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Research Article

Comparative Evaluation of Dentine Tubule Occluding Ability of Gluma Desensitizer, Viva-Sens and MS Coat in Dentin Hypersensitivity -- An *In-Vitro* Study

Kamakshi Gupta[1], Navneet Kaur[2]* and Gurpreet Kaur[3]

[1]*Post graduate student, National Dental College and Hospital, Derabassi, Punjab, India*

[2]*Associate Professor, National Dental College and Hospital, Derabassi, Punjab, India*

[3]*Professor, Head of Department, National Dental College and Hospital, Derabassi, Punjab, India*

***Corresponding Author**: Navneet Kaur, Associate Professor, National Dental College and Hospital, Derabassi, Punjab, India.

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Abstract

Background: Hypersensitivity is the common clinical condition with multi etiological factors that may cause discomfort to the patients. The condition may affect the patient from establishing or maintaining adequate oral hygiene measures which may further complicate oral health. Many desensitizing agents have been launched in market in different forms attempting to overcome such a problem. The purpose of this study was to evaluate the ability of new desensitizing agent to occlude dentinal tubule and reduce their diameter as measured by Scanning Electron Microscope.

Materials and Methods: 15 sound maxillary premolars were extracted. Samples were sectioned mesiodistally to obtain 15 buccal and 15 lingual surfaces, and enamel was removed in order to simulate hypersensitive dentin. Specimens were randomly divided into four groups. Group 1: 5 samples were coated with Gluma desensitizer, Group 2: 5 samples were coated with VivaSens, Group 3: 5 samples were coated with MS Coat, Group 4: 5 samples each of the contralateral parts of samples on which no desensitizing agent was applied, which acted as the controls. All the specimens were examined under SEM and photomicrographs were evaluated to assess the opening of dentinal tubules in the controls and occlusion of dentinal tubules in their contralateral parts coated with the desensitizing agents.

Results: Intra-group comparison revealed statistically significant amount of tubules got occluded after the application of MS Coat desensitizer (Group-3) as compared to tubules that got occluded after the application of VivaSens desensitizer (Group-2) and Gluma desensitizer (Group-1).

Conclusion: In present study, MS Coat (Group-3) was found to produce more com¬pletely occluded tubules while Viva Sens (Group-2) followed by Gluma desensitizer (Group-1) creating more partial occlusion on application.

Keywords: *Dentin Sensitivity; Dentin Tubule; Desensitizing Agents; Gluma; Viva-Sens; MS Coat*

Introduction

Dentinal hypersensitivity can be potential threat to individual's oral health because such pain may interfere with the maintenance of oral hygiene. However, this pathological entity still remains poorly understood by the clinical researchers and hence there is no permanent treatment or cure till date.

Dentinal Hypersensitivity is defined as "pain derived from exposed dentin in response to chemical, thermal, tactile or osmotic stimuli which cannot be explained as arising from any other dental defect or disease". Dentinal hypersensitivity is mainly caused by exposure of dentine because of loss of enamel or periodontal tissue and opening of dentinal tubule system. It may provide a direct association between the external environment of the oral cavity and internal environment of the pulp tissue.

A Definition was suggested by the Canadian Advisory Board on Dentin Hypersensitivity in 2003, which suggest that 'disease' should be substituted for; pathology' and stated that this is a distinct clinical entity. Dentin is a vital tissue composed of millions of tubules with a diameter of 0.06 μm and 3.0 μm at dentino- enamel and at the pulpal wall respectively. These dentinal tubules are filled with fluid, an odontoblastic process and occasionally with the non-myelinated pulpal nerve endings. These nerve fibers are in contact with the odontoblast cells and act as a mechanical receptor and causes pain [1]. Various hypothesis has been discussed in the literature to discuss the mechanism of dentinal hypersensitivity, but the most widely accepted hypothesis is Hydrodynamic theory which was first purposed by Gysi (1900) [2], which stated that sharp pain is caused by fluid movement and distortion on the floor cavity. Brannstrom in 1986 and 1996 demonstrated that there is a rapid fluid movement in the tubule complex which may get aggravated by air drying [3].

The number, patency and diameter of dentinal tubule may play an important role in causation of dentinal hypersensitivity. Microscopic examination revealed that patent dentinal tubules are more in number and wider in hypersensitive dentine as compared to non-sensitive dentine [4]. The result of this clinical findings suggest that because of this some patients may experience dentine hypersensitivity in the cervical one -third of tooth.

It has been reported that dentinal hypersensitivity might be reduced physiologically either by formation of intra tubular crystals or salivary mineral crystal along with the application of chemical agent [5]. Most of the compound used in the treatment of dentinal hypersensitivity are thought to achieve therapeutic benefits by tubule occlusion [6].

The dentine tubules occlusion may occur either directly or indirectly. It may block the tubules which reduces the fluid flow directly or seal off the tubule from the pain provoking stimulus indirectly. The formation of smear layer and obliteration of the tubule may enhance the effectiveness of the treatment [7]. Saliva and salivary components may play an important role in naturally reducing dentinal hypersensitivity by supplying calcium and phosphate ions into the opened dentinal tubule which blocks the tubule by aggregating the salivary glycoprotein with calcium phosphate [8]. Recent review on biological approaches tooth therapy stated that ideal treatment of dentine hypersensitivity should mimic natural desensitizing process to occlude open dentinal tubules [9]. The ideal properties of desensitizing agents are that it should not irritate or endanger the integrity of pulp, relatively painless on application, easily applied, rapid in action and should not discolor tooth structure. Scientific Literature revealed that there are several agents which have been used for the treatment of dentinal hypersensitivity However, till date none of the desensitizing agents has been proven to be completely efficient for the occlusion of dentinal tubules. Hence there is a need of developing a new gold standard desensitizing agent for treatment of the dentinal hypersensitivity.

