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Review Article

ROLE OF LASERS IN DENTIN HYPERSENSITIVITY: A REVIEW

Jain Sachin[1], Jain Shweta[2*], Jain Shikha[3], Dogra Shikha[4], Gaurav[5]

Reader.Dept. of Conservative Dentistry & Endodontics, IDST Dental College, Meerut, India
[2]Senior Lecturer, Dept. of Conservative Dentistry & Endodontics, KALKA, Dental College, Meerut, India
[3]Reader, Dept of orthodontics, PDM dental college, Bahadurgarh, India
[4]Reader, Dept of paedodontics, College of dental science, amargadg, Bhavnagar, India
[5]Senior lecturer, Dept of oral medicine, UDMRI, Dehradhun, India

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*Corresponding Author: **Dr Shweta Jain**
Senior Lecturer Dept. of Conservative Dentistry & Endodontics KALKA, Dental College, Partapur by-pass road, Meerut, India

ABSTRACT

Dentine hypersensitivity is sensation felt when the nerves inside the dentin of the teeth are exposed to the environment. The sensation can range from irritation all the way to intense, shooting pain. This sensitivity can be caused by several factors, including wear, decaying teeth or exposed tooth roots. Changes in the flow of the plasma-like biological fluid present in the dentinal tubules can trigger mechanoreceptors present on nerves located at the pulpal aspect thereby eliciting a pain response. Years ago, we were saying, "Potassium nitrate this and flouride that." It was the only way we knew to prevent root sensitivity. We told our patients they had to use the toothpaste for at least three weeks before they would feel relief from root sensitivity. The next generations of agents to provide root sensitivity relief were flouride varnishes, the products known as Duraphat, Super Seal, Gluma, etc. With the advent of laser technology and its growing utilization in dentistry, an additional therapeutic option is available for the treatment of dentinal pain. The laser, by interacting with the tissue, causes different tissue reactions, according to its active medium, wavelength and power density and to the optical properties of the target tissue This article discusses the effect of various lasers on dentin hypersensitivity and its effect on the pulp and management and prognosis.

Keywords: Dentin Hypersensitivity, Dentin Tubules, Lasers.

INTRODUCTION

Tooth hypersensitivity is a complex etiopathological syndrome that results in discomfort to a person in the form of pain in a tooth or teeth. The problem of hypersensitivity of teeth existed since historical times and is still prevalent with no specific treatment yet established. It is said that every seventh human is suffering from tooth hypersensitivity at any given time[1]. A person suffering from dentine hypersensitivity is under continuous stress from the fear of getting it with the slightest of stimulus, like thermal, osmotic etc., which can affect his or her daily life.

There has been extensive study and experimental work done to treat this condition. Some success has been achieved regarding the understanding of its mechanism and treatment. After finding that its mechanism is directly related to the permeability of dentine, tooth hypersensitivity is also known as 'Dentine Hypersensitivity', which is characterized by short, sharp pain arising from exposed dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other dental detector pathology[2].

As a health professional, it is necessary to understand tooth hypersensitivity in depth and to develop a scientific approach to treat this condition in a clinical set up for the sake of providing ideal health to the patient.

ETILOGY AND PREDISPOSING FACTORS:

The primary underline cause for Dentine Hypersensitivity (DH) is exposed dentinal tubules. Microscopic examination reveals that patent dentinal tubules are more numerous and wider in hypersensitive dentin than in nonsensitive dentin[3,4]. The most common clinical cause for exposed dentinal tubules is gingival recession; it leads to exposure of root dentine and cementum, which is more susceptible to wear[5]. Other causes include Abrasion, Attrition, Erosion, Abfraction, certain Intrinsic (recurrent vomiting, regurgitation), Extrinsic (occupation, diet, medicaments),. DH is more frequently encountered in patients with periodontitis[6] and transient hypersensitivity may occur after periodontal procedures such as deep scaling, root planing or gingival surgery.

Hypersensitivity also may occur after tooth whitening and restorative procedures[7].

MECHANISM

By far most accepted theory is Hydrodynamic theory proposed by Brannstorm and co-workers. In the hydrodynamic sequence, a pain-provoking stimulus applied to dentin increases the flow of dentinal tubular fluid. In turn, this mechanically activates the nerves situated at the inner ends of the tubules or in the outer layers of the pulp. Cooling, drying, evaporation and hypertonic chemical stimuli that stimulate fluid to flow away from the pulp more effectively activate intradental nerves than do stimuli such as heating or probing that cause fluid to flow toward the pulp[8,9].

Management

Classifying treatments for DH can be challenging because its modes of action often are unknown. It can be simpler to classify treatments according to their mode of delivery. Treatments can be self administered by the patient at home or be applied by a dental professional in the dental office. At home methods tend to be simple and inexpensive and can treat simultaneously generalized DH affecting many teeth. In-office treatments are more complex and generally target DH localized to one or a few teeth[10,11].

