
CONTEÚDO: Foi realizada uma revisão sistemática de estudos publicados de 2016 a 2020, por meio da busca bibliográfica nas bases de dados eletrônicos Pubmed e da Biblioteca Virtual em Saúde, utilizando os seguintes descritores: "Laser" e "Dentin Hypersensitivity". Do total de 51 artigos encontrados na busca, 14 foram elegíveis para a revisão. Foram analisados os possíveis riscos de viés para cada um dos artigos incluídos.
CONCLUSÃO: Diante da variedade de protocolos existentes quanto ao uso do laser, tanto de alta (LAP) quanto de baixa potência (LBP), na diminuição do desconforto causado pela HD, pode-se concluir de maneira geral que o emprego do laser tem se mostrado efetivo na grande maioria dos protocolos utilizados nos estudos, porém, ainda não é claro qual seria a estratégia mais efetiva a longo prazo. A associação de intervenções que atuem nos dois mecanismos de interceptação da dor (neural e obliterador) parece ser uma conduta apropriada no controle da HD, podendo essa combinação acontecer por meio de métodos físicos (laser de alta e baixa intensidade) e químicos (agentes neurais e obliteradores). A terapia mais adequada para HD depende de criteriosa anamnese e exame físico, enquanto o sucesso do tratamento dependerá da remoção dos fatores causais e de um plano de tratamento feito individualmente para cada paciente.

Descritores: Dessensibilizantes dentinários, Lasers, Sensibilidade da dentina.

INTRODUCTION

Light amplification by stimulated emission of radiation (LASER) is a powerful source of light, which allows numerous applications to be employed in various fields of health, including dentistry[1]. The use of photobiomodulation has resulted in great interest in various scientific fields due to the significant number of positive results achieved with the treatment[2]. The

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use of lasers as a method to treat dentin hypersensitivity (DH) dates back to 1980[3]. Compared to other treatments, lasers are advantageous because they are simple to operate, safe, reliable, and have a rapid analgesic effect[4-6], being able to modulate tissue responses and reduce pain[7].
DH is a common complaint in adult patients in dental clinics[8] and is often characterized as an exacerbated response to a chemical, thermal, tactile, evaporative or osmotic sensory stimulus, leading to fluid movement within the dentinal tubules exposed to the oral environment, causing acute and short-lasting pain[9].
Lasers used in the treatment of DH can be of two different types: low power lasers (LPL), such as Helium-Neonium (He-Ne) and Aluminum Gallium Arsenide (AsGaAl), and high power lasers (HPL), such as the Neodymium Yttrium Aluminum Granate (Nd:YAG) and carbon dioxide (CO_2) lasers[7].
High intensity lasers, such as Nd:YAG and Er:YAG lasers cause an increase in the dentin surface temperature, leading to fusion and consequent obliteration of dentinal tubules[10,11]. Low intensity lasers, on the other hand, do not emit heat and present a low wavelength that stimulates the normality of cellular functions, acting in biostimulation due to the increased production of mitochondrial ATP, generating an increase in the excitability threshold of the free nerve endings that will result in actions with analgesic effect[12-14].
Despite the benefits and the frequent expansion of laser therapy in several dental fields, many professionals don't use it because they are unaware of the equipment, the interaction of the laser with the tissues, the therapeutic actions, and the appropriate doses that should be applied in several clinical conditions, missing the opportunity to improve their treatments[14].
Thus, the objective of this study was to perform a systematic review of the literature on the effectiveness of different laser application protocols in the treatment of DH.

CONTENTS

A systematic review of the literature with the following central question: "what is the effectiveness of different protocols for the use of laser in the treatment of DH"? In order to conduct the methodology, the PICOS (**P**opulation, **I**ntervention, **C**omparator, **O**utcome and **S**tudy) strategy was adopted. The following data was defined: population - patients with DH; intervention - different laser therapies; comparator – neural and obliterator desensitizing agents and placebo group; outcome - reduction of DH by stimulation and type of study - randomized clinical trials.

Search strategy

The publications selected for this review were collected from Pubmed and the *Biblioteca Virtual em Saúde* (BVS - Virtual Health Library) from 2016 to 2020, containing the following descriptors in combination with the Boolean operator "and": "Laser" and "Dentin Hypersensitivity".

