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Comparative Evaluation of Efficacy of Diode Laser and Toothpaste on Dentinal Hypersensitivity: A Systematic Review

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KEYWORDS
Diode laser, Desensitizing toothpaste, Dentinal hypersensitivity, Systematic review.

ABSTRACT:

Dentinal hypersensitivity (DH) is a common clinical condition characterized by short, sharp pain arising from exposed dentin, significantly affecting quality of life. While desensitizing toothpastes are widely used as non-invasive management options, their effectiveness often depends on patient compliance. Diode lasers have recently gained attention as a promising alternative for providing rapid and durable relief. This systematic review and meta-analysis, conducted according to PRISMA 2020 and Cochrane guidelines, included 13 randomized controlled trials published between 2015 and April 2025 from PubMed, Scopus, and Google Scholar databases. The majority of studies demonstrated a significant reduction in DH following diode laser therapy, irrespective of wavelength (680–980 nm) or treatment duration. Compared to conventional desensitizing toothpastes such as potassium nitrate, pro-argin, or biosilicate formulations, diode lasers showed superior outcomes, except when compared with nano carbonate apatite (n-CAP), which exhibited similar efficacy. Within the limitations of the available studies, diode laser therapy appears to be an effective and safe modality for managing dentinal hypersensitivity, offering immediate and potentially long-term relief through dentinal tubule occlusion; however, further well-designed randomized trials are warranted to establish standardized treatment protocols.

1. Introduction

Dentinal hypersensitivity (DH) is the frequent complaint of patient's dental visit with global prevalence of 1.3-92.1 %, with improper tooth brushing, abrasive tooth pastes, gingival recession, exogenous and endogenous acids as etiological factors that results in loss of enamel on crown or cementum on root surface leading to exposure of dentinal tubules [1,2]. Dentinal hypersensitivity results in short sharp pain, and it affects patient's quality of life by interfering with eating, drinking and oral hygiene practices [3]. It is one of the most common annoying problems, which requires a permanent or long-lasting non-invasive solution. Conventional non-invasive treatment modalities include use of desensitizing toothpastes, varnishes, fluoride applications, dentin-bonding agents that blocks the dentinal tubules or desensitize the nerve fibers to reduce the sensitivity [4]. Since decades, it is well known that desensitizing tooth pastes are the widely accepted for treating dentinal hypersensitivity and agents like arginine

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calcium carbonate, nano hydroxyapatite are well known for its action by occluding the dentinal tubules, potassium nitrate for desensitizing the nerves, Calcium sodium phosphosilicate, Flourocalcium phosphosilicate, and Stannous fluoride also helps in remineralization along with occluding dentinal tubules[5,6]. The key limitation for their efficacy on long lasting results could be attributed to consistent patient compliance. Current research, suggests use of lasers over topical medicaments in treating the dentinal hypersensitivity due to their durable sealing effect when compared to topical desensitizing pastes [7,8].

Despite existing literature supports the use of lasers, yet there is a gap in the arena of using diode lasers in the regular clinical practice in treating DH as a routine procedure. This could be due to either ambiguity in the methodology of using lasers or durability of results when compared to desensitizing toothpaste. Hence, the present systematic review and meta-analysis seeks to address a crucial question: Is diode laser effective in occluding the dentinal tubules and reducing the DH when compared to desensitizing toothpaste?

2. Materials and Methods

Protocol and Registration

The protocol for this systematic review and meta-analysis was prepared referring to the Cochrane guidelines and the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [9,10]. The study was prospectively registered in PROSPERO (International Prospective Register of Systematic Reviews) under reference number of CRD420250650801.

Focused Question

This systematic review was based on the main question: is diode laser effective in occluding the dentinal tubules and in reduction of dentinal hypersensitivity when compared to tooth paste? The null hypothesis tested was that there is no significant difference in the success rate among the different materials.

Search Strategy

An electronic search was conducted in databases including Google scholar, PubMed, EMbase, Scopus limited to English articles published from 2015 to 2025 using MeSH terms with Boolean operators (‘Sensitivity OR Hypersensitivity OR dentinal hypersensitivity OR discomfort OR pain’ AND ‘low level laser OR diode laser OR soft tissue laser’ AND ‘desensitizing tooth paste OR desensitizing agents’ AND ‘Randomized controlled trial’ AND ‘Scanning Electron Microscope (SEM) analysis’ AND ‘ Visual Analog Score (VAS) scale’).

