The Effect of Three Desensitizing Agents on Dentin Hypersensitivity: A Randomized, Split-mouth Clinical Trial

Abstract

Objectives: This randomized clinical trial tested the effect of three different desensitizing agents on reduction of pain due to hypersensitive cervical dentin lesions. Materials and Methods: Twenty-eight individuals with 84 teeth diagnosed with cervical dentin hypersensitivity (DH) in at least one tooth in any three of the four quadrants were selected. Patients exhibiting pain scores of two or more on the visual analog scale (VAS) were included in the study. Each quadrant in an individual was randomly assigned to one of the three treatment groups based on computer-generated random number. The desensitizing agents used were Profluorid Varnish (Voco: Cuxhaven Germany), Admira Protect (Voco: Cuxhaven Germany), and PRG-Barrier Coat (Shofu: Japan). One operator recorded the baseline sensitivity scores after evaporative and tactile stimuli by visual analog score system. The second operator who was not aware of the baseline values applied the desensitizing agents and recorded the sensitivity scores. VAS scores for both the stimuli were noted immediately after application, 1 week, and after 1 month. The data were analyzed using repeated measure ANOVA and post hoc Tukey’s multiple comparison tests (P < 0.05 was considered statistically significant).

Results: There was a significant reduction in VAS scores from baseline in all the three groups at all the time intervals (P < 0.001). Admira Protect showed significant reduction of hypersensitivity scores at 1 month compared to other groups (P < 0.001). Conclusion: Admira Protect was proved to be better in reducing pain due to DH than PRG-Barrier Coat and Profluorid Varnish after 1 month of application.

Keywords: Dentin hypersensitivity, desensitizing agents, pain score

Introduction

Dentin hypersensitivity (DH) is an exaggerated response to sensory stimuli, which usually does not cause pain response in a normal tooth. DH is characterized by short and sharp pain caused by thermal stimulus (e.g., on taking water and hot or cold foods) or by chemical (pH change) or mechanical (pressure applied during tooth brushing) actions on exposed dentin.[1] Dentin can be exposed due to enamel loss (abrasion, abfraction, or erosion) or exposed root surface after periodontal treatment or gingival recession, or both the factors.[1]

The prevalence of DH varies from 4% to 73%[2-4] according to various studies. However, a greater incidence has been reported in the elderly population. We can expect rise in hypersensitivity due to increased teeth retention by improved preventive care.[5]

The most acceptable theory for the cause of DH is the Hydrodynamic theory.[6] Consequently, treatments including therapeutic agents focus on the occlusion of dentinal tubules[5] while some desensitizing agents may work by a neural blocking mechanism.[7,8]

A recent study has reported that DH can negatively influence the oral health-related quality of life.[9] One of the objectives of treatment of DH is the pain reduction[10] by occlusion of permeable dentin tubules or by nerve desensitization.[11,12] Desensitizing agents applied to reduce DH can be applied in the dental office by a professional or by the patient at home.[13]

The aim of the present study was to investigate the clinical efficacy of three different desensitizing agents in reducing pain due to DH over a period of 1 month.

The null hypotheses tested were that (1) the desensitizing agents are not able to reduce the pain resulting from DH and (2) the...
desensitizing effects do not differ between the tested agents when tactile and evaporative stimuli are applied.

Materials and Methods

Eighty patients who presented with a complaint of DH at the Department of Conservative Dentistry, Thai Moogambigai Dental College and Hospital, were considered for the study. Twenty-eight individuals within the age group of 18–60 years with DH in at least one tooth in any three of the four quadrants were selected. Patients exhibiting pain scores of two or more on the visual analog scale (VAS) were included in the study. The exclusion criteria included patients who have teeth with active carious lesions or who required restorative treatment, patients who were receiving periodontal treatment, patients who received desensitizing treatment within the last 6 months, patients who were using anti-inflammatory drugs, pregnant patients, or smokers.

The patients were well informed about the procedure both orally and written; written consent was also obtained from them. The ethical committee clearance was obtained from university review board.