Inclusion of studies

The predetermined inclusion criteria for the articles were randomized clinical trial studies, in Portuguese and English, addressing the topic in relation to available laser therapy devices and existing protocols for the treatment of DH.
After the first stage of the search, duplicate articles were removed and then the titles, abstracts, and full texts of all the articles found were read. All articles that were not related to the theme in the title and/or abstract were excluded, such as the articles that dealt with laser therapy associated with tooth whitening and antimicrobial photodynamic therapy. Literature review articles, case reports and others that weren't clinical trials were also excluded.
Fifty-one publications were identified. After applying the described criteria, 14 articles were selected, read in full, and included in this review (Figure 1).

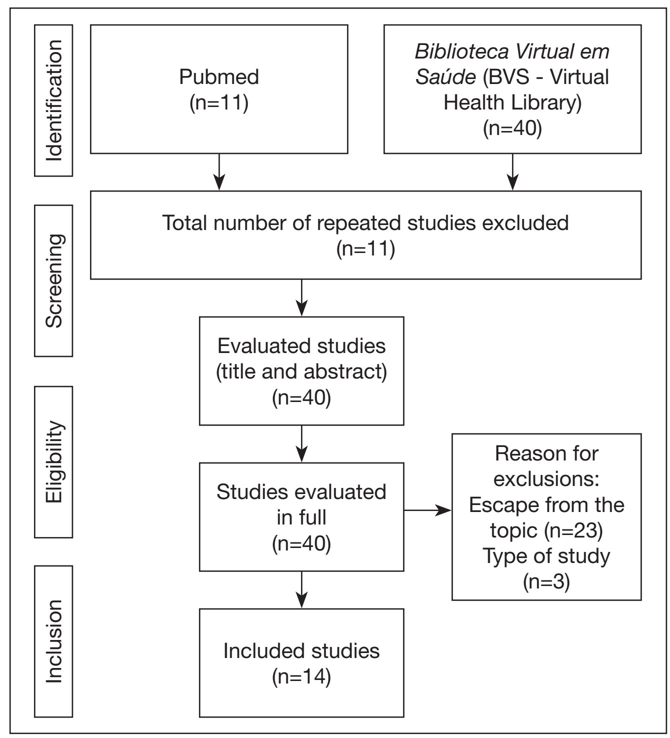

Figure 1. Flowchart of study selection

Risk of bias

Since all studies are randomized clinical trials, they were analyzed regarding the potential risk of bias based on the RoB 2.0 tool (revised tool for Risk of Bias in randomized trials)[15]. This tool allows the identification of possible methodological biases through questions about the following aspects in each study: randomization process, intervention deviations, lost data, outcome assessment, selection of reported outcomes, and overall risk. For each item, a score of low risk, uncertain risk and high risk of bias is generated.
According to the researchers' evaluation, in general, there was a low risk of bias in the evaluated studies, and some items were scored as "uncertain risk" for not presenting sufficient information for the correct understanding of the methodological process. Figure 2 shows the distribution of potential risks in relation to the evaluated items. Figure 3 shows the distribution of the bias risk analysis categories for each study.

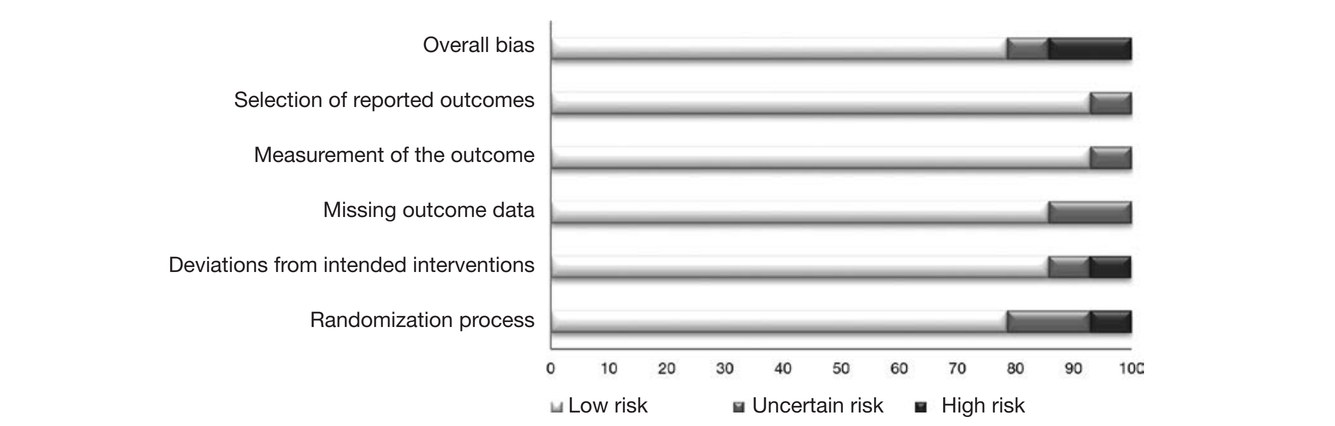

Figure 2. Risk of bias assessment for the categories of analysis in all grouped studies