The various treatment modalities used for de-sensitization includes potassium oxalate (Oxagel), glutaraldehyde and HEMA (Gluma desensitizer), acidulated phosphate fluoride/Nuprogel, potassium nitrate, strontium fluoride etc. In today's era various bonding agent and de-sensitizer are commercially available in the market for the management of dentinal hypersensitivity. Some of the commercially available agents are: Admira Protect, Viva-Sens, Gluma desensitizers, Sealand Protect varnish, MS Coat, Clearfil SE Bond, Cervitec plus, G-Bond etc. Most of these agents are HEMA and Glutaraldehyde based.

Scanning Electron Microscopy (SEM) can be used *in-vitro* to provide a qualitative indication of for the degree of tubular occlusion on the exposed dentinal surface in the dentin disc-model. It is also used to evaluate both dentine morphology and surface characteristic in sensitive as well as non-sensitive dentin following the application of de-sensitizing agents.

Gluma Desensitizer is an aqueous solution which contains 5% glutaraldehyde and 35% hydroxyethyl methacrylate (HEMA). The glutaraldehyde a biological fixative solution which intrinsically blocks the dentinal tubules [1]. Hydroxyethyl methacrylate is a hydrophilic monomer compound of dentin bonding agents with an ability to infiltrate into acid-etched and moist dental hard tissue [3]. Viva Sens is a protein precipitate desensitizer which contains polyethylene glycol di methacrylate that triggers the precipitation of plasma proteins in the dentinal tubules [4]. MS Coat is commercially available as MS Coat ONE which contains methacrylate-co-p-styrene sulfonic acid called as MS polymer and 1% oxalic acid. It chemically reacts with tooth structure to form a barrier that seals the opened dentinal tubules and blocks thermal, mechanical and chemical stimulation of the odontoblastic processes.

The present study has been designed to comparatively evaluate and compare the effects of Gluma-desensitizer (Aqueous Solution of 5% glutaraldehyde and 35% HEMA), Viva-Sens (Protein precipitate Desensitizer) and MS Coat which is commercially available as MS Coat One (Metha acrylate-co-p-styrene Sulphonic acid called as MS polymer and 1% oxalic acid) on dentinal tubule occlusion under Scanning Electron Microscope after their application on dentine for the treatment of dentinal hypersensitivity.

Materials and Methods

Study population

A total of 15 sound maxillary premolars were selected and washed with distilled water, ultrasonic scaling was done followed by root planing with the Gracey curette 5-6 and then the samples were stored in normal saline and were randomly divided into 4 groups. This pilot study was done in the Department of Periodontology and Oral Implantology, National Dental College and Hospital, Derabassi, Punjab. An ethical approval for the study was obtained from the Institutional Ethical Board Committee.

Inclusion criteria

1. Sound maxillary premolars extracted for orthodontic purposes.
2. Vital teeth at the time of extraction.

Exclusion criteria

1. Presence of caries on the surface of teeth.
2. Teeth which were fractured.
3. Teeth having periapical infection or non-vital teeth.
4. Teeth with malformations.
5. Teeth with wasting disease.

Methodology

15 sound maxillary premolars teeth extracted for Orthodontic purpose were collected and stored in normal saline. The root surfaces of all the teeth were scaled with an ultrasonic scaler and thoroughly planed with #5-6 Gracey curette. The coronal portion of the root and

the apical third of the root was removed. The middle third portion of samples was grounded by a straight bur to remove the cementum layer and expose the dentinal tubules, so that it simulates the hypersensitive teeth. Samples was sectioned mesiodistally with a diamond wheel disc bur to obtain 15 buccal and 15 lingual surfaces. All the samples were kept in 17% EDTA for 40 minutes in order to completely open the dentinal tubules. These blocks were ultra-sonicated in distilled water for 12 minutes to remove the residual smear layer. All samples were dehydrated in a graded series of ethanol (10 - 90%) for 30 minutes each and finally in 100% acetone for 30 more minutes. After chemical treatment of the dentinal blocks, the samples were randomly divided into test (Group 1, Group 2 and Group 3) groups and control (Group 4) group:

- **Group1:** 5 samples were coated with Gluma desensitizer.
- **Group 2**: 5 samples were coated with Viva Sens.
- **Group 3:** 5 samples were coated with MS Coat.
- **Group 4:** 5 samples each of the contralateral parts of samples coated with Gluma desensitizer, Viva Sens and MS Coat on which no desensitizing agent was applied, which acted as a control.

The samples were dried and mounted on metal stubs, and inserted in SC7640 sputter coating machine, the samples were sputter coated with 25 nm of gold for 10 minutes. All the specimens were examined in a POLARON-SEM at a magnification of 3000X and photomicrographs were evaluated to assess the opening of dentinal tubules in the controls and occlusion of dentinal tubules in their contralateral parts coated with the desensitizing agents as shown in figure 1-6.