Study selection:

- Inclusion criteria

P (Population / Participants):

Individuals (human subjects) diagnosed with dentinal hypersensitivity (DH) confirmed clinically; extracted human teeth used in *in vitro* studies evaluating DH may also be included.

I (Intervention):

Diode laser treatment for reduction of dentinal hypersensitivity or for occlusion of dentinal tubules.

C (Comparison):

Desensitizing toothpaste (e.g., potassium nitrate, strontium chloride, arginine-based toothpaste, etc.) used alone or as a control group.

O (Outcome):

- Clinical outcome: Reduction in dentinal hypersensitivity measured using Visual Analog Scale (VAS) or other validated pain scales with atleast 1 month follow up.
- Laboratory outcome: Occlusion of dentinal tubules assessed through Scanning Electron Microscopy (SEM).

S (Study Design): Randomized controlled clinical trials (RCTs) and *in vitro* studies published in English.

- Exclusion criteria

Case reports

Case series

Review articles

Studies published other than in English

Animal studies

Data Extraction

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Two independent reviewers worked on the project data collection, screening and retrieving the records for eligibility. Discrepancies were resolved through discussion. When consensus could not be reached, a third reviewer was consulted. The pertinent data from the qualifying studies were extracted using a standardized data extraction procedure that included study characteristics (Publication year, study protocol, sample size, study result, evaluation time [age and type of problem – *in vivo* studies]. The results included outcome measures of Mean and standard deviation of SEM analysis for in vitro studies and VAS scale for *in vivo* studies (Table 1 and Table 2)

Quality Assessment - Risk of Bias Assessment Protocol

The risk of bias across the included randomized controlled trials was assessed using the Cochrane Risk of Bias tool (RoB 2.0) in the following five domains: Bias from the randomisation process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in the measurement of the outcome, and bias in the selection of the reported result. Following the assessment of all domains, each study's overall risk of bias was graded as "Low risk, Some Concerns/Unclear, High risk.

3. Results

Screening and Selection of Papers

Following Prisma guidelines, after an initial search of electronic databases including PubMed, Scopus and Google Scholar, a total of 347 articles were identified. After removing 52 duplicates, 295 records were screened based on titles and abstracts. Of these, 260 articles were excluded as the articles being limited to abstracts or grey literature, not being in English literature, being reviews, position papers, case reports or conference papers. The remaining articles were 35 for full-text retrieval, but 15 could not be accessed. The 20 retrieved full-text articles were then evaluated against the inclusion criteria, 7 articles were not matching with the inclusion criteria. Finally, 13 studies were included in the qualitative synthesis**. (Figure 1)**

