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DESENSITIZING EFFICACY OF NOVAMIN, BIODENTINE ALONE AND BIODENTINE IN COMBINATION WITH DIODE LASER UNDER SCANNING ELECTRON MICROSCOPE

Endodontics

Dr. Mitali Jani* Final Year Post Graduate Department of Conservative Dentistry And Endodontics, Jaipur Dental College. *Corresponding Author

Dr. Deepak Sharma HOD & Professor MDS Department of Conservative Dentistry And Endodontics, Jaipur Dental College.

Dr. Manu Bansal Reader MDS- Department of Conservative Dentistry And Endodontics, Jaipur Dental College.

ABSTRACT

AIM: The aim of the study was to check the desensitizing efficacy of Novamin, Biodentine alone and Biodentine in combination with diode laser under Scanning Electron Microscope. **METHODOLOGY:** 40 freshly extracted intact permanent first and second premolars were selected from extracted teeth. 10 of these were assigned as control group. Following the preparation of the dentin discs of size 3x3x2mm were prepared by using double-sided diamond disk. The selected 40 dentin specimens were categorized as Group 1:citric acid, Group 2: novamin , Group 3: Biodentine and Group 4: Biodentine + diode laser,. The samples underwent scanning electron microscope analysis. **RESULTS:** The mean Percentage of completely occluded tubules in test the groups were 0, 90.07, 65.54, 40.95 for Group 1, 2, 3 and 4 respectively. There was a significant difference ($p<0.001$) between the experimental groups and the control group. Group 2 showed the dentinal tubule occlusion ability as compared to other groups. **CONCLUSION:** Novamin showed the best densensitizing effect followed by Biodentine and than Biodentine in combination with diode laser in dentinal tubule occlusion. As novamin precipitated precipitates hydroxy carbonate apetite over the entire dentin surface which occluded dentinal tubules maximum rate.

KEYWORDS

Calcium sodium phosphosilicate, Dentinal hypersensitivity, Biodentine, diode laser, scanning electron microscope

INTRODUCTION

Dentin hypersensitivity is most common oral problem affecting more than 40% population in many cases.[1,2] dentin hypersensitivity can be caused by non carious lesions such as attrition, abration and erosion leading to denudation of root surface causing cervical lesions.[3] There are numerous methods proposed for treatment of hypersensitivity which includes in office and at home treatments. [4,5] There are many desensitizing agents causing occlusion of dentinal tubules and reduce dentin permeability and fluid movement such as potassium nitrate, oxalates, strontium-based compounds, citrate-based compounds, stannous fluoride, calcium sodium phosphosilicate (CSPS) etc.[6] Among which Novamin which is the trade name of a particulate bioactive glass containing the active ingredient calcium sodium phosphosilicate (CSPS) which when exposed to an aqueous media provides calcium & phosphate ions forming a hydroxy- carbonate apatite like layer that is chemically similar to that present in enamel & dentine, aid in remineralization of tooth surfaces.[7,8]

Another material such as, Biodentine which is a calcium silicate-based product, is specifically designed as a "dentine replacement" material.[11] Biodentine has a property to adhare over the tooth surface by micromechanical bonding, this leads to resistance to microleakage and bacterial infiltration.[10] In recent times, due to improves technology and advancement has led to develop lasers with wavelengths suitable for therapeutic treatment. [11,12] The laser is able to completely or partially occlude dentinal tubules also hleps in additional effect on tertiary dentin formation.[13,14] Several studies describe the synergistic effect of lasers in conjunction with desensitization agents. These studies demonstrated that lasers can improve the perfomanence of the desensitizer for longer time than when they are used alone. For this reason, if a laser device is used in addition to a conventional desensitizing agent.[15]

The present study was carried out to evaluate and compare the dentinal tubule occlusion ability of Novamin, Biodentine,® and Biodentine® in combination with diode laser under scanning electron microscope.

