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# COMPARATIVE ASSESSMENT OF THE EFFECT OF FOUR DIFFERENT DESENSITIZING AGENTS ON DENTINAL TUBULE OBLITERATION AND CONDUCTANCE: AN IN VITRO SEM ANALYSIS

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**ABSTRACT**

Dentinal Hypersensitivity (DH) is a prevalent disorder and one of the most annoying diseases. It is mainly due to exposed dentinal tubules, and the most common clinical cause of exposed dentinal tubules is gingival recession. Besides other treatment options, agents were introduced for partial or complete obturation of dentinal tubules (tubule occluding agents), protein precipitation, or sealing the tubules. This in vitro study aimed to evaluate and compare the occluding effect of Novamin. Colgate propolis, VivaSens and Sensodyne by Scanning Electron Microscopy in a dentin disc model. The test specimens were treated with the desensitizing agents as per the manufacturer's instructions. Subsequent to the treatment, the specimens were dried and prepared for analysis by SEM. The results obtained were statistically analysed by one way analysis of variance (ANOVA). The results of this in-vitro study showed that the majority of dentinal tubules were blocked by Novamin and sensodyne as compared to control group where only few dentinal tubules were blocked.

**Keywords:** Novamin and sensodyne

## Introduction

Different terms have been used to describe dentin hypersensitivity like Dentin Hypersensitivity, Sensitivity, and Dentinal Hypersensitivity etc. Dentin hypersensitivity (DH) is defined as a short, sharp pain arising from exposed dentin in response to stimuli such as cold, heat, air, touch, chemical or osmotic stimuli which cannot be ascribed to any other form of dental defect or pathology. [1] The subjects' evaluation of their own overall sensitivity, i.e. subject assessment, has been used frequently to measure hypersensitivity in clinical studies. This assessment is done through various types of stimuli, which can be applied on the teeth to evoke a response from the patient. Patient's own perception of overall hypersensitivity, as experienced by them, following application of various stimuli, can be reported using either a verbal rating scale (VRS) or a visual analogue scale (VAS). [2] Although DH is a prevalent disorder and one of the most annoying diseases, with as many as 1 in 7 (8-57%) patients attending for dental treatment. [3]The greatest incidence has been documented in the 20-40 years age group. The most frequently affected teeth are premolars (68.8%), followed by molars, canines, and incisors.[4] Dentinal hypersensitivity is closely related to exposed dentinal tubules, and the most common clinical cause of exposed dentinal tubules is gingival recession. Brushing habits, diet, chewing tobacco and some diseases including gastroesophageal reflux can also cause dentin hypersensitivity. It may also result from abfraction, abrasion, or erosion and denudation of the root surface. [5] The DH mechanism is still uncertain, and the most acceptable hypothesis is based on the hydrodynamic theory.[6] A number of treatment options are currently available for the

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treatment of hypersensitivity. Agents may bring about their therapeutic effects, either by partial or complete obturation of dentinal tubules (tubule occluding agents), by anti-inflammatory activity, protein precipitation, or sealing the tubules. Thus, most treatment options focus on controlling dentin fluid movement. Accordingly, therapeutic agents that promote the occlusion of the dentin tubule apertures, such as fluoride-based agents, are interesting strategies. [7,8,9] The treatments which have been suggested for it are not sufficient and very successful.[10] The search for an agent that would predictably and permanently occlude the tubules and blend with them still going. This in vitro study aimed to microscopically evaluate and compare the occluding effect of different dentin desensitizing agents on human dentinal tubules. The present study evaluated the influence of topical application of a hydroxyapatite containing desensitizing agent (Novamin), propolis containing agent (Colgate propolis), varnish(VivaSens®) and10% of strontium chloride (Sensodyne) on dentinal tubule occlusion.

**Materials and method**

Fifty extracted human premolars were included all of which had been extracted for orthodontic reasons from the department of oral and maxillofacial surgery, government dental college and hospital Srinagar.