In Office Treatment for hypersensitive dentine[12]

I. Treatment agents that do not polymerize

A) Varnishes/Precipitants

1 Shellacs
2 5% sodium fluoride varnish
3 1% NaF, 0.4%SnF2, 0.14% HF solutions
4 3%Mono-potassium –mono-hydrogen oxaalate.
5 6% acidic ferric oxalate.
6 Calcium phosphate preparations
7 Calcium hydroxide

II. Treatment agents that undergo settings of polymerization reactions

A) Conventional glass ionomer cements
B) Resin reinforced glass ionomers /compomers
C) Adhesive resin primers
D) Adhesive resin bonding systems

III. Use of mouth guards
IV. Iontophoresis
V. Lasers

LASERS

With the advent of laser technology and its growing utilization in dentistry, an additional therapeutic option is available for the treatment of dentinal pain. The laser, by interacting with the tissue, causes different tissue reactions, according to its active medium, wavelength and power density and to the optical properties of the target tissue.

The laser photobiomodulating action in the dental pulp was reported by Villa et al. with histological studies of dental pulp of mice after irradiation with laser, in teeth previously eroded with high rotation in order to expose the dentine. The profiling of the odontoblasts was observed, showing evidence of a large quantity of tertiary dentine production, causing the physiological obliteration of the dentinal tubules. The non-irradiated control teeth showed intense inflammatory process that, in some cases, evolved to necrosis.

The immediate analgesic effect in the treatment of dentine hypersensitivity with diode laser was reported by Brugnera Júnior et al[16], with an improvement index of 91.29% in 1102 treated teeth, operating in different bands of wavelength, 780 nm and 830 nm, and different power densities of 40 mW and 50 mW, but maintaining the same energy density deposited per dental element of 4 J/cm^2.

According to the consulted literature, both red and infrared wavelength lasers have been effective in the treatment of dentine hypersensitivity. They are physical methods which, even operating at different bands of wavelength, cause the dentine-pulp complex to respond to the irradiation with the obliteration of the dentinal tubules by the means of specific biological mechanism. The laser interaction with the dental pulp causes a photobiomodulating effect, increasing the cellular metabolic activity of the odontoblasts and obliterating the dentinal tubules with the intensification of tertiary dentine production.

The laser used for treatment of dentinal hypersensitivity are divided in to two groups;

1 Low output power lasers [He-Neand gallium/ aluminium/arsenide. (GaALAs) lasers]
2 Middle output powers lasers9Nd; YAG and CO_2 lasers. Several authors investigated the He Ne laser emmiting at 632.8nm (Senda et al.1985, Matsumoto et al. 1986, Gomi et al. 1986, Wilder smith 1988b) parameters used for the treatment of dentinal hypersensitivity approximate 6mW for 1-3 min. effectiveness could be up to 90%.

- Using GaALAs laser-wavelength used were 780nm (mastumoto et al. 1985a,b, Kawakami et al. 1989, Gerschman et al.1994) & 830nm (Hamachi et al.1992, Mezawa et al.1992). Parameter used were 30Mw for .5-3min.effectiveness rated up to 80%.
- The Nd:YAG laser (wavelength of 1.064µm)was first investigated by Matsumoto et al.(1985c),then also by others (Renton-harper&Midda1992,Gelskey et al. 1993, Lan & liu 1996),total output energy ranged from 1.8 to 25J.effectiveness rates averaging 72%.
- Mortiz et al. (1996) reported the treatment using Co2 laser, followed by others. (Mortiz etal.1998a, Zhang et al 1998a), output powers ranged from .5-3W, and a success rate over 90%.

MECHANISM

Mostly unknown, but it is thought that the mechanism for each laser is different, in case of low power lasers (He-Ne & GaALAs lasers),

- He-Ne laser irradiation may affect the electric activity (action potential) and not affect pheripheral Að or C- fiber nociceptor (Rochkind et al.1987, Jarvis et al.1990).
- GaALAs laser radiation at 830nm has a pain suppressive effect by blocking the depolarization of C- fiber afferents (Wakabayashi et al.1993); GaALAs laser emission at 904nm have an anaelgesic effect on the cat tongue although mechanisms remain unclear (Mezawa etal. 1988). Pulpal effects: GaALAs laser at wavelength of 780nm, and an output power of 30 mw for 3 min caused no damage to pulp tissues in monkeys (Mastumoto et al 1985d).

