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A COMPARATIVE EVALUATION OF SELF APPLIED DENTIFRICE CONTAINING BIOMIN-F, A DENTIFRICE CONTAINING NOVAMIN AND A HERBAL DENTIFRICE CONTAINING POTASSIUM NITRATE AND SPINACH ON DENTINAL HYPERSENSITIVITY-AN IN VITRO RANDOMISED DOUBLE BLIND SEM STUDY

Dental Science

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ABSTRACT

Introduction: Tooth hypersensitivity, or more precisely dentine sensitivity or hypersensitivity is described clinically as an exaggerated response to non-noxious stimuli and satisfies all the criteria to be classified as a true pain syndrome.

Aim: To evaluate the occluding effect of three self-applied commercially available dentifrices containing Novamin, dentifrices containing Biomin-F and dentifrices containing potassium nitrate and spinach under scanning electron microscope (SEM).

Design: In this study, 10 sound extracted third molars were selected for all three groups and sectioned. Out of all the sections, 30 specimens were taken. The specimens were then divided into three groups with 10 specimens in each group, which were Group 1 - Novamin, Group 2- Biomin-F, Group 3 - Hiora-k (contains spinach and potassium nitrate) respectively. In all three groups, dentifrice were applied to the specimens with the help of a micro brush, left for 2 minutes and then lightly rinsed away with distilled water, they were mounted on SEM stub. Data obtained was analysed using ANOVA test followed by tukey's post hoc analysis.

Results: There was a significant difference observed between the 3 groups for all the variables except for total number of tubules.

Conclusion: BIOMIN-F containing dentifrice was found to produce more completely occluded tubules than dentifrice containing Novamin and Hiora-K on initial application. Number of closed tubules was almost similar in the specimens treated with Novamin and Hiora-K. Novamin containing dentifrice was found to produce more number of partially occluded tubules than BIOMIN-F and Hiora-k.

KEYWORDS

Dentin hypersensitivity, scanning electron microscope, dentinal tubules

INTRODUCTION

Tooth hypersensitivity, or more precisely dentine sensitivity or hypersensitivity is described clinically as an exaggerated response to non-noxious stimuli and satisfies all the criteria to be classified as a true pain syndrome.¹ The condition has been defined by an international workshop on dentine hypersensitivity as follows:² "Dentine hypersensitivity (DH) is characterized by short, sharp pain arising from exposed dentine in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other dental defect or pathology".

Patients undergoing periodontal treatment are particularly susceptible to the condition because of the recession following periodontal therapy or loss of cementum following non-surgical periodontal therapy.³ In addition periodontal disease and improper brushing habits can also result in gingival recession accompanied by sensitive teeth.⁴ Two major approaches are presently available for treating DH. The first one is to interrupt the neural response to triggering factors; secondly by occluding exposed dentinal tubules thereby blocking the hydrodynamic mechanism. Customarily, the first treatment option for DH would be recommending desensitizing toothpaste. When used regularly over a few weeks many individuals feel relieved, although it is not a permanent solution. The treatment strategies for dentinal hypersensitivity include nerve desensitization by using potassium nitrate, anti-inflammatory agents (corticosteroids), plugging dentinal tubules (ions/salts: calcium hydroxide, ferrous oxide, potassium oxalate, sodium monofluorophosphate, sodium fluoride, sodium fluoride stannous fluoride combination, stannous fluoride, strontium chloride), protein precipitants (formaldehyde, glutaraldehyde, silver nitrate, strontium chloride hexahydrate), dentine sealers (glass ionomer cements, composites, resins, varnishes, sealants, methyl methacrylate), periodontal soft tissue grafting, crown placement/restorative material, lasers.⁵

Hence the aim of the present in vitro study is to evaluate the occluding effect of three self-applied commercially available dentifrices containing Novamin, dentifrices containing Biomin-F and dentifrices containing potassium nitrate and spinach under scanning electron microscope (SEM).

MATERIALS AND METHOD

In this study, 10 sound extracted third molars were selected for all three groups. Hypo plastic, carious, non-vital, restored & fractured teeth were excluded. The extracted teeth were immediately washed in running tap water and stored in bottles containing 3% glutaraldehyde, until the time of use. Sectioning was done in the department of oral pathology. To prepare the discs, the enamel and cementum were removed with a high speed hand piece which was water cooled and sectioned with diamond saw. Out of all the sections, 30 specimens were taken. The 30 specimens were then placed in distilled water for 30 seconds etched with 6% citric acid for 2 minutes to remove the smear layer and rinsed in distilled water.