	Authors	Experimental Group	Control group	Evaluation	Randomization process	Intervention deviations	Lost data	Outcome assessment	Outcome selection	Overall risk
1	Lima et al.[16]	GaAlAs and Cyanoacrylate Laser	No placebo group	OHIP-14/VAS	+	+	+	+	+	+
2	Pourshahidi et al.[11]	GaAlAs and Er,Cr:YSGG lasers	No placebo group	VAS	+	+	?	+	+	?
3	Maximiano et al.[17]	Nd:YAG laser and sodium calcium phosphosilicate paste	Placebo group	VAS	+	+	+	+	+	+
4	Ozlem et al.[18]	5 groups (Nd:YAG; Er,Cr:YSGG; Glutaraldehyde and combination)	No placebo group	Sonda Yeaple	?	−	+	+	?	−
5	Chebel et al.[19]	Nd:YAG laser/varnish with casein phosphopeptides and amorphous calcium phosphate	No placebo group	VAS	−	?	+	?	+	−
6	Narayanan et al.[20]	GaAlAs Laser/Potassium Nitrate/Combination	No placebo group	VAS	+	+	+	+	+	+
7	Lopes, de Paula Eduardo e Aranha[12]	9 groups (LPL in high and low dosages, glutaraldehyde, Nd:YAG and combination)	No placebo group	VAS	+	+	+	+	+	+
8	Osmari et al.[21]	Potassium oxalate, 5% sodium fluoride, high power diode and adhesive	No placebo group	VAS	+	+	+	+	+	+
9	Moura et al.[22]	Potassium nitrate with fluoride, ionomeric varnish and LPL	No placebo group	VAS	+	+	+	+	+	+
10	Guanipa Ortiz et al.[23]	LPL, CPP-ACPF and combination	Placebo group	VAS/DHEQ	+	+	+	+	+	+
11	Feminiano et al.[24]	Diode laser before the restorative procedure	Placebo group	VAS	+	+	+	+	+	+
12	Tabibzadeh et al.[25]	HPL and LPL combined	No placebo group	VAS	?	+	?	+	+	?
13	Praveen et al.[26]	LPL/glutaraldehyde	No placebo group	VAS	+	+	+	+	+	+
14	Soares et al.[27]	Nd:YAG, GaAlAs and 2% fluoride gel	No placebo group	VAS	+	+	+	+	+	+

+ Low risk
? Uncertain risk
− High risk

Figure 3. Risk of bias assessment for each study included in the systematic review

VAS = visual analog scale; OHIP = Oral Health Impact Profile; DHEQ = Dentine Hypersensitivity Experience Questionnaire

Table 1. Types of laser devices used in the included studies

Abbreviation	Specification
HeNe	Helium-Neonium
GaAlAs	Diode of gallium aluminum arsenide
Nd:YAG	Yttrium, aluminum, garnet doped Neodymium
Er:YAG	Erbium, aluminum, garnet doped Yttrium
Er,Cr:YSGG	Yttrium, Scandium, Granada, Gallium doped Erbium, Chromium

RESULTS

Several laser devices were identified in the studies (Table 1) with different application protocols for the treatment of DH. Results are presented in table 2, containing the following information: title of the article, author, year, objective of the study, type of laser used, protocol for treating hypersensitivity and results found.

Table 2. Studies evaluated in the review in order to identify the different protocols and efficacy of lasers in the treatment of Dentin Hypersensitivity