Inclusion criteria: 1.Caries free crown and root surface

2. Roots without any abrasion or erosion

Teeth with history of scaling in last six months and endodontically treated teeth were excluded from the study. The teeth were cleaned for debris and tissue. Using plain cut tungsten carbide fissure burs the enamel was removed at high speed under a continuous water spray and crown dentin discs, with a thickness of 1mm, were prepared by cutting perpendicular to the long axis of tooth. The dentin discs were polished with carborundum paper. Dentinal debris was removed from the discs by ultrasonication in distilled water for 30s followed by rinsing in distilled water. Each specimen was etched with 30% phosphoric acid for 15 minute to remove any smear layer from the grinding process and open the dentine tubules to simulate dentine hypersensitivity. All the discs were stored in distilled water. A total of 50 dentin discs of 1mm thickness were divided into five groups of 10 specimens each according to the surface treatment.

Group A: Novamin.

Group B: Colgate propolis.

Group C: VivaSens.

Group D: Sensodyne

Group E: Control group, consisted of dentin discs immersed in normal saline.

The test specimens were treated with the desensitizing agents as per the manufacturer's instructions. Subsequent to the treatment, the specimens were dried and prepared for analysis by SEM. The surfaces of the samples were scanned and examined using SEM. The percentage of partially and/or fully occluded tubules was approximated from the various images captured in the regions of interest by the SEM for each representative micrograph from all groups.

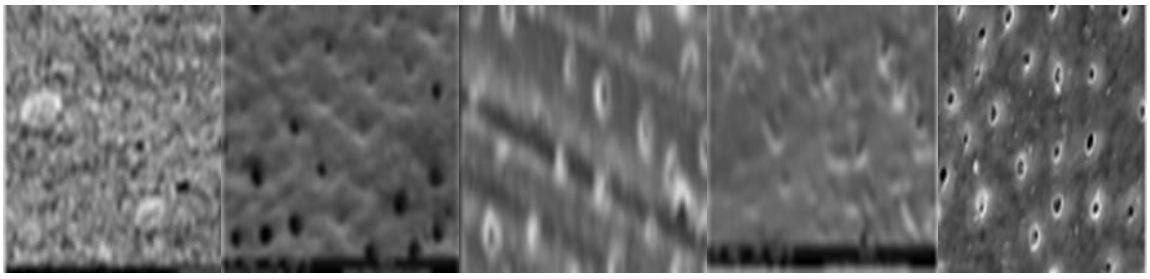

**Figure 1: Occluding ability and durability of four Desensitizing agents after application on exposed dentinal tubules followed by brushing and control group.**

### Statistical analysis

The number of tubules evident in each of the 1000X images was counted to provide a measure of tubule occlusion efficacy. Both the fully-open tubules and the partially-open tubules were included in the count.

$$\text{Percentage of partially or fully occluded tubules} = \frac{\text{Number of partially or fully occluded}}{\text{Total number of tubules}} \times 100$$

The results obtained were statistically analysed by one way analysis of variance (ANOVA). All the analysis was carried out using SPSS version 20 (Chicago, IL, USA). Student's

t-test was used for intergroup comparison with $P < 0.05$

considered to be statistically significant.

Evaluation was done as follows:[11]

1. Occluded (100% of tubules occluded)

2. Mostly occluded (50%–<100% of tubules occluded)

3. Partially occluded (25%–<50% of tubules occluded)

4. Mostly unoccluded (<25% of tubules occluded)

5. Unoccluded (0%, no tubule occlusion).

### Results

Comparisons among groups according to experimental condition for tubule occlusion were tested by one way ANOVA. The number of dentinal tubules per $mm^2$ (mean and SE) was significantly different among the Group A and Group D. In Group B, most of the dentinal tubules were opened, with no deposits on peritubular and intratubular dentin. A higher amount of smear layer was found in Group E. The groups A and D were significantly more effective than control group E ($P < 0.01$) and groups B and C are show insignificant difference from control group E. The results of this in-vitro study showed that the majority of dentinal tubules were blocked by Novamin whereas in the control group, only few dentinal tubules were blocked.

