Diode Laser And Calcium Sodium Phosphosilicate In The Management Of Dentinal Hypersensitivity

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ABSTRACT

Objective: Dentinal hypersensitivity (DH) is an abnormal response of the exposed vital dentine to thermal, chemical, or tactile stimuli. The prevalence of hypersensitivity has been reported ranging from 4% to 57% in the literature. So this study was aimed to compare the immediate effectiveness of diode laser alone and with topical calcium sodium phosphosilicate (CSPS) in management of DH.

Materials & Methods: Three groups were taken with 15 samples in each. Group A was treated with diode laser alone, Group B with diode laser and CSPS and Group C was given only topical CSPS. The 3 groups were assessed by air and tactile stimuli measured by Numerical Rating Scale before and after every treatment session for a total of 3 treatment sessions for 3 consecutive days.

Results: The collected data were subjected to paired ‘t’ test and independent t-test. Results showed that all the treatment groups reduced hypersensitivity immediately after the applications. Group B showed concrete decrease in DH than the other 2 groups.

Conclusion: Diode laser along with topical CSPS can be considered a very useful protocol for immediate relief from DH pain.

KEYWORDS
dentinal hypersensitivity, laser dentistry, diode laser, calcium sodium phosphosilicate.

INTRODUCTION

Dentinal hypersensitivity is an oral condition which is routinely encountered in daily dental practice. It is described as a short, sharp pain arising from exposed dentine in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other dental defects or pathology. [1] On the basis of the reports from various population based studies, the prevalence of dentinal hypersensitivity ranges from 4- 74%. [2-6]

Hypersensitivity can be localized to one tooth or may be generalized affecting many teeth with premolars and the buccal surfaces being commonly affected. [7]

Although various theories have been proposed to explain the mechanism of dentinal hypersensitivity, most of the studies validate the hydrodynamic theory by Brannstorm. [8] According to this theory, when an external stimulus is applied to open tubules dentin, there is an increase in 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.\cite{9}

The dentine of the tooth is covered by enamel and cementum in the crown and the root respectively. Once this enamel or the cementum is removed, the dentine is exposed which can produce hypersensitivity. This loss of enamel or cementum may be due to overzealous or improper tooth brushing, attrition, abfraction, erosion, parafunctions or occlusal disequilibrium.\cite{10}

Multiple treatment options have been used to treat dentinal hypersensitivity without any satisfactory results. Most of these treatments are based on local application of desensitizing agents either in office or at home targeting either nerve depolarization or dentinal tubule occlusion.\cite{11}

Calcium sodium phosphosilicate (CSPS) comes from the bioactive glass family which is effective in reducing dentinal hypersensitivity.\cite{12} When exposed to the aqueous oral environment, CSPS forms hydroxycarbonate apatite which adheres to the dentinal surface to form a mineralized surface. This layer is acid-resistant and strong thus protecting the dentine.\cite{13-14} CSPS bioglass particle is made of 25% sodium, 25% calcium, 6-8% phosphate and remainder, silica.

Lasers are a very effective option in the treatment of dentinal hypersensitivity. High power lasers (Co2, Nd:YAG) have shown to have reduced dentinal pain by occluding the dentinal tubules by having a melting effect with crystallization of inorganic dentine and the coagulation of fluids contained into the dentinal tubules causing stenosis.\cite{15-17} Low power lasers have photobiomodulation action on the dental pulp where histologic studies in animal models have reported formation of tertiary dentine after irradiation of the teeth with laser.\cite{18} Another action which these low level lasers can have is interfering with the sodium pump mechanism and causing depolarization of the nerve endings thus blocking transmission of the pain impulse.\cite{19}
Therefore, the aim of the study here was to assess the efficacy of diode lasers along with topical CSPS for the immediate management of dentinal hypersensitivity.

**MATERIALS AND METHODS**

The study was conducted on forty five patients (20 female, 15 male; aged from 25 to 60 years) who reported to the Department of Periodontology, Sri Hasanamba Dental College and Hospital, Hassan, India, with the chief complain of dental hypersensitivity. Duration of the study was from January 2016 to March 2016. The study was approved by the Institutional Ethical Committee of Sri Hasanamba Dental College and Hospital, Hassan, India. The study has been registered in Clinical Trials Registry-India with the registration number CTRI/2017/05/008547.

The inclusion criteria for the patients enrolled were presence of at least two sensitive permanent teeth surfaces (buccal/ facial aspects), presence of wasting disease of teeth or gingival recession, no history of periodontal treatment in the past one year. The exclusion criteria was presence of any systemic conditions, chronic or recent use of anti-inflammatory and analgesic drugs, eating disorder, previous treatment for dentinal hypersensitivity, pregnancy and lactation, allergies or hypersensitivity to desensitizing agents. Informed consent was obtained from the compliant patient after explaining the rationale and objective of the study.