Authors	Objectives	Type of laser	Application protocol	Results
Lima et al.[16]	To verify changes in patients' oral health-related quality of life at 24 hours, 30, 90, and 180 days after treatment of dentin hypersensitivity (DH) with laser and cyanoacrylate.	Infrared low power laser (LPL) (GaAlAs) (Clean LineEasy Laser - *Clean Line Indústria e Comércio de Produtos Médicos e Odontológicos Ltda*, Taubaté, SP, Brazil)	The laser was used in three sessions, with 48h intervals, according to the manufacturer's recommendations. The irradiation parameters were: wavelength of 795nm and power of 120mW. The deposited energy density was 30.96J/cm² for 8 seconds, at three points around the cervical region of the tooth.	There was a reduction in the impact of DH on the quality of life of the participants after interventions with laser and cyanoacrylate. A statistically significant difference was observed only at the 24-hour post-treatment interval. At this time, cyanoacrylate performed better in reducing DH when compared with laser.
Pourshahidi et al.[11]	To compare the clinical efficacy of the diode laser (GaAlAs) and the Er, Cr: YSGG laser in the treatment of DH.	GaAlAs 940nm diode LPL (EzLase, Biolase, San Clemente, CA, USA) and Er, Cr: YSGG high-power laser (HPL) (Waterlase Biolase®, Biolase, Inc, San Clemente, CA, USA)	Lasers were irradiated on the cervical surface of the tooth, single session, using the following configuration: Diode laser: wavelength 940nm, power 0.4W, contact point area 0.8cm², time 10s, DE 2.5J/cm². In the Er, Cr:YSGG laser the following was used: wavelength 2780nm, scanning motion, 1mm blurring, 0% water and 0% air, power 0.25W, frequency 50Hz, pulse duration 140μs, spot area 600μm.	Decrease in DH was observed in both groups immediately, 1 week and 1 month after laser irradiation. Statistically significant differences in DH severity were found between the two groups only 1 month after laser application. The decrease in DH by the Er, Cr: YSGG laser was greater than that of the diode laser in this time interval.
Maximiano et al.[17]	To evaluate the effect of desensitizing treatments based on a prophylaxis paste containing 15% sodium calcium phosphosilicate (SCP) (NovaMin®) and Nd:YAG laser irradiation, on the reduction of DH after 1 month of clinical follow-up.	HPL Nd: YAG (Power Laser, Lares Research, San Clemente, CA, EUA)	The laser was used in the pulsed form, with a pulse width of 150μs and a fixed repetition rate of 10Hz. Irradiation was performed with the 400μm quartz optical fiber, perpendicular to the tooth, in contact mode. Four irradiations were performed with sweeping movements: 2 in the mesio-distal direction and 2 in the occlusal-gingival direction, for up to 15s each, with a 10s interval between each irradiation. The parameter used was 1W power, 10Hz repetition rate, 100mJ energy and 85J/cm² energy density.	There was pain reduction in all 3 groups (calcium phosphosilicate paste, Nd:YAG laser, and placebo) when all experimental periods were compared with baseline values. There were no significant differences between the groups in DH-related pain reduction for both immediate and long-lasting effects at any of the time intervals evaluated.
Ozlem et al.[18]	To determine and compare the effectiveness of a glutaraldehyde-containing agent (GCA-Gluma®) with Nd:YAG and Er,Cr:YSGG lasers and their combination in the treatment of DH.	High-power Nd:-YAG and Er,-Cr:YSGG lasers (Fotona; Ljubljana, Slovenia)	Treatment protocol on teeth with DH (5 groups): (1) application of glutaraldehyde-containing agent (GCA), (2) Nd:YAG laser irradiation (1W/cm², 10Hz), (3) application of GCA and then application of Nd:YAG laser, (4) Er,Cr: YSGG laser (0.25 W/cm², 20Hz), (5) application of GCA and then application of Er,Cr:YSGG laser.	After the sessions, DH was significantly reduced in all groups at each measurement point. The Er,Cr:YSGG laser with or without application of GCA was the most effective in treating DH. The Nd:YAG laser and the GCA appear to have similar effects in the treatment of DH.
Bou Chebel, et al.[19]	To compare the effect of the Nd:YAG laser with the effect of a new varnish (MI Varnish) containing added casein phosphopeptides (CPP) and amorphous calcium phosphate (ACP) in the treatment of DH within 6 months.	Nd:YAG HPL (Fotona Medical Lasers; Light Walker AT / AT S, Liubliana, Eslovênia)	The laser was applied according to the manufacturer's instructions. The irradiation parameters were set at 60mJ (energy), 2Hz (repetition rate), 0.64W (power) and 100mJ pulse energy (35.8J/cm²). A 300μm quartz fiber was used with scanning movements in mesiodistal directions: 4 times, 20s for each application (irradiation time) and a distance of 6mm from the exposed dentin surfaces.	There was a reduction in DH in both treatments (Nd:YAG laser and MI Varnish), especially between baseline and 1 week, with maintenance of this state during the 6-month follow-up period. The difference between the two treatments was not significant.

