# Low Level Laser Therapy for Dentinal Hypersensitivity - A Review


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**Abstract** Dentinal hypersensitivity (DH) is characterized by a nonspontaneous, acute short- or long-lasting pain originating from exposure of the dentinal tubules or dentine to the thermal, chemical, mechanical, or osmotic stimuli, which cannot be ascribed to any other dental defect or pathology. There are various treatment modalities, one amongst them is lasers. Lasers have been shown to fulfill the requirements of Grossman's criteria by being nonirritating to the pulp. Different lasers have been used for the treatment of dentine hypersensitivity i.e, Low output power (low-level) lasers like (HeNe) helium-neon and (GaAlAs) gallium-aluminumarsenide (diode) lasers and high output laser i.e, (Carbon Dioxide Laser (CO2), neodymium- or erbium-doped yttriumaluminum garnet (Nd:YAG, Er:YAG lasers) and erbium, chromium doped: yttrium, scandium, gallium and garnet (Er,Cr:YSGG) lasers). Each laser has different mechanism of action in causing a reduction in dentinal hypersensitivity. In case of low level lasers, a small fraction of the lasers energy is transmitted through enamel or dentin to reach the pulp tissue. Low-power laser therapy is an appropriate treatment strategy to promote biomodulatory effects, minimize pain and reduce inflammatory processes. The low-level lasers produce their effects from photobiostimulation effect within the tissues and do not cause temperature elevation within the tissues. The output powers range from 50 to 500 mW with wavelengths in the red and near infrared of the electromagnetic spectrum, from 630 to 980 nm with pulsed or continuous-wave emission. The application of LLLT has become popular in the clinical application for dentinal hypersensitivity. The aim of this paper is to review low-level laser therapy in dentin hypersensitivity.



**Keywords:** Dentinal hypersensitivity, low level laser therapy.


## INTRODUCTION

Dentine hypersensitivity associated with the neck of the tooth is the enigma amongst all the odontological problems associated with pain which has a difficult solution for the dentist. Dentine Hypersensitivity (DH) is an abnormal response of the exposed vital dentine to thermal, chemical, or tactile stimuli, and which cannot be ascribed to any other form of dental defect or pathology.[1] DH affects one in every seven adult patients, affecting both the sexes with no significant difference and the most affected age group is 20–30 years old.[2] Cervical areas of buccal surface of canines and premolars have a larger frequency of occurrence of this disorder than other teeth.[3] The occurrence of DH is due to the denudation or alteration of the outer layer of the tooth i.e enamel and / or root cementum by processes that include attrition, abrasion and erosion, or by radicular denudation as a result of gingival recession, any periodontal disease or any post periodontal surgery.[4]

Although different theories have been proposed for the mechanism involved in DH etiology like neural theory, odontoblastic theory but recent studies gave support to Brannstrom's hydrodynamic theory, which states that, a stimulus applied to open dentinal tubules, increases the flow of dentinal tubular fluid, with mechanical deformation of the nerves located into the inner ends of the tubules or in the outer layers of the pulp. Type A delta fibers are supposed to be responsible for dentinal sensitivity being probably activated by the hydrodynamic process.[5-6]

In order to eliminate such discomfort for patients, different treatment modalities having several substances like desensitizing pastes, varnishes, sealants (i.e for both home and office technique) iontophoresis, fillings have been tested. Most of the treatment modalities have aimed to block exposed dentinal tubules, but none of these treatments has produced consistently effective or long-lasting results without any black points. Seeking a solution for this problem, keeping in mind all the requirements and black points of the previously used treatment solutions or agents and also considering the technological development, the laser therapy was introduced as an alternative for the management of dentin hypersensitivity.

Laser ( acronym for LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION) therapy was first introduced as a potential method for treating DH in the mid-1980s.[8] Various types of laser used in treatment such as low-power lasers are He-Ne (632.5 nm), diode lasers (DLs) with various wavelengths 810, 940, and 980 nm, and medium-power lasers as Nd: YAG (1064 nm), CO2 (10600 nm), Er: YAG (2940 nm), and Er, Cr: YSGG (2780 nm). In these lasers, He-Ne (632.5 nm) and Diode Lasers have analgesic effect, they can have effect alone or in combination with desensitizing agents.