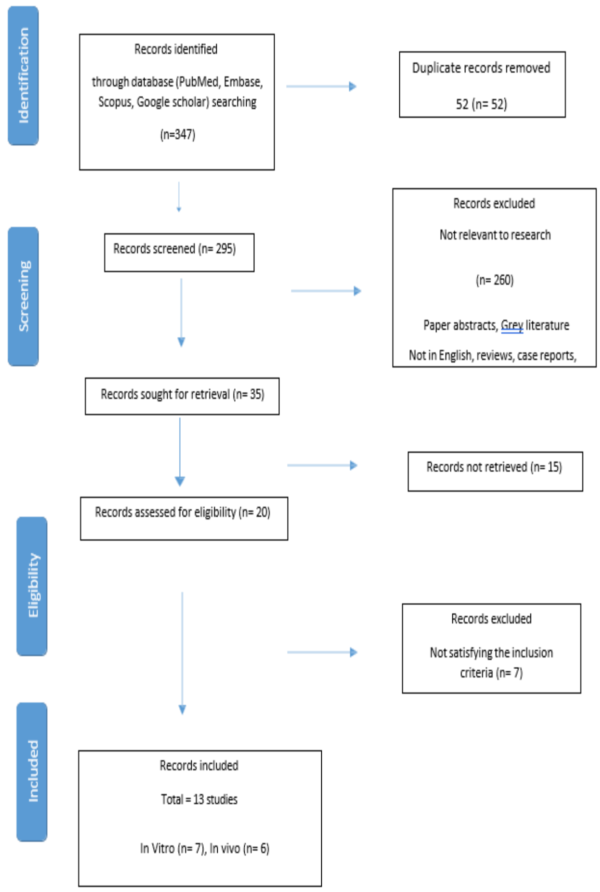

Figure 1: Prisma flow chart

Subdivision of Selected Studies

All selected studies were subdivided according to the subjects involved. Among 13 studies, 7 studies were *in vitro* and 6 studies were *in vivo*. All studies differ in laser protocol in terms of wavelength, watts, exposure time which are the main determinants in the outcome either dentinal tubule occlusion evaluated by SEM for *in vitro* studies or reduction in hypersensitivity evaluated by VAS scale for *in vivo* studies.

Data Extraction:

In vitro studies include data regarding protocols of diode laser of 810-980 nm and different desensitizing tooth pastes like Novamin, pro-argin,, 8% Arginine, calcium carbonate, SHY XT, Biomed sensitive natural, Nano carbonate apatite (n-CAP), Nano hydroxyapatite, biosilicates with their evaluation time and the outcome i.e., occlusion of dentinal tubules through SEM (Table 1)

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Table 1: Characteristics of *In vitro* studies

Sl.No	Author and year of the study	Protocol 1	Protocol 2	Sample size	Evaluation time	SEM Results Mean and standard deviation	Conclusion
1	Reddy G V *et al.*2017 [11]	**GaAlAs Diode Laser** 980 nm, 1 W, pulse length- 200 µm pulse interval -200 µm Noncontact mode for 60 s.	**NovaMin group** EDTA (Ethylenediaminetetraaceticacid) etched specimens were brushed with NovaMin- containing toothpaste for 6 min twice a day for 7 days	N=10 per group	7 days	Percentage of occlusion Diode 96.57 ± 0.64 NovaMin 92.73 ± 1.38	Diode laser is more effective than Novamin in dentinal tubule obliteration
2	Reddy G V *et al*. 2017 [11]	**GaAlAs Diode Laser** 980 nm, 1 W, pulse length- 200 µm pulse interval -200 µm Noncontact mode for 60 s.	**Pro-Argin group** EDTA-etched specimens were brushed with Pro-Argin™- formulated toothpaste for 6 min twice a day for 7 days	N=10 per group	7 days	Percentage of occlusion Diode 96.57 ± 0.64 Pro-Argin 90.67 ± 1.86	Diode laser is more effective than Pro- Argin group in dentinal tubule obliteration
3.	Vasudevan *et al.* 2020 [12]	Diode laser 810 nm, 0.8-1 W. 10seconds Non - contact 1 mm away Continuous mode on the region of exposed dentin,	**8% Arginine, calcium carbonate** Desensitizing toothpaste of Pea-size amount was applied on the dentin surfaces and kept for at least 2 minutes. **(Colgate sensitive plus tooth paste)**	N= 10 per group	Single point of time	Percentage of occlusion Diode 1.10 ± 0.316 Tooth paste 2.20 ± 0.422	Diode laser is more effective than Arginine Calcium Carbonate toothpaste in dentinal tubule obliteration
4.	Doppalapudi *et al.* 2023 [13]	Diode laser 810 nm, 1 W in a noncontact mode for 60 s for seven days.	**NovaMin** applied cotton pellet with gentle firm rubbing motion, for 6 min a day for seven days	N= 15 per group	7 days	Percentage of occlusion Diode 22.39 ± 6.23 NovaMin 14.75 ± 1.72	Diode laser is more effective than NovaMin in dentinal tubule obliteration
5.	Doppalapudi *et al.* 2023[13]	Diode laser in 810 nm, 1 W in a noncontact mode for 60 s for seven days.	**Pro-Argin** group tooth paste, using cotton pellet with gentle firm rubbing motion, for 6 min a day for seven days	N = 15 per group	7 days	Percentage of occlusion Diode 22.39 ± 6.23	Diode laser is more effective than Pro Argin in dentinal tubule obliteration

