Research Article

EVALUATION OF THE EFFECTIVENESS OF DESENSITIZING DENTIFRICE-FLURO CALCIUM PHOSPHO SILICATE AND DENTAL LASER ON DENTINAL TUBULE OCCLUSION- AN INVTRO –SEM STUDY

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Conflict of interest: Nil

Abstract

Background: the present study aims to evaluate whether fluoro calcium phospho silicate(Biomin or Elzenes) or in combination with Diode laser has better dentinal tubule occlusion and can be suggested as a effective treatment modality for patients with dentinal hypersensitivity. In study setting, SEM analysis was done at Sophisticated test and instrumentation centre, Cochin University of Science and Technology (CUSAT), Kerala. 80 Dentine specimens were obtained from sound premolars extracted for orthodontic purpose from the patients of age group 13 to 40 years. All the teeth were stored in 0. 2% thymol at room temperature. In our study, Fluoro calcium phospho silicate (Biomin) showed an average results of 70.37% completely occluded tubules and 23.48% of partially occluded tubules compared to 2.68% and 28.43% in the control group. Conclusion: In our invitro study the treated groups the specimens brushed with combination group (Biomin and Laser) showed the highest percentage of tubule occlusion followed by Biomin alone and then Laser. Hence from the results, it can be stated that combination of Biomin and laser can be considered as the best effective method in office treatment modality for dentinal hypersensitivity because of its ability to occlude more tubules.

Keywords: CUSAT.

Introduction

Dentinal hypersensitivity (DH) is characterized by a short, sharp, pain of rapid onset arising from exposed dentin in response to thermal, osmotic, mechanical or chemical stimuli that cannot be attributed to any other form of dental disease or defect. The prevalence of Dentinal hypersensitivity range from 4 to 73 percentages with highest occurrence in 20yr to 40 yr age group and with incisors, canine and premolars being the most commonly affected teeth.[1] Its occurrence seems to be the consequence of the presence of open dentinal tubules on exposed dentinal surfaces.

It is a common problem associated with gingival recession, incorrect tooth brushing habits, parafunctional habits, abrasion due to brushing, dietary erosion, abnormally positioned tooth in the arch, periodontal

disease, periodontal surgery, crown preparation, wasting diseases, occlusal wear and aging.[2] Following periodontal therapy, increased root sensitivity is encountered due to the removal of 20-50 μm of cementum during scaling and root planing thus exposing the dentinal tubules. The exposure of dentinal tubules after removal of supra and/or subgingival calculus and the removal of diseased cementum from exposed root surfaces is likely to increase the sensitivity experienced in such patients.[3] Patency and permeability of dentin tubule in hyper sensitive dentin was confirmed by several studies and explains why patients with exposed cervical dentine exhibits dentine hypersensitivity.[4,5,6] The hydrodynamic theory states that movement of fluid in the dentinal tubules stimulates the mechano receptors in or near the pulp, which is the reason that the tubule occlusion reduces dentin permeability and proportionality decreases, the degree of dentin hypersensitivity.[7]

Various agents and methods have been recommended to reduce Dentinal hypersensitivity including chemical compounds such as, Silver nitrate, Formalin, Glycerin, Strontium chloride, Dicalcium phosphate ,chemical methods such as use of dentifrices or gel containing fluoride, potassium nitrate, oxalates and physical methods such as dentin bonding agents. , etc. However, most of these treatments are either ineffective or only last for short period of time.[8]

Recently a bio active glass Calcium sodium phospho silicate (Novamin) and Fluoro calcium phospho silicate (Biomin) has been incorporated as mineralizing ingredient in dentifrice for treating Dentinal hypersensitivity with better results. The use of lasers also opens a new dimension in the treatment of dentin hypersensitivity. Laser mediated treatment of exposed dentine has been used to address the patency of tubular openings, causing closure of tubule openings to a depth of several microns, or to coagulate the tubular contents. The most commonly explored lasers are the low level diode (He-Ne 633 nm, Ga-Al-As 810 nm) group and moderate powered diode and Nd:YAG laser wavelengths. The effectiveness of the low-level group(Diode laser) is thought to be through bio stimulatory effect and the higher powered lasers through heat-welding of tubule openings. [9]