MATERIALS & METHOD

This comparative in vitro study was carried out on 40 randomly selected extracted premolar teeth in Department of conservative dentistry and endodontics, Jaipur Dental College and Hospital, Jaipur, India. After selection of the extracted teeth, Dentine specimens of size 3x3x2mm were prepared by using double-sided diamond disk (Pashley's dentin- disc model) (SS White, Lakewood, NJ, USA) , surface attached to water cooled air motor (NSK .PNEU- MART TN203.H6455.JAPAN) and straight handpeice (NSK.SH- E922785). The specimens were randomly divided into 4 groups of 40 dentin blocks for treatment group & 1 group of 10 dentin blocks for negative control group. These dentin blocks were mounted on 2 mm thick acrylic plate of using Cyanoacrylate adhesive (super glue). The smear layer was removed by immersion all the dentine discs in 6% citric acid for two minutes. The discs remove from the citric acid solution and are immerse in deionized water for 30 seconds. All the specimens were immersed in distilled water for 12 min to remove residual smear layer and to open the dentine tubule to simulate hypersensitive cervical dentin.

The 40 specimen discs were randomly divided using coin toss method, each groups comprising specimens by following:

- Group 1 (n=10) Specimens were treated with citric acid (Control Group: No Treatment)
- Group 2 (n = 10): Specimens were treated with SENSODYNE Repair ® Group Pharmaceuticals Ltd., India
- Group 3 (n = 10): Specimens were treated with Biodentine Seotodont ® Group Pharmaceuticals Ltd., India
- Group 4 (n=10): Specimens were treated with Biodentine Seotodont ® Group Pharmaceuticals Ltd., India and Picasso lite, AMD LASERS ®Inc. Ltd., India

Specimens of Groups 2 NovaMin® containing dentifrice dispense on brush with a dab-on application of the undiluted respective dentifrice with circular motion using a powered toothbrush (Oral-B Pro-Health Precision Clean Electric Toothbrush) of circular head (soft round bristle) for two minutes under oscillation speed of 800rpm/min , constant pressure ofapproximately 92.7grams & Group 2 were rinsed with distilled water. This procedure was repeated for seven consecutive days.

Group 3 and Group 4 Specimens were treated with Biodentine Seotodont, and on group 4 after the treatment with biodentine, Picasso lite, AMD LASERS (810 nm) was used in contact mode at 90 joules for 1 minute on the root surface of tooth specimens. The Biodentine® was left on the tooth and removed immediately prior to analysis. All treatment groups except control group were immerse in a plastic jar filled with distilled water and stiring for one minute with a plastic stirrer to ensure removal of any excess desensitizing agent.

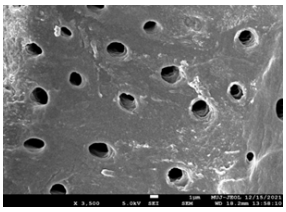
The specimens were washed in tap water and dry. The specimens were then sputter coated with gold for 5 min using fine coat ion sputter (JEOL, JFC-1100, Japan). The photomicrographs of the surface from the center of each dentinal block were obtain using a scanning electron microscope. Photomicrographs were taken at 20 kV and at

3500×magnification. Results were statistically analyzed by one-way Analysis of Variance (ANOVA) and Tukey test. The data were analyzed Using SPSS by one-way analysis of variance (ANOVA) followed by Tukey's post hoc test.

The percentage of occluded tubules for each photomicrograph was calculate as:

- Number of occluded tubules
- Total number of tubules

RESULTS



VFig-1, shows the SEM photomicrograph (at 3500x) where dentin specimens were treated with citric acid [Group I control group-citric acid]

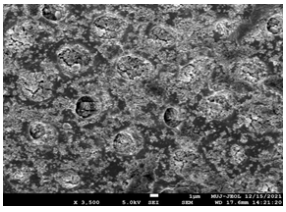


Fig-2,shows the SEM photomicrograph (at 3500x) Protect [Group II-novamin]

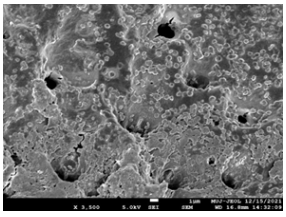


Fig-3,shows the SEM photomicrograph (at 3500x) Protect [Group III biodentin]

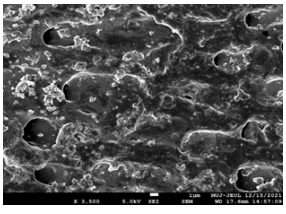


Fig-4 Shows the SEM photomicrograph (at 3500x) [Group IV-biodentin with diode laser]

There was a statistically significant difference in mean test value between the groups according to the one-way analysis of variance (ANOVA) test ($P < 0.001$).