**Table 1: Showing mean percentage of tubule occluding capacity of different agents.**

| Groups | Sample | Mean | SD | P value |
|---|---|---|---|---|
| Group A | Novamin. | 23.8 | 5.30 | 0.0 |
| Group B | Colgate propolis | 30.7 | 7.51 | 0.57 |
| Group C | VivaSens | 30.5 | 7.6 | 0.7 |
| Group D | Sensodyne | 7.1 | 7.0 | 0.0 |
| Group E | Control group | 1.54 | 0.89 | 0.29 |

$P < 0.05$, *statistically significant, SD: Standard deviation

### Discussion

A large number of treatment options are available for managing dentinal hypersensitivity but there is currently no "gold standard" treatment option for dentin hypersensitivity. Now days desensitizing agents which block the dentininal tubules have been shown to achieve easy, quick, non-invasive, and substantial relief of hypersensitivity. [12] The purpose of our in vitro study was to evaluate the potential tubule occluding properties of different commercial pastes. For the purpose of the present study, where comparison of the different commercial treatment procedure was required, we have taken standardized dentinal discs to match the variation in tubule density and

diameter. The commercially available bioactive glass based toothpaste is NovaMin, containing Calcium-sodiumphosphosilicate ,an inorganic compound in the class of highly biocompatible materials that reacts in aqueous environments to release calcium ($Ca^{2+}$), sodium ($Na^{+}$), and phosphate ions ($PO4^{3}$). $Ca^{2+}$ and $PO4^{3-}$) ions from the Novamin toothpaste, along with mineral ions in saliva, are able to form a calcium phosphate (Ca-P) layer onto dentine surfaces or into tubules, which may result in the physical occlusion enhanced by silicates.[13,14,15] NovaMin dentifrice was shown to be significantly more effective than both the strontium chloride and placebo control toothpastes after 6 weeks' use. Propolis was found to be safe and effective in reducing plaque accumulation and have been found to be an effective desensitizing agent.[16,17] Investigation on the properties of propolis for oral conditions has indicated that it has an anti-inflammatory action and stimulates the formation of reparative dentin, which may reduce the dentin permeability. VivaSens is a film-like varnish that creates a protective shield against uncomfortable stimuli. Its innovative formulation combines a variety of synergistic mechanisms. Calcium and protein precipitates are formed, which tightly seal the dentin tubules. VivaSens forms compact precipitates. It coats the entire dentin surface and seals the dentin tubules completely.[19] VivaSens offers patients' fast relief of the pain associated with hypersensitive teeth. [19,20] Sensodyne is a strontium chloride based paste which has been introduced as effective and reliable desensitising paste based on tubule occluding efffects.

The in vitro studies, after SEM observation, produced very positive results concerning the immediate occlusion of dentinal tubules. Statistical analysis of data shows significant difference in Novamin and Sensodyne compared to control group and insignificant differences between propolis ,viva sens and control group. Results of our study reveal that the bioactive glass toothpaste (NovaMin) occlude the dentinal tubules by more than 50%.These results in terms of the surface deposition appeared to be similar to those Gillman et al and Burwell et al.[21,22] In terms of sealing ability of dentinal tubules there was statistically significant difference between Novamin and propolis ,between Novamin and vivasens. Similarly dentinal tubule occluding property of sensodyne is statistically better than vivasens and propolis. The limitations in our study are small sample size. Other tubule blocking commercially available pastes or lasers should have been incorporated in comparison. SEM analysis does not measure depth of tubule penetration by different agents used in study.

## Conclusion

In terms of sealing ability of dentinal tubules there was statistically significant difference between Novamin and propolis ,between Novamin and vivasens. Bio glass based Novamin pastes are superior dentinal tubule blocking agents and may help in management of dentinal hypersensitivity better than other agents.

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