The desensitizing effect of the high power laser is thought to be related to the occlusion or narrowing of the dentinal tubules. These effects of these lasers are related to an increase in surface temperature which can result in the complete closure of dentinal tubules after recrystallization of the dentinal surface. According to hydrodynamic theory, such occlusion could mediate stimulus transmission from the dental surface to the pulp.[9] Low-level laser therapy (LLLT) is a sensitizing method to promote biomodulatory effects, minimize pain and reduce inflammatory processes that shows a great promise. This treatment induces alterations within the net of nerve transmission of the dental pulp, instead of altering the exposed dentinal surface, as in most other types of treatment. LLLT has been used for DH since the 1980s. Studies using the gallium aluminum arsenide (GaAlAs) laser showed DH reduction in the range of 60%–98%. The aim of this paper is to review effects and critically discuss most relevant aspects related to LLLT( Low level laser therapy) in minimizing dentinal pain.

**LLLT and its Clinical Applications**

The application of low-level lasers in medicine was introduced in the 1980s. Since then considerable scientific work including the use of cell cultures, animal models and clinical studies has been undertaken to evaluate its potentially beneficial effects. The application of LLLT has become popular in a variety of clinical applications, including promotion of wound healing and reduction of pain. Low level laser applications in dentistry include the promotion of wound healing in a range of sites, like surgical wounds, extraction sites, recurrent aphthous ulcerations, etc. Applications of LLLT in dental and periodontal treatments represent the subject of many in vivo and in vitro studies, which recommend the use of laser therapy after gingivectomy and gingivoplasty procedures due to its ability to speed up the healing process.

The low-level lasers facilitate fibroblast and keratinocyte motility, collagen synthesis, angiogenesis and growth factors release, thus facilitating the healing process. This therapy has been used in pain management protocols following gingivectomies, and as an adjunct treatment in nonsurgical periodontal procedures.[13-14] Low-level laser therapy (LLLT) has also been considered as an alternative treatment option for pain in dentinal hypersensitivity. Kimura et al. summarized the current knowledge regarding laser applications for the treatment of dentin hypersensitivity.[15] Several other studies evaluated the effectiveness of the clinical use of diode lasers for the treatment of dentin hypersensitivity and reported their use as effective in reducing dentinal hypersensitivity.[16-22] Three wavelengths (780, 830, and 900 nm), all within the infrared spectrum of (galium-aluminium-arsenide) GaAlAs diode laser, have been used for the treatment of dentin hypersensitivity.

**Different Low Level Lasers for Dentinal Hypersensitivity**

Low power output laser therapy was initially used to support wound healing . Subsequently, in the 1980s, the benefit of LLLT delivery systems were used as an anti-inflammatory tool. After that, it was demonstrated that LLLT systems stimulates nerve cells in a clinical environment.[23-25]

The low level lasers used for the treatment of dentinal hypersensitivity are of two types:

1. (He-Ne) Helium neon laser (632nm)
2. (Ga-Al-As) Gallium aluminium arsenide or diode laser (655nm to 980nm)

**(He-Ne) Helium neon laser (632nm)**

The first low-level laser introduced was helium-neon (He-Ne), which combined a gaseous mixture to produce a wavelength in the visible light spectrum ($\lambda$ = 632.8 nm) and low power output (ranging from 5 mW to 30 mW). Since the wavelength produced by He-Ne laser was highly absorbed by soft tissues, its penetration was limited. The first use of this laser for the treatment of dentine hypersensitivity was reported by Senda et al. (1985), then, consecutively by several other investigators.[26] Irradiation modes were two types: pulsed (5 Hz only) and continuous wave (CW) mode. The laser tip has to be placed as close as possible to the tooth surface in noncontact mode. The mechanism involved is mostly unknown. Treatment effectiveness rates of He-Ne laser ranges from 5.2%– 100% based on different studies. According to physiological experiments, He-Ne laser irradiation does not affect peripheral A-delta or C-fiber nociceptors, but does affect electric activity (action potential) which in the healthy nerve increased by 33% following a single transcutaneous irradiation.[27-28] This was found to be a long-lasting effect, inducing an increase in the size of nerve action potential for more than 8 months after cessation of irradiation. He-Ne laser irradiation at 6 mW does not affect the enamel or dentin surface morphologically, but a small fraction of the laser energy is transmitted through enamel or dentin to reach the pulp tissue. With low power-output lasers, there is no danger of causing skin burns or damaging cells.[29-31]