Sl.No	Author and year of the study	Protocol 1	Protocol 2	Sample size	Evaluation time	SEM Results Mean and standard deviation	Conclusion
						Pro-argin 10.13 ± 1.90	
6.	Barkestani *et al.* 2024 [14]	Diode laser 980 nm 0.5 W 15 seconds, 3 times with an interval of 24 hours.	**Pro-Argin** toothpaste of pea-sized with the bristles at a 90-degree angle to the samples for 2 minutes per day for 14 days	N= 10 per group	2 weeks	Percentage of occlusion Diode 90.3 ± 8.23 Colgate Sensitive Pro-Relief 67.6 ± 10.62	980 nm diode laser appears more effective
7.	Dwivedi *et al.* 2022 [15]	Diode Laser 980 nm 4.0 W Non-contact 1mm away 5 times for 5 secs in continuous mode. Laser was applied for 2 mins twice daily at interval of 8 hours for 2 weeks	**SHY XT** Each dentin disc was treated with for 2 mins twice daily at the interval of 8 hours for 2 weeks	N= 6 per group	2 weeks	Diameter of patent dentinal tubules Diode 0.42 ± 0.12 Shy XT 0.86 ± 0.25	The efficacy of occlusion of dentinal tubules in Diode laser was more and statistically significant when compared to the shy xt group
8.	Dwivedi *et al.* 2022 [15]	Diode Laser 980 nm 4.0 W Non-contact 1mm away 5 times for 5 secs in continuous mode. Laser was applied for 2 mins twice daily at interval of 8 hours for 2 weeks	**Biomed sensitive natural** Each dentin disc was treated with for 2 mins twice daily at the interval of 8 hours for 2 weeks.	N= 6 per group	2 weeks	Diameter of patent dentinal tubules Diode 0.42 ±0.12 Bio med sensitive 2.14 ± 0.17	The efficacy of occlusion of dentinal tubules in Group A (Diode laser) was more and statistically significant when compared to the biomed sensitive natural tooth paste group
9.	Keshaw *et al*. 2024 [16]	Diode laser 810 nm, 2 W, 3-5 seconds. Noncontact mode at a distance: 1-2 mm Irradiation - pulse mode, pulse width 30 ms, interval 30 ms. Power density-1.59 Watts/cm2. Energy-10.61 joules/cm 2.	**Nano carbonate apatite (n-CAP)** dentifrice was manually tooth-brushed with 20 % with 50 back-and-forth strokes in linear motion with manual tooth brushing - one minute	N= 6 per group	Single point of time	Diameter of dentinal tubules Diode Mean ±SD 1.9978 ±0.1904 n-CAP Mean ±SD 0.4552 ±0.1352	The n-CAP group showed more reduction in the diameter of the open dentinal tubules.
10.	Siddiqui *et al.* 2024 [17]	Diode Laser 0.5 W, 60 seconds, and each site received two	**Aclaim** containing nano Hydroxy apatite (**nano-HA**) was	N= 12 per group	After 2 weeks	Percentage of occlusion	Laser has more dentinal tubule occluding

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Sl.No	Author and year of the study	Protocol 1	Protocol 2	Sample size	Evaluation time	SEM Results Mean and standard deviation	Conclusion
		applications of 1 minute. Continuous noncontact mode, applied 2–3 mm away from the tooth surface	applied with the help of an applicator tip and it was left for 15 minutes.			Diode 83.50 ±7.39 Aclaim 78.92 ± 6.05	efficacy than nano HA
11.	Siddiqui *et al*. 2024 [17]	Diode Laser 0.5 W, 60 seconds, and each site received two applications of 1 minute in continuous noncontact mode, applied 2–3 mm away from the tooth surface	**Vantej** containing **biosilicate**, was applied with the help of an applicator tip and it was left for 15 minutes.	N= 12 per group	After 2 weeks	Percentage of occlusion Diode 83.50 7.39 Vantej 70.83 ± 14.92	Laser has more dentinal tubule occluding efficacy than Vantej

In vivo studies include data regarding protocols of diode laser of 810-980 nm and different desensitizing tooth pastes like 8% Arginine, calcium carbonate, Potassium nitrate, pro-argin with their evaluation time and the outcome i.e., reduction in dentinal hypersensity through VAS scores with atleast 1 month follow up. (Table 2)