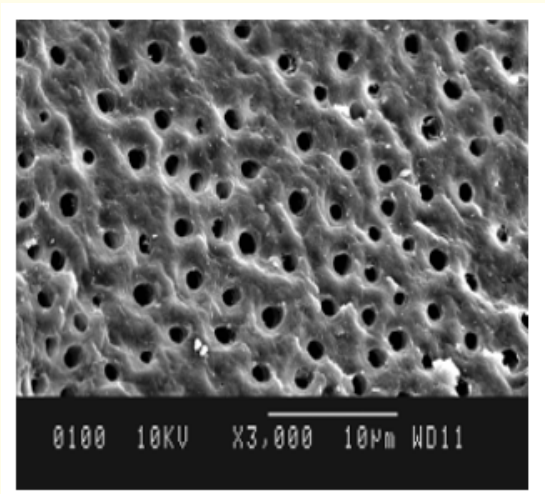


Figure 1: *Photomicrograph showing open dentinal tubules without occlusion in Gluma control group.*

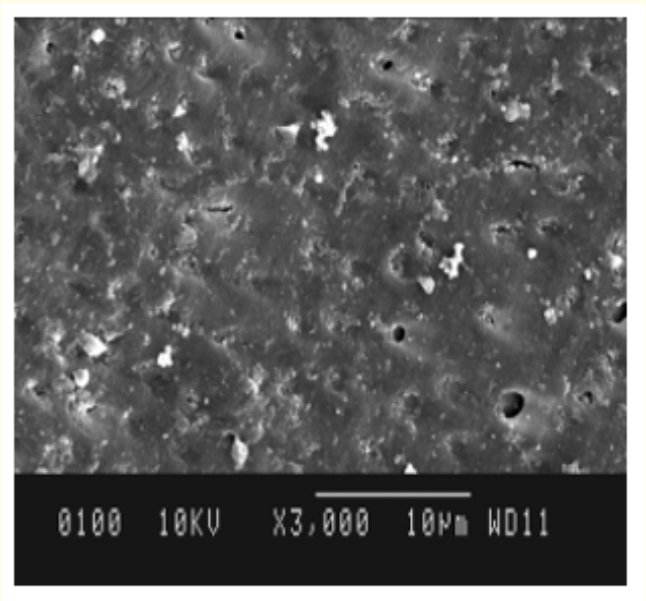


Figure 2: *Photomicrograph showing occluded dentinal tubules in Gluma desensitizer group.*

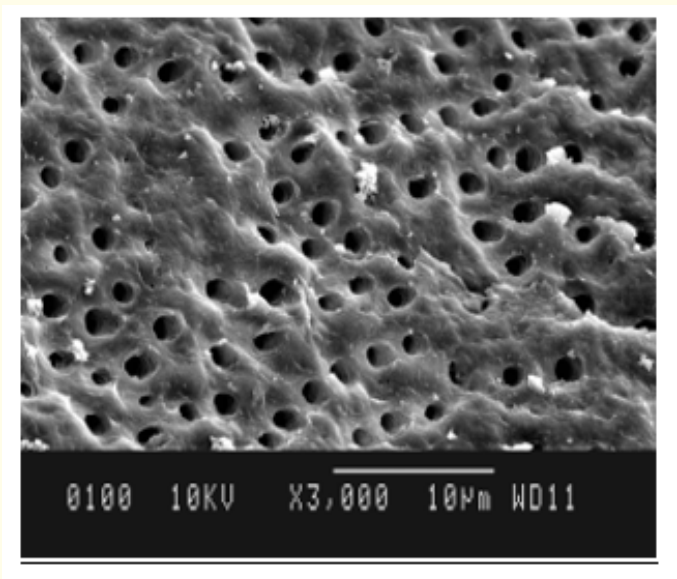


Figure 3: *Photomicrograph showing open dentinal tubules without occlusion in Viva-Sens control group.*

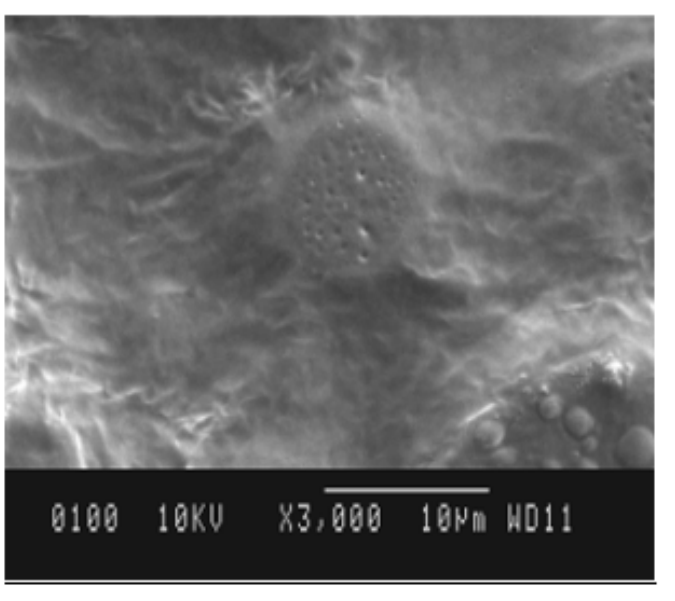


Figure 4: *Photomicrograph showing occluded dentinal tubules in Viva-Sens desensitizer group.*

