A randomized controlled clinical study evaluating the efficacy of two desensitizing dentifrices.

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Abstract

The primary aim of this study was to compare the in vivo efficacy and safety of dentifrices containing either 5% NovaMin or 5% potassium nitrate, and a non-desensitizing dentifrice, on dentin hypersensitivity in a four-week, double-blind clinical study among a population in south India. In addition, a companion scanning electron microscopy evaluation was performed to demonstrate whether or not the test products occlude open dentin tubules in vitro. Thirty volunteers with tooth sensitivity were recruited, and a double-blind, randomized, parallel, controlled clinical trial was conducted in a hospital setting. Clinical evaluation for dentin hypersensitivity was done using tactile, air blast, and cold water methods. Following baseline measures, subjects were randomly divided into three groups and treated as follows: Group A—dentifrice containing 5% potassium nitrate; Group B—dentifrice containing 5% NovaMin; and Group C—dentifrice containing no desensitizing ingredients. Clinical evaluations were repeated after two and four weeks of product use. Compared to baseline, there was a significant decrease in dentin hypersensitivity in Groups A and B following four weeks' use of the dentifrice containing 5% potassium nitrate and the dentifrice containing 5% calcium sodium phosphosilicate (NovaMin), respectively. There was a statistically greater reduction in hypersensitivity at both two and four weeks following use of the dentifrice containing NovaMin compared with the use of a non-desensitizing dentifrice, as well as the dentifrice containing potassium nitrate. Air and cold water scores were significantly lower following four weeks' use of the potassium nitrate dentifrice compared to the non-desensitizing dentifrice. Tubule occlusion was observed in the companion in vitro study following treatment with 5% NovaMin, but not after treatment with the 5% potassium nitrate or non-desensitizing dentifrices. The results suggest that the dentifrice containing 5% NovaMin occludes dentin tubules, and provides rapid and significantly more relief from dentin hypersensitivity in four weeks compared to a dentifrice containing 5% potassium nitrate or a non-desensitizing dentifrice. All three dentifrices tested in this study were well-tolerated.
A RANDOMIZED, PARALLEL GROUP CLINICAL STUDY EVALUATING THE EFFICACY OF TWO DESSENSITIZING DENTIFRICES.

-A clinical Study

Abstract:

Background:
Bioactive glass (NovaMin) is a material in aqueous solutions; the bioactive composition (45% SiO2, 24.5%Na2O, 24.5% CaO and 6% P2O5) forms silicate and calcium phosphate rich layers. Hence it could be used in treatment of dentinal hypersensitivity by occlusion of the open dentinal tubules. Thus the aim of this study was to compare in vivo the effect of Novamin and 5% potassium nitrate containing dentifrices on the open dentinal tubules in a 4 week double blind study.

Methods:
Thirty subjects were evaluated clinically for dentinal hypersensitivity using tactile method, air blast method (dental air syringe) and cold water method along with subjective perception of pain (0 to 10 scale) at baseline and at 2 and 4 weeks. The subjects were then randomly divided into three groups and where treated with the three test dentifrices respectively, group A (potassium nitrate), group B (Novamin) and group C (control group).

Results:
There was a general decrease in dentinal hypersensitivity levels in both the groups over 4 weeks but there was a statistically greater difference in hypersensitivity at both 2 weeks and 4 weeks in the group B (Novamin) when compared with the group A (potassium nitrate).

Introduction

Dental hypersensitivity is characterized by pain of short duration arising from exposed dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic, or chemical and which cannot be attributed to any other dental defect or pathology. The response varies substantially from person to person due to difference in tolerance, environmental factors & emotional status.

The etiology of dentinal hypersensitivity is multifactorial. Dentinal hypersensitivity usually is diagnosed after other possible conditions have been eliminated. Alternative causes of pain include chipped or fractured teeth, cracked cusps, carious lesions, leaky restorations and palatogingival grooves. Dentinal tubules become exposed when the enamel covering the crown, cementum and overlying periodontal tissues covering the root surface are lost. Removal of enamel may result from attrition, abrasion or erosion, while
denudation of the root surface can occur as a result of gingival recession or periodontal therapy. Dentinal hypersensitivity usually is diagnosed after other possible conditions have been eliminated. Alternative causes of pain include chipped or fractured teeth, cracked cusps, carious lesions, leaky restorations and palatogingival grooves. Excessive dietary acids such as citrus juices and fruits, carbonated drinks, wines, and ciders have been identified as potential risk factors for dental hypersensitivity. Studies indicate that over-enthusiastic and/or improper toothbrushing, along with acidic foods, can expose dentinal tubules and can contribute significantly to tooth sensitivity.