Evaluation of sensitivity

The individuals were randomly assigned to one of the three treatment groups based on computer-generated random number. All the three quadrants in each individual were randomly allocated to one of the three treatment groups based on computer-generated random number [Figure 1]. The study deployed two different operators: one operator recorded the baseline sensitivity scores for the teeth after evaporative and tactile stimuli by visual analog score system and the second operator who was not aware of the baseline values applied the desensitizing agents and recorded the sensitivity scores for both the stimuli. Thus, the study was double blinded (the patient and the examiner).

Preoperative evaluation

The teeth were cleaned with pumice and rotary brush using slow-speed handpiece and isolated with cotton pellets and suction. Tactile stimulus was applied with an explorer in mesiodistal direction across the cervical area, and VAS score was recorded.[14]

For evaporative stimulus, the teeth were isolated from the adjacent teeth with cotton rolls. A 1 s blast of air from the three-way syringe at 40–65 PSI at 1–3 mm away and perpendicular to the cervical area was applied. The sensitivity was recorded using VAS scale.[15]

Application of desensitizing agents

The teeth were air-dried and isolated by cotton pellets and suction. In each quadrant, a single application of different desensitizing agents was randomly applied according to the manufacturer’s instructions [Table 1].

This study used a split-mouth model using at least three quadrants, and placebo was not included due to ethical reasons. The patients were instructed to avoid eating/drinking for 2 h and avoid brushing for 12 h. Hypersensitivity assessment was done immediately after application of desensitizing agents, after 1 week, and after 1 month using the tactile and evaporative stimuli.

Statistical analysis

The intergroup comparison was done using repeated measure ANOVA and post hoc Tukey’s multiple comparison tests (P < 0.05 was considered statistically significant). The within-group comparison was done using repeated measure ANOVA and post hoc multiple comparison was done using Tukey’s honest significant difference (P < 0.05 was considered statistically significant).

Results

All the desensitizing agents showed significant (P < 0.001) reduction in DH immediately after application, at 1 week, and 1 month compared to baseline mean VAS scores for both tactile and evaporative stimuli. There were 8 dropouts in this study.

Within-group comparison

Immediately after application, there was no significant difference between all three groups.

At 1-week follow-up, Admiria Protect (mean VAS, 0.000) and PRG-Barrier Coat (mean VAS, 0.300) groups were significantly effective in reducing (P < 0.001) DH compared to Profluorid Varnish group (mean VAS, 2.000).
At 1-month follow-up, Admira Protect (mean VAS, 1.100) was significantly better ($P < 0.001$) than Profluorid Varnish (mean VAS, 2.500) and PRG-Barrier Coat (mean VAS, 1.700) for both tactile and evaporative stimuli [Table 2].

**Discussion**

DH is characterized by sharp pain of short duration due to thermal or evaporative stimuli on exposed dentinal surfaces.[1] According to the Hydrodynamic theory by Brannstrom,[6] stimulation of dentin results in a flow movement in the dentinal tubules, either toward or away from the pulp which can cause a mechanical deformation of nerve endings in dentin or in dentin/pulp interphase resulting in pain transmission. Treatment for DH is mainly focused on the occlusion of dentinal tubules.[5] Other therapeutic modalities may work by a neural blocking mechanism.[7,8]

Different mechanisms have been proposed for occlusion of dentinal tubules. Occlusion can be done by the precipitation of proteins present in dentinal tubular fluid, precipitation of amorphous particles over exposed dentin surfaces and/or inside tubules, or by the formation of a superficial pellicle which may penetrate into the dentin tubules.[16] The neural blocking method is done by the direct diffusion of potassium ions through dentin increasing its concentration in the pulp tissue which can block nerve impulse conduction by alteration of action potentials.[7,8]

