The Assessment of the Effectiveness of Remineralization and Laser Therapy in Cervical Dentine Hypersensitivity

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The aim of study was to compare the clinical effectiveness of 810nm laser therapy, remineralising therapy with MI PASTE PLUS® (GC), and toothbrush with Sensodyne® Repair&Protect (GSK) in cervical dentine hypersensitivity. The study was performed on 60 subjects (34 females, 24 males), with at least one tooth affected by cervical dentine hypersensitivity. The patients were randomly divided in three study groups (20 subjects for each group), related to the type of desensitizing therapy: 810nm laser therapy, remineralising therapy with gel MI PASTE PLUS®, toothbrushing with Sensodyne® Repair&Protect). The assessment of the therapy effectiveness was performed by analysis of Schiff Cold Air Sensitivity Scale, with scores directly related to the level of dentine hypersensitivity. For laser group the scores decreased from 2.25 at baseline, at 1.35 at 3 days, and 0.2 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline. For MI PASTE PLUS® (GC) study group the scores decreased from 2.20 at baseline, at 1.60 at 3 days, and 1.30 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline. For Sensodyne® Repair&Protect (GSK) study group the scores decreased from 2.15 at baseline, at 1.90 at 3 days, and 1.45 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline. Low level laser therapy showed better reduction in cervical hypersensitivity, followed by the therapy using MI PASTE PLUS® (GC) gel, and by the toothbrush with Sensodyne® Repair&Protect (GSK) toothpaste.

Keywords: Casein-Phosphopeptide-Amorphous Calcium Phosphate Fluoride, Calcium Sodium Phosphosilicate, low-level laser therapy, desensitizing produced, Schiff Cold Air Sensitivity Scale

Nowadays the prevalence of gingival recessions, abrasions, or erosions has increased due to the periodontal pathologies, excessive use of dental bleaching or professional oral hygiene, acid foods and beverages, bad oral hygiene habits, incorrect brushing techniques, or salivary disorders [1-6]. These disorders are frequently associated with cervical dentinal hypersensitivity, characterized by sharp pain of short duration occurring on exposure to the thermal, tactile, evaporative, osmotic, chemical stimuli, and it cannot be ascribed as other dental pathology [7].

One European-population based cross-sectional study found that 41.9% of patients reported pain on tooth stimulation and 13.4% scored ≥ 2 on Schiff scale for at least one tooth. In this study a strong, progressive relationship was found between the cervical dentine hypersensitivity and erosive tooth wear [8].

One study performed in USA also found a 12.3% prevalence of dentin hypersensitivity, with an average of 3.5 hypersensitive teeth per patient [9]. The discomfort provoked by dentine hypersensitivity can vary from minor discomfort to very disturbing discomfort and emotional distress, affecting the normal hygiene maintenance, stimulating the accumulation of dental plaque and increasing the risk for caries formation, gingival inflammation, and further periodontal problems.

An important role in cervical dentinal hypersensitivity is also periodontal therapy. Thus, through root planning, the root dental surface may suffer significant losses of minerals with the appearance of HD [10-15].

Various therapeutic approaches are available for the dentine hypersensitivity, with a large broad of effectiveness rate. The most frequently used traditional means are desensitizing toothpastes, gels, dental adhesives, and fluoride varnishes [16].

In the modern dentistry the low level laser therapy (LLLT) is successfully used for various categories of teeth sensitivity [17-19]. LLLT was also introduced in the treatment of dentine hypersensitivity due to the slow onset of action of the traditional desensitizing agents. It has been suggested that LLLT decreases dental hypersensitivity pain by stimulating the stimulation of endorphin and nitric oxide production, by inhibition of C-fiber afferent nerve depolarization as well as the decrease of bradykinin levels [20, 21]. Laser therapy is sustained by literature data that indicates conflicting results from the laser related researches, but a slight clinical advantage of laser therapy over topical desensitizing agents [21].

Experimental part

*Materials and method*s

The study was performed on 60 subjects (34 females, 24 males), with at least one tooth affected by cervical dentine hypersensitivity. The patients were randomly divided in three study groups (20 subjects for each group), related to the type of desensitizing therapy (laser, desensitizing gel, desensitizing toothpaste).