Diagnosis of the dentinal hypersensitivity depended on the chief complaint and a detailed history of the patient’s perception of sensitivity to thermal stimuli, sweet or sour foods, drinks and to tooth-brushing. During the clinical examination, pain from dental caries and periodontitis were eliminated.

All the enrolled patients underwent ultrasonic scaling with proper oral hygiene instructions prior to the desensitizing treatment. Then they were randomly allocated into three groups by chit picking method: (Figure 1)
Figure 1: Outline of the study

A – lased with diode laser (Photon plus diode laser, Zolar technologies and Mfg Co. Inc, Mississauga On, Canada, 980 nm) 0.5W in power, non contact mode, of 3 applications of 1 minute each for 3 consecutive days.

B – treated with CSPS which was applied for 60s over the tooth surface and then irradiated with 3 applications of diode laser of 1 minute each for 3 days.

C – treated only with CSPS for 60s for 3 days.

All the three groups were subjected to tactile and air stimuli at baseline and before each treatment session for 3 days. The patient’s response was recorded with the NRS scale from 0-10, where 0 was the lowest score meaning no pain and 10 was the highest score meaning extreme pain or discomfort.
STATISTICAL METHODS

The collected data was statistically analyzed with the help of SPSS v22.0 software. The mean NRS and mean ± SD scores were calculated from all the subjects who took part in the study. One way Analysis of Variance test was done to find out the difference between the scores in all the three groups at baseline and after 3 days post treatment. Tukey’s HSD post hoc test was done to compare the difference in tactile stimulus in all the three groups. The difference in air stimuli in the three groups were analyzed by Games-Howell post hoc test. P value <0.001 was considered to be statistically significant.

RESULTS

A total 45 patients took part in this 3-day trial. There were no drop outs seen by the end of the study. None of the patients reported with any adverse effects or complications during the study period. There was improvement in both the tactile and air stimulus response in all the three groups from baseline and after 3 days. (Figure 2, 3)

Figure 2: difference in mean scores of tactile stimulus from baseline to 3 days
There was a statistically significant difference in the tactile stimulus scores between groups A, B and C as determined by one-way ANOVA ($F = 49.492, p<0.001$) (Table 1)

<table>
<thead>
<tr>
<th>Tactile difference</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LASER</td>
<td>15</td>
<td>4.600</td>
<td>1.404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LASER+CSCP</td>
<td>15</td>
<td>5.666</td>
<td>1.290</td>
<td>49.492</td>
<td>&lt;0.001a</td>
</tr>
<tr>
<td>CSCP</td>
<td>15</td>
<td>1.466</td>
<td>0.833</td>
<td></td>
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</tr>
</tbody>
</table>

There was a statistically significant difference in the air stimulus scores between groups A, B and C as determined by one-way ANOVA ($F = 42.014, p<0.001$) (Table 2)
Table 2: difference in the air stimulus scores

<table>
<thead>
<tr>
<th>Oneway ANOVA</th>
<th>Air Stimulus difference</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>LASER</td>
<td>15</td>
</tr>
<tr>
<td>LASER+CSCP</td>
<td>15</td>
</tr>
<tr>
<td>CSCP</td>
<td>15</td>
</tr>
</tbody>
</table>

A Tukey post hoc test revealed that even though there was reduction in tactile stimulus when group A was compared with group B, it was not statistically significantly (lower after taking the intermediate (p=0.050), whereas with group C, it showed statistically significant result (p<0.001). When the difference in reduction was compared between group B and C, it was statistically significant (p<0.001). (Table 3)

Table 3: Post Hoc Test-Tactile Difference

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Dependent Variable: Tactile difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(I) GROUP</td>
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<tr>
<td>Tukey HSD</td>
<td>LASER</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>LASER+CSCP</td>
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</table>

For the comparison of the reduction in air stimulus, Games-Howell post hoc test was done. The difference between group A and B was not statistically significant (p=0.010). When both group A and group B were compared to group C, the difference in reduction in air stimulus was statistically significant (p<0.001). (Table 4)
Table 4: Post Hoc Test- Air Stimulus Difference

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Dependent Variable: Air Stimulus difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) GROUP</td>
<td>(J) GROUP</td>
</tr>
<tr>
<td>Games-Howell</td>
<td>LASER</td>
</tr>
<tr>
<td></td>
<td>CSCP</td>
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<tr>
<td></td>
<td>LASER+CSCP</td>
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</tbody>
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DISCUSSION

Dentinal hypersensitivity is an indispensable problem in dental practice. Various choice of treatments are available but with limited success in providing relief to patients.

The purpose of the present study was to assess the immediate efficacy of diode laser, whether the combination of laser and CSCP had any synergistic effect when compared to laser or CSCP alone in the treatment of dentinal hypersensitivity.