**Fig 1: He-Ne laser device**

**Indications:** Mild cervical dentin hypersensitivity (score 1) is only one indication (acc. To VAS score). In the cases of moderate or severe dentin hypersensitivity (score 2 or 3), the effects cannot be expected.

**Parameters:** 6 mW and 5 Hz or continuous wave (CW) mode for 2 to 5 minutes.

**Technique:** The laser tip has to be placed as close as possible to the tooth surface in non contact mode. The irradiation is applied to the same tooth surface without scanning. The examination of change of dentin hypersensitivity is carried out every 30 minutes until the dentin hypersensitivity decreases.[32-38]

**(GaAlAs) Gallium-Aluminium-Arsenide laser or Diode laser**

Diode lasers are usually variants of gallium:aluminum:arsenide (GaAlAs), which emit in the near infrared spectrum (780 nm, 830 nm, and 900 nm; power output from 20 to 100 mW), or indium:gallium:arsenide:phosphorus (In:Ga:As:P) devices, which emit wavelengths in the red spectrum of visible light (600 to 680 nm, power output from 1 to 50 mW). In their early stages of development, GaAs systems were difficult to run for long periods in a CW mode because of the propensity of the chip to overheat. However, by

1979, experiments using a new diode were looking very promising. This new chip, which used wafer-thin crystals of GaAlAs, could produce a variety of wavelengths from 720 to 904 nm, all within the infrared spectrum. It could also generate a continuous wave with no likelihood of overheating. Mainly four wavelengths (780, 790, 830, and 900 nm) of GaAlAs laser have been used for the treatment of dentin hypersensitivity. New diode lasers were developed in the attempt to obtain slightly higher power output and wavelengths that could penetrate soft tissues without damaging them.

**Indications:** Mild and moderate dentin hypersensitivity (score 1 and 2) are indications.

**Parameters:** The laser devices of 3 W with the wavelength of 810 nm (Osada, Tokyo, Japan) and 0.5- 20 W with the wavelength of 805 nm (Panasonic, Osaka, Japan) are sold now. The 3 W power output device is a CW laser device, and the 0.5-20 W power output device is CW or pulsed mode, with a pulse width range from 0.003 to 0.2 s. As the guide beam, a semiconductor laser of the 635 nm wavelength and 1 mW power is used.

**Technique:** In order to prevent thermal damage to the dental pulp by lasers, the laser tip is kept more than 5 cm from the tooth surface. Furthermore, when the patient feels pain, the laser tip has to be scanned quickly over the tooth surface. Sometimes, the air spray is also used for preventing a temperature rise on the surface during laser irradiation.


**Fig 2: GaAlAs laser (Diode Laser)**

**Mechanism of pain reduction by Low Level Lasers**

The desensitizing mechanism obtained with LLLT is as yet elusive. It is believed that low-level therapy lasers stimulate nerve cells, interfering with the polarity of cell membranes by increasing the amplitude of the action potentials of cellular membranes, thus blocking the transmission of pain stimuli in hypersensitive dentin. It seems that the low output lasers mediate analgesic effects due to depressed nerve transmission.[39-40]

Also according to the recent literatures, the low absorbed energy by the dentin surface (via its mineral such as phosphate and carbonate) leads to heat accumulation, which gradually increases the surface temperature (Ying, Gao et al., 2013).[41] This results in denaturation and modification of organic matrix layer with an amorphous form and hence DTs sealing (Marchesan, Brugnera-Junior et al., 2008).[42]