Quality Assessment

Risk of Bias Assessment – *In Vitro* Studies

All included studies, demonstrated low risk for bias in missing outcome data, for bias due to deviations from intended interventions, and for bias in selection of the reported result. Studies done by Vasudevan *et al.*,[12] Doppalapudi *et al.*,[13], Dwivedi *et al.*,[15], and Keshaw *et al,* [16] has low risk for bias in the measurement outcome where images generated by SEM were analyzed with image software. Despite low risk in 3 domains, on overall assessment majority of the studies included has some concerns largely driven by randomization process where there is no specification of randomization process (Vasudevan *et al.*,[12], Dwivedi *et al.*,[15] Keshaw *et al.,*[16] and Barkestani *et al.,*[14] and in study by Siddiqui *et al.,*[17] randomization was not mentioned and measurement outcome domains, and in around 40 % of the studies measurement outcome was not blinded, where results were measured manually (**Figure 2 and 3).**

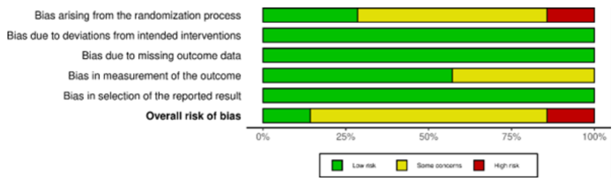

Figure 2: Risk of bias summary plot for *in vitro* studies

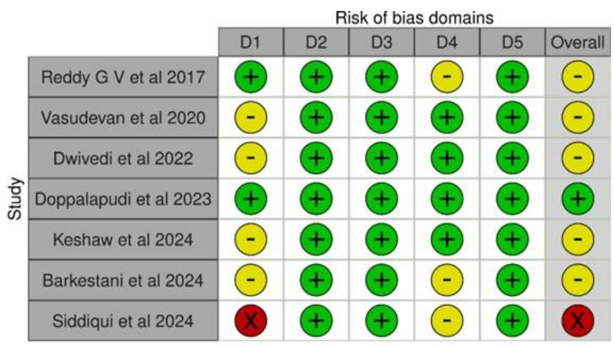

Figure 3: Risk of bias traffic plot for *in vitro* studies

Table 2: Characteristics of *In Vivo* studies

Sl.No	Author and year of the study	Protocol 1	Protocol 2	Sample size	Age	Type of problem	Methods of assessment	Total Follow-up	VAS Results Mean and standard deviation	Conclusions
1.	Merh A *et al*. 2015 [18]	Diode laser 810 nm, 1.5 W for 30 seconds. by keeping perpendicular to the area of interest.	**8% arginine - calcium carbonate** consisted of two consecutive rounds of 3 second application. Rinsing was avoided up to 15 minutes after application.	N=25 per group	18-70 year s	Two or more teeth with dentinal hypersensitiv ity. Non carious lesions	VAS scale	2 months follow up	Diode 0.2 ±0.258% arginine-calcium carbonate 0.36 ±0.05	Diode laser showed progressive reduction till 8 weeks whereas Colgate Pro Relief showed progressive reduction only till 4 weeks. Diode laser has higher reduction than 8% arginine and calcium carbonate at 4 Weeks
2.	Bal M V 2015 [19]	Diode laser 685 nm, 100 sec 25 Mw power, 9 Hz frequency, and 2.0 J/cm2 density at 1 cm^2. Non contact – 2 mm from the dental outer surface.	**8% arginine - calcium carbonate** was applied using a rotating rubber cup (2000 rev/min) in two consecuti ve rounds lasting 3 sec each.	Diode laser n=41 Tooth paste N=32	19-60 years	Two or more teeth showing hypersensitiv ity	VAS	3 months follow up	Diode 14.1±16.04 Tooth paste 23.9 ±29.05	The applicati on of either LLL or DP containing 8% arginine-calcium carbonate appears to be effective in decreasing DH.
3.	Achar ya A B *et al.* 2022 [20]	Diode laser 940 nm, 1.2- 1.5 W, Energy per applicatio n was 19 J. Pulse duration 0.20 seconds, Pulse interval of 0.20 seconds. Time per application was 15 seconds.	**Potassiu m nitrate** Brush twice daily for a period of 4 weeks.	N=15 for each group	25 to 45 years	Wasting diseases and/or gingival recession	VAS	1 month follow up	Diode 3.2 ±0.77 Potassium nitrate 3.6 ± 1.24	Diode Laser showed the best results than potassium nitrate tooth paste
4.	Srivast ava S *et al.* (2022) [21]	GaAlAs diode laser 810 nm, 1 W Energy per application was 19 J, continuous	**Pro- Argin™ Technology,** Colgate Sensitive Pro-Relief®	N= 22 each group	25-55 year s	Gingival recession / cervical abrasion	VAS	1 month follow up	Diode 1.2±0.48 Potassium nitrate	Diode group has more percentage in reduction than tooth paste