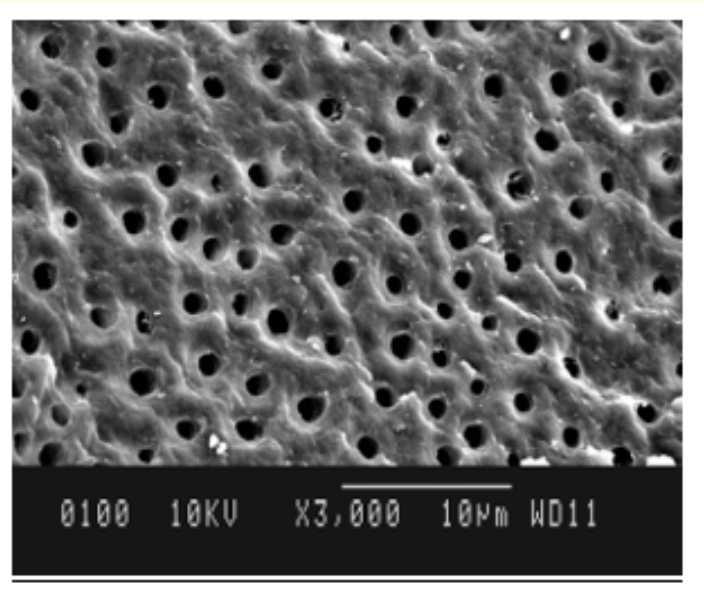


Figure 5: *Photomicrograph showing open dentinal tubules without occlusion in MS Coat control group.*

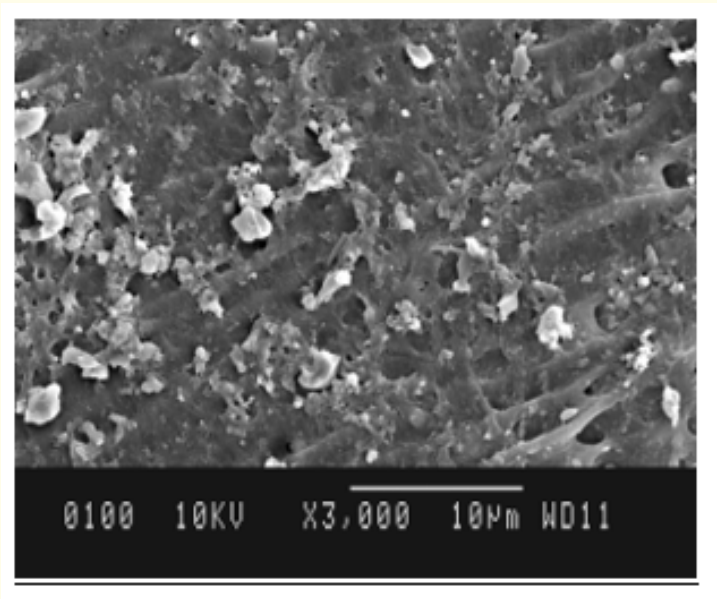


Figure 6: *Photomicrograph showing occluded dentinal tubules in MS Coat desensitizer group.*

The differences between desensitizer coated teeth and their contralateral was analyzed. The total number of tubules, number of open, number of completely occluded, and number of partially occluded tubules were counted in each photograph of all of the samples.

Scanning electron microscope scoring

After observing the SEM images at a magnification of ×3000, the images were assessed to score the level of tubule occlusion (on a categorical scale of 1 - 5), in accordance with the tubule occlusion classification scoring system:

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

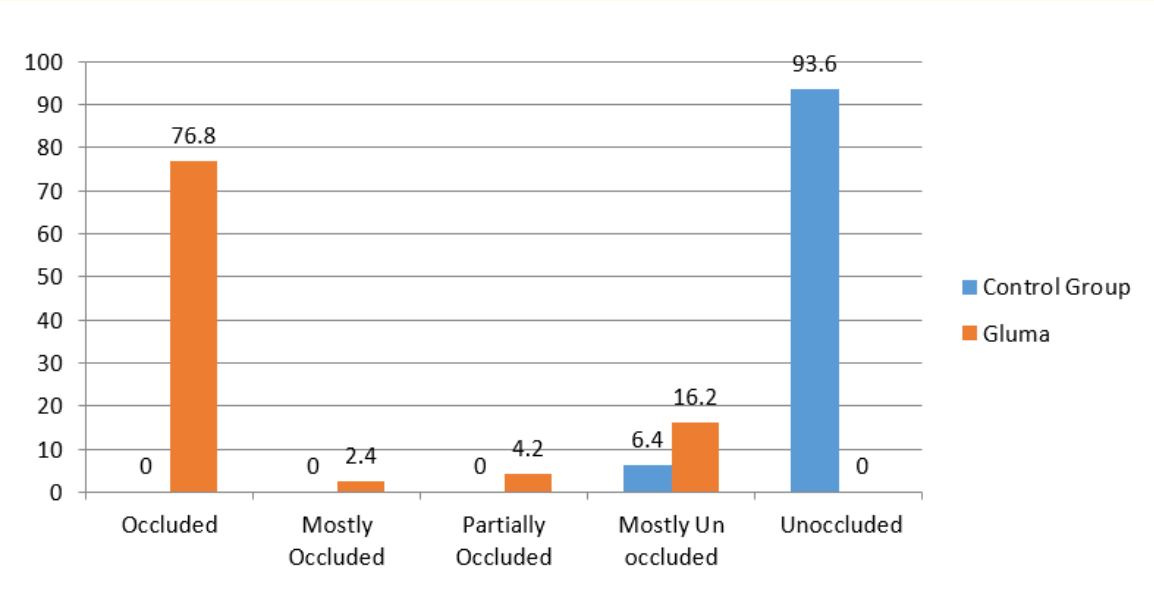
Statistical analysis

The data for the present study was entered in the Microsoft Excel 2013 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics analysis was expressed as mean and standard deviation for each group. The intergroup comparison for the

difference of mean scores between independent groups was done using the one-way ANOVA and Post Hoc Tukey Analysis**.** The Intragroup comparison of mean score was analyzed using independent t test.

