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Clinical Evaluation of Three Desensitizing Agents in Relieving Dentin Hypersensitivity

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Clinical Relevance

Three desensitizing agents with different active ingredients exhibited similar effects in the treatment of dentin hypersensitivity by mechanical blockage.

SUMMARY

Objectives: This *in vivo* study determined whether the application of three different desensitizing agents on exposed dentin surfaces was effective in reducing dentin hypersensitivity in subjects with slight-to-moderate sensitivity.

Methods: Sixty patients with a history of sensitivity were included in this study. At baseline visit, the initial sensitivity levels were recorded using a visual analog scale (VAS). In order to activate the sensitivity, evaporative (air-blast) and thermal (chloraethyl) stimuli were applied to each subject. The subjects' responses to the stimuli were marked on the VAS. Then, the subjects were assigned to one of the treatment groups or to a placebo. The agents used were Seal&Protect (Dentsply DeTrey GmbH, Konstanz, Germany), Vivasens (Ivoclar Vivadent AG, Schaan, Liechtenstein) and BisBlock (BISCO, Schaumburg, IL, USA); whereas, distilled water was used as the placebo. The subjects were recalled after four weeks, and their responses were again recorded.

Results: The VAS scores of the treatment and placebo groups were not different from each other at baseline ($p>0.05$), and thermal stimuli caused higher patient discomfort than evaporative stimuli ($p<0.05$). Alleviation effects of the desensitizing agents were not significantly different from each other; however, the placebo was an exception ($p<0.05$). The differences between the VAS scores at baseline and after four weeks were significant for all three desensitizing agents ($p<0.05$). However, in the placebo group, the evaporative stimuli led to insignificant pain variations ($p>0.05$).

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Conclusion: It was concluded that the desensitizing agents used in this clinical study were effective in alleviating dentin hypersensitivity. Meanwhile, the placebo response was shown to play a significant role.

INTRODUCTION

Dentin hypersensitivity (DH) has been defined as a short, sharp pain arising from exposed dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical, which cannot be ascribed to any other form of dental pathology.[1-2] Dentin hypersensitivity has been researched extensively, and many authors express an agreement that a greater prevalence of DH seems to occur among the patient population than has been reported.[3] Several reviews have been published on the etiology of DH.[4-8] Chronic trauma from toothbrushing, acidic erosion from the environment, gastric regurgitation or dietary substances, anatomical factors, gingival recession caused by periodontitis or periodontal surgery are some of the etiological factors that have been implicated. The most accepted theory to explain DH was the hydrodynamic theory by Brännström, even though several hypotheses have been put forward to date. This theory claimed that stimulus to an exposed dentin surface increased fluid flow in the tubules, and this increased flow caused pressure changes across the dentin, which activated the pulp-dentin border within the dentin tubules.[9]

According to the measurable responses of the patients to the stimuli, such as a cold air blast or touch, the subjective responses should be recorded on a visual analogue scale (VAS). Then, sensitivity can be categorized as "slight," "moderate" or "prolonged or severe," if successful management of DH is desired. The use of desensitizing dentifrices has been advocated for cases with slight sensitivity; whereas, varnishes or lacquers can be used for moderate sensitivity. The active ingredients of these systems may either occlude the dentin tubules or block neural transmission. These described treatment regiments, used for both "slight" and "moderate" sensitivity, can be referred to as "non-invasive" treatments of DH.[10] In cases of severe hypersensitivity, glass ionomer cements or adhesive bonding agents can be used as semi-invasive treatment regimens by occluding the dentin tubules.[11]

In this randomized double-blind clinical study, the authors hypothesized that a desensitizing agent, which occludes the dentin tubules, may be advantageous in reducing DH. Therefore, this study compared the relieving efficacy of three different formulations of desensitizing agents, which have several occluding mechanisms.

METHODS AND MATERIALS

This study was a double-blind, randomized, placebo-controlled clinical trial. The protocol was conducted according to the Guidelines for Clinical Trials on DH, stated by Holland and others.[1] Sixty subjects (42 female and 18 male) with a history of dentin sensitivity, ages 18 through 57 years and in good general health, were recruited for the study. They were given both verbal and written information about the process and signed forms to participate. Subjects were excluded from the study if they were having active periodontal therapy or had received non-surgical periodontal treatment within the last three months. Other exclusion criteria were chronic use of anti-inflammatory and analgesic medication; pregnant or lactating females; any denture bridgework; active cervical caries or deep abrasion requiring Class V fillings; fractured, crowned or root filled teeth and teeth with large restorations.