Preparation for SEM:

The specimens were then divided into three groups with 10 specimens in each group, which were Group 1 - Novamin, Group 2- Biomin-F, Group 3 - Hiora-k (contains spinach and potassium nitrate) respectively. In all three groups, dentifrice were applied to the specimens with the help of a micro brush, left for 2 minutes and then lightly rinsed away with distilled water, they were mounted on SEM stub. Each sample was air-dried at a constant room temperature (21-23°C) in a desiccators for 20 min and all the samples were placed in a sputter for titanium coating to see under scanning electron microscope (JEOL Model 5400, JEOL Co., Tokyo, Japan) operating at a voltage of 20Kv. The surface of specimens was visualized under scanning electron microscope at a magnification of x2000 and the photographs of the right and left side of each specimen in the middle areas were obtained. The total number of tubules, number of open tubules, number of completely occluded tubules and number of partially occluded tubules were counted in each photograph of all the specimens. The following criteria were used for determining the type of occlusion when counting the tubules.

1. The tubules that showed complete obliteration of the canals with the reaction products were considered completely occluded.
2. The tubules that showed reduction of the tubule by more than fifty percent or circumferential closure of the tubule with the presence of a central opening in the canal were considered partially occluded.

For evaluation of dentin tubules:

- Y Three examiners separately examined each image and counted the number of completely blocked tubules, opened tubules and partially occluded tubules.
- _ Tubules that could not be fully visualized on the SEM images were not counted.
- Y For each SEM image (two images were taken from each sample) , the tubules counts from the three examiners were average together to obtained the number of open , partially occluded and total visible(unblocked). This method was followed by Anora Burwell

Scanning electron microscopy analysis

The specimens were imaged with a Phillips XL 20 Scanning electron microscope (Philips, The Netherlands), 2000x, 5000x and 10000x magnification.

STATISTICAL ANALYSIS

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean \pm SD. Level of significance was fixed at $p=0.05$ and any value less than or equal to 0.05 was considered to be statistically significant. Analysis of variance (ANOVA) was used to find the significance of study parameters between the groups (Inter group analysis). Further post hoc analysis was carried out if the values of ANOVA test were significant. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data and Microsoft word and Excel were used to generate graphs, tables etc.

RESULTS

The results show the comparison of the number & percentage of open tubules, closed tubules, partially occluded tubules & total number of tubules in terms of {Mean (SD)} among all the 3 groups using ANOVA test (Table 1). There was a significant difference observed between the 3 groups for all the variables except for total number of tubules. Further tukey's post hoc analysis was carried out where ANOVA values were found significant.

Table 1: Comparison of the number & percentage of open tubules, closed tubules, partially occluded tubules & total number of tubules in terms of {Mean (SD)} among all the 3 groups using ANOVA test

Variables	Biomini-f	Novamin	Hiora-k	P value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
No of open tubules	12 \pm 4.44	28 \pm 11.10	39.50 \pm 11.16	<0.001
% of open tubules	14.1 \pm 4.21	34.9 \pm 9.11	48.32 \pm 11.57	<0.001
No of closed tubules	55 \pm 18.7	22 \pm 9.18 ^a	22 \pm 8.56 ^a	<0.001
% of closed tubules	63.87 \pm 8.16	26.74 \pm 5.57 ^a	25.91 \pm 6.35 ^a	<0.001
No of partially occluded tubules	18 \pm 7.88 ^a	30.5 \pm 10.65 ^b	21.5 \pm 11.06 ^{ab}	0.026
% of partially occluded tubules	22.01 \pm 9.25 ^a	38.34 \pm 8.14	25.75 \pm 10.69 ^a	0.002
Total no of tubules	85 \pm 23.58	80.50 \pm 24.88	83 \pm 16.19	0.900

(Same alphabets indicate no significant difference using tukey's post hoc analysis)

DISCUSSION

The globally accepted dental hygiene method as a part of the daily routine is considered to be the tooth brushing habit.^{6,7} Topical application of desensitizing dentifrice for reduction of dentin hypersensitivity has been assessed in many studies⁸, but further research is still required. In the present study, a single application of desensitizing dentifrice was able to obliterate the dentinal tubules in any of the tested specimens to some extent. This is similar to a previous in vitro study which reported that a single application of desensitizing dentifrice for one minute was able to induce obliteration of the dentinal tubules.⁹

In the present study, group A- 10 tooth specimens applied with Biomin-F, group B- 10 tooth specimens applied with Novamin and group C- 10 tooth specimens applied with Hiora-K. In our study, after initial application, BIOMIN-F produced a greater number of closed tubules, while in the specimens treated with NOVAMIN and HIORA-K, the number of closed tubules were similar.