Dentinal hypersensitivity is a subjective symptom so therefore difficult to quantify. The NRS has good sensitivity and generates scores that can be statistically analyzed easily.\(^{[20]}\) All the patients were subjected to tactile and air stimulus because it is physiological in nature and can be easily simulated. Therefore they are widely recommended in assessing dentinal hypersensitivity. There is inward displacement of the dentinal fluid during tactile stimulus, which activates the mechanoreceptors in dental pulp causing pain. Air stimulus causes outward displacement of the fluid in the open dentinal tubules which again elicit pain.\(^{[21-23]}\) Duration of the study was in accordance to the study done by West et al.\(^{[24]}\)

A number of in vitro and clinical studies have showed the superiority of diode laser when used alone or in combination of a desensitizing toothpaste.\(^{[25-28]}\) Bornstein in 2004 explained the mechanism of diode lasers(980nm) which disarranges the crystalline dentine structure and causes melting of the dentinal tissues.\(^{[29]}\) The results in this study showed that in group A where the patients were subjected to only laser application, had statistically significant reduction(p<0.001) in both tactile and air stimulus from baseline to 3days. This was in agreement with the studies by Matsumoto et al(1988)\(^{[26]}\), Alfredo et al (2009)\(^{[27]}\), Umberto et al (2012)\(^{[28]}\), Hashim et al (2014)\(^{[30]}\) and Rajeshwari et al(2015).\(^{[25]}\)
CSPS is an active bioglass which forms hydroxycarbonate apatite, a mineral similar to enamel and dentine, when it comes in contact to body fluids. There is also release of $\text{Ca}^{2+}$ and $\text{P}_4\text{O}^{2+}$ ions into the surrounding which along with this hydroxycarbonate apatite physically occludes the exposed dentinal tubules.\cite{12} The present study here showed that there was reduction in tactile and air stimulus on CSPS application from baseline to 3 days, but not statistically significant ($p>0.05$) when compared to laser group. This was in accordance with studies done by Silicia et al (2009)\cite{31}, Nandakumar and Iyer (2014)\cite{32}, Sravani et al (2015)\cite{33}. This study disagreed with the study done by Rajeshwari et al (2015) where the authors did not find statistically significant difference in reduction of dentinal hypersensitivity between laser and CSPS. The reason here could be the study duration in the present study. Clinical trials have shown that CSPS will augment relief from symptoms of dentinal hypersensitivity with continued use with a follow-up period of at least 4 weeks.\cite{34}

Recently, many authors have shown that combination therapy of laser with topical desensitizing agents have shown improved efficacy in the treatment of dentinal hypersensitivity compared to single agents.\cite{25,27-28,32-33}

Diode laser is most widely accepted in routine dental practice. Studies are clarifying the follow-up results within the interference of the placebo effect. It has specific wavelengths which is safe for the patient and do not have any adverse effect on the dental pulp like Er,Cr:YSGG or Er:YAG lasers.\cite{35} Clinical studies by Acharya et al (2013) and Majji and Murthy (2016) showed better outcomes of CSPS on dentinal hypersensitivity compared to potassium nitrate, strontium chloride and herbal preparation.\cite{36-37}

The present study is first of its kind where the immediate effect of Diode laser combined with CSPS has been assessed. The reduction in both tactile and air stimulus in this group was greater and statistically significant when compared to CSPS alone ($p<0.001$). When compared to laser group, air stimulus showed greater reduction ($p=0.010$) than tactilestimulus ($p=0.050$) which was not statistically significant. Therefore the overall improved was majorly due to the effect of Diode laser rather than CSPS. The immediate analgesic effect seen in this group could be due to the blockade of the nerve impulse pathway in the irradiated area as explained by Kasai et al(1996).\cite{38}

The continuance of this analgesic effect on the dentine comes from the occluding of dentinal tubule, which interferes with the communication of the nerve endings in the dentinal tubules with the oral fluids. The combination of diode laser and CSPS helps to achieve this by sealing the exposed tubules by modifying smear layer to incipient melting and sectional occlusion of open dentinal tubules by hydroxycarbonate apatite.\cite{27,11} The results in this study was in accordance with the studies by Umberto et al (2012),
Nandakumar and Iyer et al (2014) and Sravani et al (2015) where the authors have used combination therapy of lasers and desensitizing agents and have found better outcomes when compared to controls. The present study is a short term study with a small sample size. Thus future studies incorporating a larger sample size with a long term follow up are required to support our results.

CONCLUSION

Within the limitations of this study, it can be concluded that diode laser when used with CSPS have a greater ability in short term reductions of tactile and air stimulus in the treatment of dentinal hypersensitivity compared to either laser or CSPS alone.

REFERENCES