**DISCUSSION**

Low-power laser therapy is an appropriate treatment strategy to promote biomodulatory effects, minimize pain and reduce inflammatory processes. Its use has been widely accepted and approved due to satisfactory results reported in the literatures. Although the desensitization mechanisms produced by HLLT i.e high-power lasers, such as the carbon dioxide, Nd:YAG, Er:YAG and Er,Cr:YSGG lasers have been widely discussed, are related to an increase in surface temperature which can result in the complete closure of dentinal tubules and image analysis also detected obliteration of tubules after laser irradiation.[43] Specials concern when deciding to use laser irradiation in the management of hypersensitive dentin are the precise irradiation parameters required for therapeutic laser effects and standardization of treatment protocols. Defined and appropriate parameters are extremely important to produce the effects desired. Different outcomes may be produced depending on the parameters employed.[44-47]

Low-level laser therapy is more effective than high energy irradiation. LLLT have no adverse effects have been reported with the use of such therapy to treat hypersensitive teeth. In addition to the biological effect of increasing the potential of action of the pulp tissue, authors emphasize that low energy wavelengths produced by LLLT are safer to the pulp because they stimulate circulation and cellular activity. However, LLLT does not produce any changes in mineralized tooth substrate. Due to the individual differences observed in response to the laser therapy, additional sessions of LLLT may be necessary in order to obtain a positive result. Since low-level energy irradiation is mostly related to biostimulation and analgesia, it seems obvious that such effects are mainly temporary. The role of the "soft laser" as a therapeutic tool is a contentious issue. According to WilderSmith, clinical trials demonstrated no advantage in replacing conventional treatment of hypersensitive dentin with low-level laser therapy, despite its positive effect on patient attitude toward treatment. Contrasting results, however, have supported LLLT. WilderSmith reported that more positive effects were observed right after the first low-level laser irradiation, whereas cumulative effects and a gradual improvement from visit to visit should be expected.[48-51]

In double-blinded studies this may be particularly true, when information given at the beginning of the study may influence patient's perception toward the treatment. Pulpal effects of the laser devices previously discussed have been investigated in various studies. The GaAlAs laser at a wavelength of 780 nm, and a power output of 30 mW for 3 min caused no thermal or other damage to pulp tissues in monkeys.[52] According to an in vitro thermometric study, GaAlAs laser irradiation at the parameters of 30 mW (CW) at 780 nm wavelength, 60 mW (CW) at 830 nm wavelength, and 10 W (pulsed) at 900 nm wavelength do not cause significant intrapulpal temperature rises.[53]

The LLLT assisted treatment of dentine hypersensitivity is a good method to solve immediate and long term pain, compared to conventional desensitizing topical agents and the high level laser treatment. It is although more expensive but leads to rapid results with less application time and more quickly for the patient. In most of the articles, fluoride gel or desensitizing substances used in combination with LLLT can potentiate effects. The same line of reasoning is considered valid for the association with desensitizing pastes. New substances as cyanoacrylate, glutaraldehyde and potassium binoxalate are spreading for the properties to stimulate laser beneficial effects and they can be used alone as preventative measures in patients with mild hypersensitivity. However, the effectiveness of these treatments has clashed sometimes with the existence of a placebo effect. In the majority of studies, patients have a decrease in VAS from baseline both immediately and over time, till six months after treatment. The diode laser appears to be the most widely used in everyday practice by dental hygienists and dentists. Studies are clarifying the follow-up results within the interference of the placebo effect. However, in vitro studies confirm a real effectiveness of these lasers. Thanks to the SEM analysis, the percentage of occlusion appears to be complete and the diameter of dentinal tubules reduced.

**CONCLUSION**

LLLT, due to its reduced side effects can be considered as an effective treatment for the dentinal hypersensitivity. All the parameters for the treatment are already set up by the manufacturer and supplied with specific protocols for each treatment. In consideration with all the literatures, it can be said that low level laser is an innovative and faster treatment both in terms of therapy time and results, with minimal side effects and greater comfort for patients, which appear more satisfied with traditional methods. Although it would seem that the LLLT effectively reduces pain symptoms, further studies and more suitable follow-ups are necessary.

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