The inclusion criteria were as follows: ages between 18-45; generally good health; minimum one hypersensitive teeth with cervical abrasion or gingival recession; less than 1 mm loss of dentin in depth which did not require any restorative regimen; subjects were required to be available during the study, and to sign an informed consent.

Exclusion criteria were as follows: advanced periodontal disease; treatment for periodontal disease (within the last 12 months); hypersensitive teeth with mobility >1; chronic

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general conditions that could affect the results; any condition that could cause xerostomia; the use of any medication that could interfere with the sensation of pain; subjects who used a desensitizing dentifrice within the last 3 months.

We provided an informed consent about the aims to all participants. The data file remained anonymous, and the identity of the participants was protected. Our study was done in accordance with the Ethical Committee regulations and in accordance to some published models [22].

The content of chemical therapeutic agents is presented in table 1. The features of each therapy and study group are presented in table 2. The laser therapy was performed using 808 nm laser (DMC), in two sessions (3 days between sessions) with 1 minexposure of the affected tooth surface (fig. 1a and b). MI PASTE PLUS® was applied daily for 7 days by patients included in the second study group. The patients of the third study group were instructed to brush only with their assigned toothpaste, Sensodyne® Repair&Protect (GSK), twice daily (morning, evening) for 7 days. During the study the subjects were not allowed to use any other oral care products other than those provided.

Sensitivity was assessed by examiner by using Schiff Cold Air Sensitivity Scale, with scores directly related to the level of dentine hypersensitivity (table 3).

The evaporative (air) sensitivity with Schiff sensitivity score is determined by directing a 1-s application of air from a dental syringe to the tooth surface 1-2 mm coronal to the free gingival margin from a distance of 1 cm. The response was rated from 0 to 3 using the Schiff sensitivity scale [23].

The statistical software used was SPSS 19.0 (SPSS, Chicago, IL, USA) for analysis of data. Excel sheet were used to generate tables. Mann-Whitney tests were used to find the significance of the reduction in dentine hypersensitivity between the three groups at different time intervals. The level of statistical significance was set at 0.05.

Results and discussions

At baseline significant statistical differences were absent between the study groups. The Schiff sensitivity mean scores decreased for all study groups both at 3 days and 7 days follow-up (fig.2).

For laser group the scores decreased from 2.25 at baseline, at 1.35 at 3 days, and 0.2 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline. For MI PASTE PLUS®(GC) study group the scores decreased from 2.20 at baseline, at 1.60 at 3 days, and 1.30 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline. For Sensodyne® Repair&Protect (GSK) study group the scores decreased from 2.15 at baseline, at 1.90 at 3 days, and 1.45 at 7 days, with significant statistical differences at 3 days, and 7 days comparing with baseline.

Significant statistical differences were recorded between laser therapy and the other study group treated by desensitizing topical therapy at 3 days and 7 days, in favor of laser therapy ($p < 0.05$) (table 4). These differences

Table 1
CONTENT OF DESENSITIZING CHEMICAL AGENTS

	CHEMICAL AGENT	INGREDIENTS
1.	MI PASTE PLUS® (GC)	RECALDENT™, CPP-ACPF: Casein-Phosphopeptide-Amorphous Calcium Phosphate Fluoride, fluoride 900ppm.
2.	Sensodyne® Repair&Protect (GSK)	NovaMin® technology, Glycerin, PEG-8, Hydrated Silica, Calcium Sodium Phosphosilicate (NOVAMIN), Cocamidopropyl Betaine, Sodium Methyl Cocoyl Taurate, Aroma, Titanium Dioxide, Carbomer, Sodium Saccharin, Sodium Fluoride (1450ppm Fluoride)

Table 2
CHARACTERISTICS OF STUDY GROUPS

	STUDY GROUPS	THERAPEUTIC AGENT	NUMBER OF SESSIONS/APPLICATIONS	TIME OF EXPOSURE
1.	Laser	808 nm laser Whitening Lase II (DMC Dental)	2 laser sessions (1 session at 3 days)	1 minute
2.	Desensitizing gel	MI PASTE PLUS® (GC)	1/day, 7 days	30 minutes
3.	Desensitizing toothpaste	Sensodyne® Repair&Protect (GSK)	2/day, 7 days	