- Laser energy at 1064nm (Nd:YAGlaser) is transmitted through dentine (Zennyu et al 1996),indicated thermally mediated effects (Funato et al.1991), & pulpal analgesia(Whitters et al.1995).the sealing depth achieved by Nd:YAG laser irradiation on dentinal tubules measured less than 4µm(Liu et al.1997) Pulpal effects: After exposure to the Nd:YAG laser ,no histologically measurable response was observed using a power of 50Mj/pulse at 10Hz for 30s (total energy:15J) (White et al.1995).At an output power of 10W for .3 s in the continuous wave mode (total energy density 31J CM-2.), the pulp showed exudative inflammatory changes with hyperemia and focal degeneration of the odontoblast immediately after irradiation (Nakamura 1987).
- Using CO_2 laser energy at moderate laser energies, mainly sealing of dentinal tubules is achieved, as well as reduction of permeability (Bonin et al 1991).CO_2 laser irradiation may cause dentinal desiccation, yielding temporary clinical relief of dentinal hypersensitivity (Fayad etal.1996).

  Pulpal effects: no damage was reported after pulpal exposure to 3W of power for 2s in the continuous wave mode using monkeys and dogs (Melcer et al.1985)[13,14].

Lasers	Parameters	Effective rate (%)	References
He–Ne	6 mW for 2–3 min	84	Senda *et al.* 1985
(632.8 nm)	6 mW for 1–3 min	90	Matsumoto *et al.* 1986
GaAlAs	30 mW for 0.5–3 min	> 85	Matsumoto *et al.* 1985a, b
(780 nm)	30 mW for 0.5–3 min	94.6	Kawakami *et al.* 1989
GaAlAs	30 mW for 0.5–3 min	83.9	Hamachi *et al.* 1992
(830 nm)	30 mW for 5 min	58	Mezawa *et al.* 1992
Nd:YAG	10 W for 0.5–2.5 s	100	Matsumoto *et al.* 1985c
(1.064 µm)	10–100 mJ/p for 2 min	100	Renton-Harper & Midda (1992)
CO_2	0.5 W for 5–30 s	98.6	Moritz *et al.* 1996
(10.6 µm)	1 W for 5–10 s	100	Zhang *et al.* 1998a

RECENT ADVANCES

Recently a laser toothbrush has been launched

Laser Toothbrush against dentin hypersensitivity!

The laser toothbrush ("Dr. M") is the world's first semiconductor medical toothbrush that utilizes low-level laser therapy (LLLT).

- This medical device treats dentin hypersensitivity (shooting tooth pain) and alleviates toothaches with its safe, low-level, semiconductor laser that works directly on the affected part of the mouth. (Clinical studies are complete.)
- Its laser technology also prevents various dieases caused by infectious bacteria, allowing the user to maintain oral hygiene and healthy teeth.
- All functions of the laser toothbrush "Dr. M" are controlled by a built-in micro-computer (micom). When the Mode Switch is pressed, the device turns on for 5 minutes and automatically deactivates, reverting to Sleep Mode for battery conservation.
- It is easy and comfortable to use with its ergonomic and weatherproof design.
- Its replacement brush heads makes this device highly economical and affordable. It runs on one 1.5 V AA battery

Dentin hypersensitivity in most cases is related to exposure of root surface by recession of gums. A tooth with dentin hypersensitivity has dentinal tubules twice the size of a normal tooth's dentinal tubules. The purpose of (**Dental. M**®) is to treat hypersensitivity by reducing the enlarged diameter of the affected dentinal tubules. Each treatment takes five minutes while brushing your teeth. For the best results, it is recommended to use**(** Dental**. M)** on problem area two to three times per day over a period of four to six weeks, 3 minutes treatment including teeth cleaning.

Clinical trial of the Laser Toothbrush

Following clinical trials are adopted in order to prove the effects of the Laser Toothbrush.
Title: A comparative, Multi-Center, Double Blind, Randomized Clinical Trial to Assess the Safety and Efficacy of the Laser Toothbrush, a "Low-Level Laser Therapy Toothbrush" for the Treatment of Dentin Hypersensitivity.

Facilities and directors of the clinical trial:

- Kook Yoon-ah, Associate Professor, The Catholic University of Korea, Seoul
- St. Mary's Hospital and Baek Seoung-hak, Associate Professor, Seoul National University Dental Hospital

Clinical Trial Results

In the reference, dentin hypersensitivity patients visited a hospital and received low-level laser therapy from a medical specialist. The best result they found was 3.17. Our clinical trial statistics resulted in a score of 2.44, which is 77% of the best result obtained by a medical specialist. Therefore, it was evaluated that treatment of Dentin Hypersensitivity using the Laser Toothbrush is effective[16].

CONCLUSION

With the LASER application on patients, the most important benefit of this revolutionary technology for treatments is the ease of using the system and the great degree of patient comfort during and after the procedure. Furthermore, postoperative complications such as inflammation and pain

were significantly reduced. All of these factors help to improved patients' attitudes toward dentistry.

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