High intensity laser (ErCr:YSGG, CO2, Nd:YAG and Diode) work on dentin via photothermal effects, heating and melting the surface of the hard tissue. Not only the diode lasers act by occluding the dentinal tubules but also by depressing the nerve transmission by blocking depolarization of C-fiber afferents.[10,11,12]

Combined use of Diode laser along with desensitizing tooth paste has shown encouraging results.[10,13] So we wanted to test hypothesis whether a combined therapy with new desensitizing agents and Diode laser provide better relief from dentinal hypersensitivity. The purpose of this study is to compare the effects of desensitizing by diode laser and desensitizing toothpaste on dentinal tubule occlusion in extracted teeth.

Relevance

From previous studies we could make out that desensitizing dentifrices along with Diode laser resulted in significant decrease in dentin hypersensitivity, but less studies have been reported on the tubular occlusion of the dentinal tubule for these agents as an in vitro study. Hence this study was to evaluate and compare the effectiveness of desensitizing dentifrices and diode laser.

No studies have been reported as per our knowledge by using Biomin and laser for the treatment of dentin hypersensitivity. In this study we were comparing dentin specimens treated with Biomin, Biomin+ Laser, Diode laser and control (Distilled Water) which will be more significant. Hence this study would definitely add to the existing informations available on dentinal tubule occlusion by these agents which could be extrapolated into clinical use.

Materials and methods

Study design: In vitro study using extracted sound premolar human teeth.

Study setting: SEM analysis was done at sophisticated test and instrumentation centre, Cochin University of Science and Technology (CUSAT), Kerala.

Study Population:

Specimens were obtained from sound premolars extracted for orthodontic purpose from the patients of age group 13 to 40 years. All the teeth were stored in 0. 2% thymol at room temperature

Materials

1. 80 Dentine specimens

Specimens were obtained from sound premolars extracted for orthodontic purpose from the patients of age group 13 to 40 years.

2. Biomin tooth paste (Product of group pharma company)

3. Double sided diamond disk

4. 18% EDTA

5. Battery powered tooth brush

6. Diode laser(Epic 940nm – Biolase Inc)

7. SEM (Scanning electron microscope)- JEOL Model JSM-6390 LV

Experimental group

Group 1-Fluoro calcium phosphosilicate (Biomin)

Group 2-Fluoro calcium phospho silicate and laser

Group 3-Diode Laser

Group 4-Distilled water (control)

Exclusion and Inclusion criteria

Tooth with caries or fractured during the extraction will be excluded from the study.

Sound premolars extracted for orthodontic purpose from the patients of age group 13 to 40 (Adult age group) years are included in the study

SEM Analysis:

After the desensitizing by diode laser and brushing session of specimens dentine specimens coated with thin layer of gold sputter.

Photomicrographs were taken using Scanning Electron Microscope from dentine blocks at 3000X magnification to calculate total number of tubules, number of open tubules, number of completely occluded tubules and number of partially occluded tubules.

Statistical Analysis:

Percentage of occluded tubules was obtained by dividing the total number of occluded tubules by total number of tubules in each photomicrography. This result was then multiplied by 100 to obtain the percentage of occluded tubules for each photomicrography. Results were statistically analyzed by one-way Analysis of Variance (ANOVA)

Results

The present study evaluated effectiveness of the desensitizing dentifrice and dental laser

on dentinal tubule occlusion .A total of 80 dentin specimens were taken for this study. The percentages of dentinal tubule occlusion were evaluated by scanning electron microscopy. The data were statistically analyzed with one way analysis of variance of the four groups with respect to the percentage of completely occluded, partially occluded, not occluded tubules. The study showed that number of occluded tubules in all experimental groups (1-3) was significantly higher than in the control group (Distilled water).

Completely occluded tubules

Highest mean completely occluded tubules was observed in Group 2 (79.27%) followed by Group 1 (69.41%), Group 3 (8.77%), Group 4 (2.68%). (Table-2, Graph - 1)

Hence, with the above mentioned data obtained from our results we report that combination treatment Group 2 (Biomin and Diode Laser) showed highest mean value of complete tubule occlusion followed by Group 1 (Biomin), Group 3(laser) and Group 4(control).