It may be difficult to accurately quantify DH as it is a subjective condition.[1] Previously reported methods to

| Materials       | Manufacturers | Ingredients                                                                                     | Application procedures                                                                                     |
|-----------------|--------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Admira Protect  | Voco         | Monomers (bisphenol A diglycidyl ether dimethacrylate, 2-hydroxyethyl methacrylate) organic acids; and ormofer | Remove excess water with an oil-free air jet<br>Do not over dry dentine<br>Apply on all dentine surfaces for 20 s<br>Disperse with a faint air jet<br>Light-cure with a conventional polymerization device for 10 s<br>Apply a second layer; disperse it with a faint air jet and light-cure for 10 s<br>Remove the oxygen-inhibited layer with a cotton pellet |
| PRG-Barrier Coat| Shofu: Japan | Base: S-PRG filler based on fluoro-boroaluminosilicate glass distilled water, methacrylic acid monomer, and others active: Phosphonic acid monomer, methacrylic acid monomer Bis-MPEPP, carboxylic acid monomer, TEGDMA, reaction initiator, and others | Mix base and active in the base container<br>Apply a thin layer of the mixture on the dried tooth surface and leave undisturbed for >3 s<br>Light-cure using a dental light-curing unit 10 s<br>After light-curing, remove uncured layer by gently rubbing the surface with a water-moistened cotton ball |
| Profluorid Varnish | Voco       | 5% sodium fluoride                                                                                       | Use brush applicator or foam pellet to uniformly apply VOCO Profluorid Varnish, covering the entire surface to be treated as a thin film<br>Allow area to become wet (either by gentle rinsing or natural salivary flow) to ensure setting of VOCO Profluorid Varnish |

TEGDMA=Triethylene glycol dimethacrylate, Bis-MPEPP=2,2-bis ([4-methacryloxy polyethoxy] phenyl) propane, S-PRG=Surface pre-reacted glass

**Table 2: Mean (standard deviation) of baseline, immediate, 1 week, and 1 month of visual analog scale scores recorded after topical application**

| Evaluations | Test Groups | $n$ | Tactile stimuli, mean (SD) | $P < 0.001$ | Air blast stimuli, mean (SD) | $P < 0.001$ |
|-------------|-------------|-----|---------------------------|-------------|-----------------------------|-------------|
| Baseline    | Admira Protect | 20  | 2.2 (0.6) | 0.743  | 2.5 (0.8) | 0.033  |
|             | PRG-Barrier Coat | 20  | 2.3 (0.9) | 0.033  | 3.0 (1.5) | 0.000  |
|             | Profluorid    | 20  | 2.4 (0.8) |          | 3.6 (1.3) |          |
| Immediately | Admira Protect | 20  | 0 | 0.342  |          | 0 | 0.000  |
|             | PRG-Barrier Coat | 20  | 0 |          |          | 0 |          |
|             | Profluorid    | 20  | 0.1 (0.4) | <0.001 | 0.4 (0.8) | <0.001 |
| 1 week      | Admira Protect | 20  | 0 | <0.001 | 0 | <0.001  |
|             | PRG-Barrier Coat | 20  | 0.2 (0.6) | 0.3 (0.7) | 0 |          |
|             | Profluorid    | 20  | 1.4 (0.9) | 2.0 (1.2) | 0 |          |
| 1 month     | Admira Protect | 20  | 0.5 (0.8) | <0.001 | 1.1 (1.0) | <0.001 |
|             | PRG-Barrier Coat | 20  | 1.5 (0.8) | 1.7 (1.3) | 0 |          |
|             | Profluorid    | 20  | 1.8 (0.6) | 2.4 (1.2) | 0 |          |

SD=Standard deviation
reduce and quantify pain of DH are the evaporative method and the tactile method.\cite{17,18} The tactile method using a probe tip can cause movement of dentinal fluid as a result of dentin compression.\cite{19} An air blast can decrease the temperature at the exposed dentin surface and can cause evaporation of fluid inside the tubules. Dentinal fluid movement can also occur due to both these effects.\cite{20}

Pain due to DH using tactile and evaporative stimuli was determined by VAS. VAS has been reported to be the most appropriate method to diagnose pain levels as it allows for the translation of subjective feedback into objective data.\cite{21}

In this study, patients with DH in at least three quadrants were selected. We evaluated Profluorid Varnish, Protect, and PRG-Barrier Coat as treatment modalities for DH by their application in different quadrants in the same patient.