Reasons for Continued Dentinal Tubular Exposure

1. Poor plaque control, i.e., acidic bacterial byproducts
2. Excess oral acids, i.e., sodas, fruit juice, swimming pool chlorine, bulimia
3. Cervical decay
4. Toothbrush abrasion
5. Tartar control toothpaste

Currently, there are many agents used to manage hypersensitivity. Conventional therapy for hypersensitivity is based on using topically applied desensitizing agents, either professionally or at home. Dental professionals have a variety of regimens to manage patient dentinal hypersensitivity, including both in-office treatments and patient-applied products for home use. Over-the-counter desensitizing dentifrices, many containing the active ingredient potassium nitrate, have proven to be a frequent choice among both patients and dentists for the treatment of sensitive teeth. The desensitizing efficacy of dentifrices containing potassium nitrate is thought to be provided by potassium ions, via chemical interference with the transmission of pain signals in the pulpal nerve fibers.

Since both pulpal nerves (Byers & Kish, 1976) and odontoblastic processes (Brannstrom & Garberoglio, 1972) are limited to the pulpal region of the dentine various mechanisms for the transmission of stimuli to this region have been proposed. To date research has been concentrated on the hydrodynamic theory of dentine hypersensitivity (Brannstrom, 1962), which proposes that stimulus transmission is due to the rapid shift of fluid movement in either direction within the dentine tubules stimulating mechano-receptors in or near the pulp. Increased sensitivity may, therefore, be due to an increase in fluid flow within the tubules resulting from the absence of the smear layer and probable removal of some tubule-occluding material (Yoshiyama et al, 1989).

The corollary to this is that blocking the tubules and/or reintroducing the smear layer may reduce stimulus transmission across dentine and subsequently consequently reduce sensitivity.

NovaMin is an amorphous, sodium calcium-phosphosilicate that was developed as a fine particulate to physically occlude dentin tubules. Thus the purpose of this study was to evaluate the effectiveness of three dentifrices containing 5% potassium nitrate, 5% sodium
calcium phosphosilicate (NovaMin) containing dentrifices in the treatment of dentinal hypersensitivity with a control dentifrices. The study was a single centre, randomized double blind, parallel group design with a duration of 4 weeks. The study included 30 subjects and the protocols for the study were followed as per the guidelines for the design and conduct of clinical trials on dentinal hypersensitivity.

MATERIALS AND METHODS:

IN VIVO / CLINICAL STUDY:

Patients with a history of tooth hypersensitivity, who were seeking treatment in the outpatient dental department of S.D.M Dental college, Dharwad, were recruited for the study with the following inclusion and exclusion criteria.

**Inclusion criteria**: the inclusion criteria required patients between the ages of 20-50 years. Subjects included in the study were in good general health and had at least 20 natural permanent teeth in the oral cavity and history of hypersensitivity to hot, cold or sour stimuli on at least two teeth. All patients were evaluated to ensure that they were currently using toothbrush and tooth paste for their oral hygiene procedures.

**Exclusion criteria**: patients with active cervical caries or deep abrasion requiring class v filling, chipped teeth or fractured cusps were excluded from the study.

In addition, a tender tooth in the same quadrant as the hypersensitive teeth, and those patients using any type of desensitizing therapy for the last 6 months were excluded. Subjects with history of chronic use of anti inflammatory and analgesic medication, pregnant or lactating females, those with history of chronic regurgitation of acids, those undergone periodontal surgery in the preceding 6 months were also excluded.

EVALUATION OF HYPERSENSITIVITY:

The reported hypersensitive teeth in the subjects were verified by light strokes of dental explorer along the cervical margins/ areas of all the teeth present following enrollment in the study. The study was explained to the subjects and informed consent forms for their willingness to be a part of the study for a duration of 4 weeks was obtained. All the subjects underwent oral prophylaxis before the study. After a 2 weeks of wash out period, baseline visual analogue scale score (Hurkisson 1974) indicating dentinal hypersensitivity level to cold water and air blast and tactile stimuli were recorded. A mean sensitivity score for each patient were calculated using these stimuli. These mean scores later became the data that was later analysed.