The result of the current study revealed that BIOMIN-F treated dentin specimens showed more number of complete tubule occlusion. This is in accordance with the findings of Robert G. Hill et al¹⁰ who found BIOMIN-F to be an effective desensitizer. This study reported that novel multi component bioactive glasses form apatite in physiological solutions and can successfully occlude exposed dentinal tubules. In addition (unlike conventional bioactive glasses such as Novamin or Bioglass) they release therapeutically active ions such as fluoride, strontium and potassium. This combined action of apatite formation and ion release makes these glasses attractive components for use in remineralising dentifrices, particularly for treating dentine hypersensitivity.

Furthermore the numbers of partially occluded tubules were more in Novamin as compared to specimens treated with Biomin-F and Hiora-K. The numbers of partially occluded tubules were almost similar in Biomin-F and Hiora-K groups. Novamin is a material that has been shown to reduce sensitivity by blocking open tubules in both in vivo and in vitro studies.¹¹ Z Wang et al assessed the effectiveness of novel bioactive glass containing toothpaste on dentine permeability and remineralization. The results of this study showed that the dentin specimens treated with Novamin showed higher content of minerals and apatite compared to the other toothpastes, even after citric acid challenges. The SEM examination showed that the dentin surfaces treated by Novamin appeared to have few exposed dentinal tubules and less diameter enlargement after 6% citric acid challenge. This supports the concept that desensitizing toothpaste with remineralising properties may be more appropriate for long term home treatment of dentine hypersensitivity.¹²

In specimens treated with Hiora-K showed more number of open tubules as compared to specimens treated with Novamin and Biomin-F. A clinical study done by M Kumari, SB Naik et al¹³ concluded that the novel herbal dentifrice can be recommended for treatment of dentinal hypersensitivity. The result of the study demonstrated a reduction in symptoms of DH for the test product from baseline to 6 and 12 weeks. The components responsible for reducing DH in the test group were suryakshara (potassium nitrate) and spinacia oleracea.

According to Wichgers and Ermert and Kim¹⁴, potassium nitrate has an effective desensitizing action. The increase in the concentration of extracellular potassium around the nerve fibres causes their depolarization, avoids repolarization and blocks the axonic action and passage of nerve stimulus, thus inactivating the action potential. It has been shown that treatments with oxalate- containing phytocomplexes induce microcrystal deposition on dentine and inside dentinal tubules and thus reduce the tubular diameter by forming crystals or crystal like structures¹⁵. Therefore spinacia oleracea may have a possible mechanism of having a synergistic effect along with potassium nitrate in reducing DH by its dentinal tubule obliterating property.

In this study, it has been shown that Biomin-F, Novamin and Hiora-k are materials with different modes of action and produce varying degrees of obliteration of tubules at initial application and hence could have difference in reduction in sensitivity based on the type and amount of blockage of tubules. All the novel biomaterials produced varying degrees of tubule occlusion in the form of complete and partial occlusion and can be promoted in the treatment of dentine hypersensitivity for both home application and in office due to low cost and ease of application. Further research should assess whether the reduction of dentin hypersensitivity observed after a single application of desensitizing dentifrice is attributable to the formation of a mechanical barrier on the dentin rather than by a true effect on the dentinal tubules.

CONCLUSION

BIOMIN-F containing dentifrice was found to produce more completely occluded tubules than dentifrice containing Novamin and Hiora-K on initial application. Number of closed tubules was almost similar in the specimens treated with Novamin and Hiora-K. Novamin containing dentifrice was found to produce more number of partially

occluded tubules than BIOMIN-F and Hiora-k. Number of partially occluded tubules was almost similar in Biomin-F and Hiora-K. Within the limitation of the study, it can be concluded that all the three desensitizing pastes can be an effective and economical option in the management of the dentinal hypersensitivity.

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