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# Diode Laser as an Adjunct to Novamin versus Diode Laser Alone: As Troubleshooter in Dentinal Hypersensitivity- A Split-Mouth Clinical Study.

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**_Abstract:_**
***Introduction:*** *Dentine hypersensitivity (DH) is characterized by pain after stimuli that usually provoke no symptoms. This study compared the effectiveness of GaAlAs diode laser alone and with topical calcium sodium phosphosilicate (Novamin).*
***Materials and Methods****: The study was conducted on 10 patients (age 18–60) and 60 teeth with DH assessed by air and tactile stimuli measured by Numeric Rating Scale (NRS). Teeth were randomly divided into Group A (30 teeth) treated by with calcium sodium phosphosilicate (Novamin) applied for 60 seconds on tooth surface, followed by diode laser (980 nm) application for 1 minute each; Group B(30 teeth) lased by a diode laser (980 nm) : 0.5W in no contact mode. Each site will receive 2 applications of 1 minute each once a week for 2 weeks. Both air and tactile stimuli evaluations were performed before and after every treatment session. Pre and post treatment air and tactile stimuli was measured by Numeric rating scale (NRS) at baseline, 1 week & 1 month.*
***Results****: Both the groups registered significant improvements of discomfort. A reduction of DH occurred during the treatment sessions and the positive values were maintained 1 month. Comparing the regimens, a higher decrease of DH was registered in Group A followed by Group B.*
***Conclusion****: Diode laser is a useful device for DH treatment if used alone and mainly if used with calcium sodium phosphosilicate (Novamin).*

## I. Introduction

Dentin hypersensitivity (DH) is one of the most commonly encountered clinical problem and 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 due to any other dental defect or disease. Its incidence ranges from 4% to 74%. A slightly higher incidence reported in females than in males. While DH can affect the patient of any age, most affected patients are in the age group of 20–50 years, with a peak between 30 and 40 years of age. Regarding the type of teeth involved, canines and premolars of both the arches are the most affected teeth. A buccal aspect of the cervical area is the commonly affected site[1].

Etiologic factors for DH include gingival recession and enamel loss, both conditions resulting in exposure of underlying dentin. Overzealous tooth brushing and surgical or nonsurgical treatment of periodontal disease are predisposing factors for gingival recession, whereas enamel loss may be related to tooth wear by attrition, erosion or abrasion[2]. The most common clinical cause of DH is gingival recession, which exposes the root surface due to periodontal treatment, surgical/dental operative procedures, gum diseases, aging and incorrect tooth brushing or association of two or more of these factors.Other factors include patient's deleterious habits, poor hygiene and diet, exposure of teeth to chemical products, excessive occlusal forces and premature occlusal contacts[3].

The exact mechanism of dentinal hypersensitivity is not very clear but several theories have been proposed to explain the phenomenon: 1) Direct innervation theory which states that nerve fibers present within the dentinal tubules induce impulses when they are injured, hence causing dentinal hypersensitivity. 2) Odontoblast deformation theory/Transducer mechanism suggests that dentinal hypersensitivity is caused due to damaged odontoblasts or their processes when external stimuli are applied to the exposed dentin. They conduct impulses to the nerves in predentin and underlying pulp from where they proceed to central nervous system where these impulses are relayed as pain; but these theories are not well accepted succumbing to their own limitations. The most accepted theory amongst the proposed is the theory given by Branstorm. 3)Hydrodynamic Theory which states that when dentinal tubules are exposed to the oral environment, fluid within the dentinal tubules may flow in either inward or outward direction depending on the pressure differences in the surrounding tissue. These intratubular fluid shifts, in turn activate mechanoreceptors in intratubular nerves or in the superficial pulp and are perceived as pain by the patient. Type A fibres, both A delta and A beta are supposed to be responsible for dentinal hypersensitivity being activated by the hydrodynamic process[4].