Partially occluded tubules

Highest mean partially occluded tubules was observed in Group 3 (81.88%) followed by Group 4 (28.43%), Group 1 (23.84%) and Group 2 (17.98%). (Table-2, Graph - 1)

Not occluded tubules

Highest mean unoccluded tubules was observed in Group 4 (68.89%) followed by Group 3 (9.36%), Group1 (6.76%), and Group 2 (2.24%). (Table-2, Graph - 1)
When mean complete occlusion/ partial occlusion / non occlusion was compared between groups, all the results showed statistically significant difference (P<0.001).

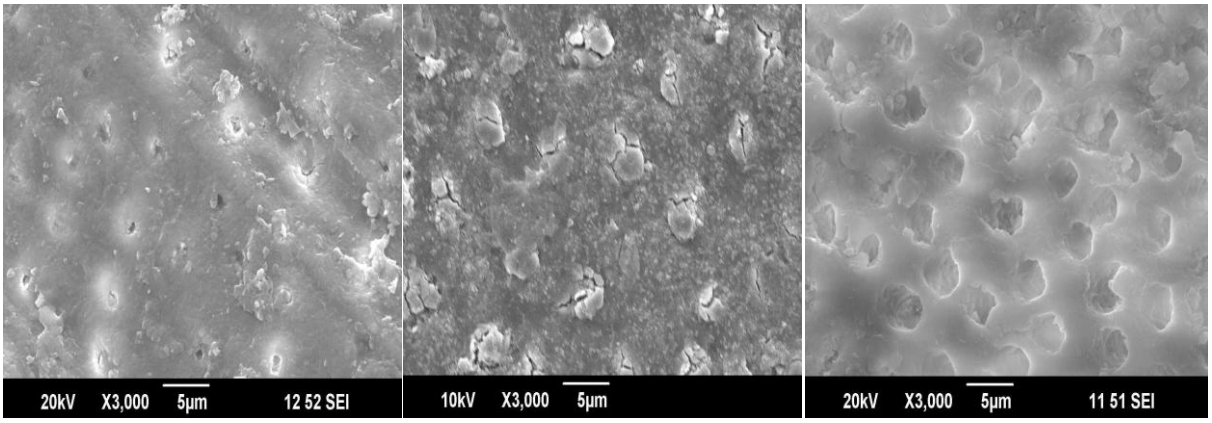


Figure 1,2,3 resp. - DENTIN SPECIMEN TREATED WITH FLUORO CALCIUM

PHOSPHO SILICATE (GROUP 1) AND LASER(GROUP 2); SPECIMEN IRRADIATED WITH DIODE LASER(GROUP 3)

Inter group comparison

A-Completely Occluded Tubule

In Group 2 percentage of mean tubular occlusion was found to be 79.27% and group 1 it was 69.41% (Table-3, Graph-2)

In Group 1 percentage of mean tubular occlusion was found to be69.41% and Group 3 it was 8.77% (Table-4, Graph-3)

B-Partially Occluded Tubule

In Group 2 percentage of mean partial tubular occlusion was found to be 17.98%

and group 1 it was 23.84%(Table-3, Graph-2)

In Group 1 percentage of mean partial tubular occlusion was found to be23.84% and Group 3 it was 81.88% (Table-4, Graph-3)

C-Not occluded Tubule

In Group 2 percentage of mean non tubular occlusion was found to be 2.24% and group 1 it was 6.76% (Table-3, Graph-2)

In Group 1 percentage of mean non tubular occlusion was found to be6.76% and Group 3 it was 9.36% (Table-4, Graph-3)