	Gluma control group (Group 4)	Gluma test group (Group 1)	P-Value
Occluded	0.00 ± 0.00	76.80 ± 41.84	0.001**
Mostly Occluded	0.00 ± 0.00	2.40 ± 2.19	0.043**
Partially Occluded	0.00 ± 0.00	4.20 ± 7.75	0.261**
Mostly Un occluded	6.40 ± 4.98	16.20 ± 35.66	0.560
Un-occluded	93.60 ± 4.98	0.00 ± 0.00	0.001**

Table 1: *Intragroup comparison of mean ± SD of occlusion of tubules between gluma test group and gluma control group. **Indicates that the value is statistically significant; SD is Standard Deviation.*

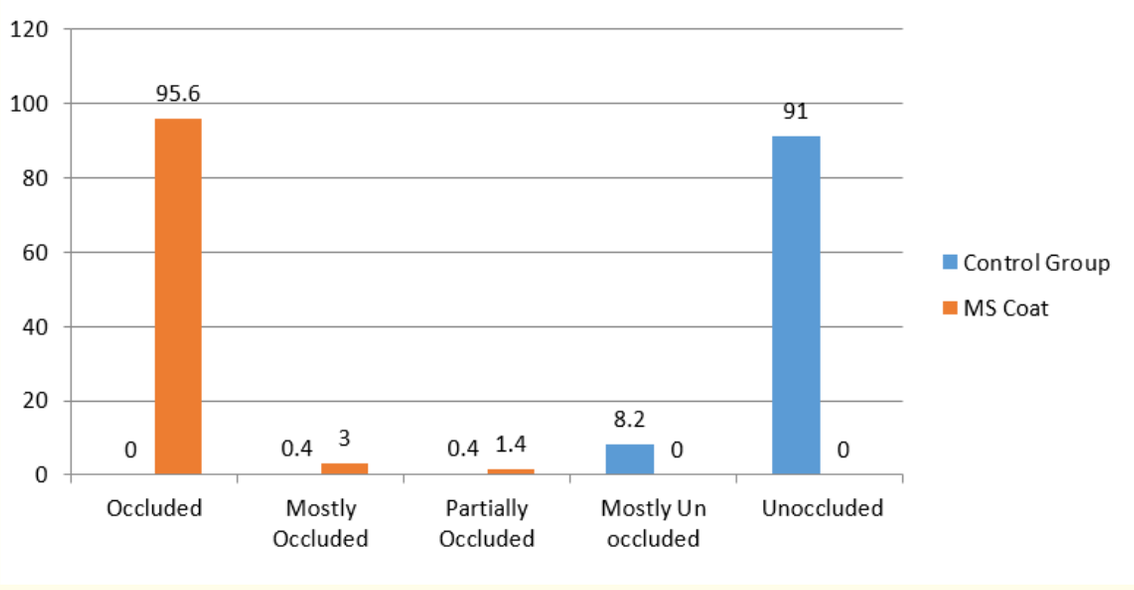


Graph 1: *Intragroup comparison of occlusion of tubules between gluma test group and gluma control group.*

In table 1, graph 1, in Gluma Group, the mean percentage of 76.80 ± 41.84 of the tubules were occluded, 2.40 ± 2.19 of the tubules were mostly occluded, 4.20 ± 7.75 were partially occluded and 16.20 ± 35.66 percent were mostly unoccluded and 0.00 ± 0.00 were unoccluded. In the control group. The mean percentage of 0.00 ± 0.00 of the tubules were occluded, 0.00 ± 0.00 of the tubules were mostly occluded, 0.00 ± 0.00 were partially occluded, 6.40 ± 4.9893.60 percent were mostly unoccluded and 93.60 ± 4.98 percent were unoccluded. On intragroup comparison by independent t test showed that the difference in percentage of tubule occlusion was significant (P = 0.001).

	MS coat control group (Group 4)	MS coat test group (Group 2)	P-Value
Occluded	0.00 ± 0.00	95.60 ± 1.94	0.001**
Mostly Occluded	0.40 ± 0.89	3.00 ± 1.22	0.005**
Partially Occluded	0.40 ± 0.89	1.40 ± 0.89	0.195
Mostly Un occluded	8.20 ± 7.88	00.00 ± 0.00	0.049**
Un-occluded	91.00 ± 7.21	0.00 ± 0.00	0.001**

Table 2: *Intragroup comparison of mean* ± SD *of occlusion of tubules between MS coat test group and MS coat control group.*
***Indicates that the value is statistically significant; SD is Standard Deviation.*