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Table 2. Studies evaluated in the review in order to identify the different protocols and efficacy of lasers in the treatment of Dentin Hypersensitivity – continuation

Authors	Objectives	Type of laser	Application protocol	Results
Narayanan, et al.[20]	To compare the efficacy of 5% potassium nitrate (PN), and LPL and the combination between these methods (LPL + PN) in DH patients with and without fluorosis.	Low-power diode laser of the GaAlAs type (A.R.C Laser; Nürember, Germany).	LPL was used with a wavelength of 810nm, output power of 1W, continuous wave mode, irradiation time of 10s/tooth, with the tip applied tangentially on the tooth surface and at 1mm distance. The teeth were evaluated at baseline, 30 min, 1, 4 and 12 weeks after treatment.	The LPL+PN group showed better results than the other two groups at all follow-up visits. The study as a whole showed better treatment results on fluorotic teeth. At 12 weeks, a statistically significant difference was observed between the three subgroups, with more favorable results in the group that combined LPL+PN on fluorotic teeth.
Lopes, de Paula Eduardo e Aranha[12]	To evaluate different protocols for the treatment of DH with low intensity laser (with different doses), HPL and a desensitizing agent, for a period of 12 and 18 months.	LPL Photon Laser (DMC, São Carlos, SP, Brazil). HPL Nd:YAG (Power Laser™ ST6, Research® (San Clemente, CA, USA).	9 evaluation groups: G1: Gluma desensitizer (Heraeus Kulzer), G2: Low-dose LPL (three irradiation points in the buccal portion and one apical point 30 mW, 10J/cm², 9s per point at a wavelength of 810nm, with three sessions 72h apart), G3: LPL with high dose (one point in the cervical area and one apical point 100 mW, 40J/cm², 11s per point with wavelength of 810nm in three sessions with 72h interval), G4: LPL with low dose + Gluma desensitizer, G5: LPL with high dose + Gluma desensitizer, G6: Nd:YAG laser 1.0W, 10Hz and 100mJ, ≈85J/cm², with a wavelength of 1064nm), G7: Nd:YAG + Gluma desensitizer, G8: LPL with low dose + Nd:YAG laser and G9: LPL with high dose + Nd:YAG laser	After statistical analysis, all treatments were effective in reducing DH and the results were considered not statistically different between the groups
Osmari et al.[21]	To evaluate the efficacy of four therapies (5% sodium fluoride varnish, 3% potassium oxalate, self-etching adhesive, high-powered diode laser) used in clinical treatment of DH after a single application.	High Power Diode Laser (Thera Lase Surgery DMC Equipamentos - São Carlos, SP Brazil).	Irradiation was performed at a distance of 1mm from the dentin surface, with horizontal scanning movements, for 20s. The parameters were: power 1W, continuous mode, energy 20J, generating an energy density of approximately 100J/cm² per s.	Compared to the baseline values, fluoride varnish and potassium oxalate showed a desensitizing effect that remained constant at 15, 30 and 60 days. The diode laser showed statistically significant difference compared to baseline after 15 days, while the adhesive only after 60 days. There was a difference between the groups evaluated only in the immediate result of therapy, with no difference in the period of 15, 30 and 60 days.
Moura et al.[22]	To evaluate the efficacy of desensitizing agents (2% fluoride potassium nitrate, ionomeric varnish, and LPL in reducing DH after four sessions, with 24-week follow-up.	GaAlAs LPL (Photon laser III, DMC U.S.A)	Irradiation was performed perpendicular to the surface and at a distance of 10mm from the gingival surface at 4 points on each tooth: buccal (mesial, central and distal) and one apical point. The parameters applied were power of 100mW, energy density of 4J/cm² (1J/cm² each point), 10s at each point with a wavelength of 808nm.	All three groups showed a significant reduction in DH compared to baseline. All groups maintained the reduction in DH and showed no statistical differences between them after treatment at 2, 4, 8, and 24-week follow-up.
Guanipa Ortiz et al.[23]	To evaluate the effect of fluoride-containing amorphous casein-calcium phosphopeptide (CPP-ACPF) and photobiomodulation in the treatment of DH and the impact of this on health-related quality of life.	LPL, GaAlAs (Photon laser III, DMC U.S.A)	G1: Placebo; G2: CPP-ACPF; G3: LPL and G4: CPP-ACPF + LPL The laser was applied using a spectrum of infrared light with a wavelength of 808nm, (60J/cm² at each application point) for 16s.	The intra-group comparison showed significant reduction in DH with both stimuli after one month of follow-up. The intergroup comparison with the evaporative stimulus showed that CPP-ACPF + laser significantly reduced hypersensitivity compared to the rest of the treatments after one month of follow-up. The CPP-ACPF + laser group also differed statistically from the other treatment groups in the DHEQ evaluation after one month of follow-up.

Continue...