A simple clinical method of diagnosing DH includes evaporative or "air blast" method or using an exploratory probe on the exposed dentin, in a mesiodistal direction, examining all the teeth in the area in which the patient complains of pain. The severity or degree of pain can be quantified either according to the scale (i.e., slight, moderate or severe pain)[1]

Open dentinal tubules create hypersensitivity because of hydrodynamic mechanism. This is based on Hagen- Poisuelle equation wherein, the fluid flow in dentinal tubules is directly proportional to the fourth power of the diameter of dentinal tubules. Achieving this occlusion will have benefits by decreasing the diameter of the dentinal tubule and hence reducing the dentinal fluid flow, thereby reducing dentin hypersensitivity. This can be done by creating a smear layer by burnishing of the tooth structure. Dentin bonding agents or other polymeric coatings can also be applied to seal these spaces. Fine abrasive particles, based on strontium, stannous and calcium phosphate also forms physical barriers and occludes dentinal tubules[5]. Products for the management of DH typically aim to control the hydrodynamic mechanisms of pain. Two basic desensitization techniques are used as means for the treatment: desensitization by occluding the dentinal tubules by formation of smear layer on the exposed area. This can be achieved by using agents like calcium hydroxide, hydroxyapatite, silver nitrate, strontium chloride, by means of using hard tissue lasers or fluoride iontophoresis. The second technique is by blocking the pulpal sensory nerves with agents like silver nitrate[4].

Bioactive glass (NovaMin) is a material in aqueous solutions; the bioactive composition (45%$SiO_2$, 24.5%$Na_2O$, 24.5% CaO and 6% $P_2O_5$) forms silicate and calcium phosphate rich layers. CSPS is a bioactive glass and when exposed to body fluids, it reacts and deposits hydroxycarbonate apatite (HCA), a mineral chemically similar to that in enamel and dentin[6]. Hence it could be used in treatment of dentinal hypersensitivity by occlusion of the open dentinal tubules. This "biomimetic: approach will make the dentin non-sensitive and sclerotic. NovaMin dentifrice was shown to be significantly more effective than both the strontium chloride and placebo control toothpastes after 6 weeks use. Furthermore, when dentin surfaces treated with NovaMin were exposed to 6% citric acid for 1 minute and artificial saliva for 24 hours, there was only partial loss in the occlusion, in contrast to potassium containing silica based pastes which showed complete loss.

Evidence has shown that lasers are also helpful for the management of dentinal hypersensitivity, with its effect on nerve analgesia and blocking of dentinal tubules. Its application in dentistry has opened a new realm for treatment and research. Inspite the variant treatment options available for treatment of dentinal hypersensitivity a consistently effective treatment has not been yet achieved. An attempt was made to combine two treatment modalities one, using commercially available desensitizing dentrifices and other using a low output laser along with combination of dentifrice.

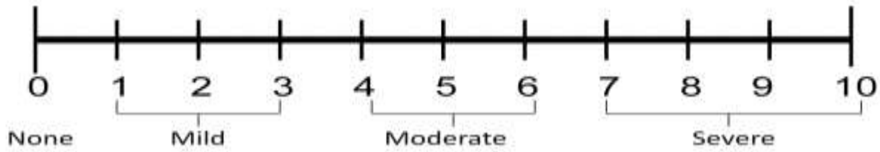
The aim of this study is to assess the efficacy of a diode GaAlAs laser alone and in combination with novamin in the treatment of DH in order to evaluate the possibilities of this device in the management of this painful condition.

## II. Materials and Methods

**2.1 Source Of Data:** Study population:10 Patients visiting the Department of Periodontics and Oral Implantology at A.M.E's Dental College and Hospital, Raichur**.**

**2.2 Sample Size:** Study sample comprises of 10 subjects with a total of 60 teeth with dentinal hypersensitivity (DH) that will be assessed by means of both air and tactile stimuli by numeric rating scale (NRS).

**Patient Numeric Rating Scale Questionnaire:** Numeric Rating Scale ( adopted from McCaffery, Beebe et al. 1989) will be used for evaluating pre treatment hypersensitivity scores and post treatment hypersensitivity scores. Patients who initially responded to the tactile and air stimulus with a score of ≥ 4 in the NRS will be included in the study**.**




**2.3 Inclusion Criteria:**
1. Patients aged between 18 to 60 years having at least 20 teeth.
2. Presence of minimum of 4 hypersensitive teeth.
3. Contraindications to the proposed therapies (e.g., allergies to desensitizing agents)
4. Presence of teeth with DH evaluated by pain response to both air and tactile stimuli that will be registered by NRS scale.
5. No desensitizing therapy had been previously performed.
6. No history of intake of analgesic drugs recently.