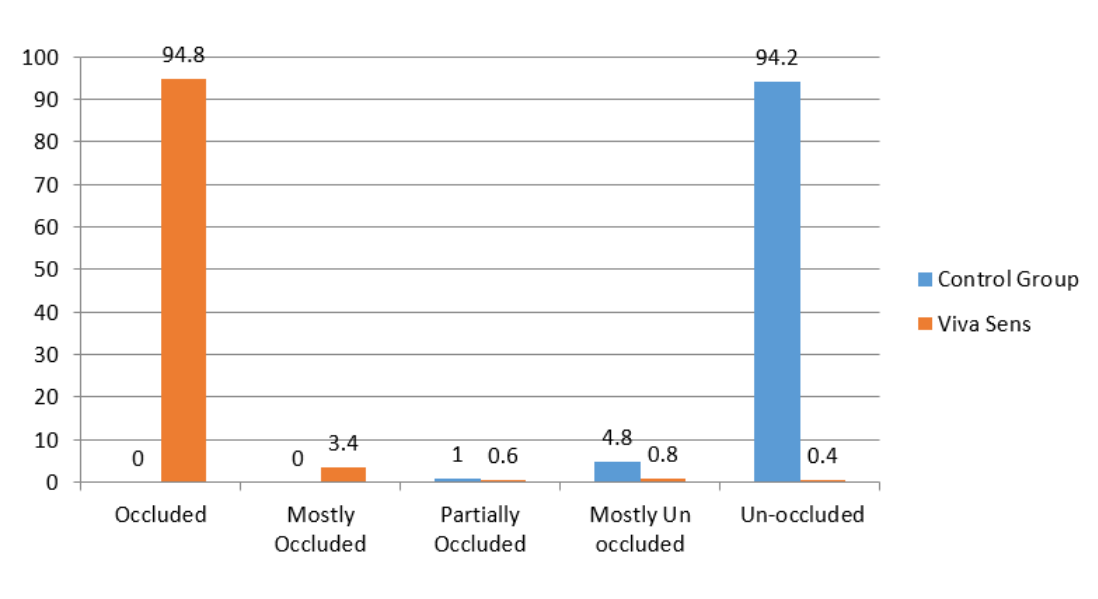


Graph 2: *Intragroup comparison of occlusion of tubules between MS coat test group and MS coat control group.*

In table 2, graph 2, in MS coat Group, the mean percentage of 95.60 ± 1.94 of the tubules were occluded, 3.00 ± 1.22 of the tubules were mostly occluded, 3.00 ± 1.22 were partially occluded and 00.00 ± 0.00 percent were mostly unoccluded and 0.00 ± 0.00 were unoccluded. In the control group. The mean percentage of 0.00 ± 0.00 of the tubules were occluded, 0.40 ± 0.89 of the tubules were mostly occluded, 00.40 ± 0.89 were partially occluded, 8.20 ± 7.88 percent were mostly unoccluded and 91.00 ± 7.21 percent were unoccluded. On intragroup comparison by independent t test showed that the difference in percentage of tubule occlusion was significant (P = 0.001).

	Viva sens control group (Group 4)	Viva sens test group (Group 3)	P-Value
Occluded	0.00 ± 0.00	94.80 ± 2.95	0.001**
Mostly Occluded	0.00 ± 0.00	03.40 ± 1.51	0.001**
Partially Occluded	01.00 ± 2.23	00.60 ± 0.89	0.720
Mostly Un occluded	04.80 ± 5.71	00.80 ± 1.30	0.166
Un-occluded	94.20 ± 7.95	00.40 ± 0.89	0.001**

Table 3: *Intragroup comparison of mean* ± SD *of occlusion of tubules between viva sens test group and viva sens control group.*
***Indicates that the value is statistically significant; SD is Standard Deviation.*



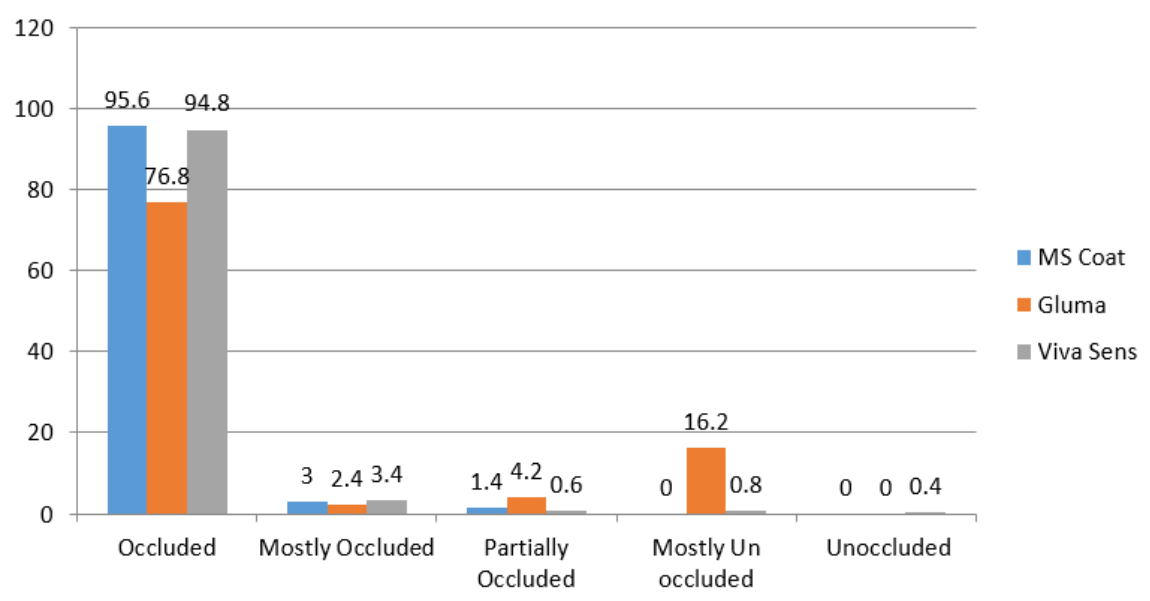
Graph 3: *Intragroup comparison of occlusion of tubules between viva sens test group and viva sens control group.*