Fluoride-containing compounds such as sodium monofluorophosphate, sodium fluoride, stannous fluoride, and fluoroosilicate have been evaluated as therapeutic agents to treat dentin hypersensitivity.\cite{13} Fluoride varnish that adheres to dentin retains the fluoride as long as possible. Immediate desensitization can be seen with the use of fluoride varnish, but since they exhibit low adhesion, they can be removed by saliva or by toothbrush abrasion.\cite{20,21}

In the present study, Profluorid Varnish which contains sodium fluoride was used.

Admira Protect contains bisphenol A diglycidyl ether dimethacrylate and 2-hydroxyethyl methacrylate monomers, organic acids, and ormocon. Ormocon materials contain inorganic-organic copolymers and inorganic silanated filler particles. According to the manufacturer, it can bond to dentin similar to a self-etching adhesive.\cite{22,23} However it has been reported that it may not contain chemicals needed for polymerisation. It may induce precipitation of proteins inside dentinal tubules thus reducing fluid movement.\cite{22}

The presence of fillers may enhance the wear resistance thereby resisting removal.\cite{24}

PRG-Barrier Coat is a light-curable varnish/desensitizer which is supplied as a base and active solutions. According to the manufacturer, the surface-partially reacted glass (S-PRG) filler is a bioactive trilaminar structure with a multifunctional glass core embedded in resin matrix. It can release and recharge fluoride ions.

All the desensitizing agents showed significant \( P < 0.001 \) reduction in DH immediately after application, at 1 week, and 1 month compared to baseline mean VAS scores for both tactile and evaporative stimuli. In addition, immediately after application, there was no significant difference between all three groups.

Similarly, Torres et al. reported a significant reduction immediately after the application of Admira Protect, Bifluorid 12, and Colgate Pro-Relief.\cite{24} 

Yu et al. have also reported that one-bottle self-etching adhesives, Gluma desensitizer, and Bifluorid 12 can cause an immediate reduction in DH.\cite{25} Samuel et al. have also have compared three agents and have reported a significant immediate reduction in DH in their study.\cite{26} Therefore, it can be interpreted that most desensitizing agents will cause an immediate and significant reduction in DH.

At 1 week and 1 month, all the desensitizing agents showed significant \( P < 0.001 \) reduction in DH compared to baseline mean VAS scores for both tactile and evaporative stimuli. However, Admira Protect and PRG-Barrier Coat groups were significantly effective in reducing DH compared to Profluorid Varnish group at 1 week. At 1-month follow-up, Admira Protect was significantly better than Profluorid Varnish and PRG-Barrier Coat for both tactile and evaporative stimuli.

Similarly, Torres et al. reported a significant reduction in DH at 1 week using Admira Protect, Bifluorid 12, or Colgate Pro-Relief.\cite{24} Another study reported the use of calcium, sodium phosphosilicate desensitizer resulted in significant hypersensitivity reduction after 1 week and 4 weeks compared to baseline values.\cite{27} Erdemir et al. reported that the three desensitizing agents (Pain-Free, BisBlock, and Seal and Protect) used in their study provided effective desensitization for 4 weeks.\cite{28}

In the present study, Admira Protect showed better reduction in pain of Dentin Hypersensitivity compared to other products evaluated in this study. Further studies using Admira Protect for a longer period of time will have to be done to evaluate long-term performance in the treatment of DH.

**Conclusion**

Within the conditions of this clinical study, it can be concluded that Profluorid Varnish, Admira Protect, and PRG-Barrier Coat can reduce DH immediately after application, at 1 week, and 1 month compared to baseline mean VAS scores for both tactile and evaporative stimuli.

Admira Protect and PRG-Barrier Coat groups were significantly more effective in reducing DH compared to Profluorid Varnish group at 1 week. At 1-month follow-up, Admira Protect was significantly better than Profluorid Varnish and PRG-Barrier Coat for both tactile and evaporative stimuli.

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**Conflicts of interest**

There are no conflicts of interest.
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