Table 2. Studies evaluated in the review in order to identify the different protocols and efficacy of lasers in the treatment of Dentin Hypersensitivity – continuation

Authors	Objectives	Type of laser	Application protocol	Results
Femiano et al.[24]	To compare the reduction in sensitivity after tooth restoration with and without prior irradiation with diode laser for DH of cervical non-carious lesions that did not respond to desensitizing agents.	High-power diode laser (Creation, Soft Touch; 810nm 5W)	Before restoration the teeth were irradiated with a Diode Laser after air drying for 3s. The parameters used were 0.2W in continuous emission using a 400μm diameter fiber, at a minimum distance from the tooth of 0.5cm and no more than 1.0cm, being kept perpendicular to the tooth and performing fast movements in the apical-coronal mesiodistal and superficial region to treat the entire tooth surface. Three 1-min applications were performed and after waiting for another 3-min period, the direct restorative procedure was started.	The results showed significant reduction of DH discomfort in the study group in which there was laser irradiation before the teeth were restored, with the decrease of 78.5, 78.9, and 78.1% immediately and at 6 and 12 months after restoration, respectively. Laser irradiation before tooth restoration may further improve the DH symptom of non-carious cervical lesions that do not respond to desensitizing agents.
Tabibzadeh et al.[25]	To evaluate the desensitizing effect of the combined application of diode lasers with two different output powers and compare it with single session diode laser therapy.	Diode laser using a combined high and low power protocol (Doctor Smile, Lambda SPA, Italy)	The first experimental group was treated for 20s with a 3W beam (wavelength = 980 nm, 30Hz, fiber = 300μ, single pulse mode) once. The teeth in the second group were irradiated three times in three treatment sessions: in the first session, the teeth were irradiated for 20s with a 0.2W beam (wavelength = 980nm, fiber = 300μ, continuous wave mode) and then for 20s with 3W output power; the second and third sessions were 48 and 96h after the initial appointment, in which the teeth were treated for 20s with a 20Hz, 0.2W diode laser beam.	The difference in DH reduction between the two study groups was not statistically significant, although there was a trend toward better results in the group that combined high- and low-intensity laser.
Praveen et al.[26]	To evaluate and compare the clinical efficacy of low-power GaAlAs diode laser and topical glutaraldehyde-based desensitizing agent on DH.	GaAlAs diode LPL (QuantaPulse Pro 904 nm - Superpulsed, Rikta, Kvantmed, Russia)	The cervical area was irradiated with a low-level GaAlAs laser emitting a wavelength of 904nm. The cone tip (convergent beam) was used as close as possible to the tooth surface without contact, resulting in a spot size of 0.8cm^2. The laser beam was directed perpendicular to the tooth surface at three points: one apical and two cervical (one mesiobuccal and one distobuccal). Each area was irradiated for 1min (total of 3min per tooth). An average power of 60mW at 4000Hz was used and 9J/cm^2 of flow was received by each tooth.	There was a significant reduction in pain in both groups when compared to baseline at 3-month follow-up. However, the GaAlAs laser group showed a significant decrease in mean VAS scores when compared to the topical glutaraldehyde-based desensitizer group at one week and three months follow-up.
Soares et al.[27]	Compare the efficacy of Nd:YAG laser and GaAlAs laser as well as 2% fluoride gel in the treatment of DH.	GaAlAs (Photon Lase III, DMC USA) and Nd:YAG laser (Fidelis Plus III, Fotona LLC)	The Nd:YAG laser was administered perpendicular to the cervical surface at a distance of 0.5 cm under 1W and 10Hz for 60 seconds. The GaAlAs laser was administered at 40 mW and 4J/cm^2 with an area of 0.028cm^2. The laser was applied for 15 seconds per point at 4 points (mesial, medial, distal and apical surfaces) for a total of 60s;	The results showed that fluoride application, Nd:YAG laser and GaAlAs laser were effective in treating DH at the 7-day post treatment evaluation. No statistically significant differences were found between the 2 lasers, but both lasers were more effective than fluoride application.

DISCUSSION

There has been a significant reduction in tooth loss caused by caries and periodontal disease in recent years. However, changes in the lifestyle of the population have shown a significant increase in non-carious diseases and DH, the latter affecting approximately 1 in 3 adults[28-30]. The literature has been pointing out a strong relationship between non-carious cervical lesions (NCCLs) and DH, and these conditions are considered multifactorial and result from 3 main etiological factors: friction, tension and biocorrosion[8,31,32].

The relationship between DH and its impact on people's quality of life has also been investigated[16]. DH can affect the daily life of patients, leading them to changes in lifestyle habits such as not eating cold or hot foods, liquids, acids, and sweets, or even changes in hygiene habits such as tooth brushing, which is often impaired due to the presence of pain[33]. Study[16] also highlights that, in addition to physical pain, the patient with DH can also present discomfort and psychological disabilities, in addition to social disability.