In table 3, graph 3, in Viva Sens Group, the mean percentage of 94.80 ± 2.95 of the tubules were occluded, 03.40 ± 1.51 of the tubules were mostly occluded, 00.60 ± 0.89 were partially occluded and 00.80 ± 1.30 percent were mostly unoccluded and 00.40 ± 0.89 were unoccluded. In the control group. The mean percentage of 0.00 ± 0.00 of the tubules were occluded, 0.00 ± 0.00 of the tubules were mostly occluded, 1.00 ± 2.23 were partially occluded, 04.80 ± 5.71 percent were mostly unoccluded and 94.20 ± 7.95 percent were unoccluded. On intragroup comparison by independent t test showed that the difference in percentage of tubule occlusion was significant (P = 0.001).

	Gluma test group (Group 1)	MS coat test group (Group 2)	Viva sens test group (Group 3)	P-Value
Occluded	76.80 ± 41.84	95.60 ± 1.94	94.80 ± 2.95	0.410#
Mostly Occluded	2.40 ± 2.19	3.00 ± 1.22	03.40 ± 1.51	0.653#
Partially Occluded	4.20 ± 7.75	1.40 ± 0.89	00.60 ± 0.89	0.445#
Mostly Un occluded	16.20 ± 35.66	00.00 ± 0.00	00.80 ± 1.30	0.403#
Un-occluded	00.00 ± 7.95	00.00 ± 0.00	00.40 ± 0.89	0.367#

Table 4: *Intergroup comparison of mean* ± SD *of occlusion of tubules between gluma test group, MS coat test group and viva sens test group.*

#Indicates that the value is statistically Non-significant; SD is Standard Deviation.



Graph 4: *Intergroup comparison of occlusion of tubules between gluma test group, MS coat test group and viva sens test group.*

In table 4, graph 4, in Gluma group, the mean percentage of 76.80 ± 41.84 completely occluded, 2.40 ± 2.19 of the tubules were mostly occluded, 4.20 ± 7.75 were partially occluded and 16.20 ± 35.66 percent were mostly unoccluded and 0.00 ± 0.00 were unoccluded. In Viva Sens group, the mean percentage of 94.80 ± 2.95 of the tubules were occluded, 03.40 ± 1.51 of the tubules were mostly occluded, 00.60 ± 0.89 were partially occluded and 00.80 ± 1.30 percent were mostly unoccluded and 00.40 ± 0.89 were unoccluded. In Viva Sens group, the mean percentage of 94.80 ± 2.95 of the tubules were occluded, 03.40 ± 1.51 of the tubules were mostly occluded, 00.60 ± 0.89 were partially occluded and 00.80 ± 1.30 percent were mostly unoccluded and 00.40 ± 0.89 were unoccluded. On intergroup comparison by One-way Anova along with Post Hoc analysis showed that the difference in percentage of tubule occlusion was non-significant (P = 0.05).

Discussion

Dentinal hypersensitivity is characterised by short, sharp pain arising from exposed dentine in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical stimulus which cannot be described to any other dental defect or pathology [5]. Dentine hypersensitivity is a distinct clinical entity and invites the clinician to consider a differential diagnosis, since other clinical conditions may have identical symptoms but require different management strategies [5].

Structurally, dentin is composed of hydroxyapatite mineral and organic components. Dentin is uniquely differentiated from other mineralized tissues in the body because it contains thousands of tubules which run perpendicular to the pulp chamber. The tubules are formed by the odontoblast cells which migrate away from the dentin-enamel junction during dentin formation. The tubule contains the fluid which surround the odontoblastic process.

The desired goal for treatment of dentinal hypersensitivity is attainment of immediate as well as lasting relief from discomfort. This is achieved by either application of a desensitizing agent alone or as an adjunct to other dental treatments. Till date no such treatment has been discovered and there is no 'gold standard' by which one can assess the efficacy of the agent used [8]. The effectiveness of desensitizing agents is based on the potential of sealing the dentinal canaliculi.

Conventional treatment of dentinal hypersensitivity is the topical use of desensitizing agents, either applied professionally or applicable at home by patient such as nerve desensitizers (Hydroxyethyl methacrylate), protein precipitators (glutaraldehyde, silver nitrate, zinc chloride, strontium chloride, dentinal tubule pluggers (sodium fluoride, stannous fluoride, strontium chloride, potassium oxalate, calcium phosphate, calcium carbonate, bioactive glasses) dentin adhesive sealers (fluoride varnishes, oxalic acid and resin, glass ionomer cements, composites, dentin bonding agents) and recently lasers.