**2.4 Exclusion Criteria:**
1. Patients who had taken any kind of treatment for hypersensitivity previously.
2. Patients showing allergic reactions to calcium sodium phosphosilicate (Novamin).

**2.5 Study Design:**

The study was conducted on 10 patients (8 females and 2 males; aged from 25 to 60 years) visiting the Department of Periodontics and Oral Implantology at A.M.E's Dental College and Hospital, Raichur**.** A total of 60 teeth with dentinal hypersensitivity were assessed by mean of both air (Fig:1) and tactile stimuli (Fig: 2) measured by the Numeric Rating Scale (NRS). Patients who initially responded to the tactile and air stimulus with a score of ≥ 4 in the NRS (from 0 to 10, where 0 meant the absence of pain and 10 represented an unbearable pain and discomfort felt by the patients in their life) were included in the study**.**

For each patient, the sensitive sites were randomly divided into two groups:
- Group A (30teeth) will be treated with calcium sodium phosphosilicate (Novamin) applied for 60 seconds on tooth surface, followed by diode laser (980 nm) application for 1 minute each once a week for 2 weeks with these parameters: 0.5W in no contact mode.
- Group B (30 teeth) lased by a Diode laser (980 nm) : 0.5W in no contact mode. Each site will receive 2 applications of 1 minute each once a week for 2 weeks (figure3).

Patient's response to cold air blast was assessed by a short blast of 1-second duration at a distance of 0.5 cm for each tooth. Both air and tactile stimuli evaluations were performed before and after every treatment session. Pre and post treatment air and tactile stimuli was measured by Numeric rating scale (NRS) at baseline,1 week & 1 month.


**Fig 1:** Air stimulus application


**Fig 2:** Tactile stimulus application

**Fig 3:** Diode laser application

## III. Statistical Analysis

Descriptive statistics, including mean and standard deviation, were calculated for each group. Intervisit-intergroup comparisons were done by Mann-Whitney test and intervisit-intragroup comparisons were done by Kruskal Wallis test. Data were stored in a database and were analyzed using Statistical Package for Social Sciences (SPSS) for Windows version 16th (SPSS version 16, Chicago, Illinois). The level of significance was considered for values of $p < 0.05$.

## IV. RESULTS

Both the groups registered significant improvements of discomfort. A reduction of DH occurred during the treatment sessions, and the positive values were maintained 1 month (Tables 1, 2 & Fig:3). Comparing the regimens, a higher decrease of DH was registered in Group A followed by Group B.The results obtained with the cold blast showed a statistically significant difference in each treated group (*P* value 0 .00009). The improvement obtained in the samples of the probe test was also statistically significative (*P* value 0.00009) in each group. However, inter group comparison was statistically significant only in cold blast test.

**Table 1:** Chart of NRS pre-treatment, post treatment and 1 month control values of group A

| Pre air evaluation | Post air evaluation | Air control 1 month | Pre probe evaluation | Post probe evaluation | Probe control 1 month |
|---|---|---|---|---|---|
| 6 | 0 | 0 | 6 | 0 | 0 |
| 6 | 1 | 0 | 6 | 0 | 0 |
| 6 | 1 | 0 | 6 | 0 | 0 |
| 8 | 1 | 1 | 8 | 0 | 0 |
| 6 | 1 | 0 | 7 | 0 | 0 |
| 4 | 1 | 0 | 4 | 0 | 0 |
| 9 | 1 | 0 | 9 | 1 | 0 |
| 4 | 0 | 0 | 3 | 0 | 0 |
| 7 | 2 | 0 | 6 | 0 | 0 |
| 7 | 4 | 0 | 7 | 0 | 0 |