Sl.No	Author and year of the study	Protocol 1	Protocol 2	Sample size	Age	Type of problem	Methods of assessment	Total Follow-up	VAS Results Mean and standard deviation	Conclusions
		mode, at three points: two cervical points (one mesiobuccal and one distobuccal) and one apical point for 1 minute and a total of 3 minutes per tooth (Picasso+ AMD Lasers, Utah)	Desensitizing Paste was applied with a cotton pellet onto the intended site and left in place for 1 minute						2.13 ±0.24	
5.	Kumar P *et al.* (2022) [22]	Diode Laser Noncontact, continuous mode. 3 applications of 1 min each	**Arginine** containing tooth paste 1cm of toothpaste was then expressed on the tooth surface for two minutes and rinsed off. For 6 months regularly	N= 20 each group	20-45 year s	Cervical abrasion	VAS	6 months follow up	Diode 1.04±1.31 Potassium nitrate 3.03±1.7	Diode laser showed higher percentage of reduction in sensitivity
6.	Colaco *et al.* (2022) [23]	Diode Laser 980 nm (975 nm ±10 nm) continuous wave mode. 0.5 W output power, non-contact mode 2mm Exposure time was 30 seconds.	**8% arginine calcium carbonate** To brush with the allocated toothpaste for 2-3 minutes twice daily.	N= 15 each group	19-60 years	Teeth with sensitivity complaint	VAS	1 month follow up	Diode Mean ± SD 2.0±1.7 Potassium nitrate Mean ± SD 2.6 ±1.0	There was an overall decrease in dentin hypersensitivity in both groups. Hence both desensitising tooth paste and low power diode laser were effective in treating dentinal hypersensitivity.

Risk of Bias Assessment – *In Vivo* Studies

All included studies, demonstrated low risk for bias due to missing outcome data, and for bias in selection of the reported result. Around 20 % of the studies had low risk for randomization process, blinding of participants and outcome assessment. Around 80 % of the studies had high risk in assessing the outcome where blinding of the outcome assessors was not followed, and around 60 % had high risk where blinding of participants was not done and 60 % had some concerns, 20 % had high risk with randomization process. Despite low risk in 2 domains, on

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overall assessment majority of the studies included has “High risk” largely driven by bias due to deviations from intended interventions and measurement outcome domains and randomization process **(Figure 4 and 5)**