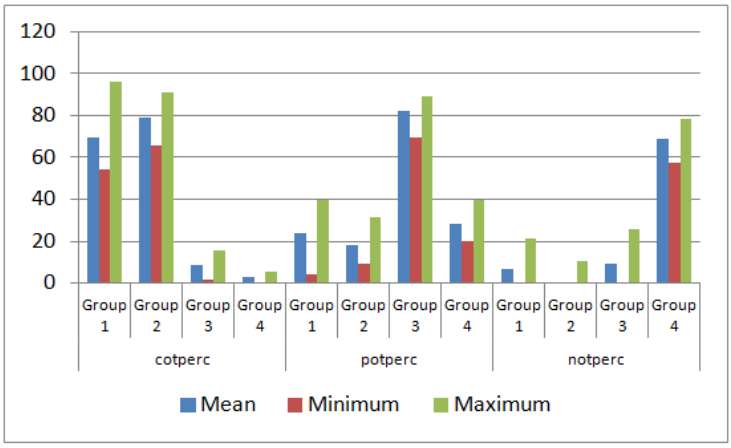
Results from the present study showed that combination treatment group 2 (Biomin and Diode Laser) showed highest mean value of complete tubule occlusion s followed by group 1 (Biomin), group 3(laser) and group 4(Control).

Table 1: Mean and standard deviation of the completely occluded tubule percentage, partially occluded tubule percentage, Not occluded percentage in the four groups.

	N	Minimum	Maximum	Mean	Std. Deviation
Cotperc	120	0.00	95.83	38.80	29.25
Potperc	120	4.17	89.47	44.52	23.72
Notperc	120	0.00	78.26	16.60	24.43

Table 2 Distribution of Mean and Standard deviation and ANOVA for different types of tubular response

	GROUP	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	F VALUE	P VALUE
						Lower Bound	Upper Bound				
cotperc	1	20	69.41	9.96	2.23	64.74	74.07	54.55	95.83	494.698	<0.001
	2	20	79.27	6.7	1.5	76.13	82.4	65.52	90.91		
	3	20	8.77	3.7	0.83	7.03	10.5	1.85	15.79		
	4	20	2.68	1.53	0.34	1.97	3.4	0	5.26		
	Total	80	38.8	29.25	2.67	33.51	44.08	0	95.83		
potperc	1	20	23.84	7.95	1.78	20.12	27.56	4.17	40	324.091	<0.001
	2	20	17.98	5.8	1.3	15.26	20.69	9.09	31.25		
	3	20	81.88	6.03	1.35	79.06	84.7	69.23	89.47		
	4	20	28.43	6.49	1.45	25.4	31.47	20.29	40		
	Total	80	44.52	23.72	2.17	40.23	48.81	4.17	89.47		
notperc	1	20	6.76	5.91	1.32	3.99	9.52	0	21.21	381.056	<0.001
	2	20	2,24	3.18	0.71	0.75	3.73	0	10.71		
	3	20	9.36	7.95	1.78	5.64	13.07	0	25.93		
	4	20	68.89	7.15	1.6	65.54	72.24	57.5	78.26		
	Total	120	16.6	24.43	2.23	12.18	21.01	0	78.26		

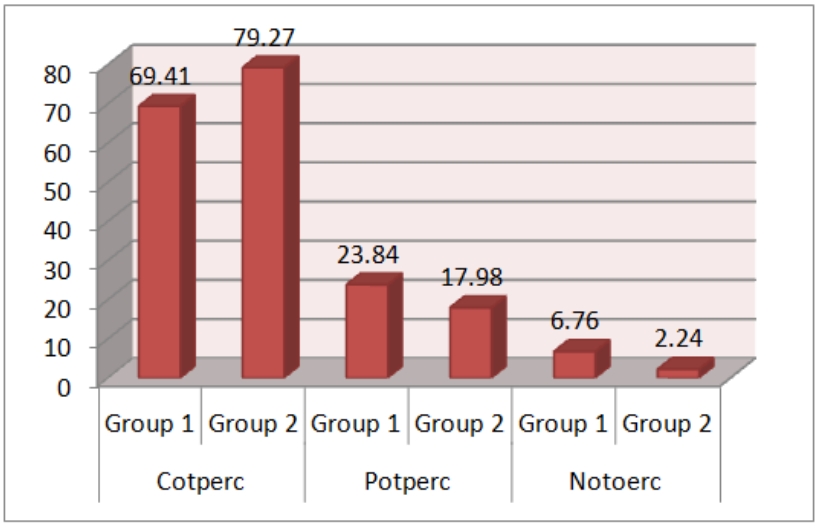


Graph 1:-

Completely Occluded Tubules percentage (COT% or cotperc) of Group 1 to Group 4, Partially Occluded Tubules percentages(POT% or potperc) of Group 1 to Group 4, and Not Occluded Tubules percentages (NOT% or notperc)of Group 1 to Group 4