**Table 2:** Chart of NRS pretreatment, post treatment and 1 month control values of group B

| Pre air evaluation | Post air evaluation | Air control 1 month | Pre probe evaluation | Post probe evaluation | Probe control 1 month |
|---|---|---|---|---|---|
| 5 | 1 | 1 | 4 | 1 | 0 |
| 6 | 3 | 1 | 6 | 2 | 0 |
| 6 | 3 | 1 | 6 | 1 | 0 |
| 8 | 2 | 2 | 8 | 2 | 0 |
| 6 | 2 | 1 | 4 | 1 | 0 |
| 7 | 2 | 1 | 7 | 0 | 0 |
| 9 | 0 | 1 | 9 | 1 | 0 |
| 5 | 1 | 1 | 5 | 1 | 0 |
| 7 | 4 | 0 | 6 | 0 | 0 |
| 7 | 5 | 1 | 7 | 2 | 0 |

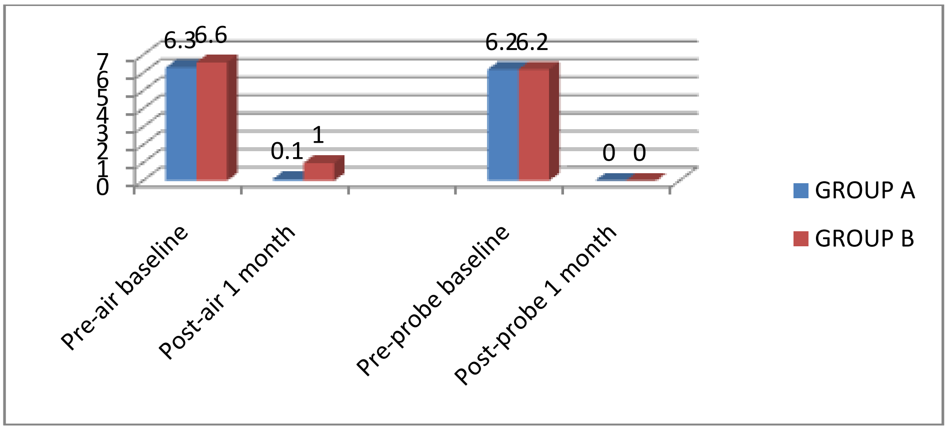



**Fig 4:** Illustrative representation of the improvement to air and tactile stimuli from baseline to 1 month

## V. Discussion

Dentin itself is a vital tissue consisting of dentinal tubules, and is sensitive because of extensions of odontoblasts and formation of dentine–pulp complex. DH develops in two phases: lesion localization and lesion initiation[4]. For DH to occur, the lesion localization has to be initiated. Dentine hypersensitivity (DH) is a common dental complaint which may have a profound effect on an individual's quality of life; however DH tends to be an underestimated condition due to underreporting by its sufferers and also the difficulty in diagnosing it. Dentinal hypersensitivity occurs after the protective covering of smear layer is removed, leading to exposure and opening of dentinal tubules. There are two basic modes to treat dentinal hypersensitivity: in office desensitizing therapy and home care methods[4]. Theoretically, the in-office desensitizing therapy should provide an immediate relief from the symptoms. The in-office desensitizing agents can be classified as the materials which undergo a setting reaction (glass ionomer cement, composites) and which do not undergo a setting reaction (varnishes, oxalates). Desensitizing toothpaste is the first line treatment of dentinal hypersensitivity[4]. Grossman listed the requirements for an ideal dentine desensitizing agent as: rapidly acting with long-term effects, non-irritant to pulp, painless and easy to apply and should not stain the tooth[7]. Traditionally, the therapy for management of DH was primarily aimed at occluding the dentinal tubules or making coagulates inside the tubules. Meta-analysis demonstrated that toothpaste containing 5% CSPS was more effective than the negative control at relieving dentin sensitivity, with the level of evidence classified as"moderate". In addition, prophylaxis paste containing 15% calcium sodium phosphosilicate was favored over the negative control at reducing post-periodontal therapy hypersensitivity with the level of evidence categorized as "low''[6].