Different types of treatments are used in clinical practice to help reduce DH, and most of them try to reduce the movement of fluids within the dentinal tubules using materials such as desensitizers, oxalates, fluoride solutions, adhesive restorative materials and applications of HPL[7]. Another known mechanism is to increase the patient's pain threshold through neural action, which can be achieved with potassium nitrate-based products and low-intensity laser[34,35].

Although there are several treatments for DH, it's not yet possible to decide which is the gold standard, since most desensitizing agents and laser-based therapies have shown efficacy in the short term after the conclusion of treatment. The challenge then is in how to provide greater longevity in the current available treatments for DH.

According to study[36], in order for the DH treatment to be effective, desensitizing agents must resist acid challenges from acidic diets and also resist mechanical obstacles, such as tooth brushing, present in the oral cavity. As a result, many of these agents have no long-lasting effect. Therefore, the use of lasers for the treatment of DH becomes an effective alternative, since lasers seem to have an interesting long-term effect[34].

Lasers with different power ranges affect the DH through two mechanisms: HPL by fusion and resolidification of the peritubular dentin and LPL by anti-inflammatory effects and increased cellular metabolic activity of odontoblasts[37]. Authors[26] also addressed the biomodulatory effects of LPL, minimizing pain and reducing inflammatory processes due to its ability to block the depolarization of nerve fibers and the decrease of neural transmission.

Fourteen articles which met the selection criteria of this systematic review were selected. Of the analyzed studies, 5 used LPL, 6 used HPL, and 3 used lasers of both powers. Among the LPL, the most used were low power diode lasers and gallium aluminum arsenide lasers (GaAlAs). Among the HPL, the most used were: high power Diode lasers and Er, Cr:YSGG and Nd:YAG lasers.

All the studies in this review that used LPL showed a reduction in DH compared to baseline values, showing the effectiveness of these types of devices in the management of DH[11,12,16,20,22,23,26,27]. When this therapy is compared with chemical desensitizing agents, whether they use neural or obliterating action, the LPL showed similar results in terms of efficacy. Study[16] showed better performance in the first 24 hours of cyanoacrylate compared to LPL, but after 30, 60 and 120 days there was no difference between the two therapies. In the same way, LPL showed similar results to the varnish-type obliterating agent (Clinpro XT®)[22] and the chemical neural agent of the potassium nitrate alone[20] or potassium nitrate associated with sodium fluoride[22]. Regarding the comparison with glutaraldehyde-based gels, authors[12] found similar results between LPL at low or high dose with Gluma®, while another study[26] found better performance of LPL when compared to this obliterator chemical desensitizer. The performance of LPL was also superior to 2% fluoride gel, but in a shorter evaluation period, one week after therapy[27].

There was a diversity of protocols regarding the use of LPL, with different power, energy density, number of sessions and application points in the tooth affected by DH. Study[12] showed no difference between low dose LPL (three irradiation points in the buccal portion and an apical point of 30mW, 10J/cm², 9s per point with a wavelength of 810nm, in three sessions, with an interval of 72h) and high dose LPL, one point in the cervical area and one apical point 100mW, 40J/cm², 11s per point with a wavelength of 810nm in three sessions with an interval of 72h, showing the efficacy of both protocols in dentin desensitization.

Several studies have also employed HPL for the treatment of DH, either singly[11,17-19,21,24,27] or combined with a chemical agent[12,18] or with LPL[12,15]. The beneficial effect of HPL is due to the photothermal mechanism that melts and fuses the hard tissue in its surface layer, obstructing the dentinal tubules and consequently preventing the movement of fluids within these tubules[25]. As mentioned for the LPL, the isolated application of HPL also showed similar results to some chemical desensitizers, such as those based on glutaraldehyde[12] or a prophylaxis paste containing 15% sodium calcium phosphosilicate (SCP) (NovaMin®) or a new varnish (MI Varnish®) containing the addition of casein phosphopeptides and amorphous calcium phosphate[19]. The similarity in the results can be explained by the fact that the laser and the products cited act in a similar manner, i.e., occluding the dentinal tubules. This occlusive strategy leads to similar results also regarding the treatment duration. The dissolution speed of these occlusive materials also seems to be similar, which explains why the desensitizing effect and duration are almost the same when using hydroxyapatite-based products (such as MI Varnish®) or when obtaining the so-called "stabilized fused dentin", caused by the "melting" effect of the Nd:YAG laser used to seal the exposed dentinal tubules[19].