Table 3
SCHIFF SENSITIVITY SCALE

0	Subject does not respond to air stimulus
1	Subject responds to air stimulus but does not request discontinuation of stimulus
2	Subject responds to air stimulus and requests discontinuation or moves from stimulus
3	Subject responds to air stimulus, considers stimulus to be painful, and requests discontinuation of the stimulus

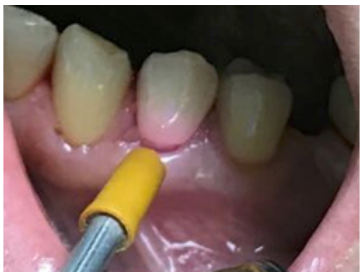

Fig. 1. Whitening Lase II (DMC Dental) therapy:
a. Biomodulation laser parameters;
b. Laser session in dentine hypersensitivity

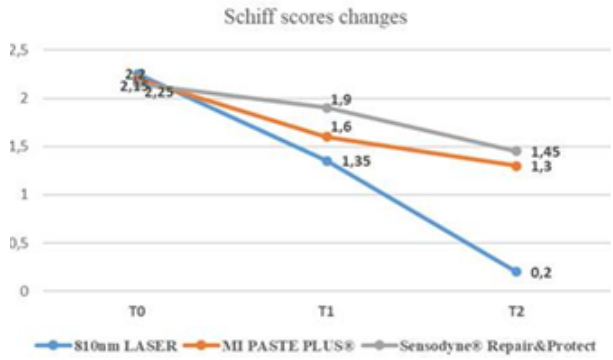

Fig. 2. Changes of Schiff sensitivity mean scores

STUDY GROUPS	T0-T1	T0-T2	T1-T2
WHITENING LASE II (DMC DENTAL)	**0.0001***	**0.0001***	**0.0001***
MI PASTE PLUS® (GC)	**0.005***	**0.0001***	0.094
SENSODYNE® REPAIR&PROTECT (GSK)	0.142	**0.0001***	**0.025***

* $p < 0.005$

Table 4
MANN WHITNEY STATISTICAL TEST FOR STUDY GROUPS AT 3 DAYS AND 7 DAYS COMPARING TO BASELINE

	T0	T1	T2
WHITENING LASE II/MI PASTE PLUS®	0.708	0.442	**0.001***
WHITENING LASE II/ SENSODYNE® REPAIR&PROTECT	0.435	**0.03***	**0.001***
MI PASTE PLUS®/SENSODYNE® REPAIR&PROTECT	0.681	0.128	0.201

* $p < 0.005$

Table 5
MANN WHITNEY STATISTICAL TEST REPRESENTING AMPLITUDE DECREASE BETWEEN STUDY GROUPS

are more pronounced at 7 days from the first day at all study groups. Between the third and seventh day statistically significant differences occurred in the WHITENING LASE II and SENSODYNE® REPAIR&PROTECT groups.

Table 5 shows significant statistical differences when were compared Whitening Lase II with MI Paste Plus and with Sensodyne Repair&Protect, after 7 days of treatment.