**Mechanism of Action of Novamin:**

The reaction of NovaMin particles begins when the material is subjected to an aqueous environment. Sodium ions (Na+) in the particles immediately begin to exchange with hydrogen cations (H+ or H3O+). This rapid release of ions allows calcium (Ca+) ions in the particle structure, as well as phosphate (PO4 3–) ions to be released from the material. This initial series of reactions occurs within seconds of exposure, and the release of the calcium and phosphate ions continues so long as the particles are exposed to the aqueous environment. A localized, transient increase in pH occurs during the initial exposure of calcium and phosphate ions from the NovaMin particle, along with calcium and phosphorus found in saliva, to form a calcium phosphate (Ca-P) layer. As the particle reactions continue and the deposition of calcium and phosphorus complexes continue, this layer crystallizes into hydroxycarbonate apatite which is chemically and structurally equivalent to biological apatite. The combination of the residual NovaMin particles and the newly formed hydroxycarbonate apatite layer results in the physical occlusion of dentinal tubules, which will relieve hypersensitivity. The biomimmetic property of novamine improves its efficiency in treating dentinal hypersensitivity[8].

Lasers which have been sought for the treatment of dentinal hypersensitivity belong to two basic categories : low output power (i.e. helium-neon and gallium/aluminium/arsenide lasers) and middle output power lasers, which include the neodymium yttriumaluminium- garnet (Nd:YAG) and CO2 lasers[9]. Low-level lasers (LLL) such as He-Ne, emitting visible spectrumred light at 630nm, or GaAlAs lasers at 780, 830, or 900 nm, are thought to act by increasing the action potential of the nerve cells, thereby limiting the transmission of pain stimulus. LLL do not modify the morphology of dentin tubules, whereas moderate-level lasers such as Nd-YAG, emitting infrared light at 1064 nm, stimulate secondary dentin production and seal open tubules, as well as having an immediate analgesic effect on nerve cells[2]. The efficacy of laser in dentinal hypersensitivity therapy can be related both to high-power, causing coagulation of fluids contained in the dentin tubules having a melting effect with crystallization of dentin inorganic component, and to the direct action of laser to low-power on nerve transmission with suppression of the pulp nociceptive nervous fibers, blocking diffusion of pain to the central nervous system[10]. Lasers act by different mechanisms. It acts on the biostimulation because of the increase in production of mitochondrial ATP, increasing the threshold of the free nerve endings, providing an analgesic effect due to the increase of b-endorphine (BENEDICENTI, 1982). The reduction of pain occurs because of the inhibition of the cyclooxygenase enzyme, which suspends the conversion of the arachidonic acid into prostaglandins. It increases the formation of a secondary dentin by the odontoblasts. It obliterates the dentin tubules. Various advantages of laser therapy include analgesic, bio-stimulant, anti-inflammatory effects, painless, safe, fast, conservative treatment, and it is well accepted by the patients. Limitations of laser therapy are high cost professional expertise and thermal side effects[10].

A study by Rajeshwari et al in 2015 concluded that both diode laser and calcium sodium phosphosilicate are effective in the treatment of dentinal hypersensitivity. Scanning electron microscopic study by Farmakis in 2012 showed laser irradiation alone and combined with novamine proved superior to novamin alone in dentinal tubule orifice occlusion. Kue and colleagues used dicalcium phosphate bioglass in combination with Nd:YAG laser in treatment of DH[13]. According to their study, this combination sealed dentinal tubules to a depth of 10 mm. In the present study combined treatment showed better results than when diode laser was used alone.

## VI. Conclusion

Dentin hypersensitivity may be considered an enigma. The pain is of a sharp nature and patients approach the dentist for permanent relief. From a review of the literature, it is noted that an effective treatment must be preceded by proper diagnosis established after the exclusion of any other possible causes of the pain. It is important to manage the cases efficiently, quickly and permanently. Although the presently available commercial desensitizing toothpaste formulations do not offer permanent relief, the recent technologies based on novamine appear promising. According to our knowledge this is the first kind of study where diode laser in combination with novamine has given encouraging and promising results when compared with diode alone in the treatment of dentinal hypersensitivity. It is possible to speculate that the laser-induced superficial melting permits to keep longer the tubules occlusion by novamin emphasizing the reduction of DH-related pain. In the study it is probable that the better performance of combined treatment was due to the higher novamin adhesion to the dentinal tubules when combined with laser energy. These results have to be confirmed by greater samples of patients and by longer follow-up periods (e.g., 3 and 6 months) to confirm or not the long-lasting action of the combined laser and novamin therapy.

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