One tooth (canine or premolar) per patient, which was categorized as slight-to-moderate sensitivity, was included in the study. VAS scores of the involved hypersensitive teeth of patients ranged from 3 to 7. All the sensitivity scores were determined by a practitioner who did not know which material was applied (TP). The initial sensitivity levels were recorded at the baseline visit. In order to activate sensitivity, evaporative (air-blast) and thermal (chloraethyl) stimuli were applied to each subject. For evaporative stimuli, a one-second blast of air from a dental unit syringe at 40-65 psi and a temperature of 19°C ± 5°C applied 1-3 mm away from and perpendicular to the exposed buccal cervical areas of exposed dentin was used. The adjacent teeth were protected by cotton rolls. Ten minutes after the evaporative evaluation, thermal stimuli were assessed using a cotton applicator saturated with chloraethyl on the buccal surfaces of the selected teeth. The subjects' responses to the evaporative and thermal stimuli were marked on a VAS, with a 10-cm line labeled from no pain (0 cm) to intolerable pain (10 cm). After recording the initial scores, the subjects were randomly assigned to one of the treatment groups or the placebo.

The desensitizing agents used in this study were Seal&Protect (Dentsply DeTrey GmbH, Konstanz, Germany), Vivasens (Ivoclar Vivadent AG, Schaan, Liechtenstein) and BisBlock (BISCO Inc, Schaumburg, IL, USA); whereas, distilled water was used as the placebo. All agents were applied by the same operator (HD). The contents of the agents and the application procedures are summarized in Table 1. Prior to application of the desensitizing agents, all sensitive tooth surfaces were cleaned with a rubber cup and pumice. Remnants of pumice were removed with air/water spray. Isolation of the operation field was obtained by cotton rolls and a suction device.

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Table 1: *The Materials Used in This Study and Their Application Procedures*

Test Groups	Contents	Treatment Options	Procedure Steps
1. Seal&Protect (Dentsply DeTrey GmbH, Konstanz, Germany)	PENTA, nanofillers, triclosan, acetone. (resin-based material)	• Seals dentin tubules after polymerization.	• Apply for 20 seconds. • Volatilize the acetone with a gentle stream of air. • Light-cure for 10 seconds. • Apply the second coat and light-cure.
2. Vivasens (Ivoclar Vivadent AG, Schaan, Liechtenstein)	Water, alcohol, hydroxypropylcellulose, methacrylate modified polyacrylic acid, polyethylene-glycoldimethacrilate, potassium fluoride.	• Blocks dentin tubules by the precipitation of calcium ions and proteins in dentin fluid.	• Apply for 60 seconds using the disposable brush provided. • Air dry for 10 seconds. • Advise patients not to eat, drink or brush their teeth for at least 30 minutes following treatment.
3. BisBlock (BISCO, Inc, Schaumburg, IL, USA)	Oxalic acid	• Blocks tubules with the formation of calcium oxalate crystals. • Seals the tubules after polymerization of bonding agent.	• Total etch for 15 seconds. • Rinse and dry. • Apply BisBlock for 30 seconds. • Rinse and leave moist. • Apply One-Step, light-cure for 10 seconds. • Apply the second coat of One-Step.
4. Distilled water (Control)	----------	----------	• Apply for 20 seconds. • Air dry for 10 seconds.

The subjects were recalled after four weeks from the time of application of the agents, and the subjects' responses were recorded according to VAS in the same manner and with the same order of stimuli as before.

Statistical Analysis

SPSS for Windows 13.0 (SPSS, Chicago, IL, USA) was used for the statistical analyzes of this study. Differences between the treatment and placebo groups were analyzed by the Kruskal Wallis test. Then, pairwise comparisons were performed with the Mann-Whitney U-test. In addition, the Friedman and Wilcoxon tests were used to determine differences between the subject responses for each material at baseline and after four weeks. The significance level of this study was set at 0.05.

RESULTS

In this study, VAS scores of the treatment and placebo groups were not different from each other at baseline ($p>0.05$), and thermal stimuli caused higher patient discomfort than evaporative stimuli ($p<0.05$).

The Kruskal Wallis test indicated differences among the VAS scores of the treatment and placebo groups with regard to alleviation of hypersensitivity. The post-hoc tests for pairwise comparisons indicated that the alleviation effects of the desensitizing agents were not significantly different from each other ($p>0.05$); however, the placebo was an exception ($p<0.05$) (Table 2).

Variations in the subject responses for the treatment and placebo groups at baseline and after four weeks are shown in Table 3. According to the Friedman and Wilcoxon signed rank test results, differences between the VAS scores at baseline and after four weeks were significant for all three desensitizing agents ($p<0.05$).

Table 2: *Significance Among the Test and Placebo Groups After Four Weeks*

	Seal&Protect	Vivasens	BisBlock	Placebo
Seal&Protect		$p>0.05$	$p>0.05$	$p<0.05$
Vivasens	$p>0.05$		$p>0.05$	$p<0.05$
BisBlock	$p>0.05$	$p>0.05$		$p<0.05$

Table 3: *Variations of the Subject Responses of the Treatment and Placebo Groups at Baseline and After Fourth Week*

	Variations of the VAS Scores					
	Evaporative (Baseline-4th Week)			Thermal (Baseline-4th Week)		
Test Groups	Negative Ranks	Positive Ranks	Ties	Negative Ranks	Positive Ranks	Ties
Seal&Protect	14	0	1	13	1	1
Vivasens	14	0	1	15	0	0
BisBlock	14	1	0	15	0	0
Placebo	9	3	3	11	0	4

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In the placebo group, however, evaporative stimuli led to insignificant pain variations ($p>0.05$). Nonetheless, in this study, it was observed that a placebo effect occurred, because there was a significant reduction in pain responses to the thermal stimulus of the placebo group in the baseline-four-week time period ($p<0.05$).