The present randomized clinical study investigated the efficacy of laser therapy in reducing dentine hypersensitivity by comparing with therapy using topical desensitizing gel and toothpaste. The Schiff sensitivity scale was used as air stimulus decreases the temperature at the dentin surface, causes a rapid outward fluid flow from opened dentin tubules, which stimulates the painful sensation [24]. In our study we used two 808 nm laser sessions for 1 minute exposure to treat dentinal hypersensitivity and the results were excellent after 7 days, with a decrease of Schiff sensitivity scores from 2.25 to 1.45 and significant statistical decrease after 3 days and the progression of Schiff scores decrease after 7 days. Low-power lasers and diode lasers with a wavelength between 780 and 900 nm, eliminate the sensitivity acting on nervous level, while the medium-power lasers, like Nd:YAG, CO_2 and Er:YAG laser, desensitize by narrowing and occlusion of dentinal tubules [25]. In one study both 660 nm red diode laser and 830 nm infrared lasers were effective after 7.30, and 60 days, following four therapeutic laser sessions [26]. The time of exposure influences the effectiveness of laser therapy for dentin hypersensitivity as 1 minute is more effective than 30 seconds exposure [27, 28]. *Kimura Y et al.* [29] reviewed the role of lasers for the treatment of dentine hypersensitivity and found that effectiveness ranged from 5.2 to 100%, dependent on the laser type and parameters used. The conclusion of this review was that the efficiency for the treatment of dentine hypersensitivity using lasers was higher than other methods, but less effective in severe cases. Biagi A. et al [30] also reviewed the literature data, and found that the laser treatment effectively reduces pain symptoms. These authors considered that more suitable follow-ups are necessary and more clarity should be obtained on the placebo effect because patients undergoing placebo still receive benefits with a reduction of pain intensity. The review performed by Sgolastra F. et al. [31] sustains the use of both diode lasers and erbium lasers in the treatment of dentine hypersensitivity.

Comparing laser therapy with desensitizing gel and desensitizing toothpaste, the decrease of Schiff sensitivity scores was significantly higher at 3 days and 7 days for laser treated group than groups treated by desensitizing MI PASTE PLUS® (GC) or desensitizing toothpaste Sensodyne® Repair&Protect (GSK) ($p < 0.05$). Literature data found similar conclusions when laser treatment was compared with remineralising and desensitizing gels or toothpastes [32-34]. However, the use of desensitizing gels or desensitizing toothpastes is an economic and effective therapeutic alternative for patients. On the other hand, when used these topic non-fluorurated remineralizing agents, the incidence of hypersensitivity is low [35].

According to the producer, Sensodyne® Repair&Protect (GSK) contains NovaMin complex, a calcium phoshosilicate bioactive glass that accelerates the formation of a mineral layer that blocks the dentinal tubules. The mechanism of action of NovaMin seems to be related to the precipitation of calcium and phosphate inducing the partial or complete occlusion of the dentin tubules. In saliva oral environment, the sodium ions (Na^+) from calcium sodium phosphosilicate complex begin to exchange with hydrogen cations (H^+ or H_3O^+), allowing calcium (Ca^{2+}) and phosphate (PO_4^{3-}) species to be released from the NovaMin structure. This stage is followed by a transient increase in *p*H that facilitates the precipitation of calcium and phosphate from the particles and from saliva to form a calcium phosphate (Ca-P) layer on tooth surfaces. Further this layer crystallizes into hydroxycarbonate apatite (HCA), similar to biological apatite. The combination of the residual calcium sodium phosphosilicate particles and the HCA layer conducts to the partial or complete occlusion of dentinal tubules [36, 37]. The toothpaste containing 5% NovaMin was found more effective in the treatment of cervical hypersensitivity comparing with other categories of desensitizing toothpastes [38]. Also chair side application of calcium phosphosilicate bioactive glass provides immediate relief for the patient with dentinal hypersensitivity [39].

The remineralising and desensitizing activity of MI PASTE PLUS® (GC) is due to casein phosphopeptide (CPP), which carries calcium and phosphate ions in the form of Amorphous Calcium Phosphate (ACP). When CPP and ACP were combined a complex named Recaldent™ was formed, the ideal delivery system for bio-available calcium and phosphate ions. Also this product is resistant to oral factors that can remove the tubule occlusion [40].

Our study demonstrated the higher effectiveness of desensitizing MI PASTE PLUS® (GC) comparing with desensitizing toothpaste Sensodyne® Repair&Protect (GSK) at 3 days and 7 days, with significant statistical differences ($p < 0.05$).

Conclusions

All the study groups showed lower Schiff sensitivity values compared with baseline. Laser group showed better reduction in hypersensitivity when compared to the chemical desensitizing products. The desensitizing MI

PASTE PLUS® (GC) gel and toothpaste Sensodyne® Repair&Protect (GSK) can be considered effective and economical options in the management of the dentinal hypersensitivity.

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