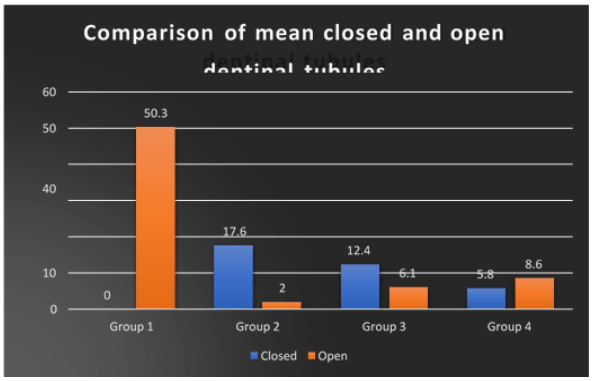
When ANOVA gave highly significant difference in mean ($P<0.001$), The inter-group comparison of mean test value was done using the Tukey post hoc test. The mean and standard deviation values of the dentinal tubule occlusion are shown in Table.

Table 1. Number of closed dentinal tubules in all the 4 group

Study group	N	Min-Max	Mean	SD	F value	P value
Group 1	10	0-0	0	0	26.35	P<0.001 HS
Group 2	10	11-21	17.6	3.06		
Group 3	10	6-19	12.4	5.1		
Group 4	10	2-9	5.8	2.1		

Table 2 Tukey post hoc test

Comparing groups	Tukey HSD Q statistic	Tukey HSD p-value
Group 2 vs Group 3	4.5134	0.009
Group 2 vs Group 4	10.2419	0.001
Group 3 vs Group 4	5.7285	0.001

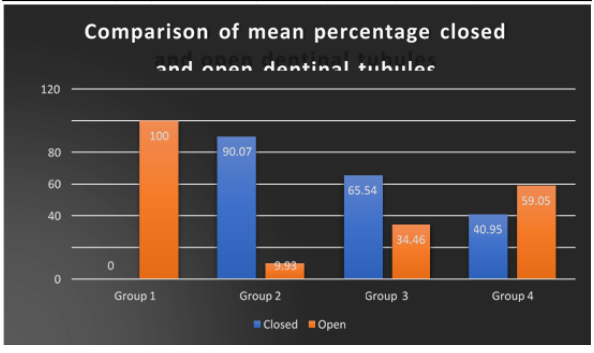


Graph 1: Graphcal Representation Of Mean Test Value Of Different Groups

The mean value was maximum among group 1 followed by Group 2, Group 3 and Group 4 (orange bars represents open dentinal tubules and blue bars represents occluded dentinal tubules)

Table 5. Percentage of completely occluded tubules in test the groups

Study group	N	Min-Max	Mean	SD	F value	P value
Group 1	10	0-0	0	0	40.02	P<0.001 HS
Group 2	10	84-95.45	90.07	4.03		
Group 3	10	33.33-81.82	65.54	15.17		
Group 4	10	13.33-58.33	40.95	14.35		



Graph 2: Graphical Representation Of Mean Percentage Closed And Open Dentinal Tubules

Comparison of mean percentage closed and open dentinal tubules revealed that group 2 had highest occluded tubules followed by group 3 and group 4. Dentinal tubule occlusion was found to be 90.07% in Group 2, 65.54% in Group 3 and 40.95% in Group 4.

DISCUSSION

Clinically treatment of dentinal hypersensitivity with agents that promote the occlusion of dentinal tubules aims to cause the precipitation of crystals which may subsequently reduce the movement of dentinal fluids.[19] The present study compared the desensitizing ability of three different materials i.e. NovaMin, biodentin and biodentin in combination with diode laser. Among which NovaMin (Group II) showed significant no of 90.07% occluded tubules compare to biodentine (65%) and biodentine with laser (40.95%) .