The Nd:YAG laser results were found to be superior to the 2% fluoride gel[27]. Study[21] showed similar efficacy in the 60-day evaluation between diode laser and 5% fluoride varnish, 3% potassium oxalate, and a self-conditioning adhesive, but immediate improvement after application of the therapies was obtained with the use of fluoride varnish and potassium oxalate, the improvement with the laser being more pronounced after 15 days of application. Authors[24] evaluated the use of diode laser prior to the restorative procedure of non-carious cervical lesions with DH that showed no improvement with prior desensitizing treatment. The results showed a more significant reduction in the degree of DH in cases where there was a previous application of the laser before the restoration was performed.

Despite the good results with the other HPL used in the evaluated studies, there seems to be a better effect when the Erbium laser is employed. Study[11] compared the Er,Cr:YSGG with an LPL (GaAlAs), presenting a similar immediate and one-week effect between the groups, but at the one month evaluation the Erbium laser was superior. This could be explained by the effect of the Er,Cr:YSGG laser on the obstruction of dentinal tubules, which seems to be more durable than blocking the depolarization of afferent C fibers, an effect of the low-power diode laser[38]. Similarly, it showed better efficacy of Er,Cr:YSGG when compared to Gluma® and Nd:YAG laser after 6 months of follow-up[18].

Given the positive results presented by various desensitizing protocols in relation to baseline data, there has been a tendency in the search for more efficient and lasting treatments, which seems to involve a combination of therapies. The benefit of combining therapies has been demonstrated[20], with the association of LPL and potassium nitrate being more effective than these two therapies alone after 12 weeks of follow-up. Study[23] also showed better results for DH treatment with combined therapy of LPL with casein phosphopeptide-amorphous calcium phosphate and fluoride (CPP-ACPF) after the first application and maintaining improvement in the evaluation after one month. An association of LPL with HPL is also possible, since the mechanisms of action are different, the desensitizing effect could be enhanced by associating these two therapies[25]. This is because the pulpal effects of LPL, when used alone, are probably more reversible because of the continuous external stimulation. The protective layer formed on the dentinal tubules in the obliterating mechanism may also be eliminated due to friction and the action of microorganisms[25].

A factor that may influence the results in clinical trials is the so-called placebo effect, especially when new products and technologies are employed. The improvement in sensitivity reported by patients who were classified as negative controls, i.e., without any type of intervention presenting an active substance, may reach up to 60% according to previous studies[17,39]. The explanation for this effect can be the simple fact that the patient is participating in a research study with a wide variety of available resources and the opportunity for personalized and careful care[40], or even the so-called "experimental subordination", which involves a positive response to all therapies involved by education on the part of the participants[21]. It's worth mentioning the importance of the measures adopted in some studies evaluated in this review when the placebo group was adopted for comparison with the purpose of minimizing the placebo effect, for example, orienting the patients about the possible inefficacy of the treatments, the possibility of being allocated to a placebo group and the double-blind design of the study itself[17,40]. However, due to ethical issues regarding some ethics committees, most of the studies in the present systematic review (11 out of 14 studies) did not use a placebo group as a comparison group, but an intervention already known as a positive control.

Lasers have arrived on the market as an innovative option with several applications in dentistry. For the treatment of DH, they can be of help in a single or combined protocol, and both high and low power lasers can be used for this purpose[34,35].

The limitations in establishing a "gold standard" desensitizing treatment are especially due to the fact that there are several studies in the literature showing effectiveness for various products and strategies, but it's difficult to compare the studies due to the lack of uniformity between the application protocols. Since the recurrence of DH is common after desensitizing treatment, patients with this condition should be carefully evaluated and a constant concern of the dental surgeon should be the control of etiological factors, which could increase the durability of therapy and improve the patient's quality of life[7,12].

CONCLUSION

Considering the variety of existing protocols for laser usage, both high and low power, for the reduction of discomfort caused by DH, the general conclusion is that the use of laser has been effective in most protocols used in the studies, however, it's not yet clear which would be the most effective strategy in the long term. The association of interventions that act in both obliterator and neural pain interception mechanisms seems to be an appropriate conduct for controlling DH, and this combination can happen through physical methods (laser of high and low intensity), and chemicals (with neural agents and obliterators). The most appropriate therapy in DH is dependent on careful anamnesis and physical examination, while treatment success will depend on the removal of causal factors and a treatment plan made individually for each patient.

AUTHORS' CONTRIBUTIONS

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Data Collection, Methodology, Writing – Preparation of the original

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