In the present study, human premolars have been chosen for evaluation of dentine hypersensitivity. The most commonly affected teeth are canines, first premolars, followed by incisors and second premolars and least affected are molars [9].

In this study saline was used as a storage media for the extracted teeth [9,10], however in other studies different concentration of thymol, sodium cacodylate buffer solution, 10% formalin were used as storage media. Other media like phosphate buffered saline solution, deionised water, Hanks balanced salt solution were also used [10].

In the present study, 17% EDTA was used for 40 minutes which not only removed the smear layer, but also opened and also effective for opening and widening the tubule apertures. This method is most commonly used method for *in-vitro* studies to evaluate the treatments for dentinal hypersensitivity [11,12]. Other agents used as etchant are hydrochloric acid and 6% citric acid [13]. The dentine disc has been used extensively as a model for assessing the surface deposition and tubule-occluding effects of desensitizing agents as well as the effect of these agents on fluid flow through dentine [14,15]. Mordan., *et al*. [16] developed a methodology where the same disc model have been used to provide the experimental and the corresponding control surfaces. Moreover, the dentine disc would appear to be the method of choice because it is easy to use, reproducible, provides a flat surface for elemental analysis. Thus, in our study we have used the specimens obtained from the same dentin disc for control and experimental groups.

In our study, the number of dentinal tubules were counted. The results showed that on application of three desensitizing agents relatively showed occlusion of dentinal tubules however, most of the tubules in the control group were found to be open, with some of them were occluded with a smear layer. On the other hand, most of the tubules treated with Gluma, MS coat and Viva Sens were Occluded, mostly occluded, partially Occluded and Mostly Unoccluded. In present study, after application of desensitizer agent, MS Coat (group 3) showed a greater number of completely occluded tubules and fewer number of partially occluded tubules, followed by specimens treated with Viva Sens (group 2) and Gluma desensitizer (group 1) were observed. The difference in between the groups I, II and III was found to be statistically non-significant. However, on intragroup comparison in between Gluma desensitizer (group 1) and control group (group 4), Viva Sens (group 2) and control group (group 4), MS Coat (group 3) and control group (group 4) were found to be statistically significant.

This might be due to protein coagulation and precipitation upon reaction with glutaraldehyde and hydroxyethyl methacrylate [17]. Glutaraldehyde present in Gluma desensitizer occludes the dentinal tubules as an effect of the reaction with plasma proteins from dentinal fluid. The study of longitudinal sections by SEM micrograph is one way of understanding the interaction of applied material on the treated surface. An *in vivo* study reported that Gluma desensitizer was not effective in relieving dentinal hypersensitivity after 4 weeks. This can be attributed due to a relatively large number of open and partially occluded tubules remaining after treatment [18].

Viva Sens, manufactured by Ivoclar Viva-dent is a protein precipitate-type desensitizer. Viva-sens also seals the root surfaces by the precipitation of calcium ions and proteins. The polyethylene glycol di-methacrylate triggers the precipitation of plasma proteins into the dentinal tubules. The results showed that higher number of dentinal tubules were completely occluded in MS Coat (group 3) as compared to Viva Sens (group 2) and Gluma desensitizer (group 1). This indicates that a statistically significant number of tubules got occluded after the application of MS Coat desensitizer on the specimens. This may occur due to the presence of methacrylate-co-p-styrene sulfonic acid and 1% oxalic acid in MS Coat desensitizer which chemically reacts with tooth structure to form a barrier that seals the open dentinal tubules and blocks the thermal and chemical stimulation of the odontoblastic cells process.

Our study results are consistent with several *in vitro* studies conducted by Ishihata., *et al*. 2011, 2012 [19,20]; Duran., *et al*. 2005 [21] and Schupbach., *et al*. 1997 [22] in terms of different concentration, duration, frequency and application of the desensitising agents applied on the cervical portion of tooth surfaces.

In this study, all the three desensitizing agents relatively showed occlusion of dentinal tubules. On application of MS Coat followed by Viva Sens and Gluma desensitizer agent has shown superior results in terms of complete tubule occlusion. Difference between our study results comparable with other studies results may be related to the dentin specimen etching process, time and mode of application of the desensitizing agent, or a combination of these variables. Significant differences in the results may be due to the multiple applications and testing the materials under the vigorous conditions. From a clinical standpoint, it is important for a dental clinician to be aware of the post-treatment durability of the desensitizers to be used and consider the need to follow up the patient.

Further clinical trials and SEM studies are recommended to compare the efficacy of different desensitizing agents flooding into the market. The detailed analysis of the tubule occluding elements in MS Coat, Viva Sens and Gluma desensitizing agent should be studied further using powder diffraction X-ray analysis and Fourier transform infrared spectroscopy.

Conclusion

Within the constraints and boundaries of an *in vitro* model, so further *in vitro* studies with larger sample size are recommended to reach at a definitive conclusion. MS Coat was found to produce more completely occluded tubules while Viva Sens followed by Gluma desensitizer show more partial occlusion on application. There was a statistically significant difference between the three-test group and subsequent control group in terms of complete and partial occlusion of dentinal tubules. Hence, MS Coat application could be more effective in occluding the dentinal tubules when compared to other desensitizer agents.

Nevertheless, further *in vivo* studies are needed to be conducted to evaluate the occlusive and mineralization effects of desensitizing agents. It should, however be mentioned that the future research on dentin hypersensitivity may entail some revisions, modifications or changes in the content of current study.

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