In Group-2 NovaMin (bioactive glass) is an inorganic amorphous calcium sodium phosphosilicate (CSPS) material containing 45% SiO2, 24.5% Na O, 24.5% CaO, and 6% PO4. (92) Sensodyne repair and protect (Glaxo SmithKline, India) is NovaMin (5%) containing desensitizing dentifrices. The dentin specimens were brushed with Sensodyne Repair & Protect [NovaMin] dentifrice mean percentage of tubule occlusion seen was 90.07 %, as it releases calcium, sodium, phosphate & silica all as an amorphous matrix which were necessary for bone & tooth mineralization. Ca-P layer crystalizes into a calcium hydroxyapatite & also known as hydroxyl carbonate apatite. [11,12] The combination of NovaMin particles and hydroxyapatite layer results in physically occluding the dentinal tubules, relieving the dentin hypersensitivity.[17]

In the D.G.Gillam et al [18]study it was concluded that possible deposition on the exposed dentine surface may be either in the form of bioactive glass or more likely as precipitation of calcium phosphorous (calcium phosphate) following ion exchange on the surface of the bioactive glass. Another study by Rajeshwari H. R et al (2015) done to evaluate and compare Desensitizing Potential of Novamin Containing Dentifrice and Gallium Aluminum Arsenide Diode Laser (GaAlAs) in the Treatment of Dentinal Hypersensitivity. Results from the study showed that novamin containing dentifrice was more effective than diode laser in reducing dentin hypersensitivity[1] .

In group 3 the "Biodentine" calcium silicate based product which became commercially available in 2009 (Septodont) which was specifically designed as a "dentine replacement" material because of its dentin like mechanical properties. [20,21] The mechanism of Biodentine induces early mineralization by increasing the secretion of TGF- 1 from pulpal cells acts by odontoblasts stimulation and cell differentiation, there by facilitating reactionary and tertiary dentin formation. In 2012, Majorie et al suggested that biodentine is bioactive because it increased OD- 21 cell proliferation and it can be considered as a suitable material for clinical indications of dentine-pulp complex regeneration.

According to Imad About et al (2016), it was revealed that The infiltration of Biodentine into the dentin tubules due to the precipitation of crystals within the tubules decreases the dentin tubule permeability and fluid movement which may decrease post-operative sensitivity forming tag- like structures into the dentin tubules. [9,14]

In present study biodentine was used in group 3, the results showed the dentinal tubule occlusion was about 65%. Some authors study accordance with this study where Sameera et al(2019), When Biodentine was viewed under scanning electron microscope, needle-like crystalline appearance were seen. In the group with Biodentine some open dentinal tubules were seen during SEM analysis in a few samples. This may be due to faults during application or processing or due to the lower water content of the used paste.[15,16]In group 4 biodentine and diode laser(AMD laser) on the pecimens .After the Biodentine application, the diode laser was used in contact mode at 90 joules for 1 minute on each specimens. There are many studies done describing about the synergistic effect of desensitizing agent along with laser improving dentinal tubule occlusion ability. On SEM analysis, it showed melted appearance of biodentin. This melted appearance would lead to dentinal tubule occlusion. On statistical analysis the dentinal tubule occlusion was about 40.95%, which is quite less than the novamin and biodentine alone group. The reason for such result might be because of surface alteration caused by removal of the portion of biodentine when laser was used over the biodentine in contact mode, leading to more number of open dentinal tubules.

The limitation of the present study was the small sample size. Even we tried to stimulate the oral condition by using artificial saliva , it is not as ideal as our oral condition . The pressure (approx 96.1gm) used by powdered toothbrush (in the present study) was more as compared to traditional toothbrush (mean 19.52 gm) used for home care which might alter the difference of our in vitro analysis & other in vivo or home care treatment. Due to processing errors in the group with Biodentine some open dentinal tubules were seen during SEM analysis in some samples.

CONCLUSION

In this study, specimens were treated with Novamin (Sensodyne repair & protect) dentifrice showed highest occlusion of dentinal tubules as it precipitates hydroxycarbonate apetite over the entire dentin surface, followed by biodentin (septodont) and biodentin with diode laser(Picasso lite diode laser). This even concludes, that biodentin alone showed better results than in combination with diode laser.

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