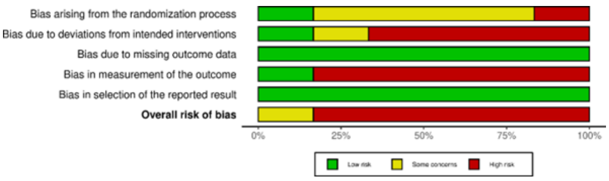

Figure 4: Risk of bias summary plot for *in vivo* studies

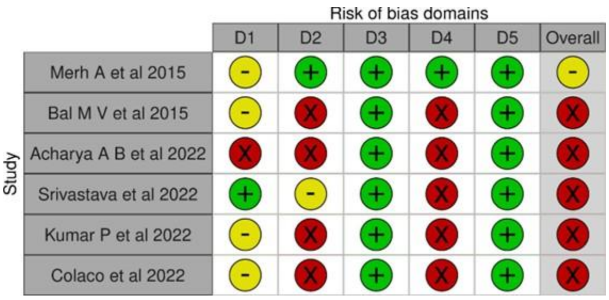

Figure 5: Risk of bias traffic plot for *in vivo* studies

4. Discussion

Dentinal hypersensitivity is a brief, sharp, well-localized pain response to thermal, evaporative, tactile, osmotic, or chemical stimuli that cannot be referred to any other form of dental defect or pathology [3]. However, all exposed dentin is not sensitive, dentin which is sensitive has a greater number of tubules which is 8 times more than non-sensitive dentin which has thick tubules, also the calcified smear layer of sensitive dentin is thin in sensitive dentin leading to increased fluid movement and consequent pain as a result of it. The rate of dentinal fluid flow depends on the fourth power of tubule’s radius [24,25]. Among the direct innervation theory, odontoblast receptor theory, and fluid movement theory, the most accepted theory is fluid Movement/Hydrodynamic theory, where the movement of the fluid inside the dentinal tubules is due to thermal, physical changes or osmotic stimuli near the exposed dentin and neural discharge takes place as a result of the fluid Movement [26].

Among the direct innervation (DI), odontoblast receptor (OR) and hydrodynamic theories, DI and OR theories are not widely accepted, as DI theory has little evidence that can support the existence of nerves in the superficial dentin where dentin has the most sensitivity [27], and Odontoblast Receptor (OR) theory has also been rejected as the cellular matrix of odontoblasts is not capable of exciting and producing neural impulses. In hydrodynamic theory, the movement of fluid can be toward the inside of the pulp or the outside of dentin. Fluid move toward the pulp in case of heat stimulus and away in case of cooling, drying, evaporation, and hypertonic chemical stimuli and lead to an increase in pain. On an estimate 75% of patients feel DH to cold stimuli [28,29].

As per the Grossman, an ideal treatment for DH should address the criteria: pulp integrity, rapid in action, permanent efficacy, comfortable and easy application and no pigmentation on tooth structures [30]. Among all non-invasive treatment approaches, topical desensitizing agents and lasers, desensitizing tooth pastes is often first choice as it is widely available, but the therapeutic effect typically develops over 4–8 weeks and is largely dependent on patient compliance [31].

Laser as a treatment modality for dentinal hypersensitivity was first introduced in 1985 [32]. Lasers are gaining importance, due to its immediate effect and it does not depend on patient compliance for the therapeutic effect. However, one should be cautious enough when using the lasers in the treatment of DH, as use of high output laser has both pros and cons - effectively sealing and also could be potentially damaging to the pulp. It was observed that there won’t be evident pulpal damage when the temperature raise within the pulp remains below 5°C. Hence, awareness regarding the protocols used in different manufacturer systems pertaining to wavelength, active medium, power (W), exposure time (seconds), energy density (J/cm2), pulsed versus continuous wave, contact or defocused irradiation, laser-beam divergence, and energy per point and total and the optical properties of the target tissue is necessary while selecting the laser [33].

Lasers alleviate dentinal hypersensitivity by different mechanisms like coagulation and protein precipitation of the plasma in the dentinal fluid or by alteration of the nerve fiber activity, or physically occluding the dentinal tubules, or interfering with the sodium pump mechanism, changes the cell membrane permeability and/or temporarily alters the endings of the sensory axons. Here are some of the desensitizing agents and their action [34,35]. (Table 3)

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Among all lasers, diode lasers are gaining much importance due to their cost-effectiveness and can be used for wide variety of clinical procedures when compared to other lasers. Diode laser is known for their photo-bio modulating effect resulting in cellular metabolic activity of odontoblasts and obliteration of the dentinal tubules with the intensification of tertiary dentine production and also for immediate analgesic effect [36]. Grag A stated that laser has transient effect on nerve analgesia but the sealing effect is considered to be durable [37].

Yet, there is ongoing debate on the effectiveness of laser stating lasers in alleviating DH, this ambiguity could be due to large variations in the parameters used or study design where some studies used positive and some used negative controls as there was no gold-standard treatment has been established [38-40].