DISCUSSION

In this study, three different desensitizing agents were examined on 60 patients, the majority of them being female. It was known that females tend to be affected with DH more often than males. The higher prevalence of DH in this gender might be connected to excessive oral hygiene habits, such as aggressive tooth brushing.[2] In order to standardize the teeth and patients, the authors of this study preferred to include a canine and premolar tooth of affected patients who had an initial slight-to-moderate sensitivity level. The sensitivity level of this study was determined by translating the subjective feedback of evaporative and thermal stimuli into objective data using VAS (a 1-10 scale, where 1=mild and 10=intolerable), which is the most appropriate method to diagnose pain levels. After categorization of the sensitivity levels, the authors preferred non- and semi-invasive treatment methods for the management of DH, as recommended previously.[2,11]

It is generally accepted that loss of enamel or gingival recession is the main cause for DH. In this clinical condition, dentin tubules must be open to the oral cavity. Several reviews reported the widespread prevalence of DH.[12-14] In order to relieve DH, various therapeutical models and agents are recommended, which could become a challenge for a practitioner when selecting appropriate therapy. Basically, two treatment options for DH can be designed. One is to seal and occlude the dentin tubules, thereby blocking the hydrodynamic mechanism; the other is to block neural transmission at the pulp level. The blockage of neural transmission theoretically can be achieved by using topically applied potassium salts. Physical blockage of the tubules can be achieved by three different active ingredients in the contents of desensitizing agents, which are ion/salts, protein-amino acid precipitates and resins.[15] All agents of this study show the desensitizing effects via blocking the dentin tubules; whereas, their active ingredients are different from each other. However, these agents presented similar effects for reducing DH. What was clear from the data in this study was the placebo effect in subjects treated with distilled water. The reduction in sensitivity of the placebo group may depend on psychological factors or natural improvement.[16-17] In some cases, a reduction in DH may sometimes occur spontaneously as a natural decrease in dentin permeability.

BisBlock is an oxalate-base desensitizer that obstructs the dentin tubules. Oxalate ions of the material react with calcium in the tooth to form insoluble calcium oxalate crystals.[15] Gillam and others[18] demonstrated in their *in vitro* study that professionally applied in-office products containing oxalate were capable of covering the dentin surface and/or occluding the tubules to varying degrees. These agents had been used in the form of solutions or as resin-free gels that consisted of high concentrations of oxalic acid.[19] Several studies indicated the effectiveness of oxalate salts;[20-21] whereas others have questioned whether oxalate precipitate can withstand displacement and acid challenge in the oral cavity.[18,22-23] The manufacturer has stated that the adhesive coverage used on top of the material prevents the dislodging of calcium oxalate crystals. Therefore, two coats of One-Step as a bonding agent were used to cover the desensitizing agent, which, in this study, was BisBlock. Tay and others[24] demonstrated that tubular occlusion created by oxalate desensitizers did not interfere with subsequent resin infiltration when oxalate desensitizers were used adjunctively on acid etched dentin prior to adhesive application. This study also presented the clinical effectiveness of BisBlock as an oxalate-based material and subsequent application of bonding agent in relieving DH.

It has been hypothesized that some desensitizing agents precipitated and coagulated proteins/amino acids within the tubules. Some dentin bonding materials, such as HEMA/glutheraldehide products, act by blocking the tubules through protein precipitation.[15,25] Vivasens, with its synergistic combination of mechanisms, has been manufactured as a desensitizing varnish for hypersensitive teeth. This agent provides blocking of the tubules due to the precipitation of calcium ions and proteins in the dentin fluid. In addition, its manufacturer claims that Vivasens contains potassium fluoride (K^+ F^-), which comes into contact with the dentin fluid.[26] In this study, this product exhibited a relieving effect on the treatment of DH, similar to the other desensitizing agents that block the tubules.

It was shown that dentin bonding derivatives were also used for desensitization by dental professionals. There are several studies indicating successful results with dentin bonding systems, even though they were not produced for the treatment of DH only.[27-31] It has been reported that bonding agents seal the exposed dentin tubules and provide an immediate blockage of the transmission of pain-producing stimuli to pulpal nerves.[25,29] Seal&Protect is a resin-based material that does not contain HEMA. It is specially manufactured to seal the open dentin tubules in hypersensitive teeth. It is a self-adhesive, light curing, translucent sealing material and contains nanofillers. The manufacturer has claimed that these nanoparticles can easily penetrate into open dentin tubules.[32] The authors have also observed the effectiveness of this material as it occurs in other desensitizing agents.

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CONCLUSIONS

In conclusion, all three desensitizing agents, acting by blocking the tubules, were effective in relieving DH. Their effectiveness was not different from each other but different from the placebo. However, a strong placebo effect was observed in this study.

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