Table 3: Inter group comparison of group 1 and group 2, Mean and standard deviation of different tubular response

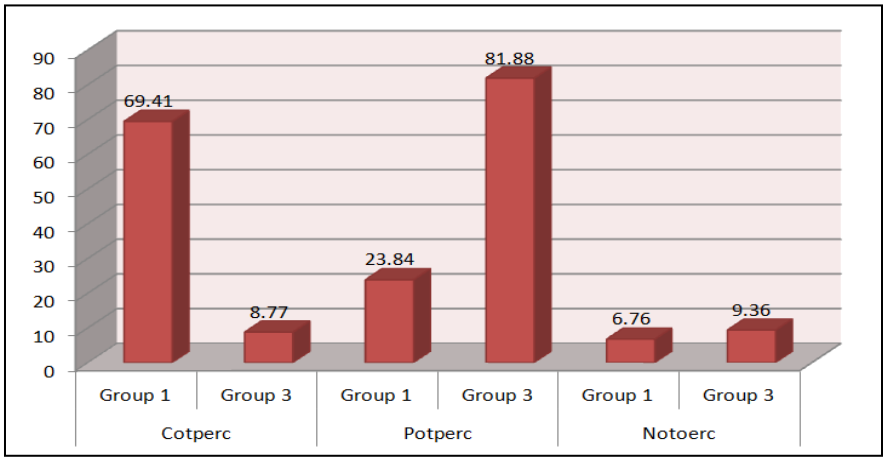
	GROUP	N	Mean	Std. Deviation	Std. Error Mean	t	p value
Cotperc	1	20	69.41	9.96	2.23	3.673	0.001
	2	20	79.27	6.70	1.50		
Potperc	1	20	23.84	7.95	1.78	2.662	0.011
	2	20	17.98	5.80	1.30		
Notoerc	1	20	6.76	5.91	1.32	3.014	0.005
	2	20	2.24	3.18	0.71		



Graph 2: Inter group comparison of group 1 and group 2, Mean and standard deviation of different tubular response

Table 4: Inter group comparison of group 1 and group 3, Mean and standard deviation of different tubular response

	GROUP	N	Mean	Std. Deviation	Std. Error Mean	t	p value
Cotperc	1	20	69.41	9.96	2.23	25.517	<0.001
	3	20	8.77	3.70	0.83		
Potperc	1	20	23.84	7.95	1.78	26.021	<0.011
	3	20	81.88	6.03	1.35		
notoerc	1	20	6.76	5.91	1.32	1.173	0.248
	3	20	9.36	7.95	1.78		



Graph 3: Inter group comparison of group 1 and group 3, Mean and standard deviation of different tubular response

Discussion

Dentin hypersensitivity is a painful condition that is highly prevalent in the world's adult population. The condition is characterized by acute, rapid and localized pain of variable intensity, which is triggered by a variety of irritants such as cold, mechanical or tactile, chemical and bacterial stimuli.[14, 15]

Dentine hypersensitivity continues to be a problem in the adult dentate population. Relatively little is known of the etiology of dentine hypersensitivity, the nature of the lesion, or the status of the pulp. This lack of knowledge makes the management of the condition difficult and recurrences appear common.[16]

Dentin hypersensitivity was found to be much higher in periodontal patients, ranging between 72.5–98%.21 In a systematic review conducted by *Von Troil et al*, it was concluded that root sensitivity occurs in approximately half of the patients following scaling and root planing.[17]

Several methods and agents have been studied for treatment of dentinal hypersensitivity. Not many studies have combined the efforts of multiple agents in the treatment of sensitivity. The aim of the present study was to compare the effect of Biomin and Novamin containing dentifrices

alone and in combination with Laser on dentinal hypersensitivity. It was an Invitro SEM study conducted on a sample size of 80 dentin discs divided into 4 groups.

Prepared dentine disc specimen were observed under SEM. Photomicrograph of the dentinal specimens were obtained at 3000X magnification and number of completely occluded tubules, partially occluded tubules, and non occluded tubules were studied.