So far, there were systematic reviews on only lasers or only desensitizing tooth pastes, or comparing lasers and with other topical desensitizing agents in the treatment of DH. This is the initial effort systematic review comparing the efficacy of diode laser with only desensitizing tooth pastes in dentinal tubules occlusion of human teeth and also on reduction of VAS scores by reduction of dentinal hypersensitivity.

Meta-analysis was not performed to avoid heterogeneity due to various reasons like – difference in outcome - in studies done by Keshaw *et a.l.,*[16], and Dwivedi *et al.*,[15] outcome was measured as diameter of patent tubules when compared with other studies, where percentage of maximum tubule occlusion was measured was based on the mean percentage reduction and the technique used - studies done by Reddy G V *et al.*,[11], Barkestani *et al.,*[14] and Siddiqui *et al.*,[17] manual counting of SEM photomicrographs was done instead of image software analysis which could be of concern and resulting in bias and over all, different laser protocols and different desensitizing tooth pastes.

Table 3: Mechanism of action of different Lasers

Sl.no	Different formulations	Mechanism of action
1.	He-Ne Laser (low output power)	Does not affect peripheral A-delta or C-fiber nociceptors, but does affect electric activity.
2.	GaAlAs Diode Laser (low output power)	Blocks the depolarization of C-fiber afferents
3.	CO2 Laser (Middle output power)	Occlusion or narrowing of dentinal tubules as well as reduction in permeability
4.	Nd:YAG Laser (Middle output power)	Occlusion or narrowing of dentinal tubules as well as direct nerve analgesia

Among all included studies in systematic review, diode laser has superiority in complete or maximum occlusion of dentinal tubules, which is similar to Yilmaz *et al.,*[41] where diode laser of 810 nm demonstrated significant reduction in dentinal hypersensitivity, attributing its effects to occlusion of dentinal tubules and desensitization of nerve endings. Similarly, in the study by George A A *et al.*,[42] diode laser was more effective when compared to desensitizing toothpaste alone. In the study by Corona *et al*.,[43] significant difference was observed in both immediate and sustained effects with diode laser, showing its superiority in efficacy not only with desensitizing toothpastes but also with fluoride varnish. But study done by Keshaw *et al* .,[16], is in contrast where n-CAP group 30 percentage has complete occlusion and in contrast diode laser has 100% partial occlusion and no percentage with complete occlusion, and the reduction in the tubular diameter caused by the application of n-CAP was 2 times than that of laser, this

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was attributed to manual brushing which could result in unequal distribution of forces.

In the meta-analysis done by Sgolastra *et al.,*[44] no difference between laser and placebo laser was observed and this was attributed to inclusion of small number of studies. In contrast, Ladalardo *et al.,*[45] investigated the effectiveness of two types of low-power lasers—red diode laser (660 nm) and infrared diode laser (830 nm)—for managing dentinal hypersensitivity (DH). Their findings indicated that the red diode laser produced superior desensitizing effects compared to the infrared laser, with most relief observed within 15 to 30 minutes post-irradiation. In contrast, Moosavi *et al.,*[46] reported that the infrared laser demonstrated significantly greater effectiveness which is similar to our review, where out of all, the studies falling under infra-red diode by Merh A *et al*.,[18] Acharya *et al.,*[20] and Srivastava *et al.*,[21] statistically significant reductions in DH favoring the diode laser group over desensitizing tooth paste was observed. In contrast, in the study by Colaco et al.,[23] though infra-red diode was used significant difference was not observed. This could be attributed to the power used which is of only 0.5 W. The results of our review is aligning with the growing body of evidence supporting laser-based treatment modalities and our findings were consistent with the findings of systematic review and meta-analysis by Shan Z *et al*., [47] and Cattoni F *et al*.,[48] where diode lasers were superior to topical desensitizing agents in the treatment of DH.

5. Limitation

Substantial heterogeneity was observed among the protocols indicating considerable variability in outcomes across trials. This may be attributed to differences in laser parameters (wavelength, power settings), treatment protocols, duration of follow-up, and patient populations.

6. Conclusion

Overall, diode lasers present a promising treatment modality for managing DH, offering fast relief with sustained effects. However, given the variability in methodologies and outcome measurement, further large-scale, standardized randomized controlled trials are warranted to establish definitive clinical guidelines.

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