In present study highest mean completely occluded tubules was observed in Group 2 (79.27%) followed by Group 1 (69.41), Group 3 (8.77%) and Group 4 (2.68%).

In our study, Fluoro calcium phospho silicate (Biomin Group 1) showed an average results of 70.37% completely occluded tubules and 23.48% of partially occluded tubules compared to 2.68% and 28.43% in the control group(group 4). Study done by *Shaik et al (2018)* showed that the mean of the percentage of occluded tubules for Biomin was 88.09% as compared to control 35.36%(Fluoride containing dentifrices).Results were similar, as in *Shaik et al* study partially occluded tubule and completely occluded tubules were taken as occluded tubules.[18] This is also in accordance with the study done by *Lynch E e*t al who showed that fluoride containing bioactive glasses occluded dentinal tubule effectively.[19]

Shah et al (2018) conducted a study to evaluate the ability of three desensitizing dentifrices − SHY-NM (Novamin), Sensitive Pro-Relief (8% Arginine and calcium carbonate) and Thermoseal (10% strontium chloride) − for dentinal tubule occlusion using a scanning electron microscope. All of the desensitizing dentifrices evaluated, SHY-NM showed the highest percentage of tubular occlusion (95.58%) followed by Sensitive Pro-Relief (89.90%). The least amount of tubular occlusion was shown by Thermoseal (86.12)**.**[20, 21] In this study dentin disc was brushed for 2 min per session and specimen immersed in artificial saliva were stored in a beaker at room temperature until the next brushing session and this procedure was repeated for seven consecutive days.

In a study by *Amaechi et al (2014)* twice daily usage of a CSPS(Novamin) containing dentifrice on dentin discs for one week resulted in 54.1% complete occlusion and 16.9% partial occlusion of dentinal tubules.[22] In studies done by *Amaechi and Shah et al.* increased complete tubular occlusion could be attributed to multiple applications of Novamin over a week.

In case of products with Novamin, the active ingredient is calcium sodium phosphosilicate, that reacts when exposed to aqueous media and provides calcium and phosphate ions that form HCA with time. The combination of the residual Novamin particles and the HCA layer results in the physical occlusion of dentinal tubules and relieve hypersensitivity.[23]

Conclusion

Dental professionals have a variety of regimens to manage patient dentinal hypersensitivity, including both in-office and patient applied products for home use.

Based on principles of hydrodynamics theory, any decrease in dentin fluid movement should result in reduction of sensitivity. In accordance with this theory Pashley in 1986 reported that dentine hypersensitivity might be reduced physiologically by formation of intratubular crystals from the dentinal fluids and saliva minerals or by the application of therapeutic chemical agent to occlude the exposed dentinal tubules. It is thought that most of

these chemical compounds reduce dentinal hypersensitivity either by crystallizing inside the dentinal tubules or by forming a precipitate at the entrance of the tubule, thereby decreasing the dentinal tubular flow.[4]

The treatment of dentine hypersensitivity must match its severity. The treatment options are often dictated by the clinical condition. Home-use OTC-desensitizing products appear to be the most realistic and practical means of treating most patients with tooth hypersensitivity and should be the first step in routine management. On the other hand, in-office products should be used in all cases of severe hypersensitivity, especially if the condition has changed the patients' lifestyle (e.g. they cannot jog in cold air, must avoid cold drinks even in a hot climate, etc.)

In our invitro study all the treatment groups exhibited significantly higher percentage of tubule occlusion compared to control group. Among the treated groups the specimens brushed with combination group (Biomin and Laser) showed the highest percentage of tubule occlusion followed by Biomin alone and then Laser. Hence from the results, it can be stated that combination of Biomin and laser can be considered as the best effective method in office treatment modality for dentinal hypersensitivity because of its ability to occlude more tubules. Biomin containing dentifrices can be recommended for home use OTC toothpastes. However the results should be extrapolated with caution clinically as in clinical situation various parameters like brushing habits, salivary constituents, acidic pH may influence the tubule occlusion. Clinical studies of longer duration are required to validate the findings of this in vitro study.

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