**For the air method**, a standard air water syringe with restricted air stream (60 psi) was directed towards the sensitive portion of the tooth perpendicular to the long axis of the tooth for duration of 1.0 seconds. And at a distance of about 0.5 cm. adjacent teeth were protected by the operator’s fingers and cotton rolls. Patients response on the visual
analogue scale of 10 cm was measured. The test was repeated three times and the average final score was recorded. Those between the VAS score of 4-10 response was selected. (10 – severe pain, 0 – no pain).

**The cold water or the ice test** was performed approximately 10 minutes after the air blast test. The tooth reported to be sensitive by the patients was isolated with cotton rolls. Cold water or ice was delivered in the form of freshly melted ice applied immediately to the buccal cervical region using an micropipette. Patients response on visual analogue scale of 10 cm was measured. The test was repeated three times and the average final score was recorded. Those between the VAS score of 4-10 response was selected. (10 – severe pain, 0 – no pain).

**For the tactile method** the teeth reported to be hypersensitive by the patients were examined with an dental explorer and slight pressure was applied. Then the patients response to the VAS score was recorded. Even this test was performed three times and the average final score was recorded.

Dentifrices tested:

Three dentifrices containing the following three ingredients respectively, as their active ingredients were used for the study.

1] 5% potassium nitrate
2] 5% calcium sodium phosphosilicate
3] control dentifrices.

After the collection of the baseline data, the subjects were divided randomly into three groups had 10 subjects each. Each group designated A, B and C was provided with one the test dentifrices. The dentifrices were dispensed by an examiner to the subjects of the three groups so that neither the examiner nor the patients knew the contents of the toothpaste.

Each patient was provided with adult soft bristle toothbrush and was advised to put half an-inch of the provided dentifrices on the brush. The patients were instructed to brush their teeth in the usual manner for 2 minutes, twice daily. Patients were instructed not to eat or drink anything within half an hour of brushing with the dentifrices. Patients were recalled at 2 weeks and 4 weeks for the measurement of tooth sensitivity by the three methods. At the recalled visits all the used dentifrices was returned and new material was dispensed. During the study period the following were not permitted:

The use of other oral hygiene products, any other dental treatment for hypersensitive teeth, and drugs like analgesics that may alter the pain perception within 24 hrs of the assessment days.
STATISTICAL METHODS:

ANOVA analysis of the groups was performed to determine any significant differences in the stratification of the groups. Paired t-test were performed for each group to determine differences at each time point. ANOVA analysis of the group affects at each time point was performed. A Tukey post-hoc pair wise comparison was carried out to determine differences between groups at each time point, using a p<0.05 as a significance level. All analysis were performed using Sigma Stat and Sigma Plot 9.0.

RESULTS:

ANOVA of baseline air sensitivity and baseline water or ice sensitivity indicated no significant main effects for groups (p=0.96 and p=0.056 for air and ice respectively). Since the baseline score were almost similar it was taken as covariate for the ANOVA analysis. Paired t-tests, for each group, were done comparing sensitivity for tactile, water and air at time points 2 and 4 to baseline, the results shows that all products resulted in significantly reduced sensitivity compared to baseline for all the three tactile, air and water tests and that the clear trends was for increasing reductions in sensitivity over time.

ANOVA for the group effect were done for all the three tests at times 2 and 4 weeks with baseline as the covariate (in all the ANOVAs, the effect of the covariate was significant at p<0.0001). Post-hoc pair wise comparisons were done using Tukey for water at weeks 2 and 4, there were significant main effects for group with NovaMin more effective than the other two groups, which did not differ between themselves. There was a statistical difference found when group A (potassium nitrate) and group B (Novamin) was compared as well as when group B (test) and group C (control) was compared (p=0.0001), however no significant difference was found when group C (control) & group A (potassium nitrate) and For water / ice at weeks 2 and 4, there were significant main effects for group with NovaMin more effective than the other two groups, themselves.
Table 1 shows the results of group A (potassium nitrate). There was a reduction in dentinal hypersensitivity seen in four weeks in all the three methods but there was no significant reduction seen in 2 weeks when compared to baseline.
Table 2 - shows the results of group B (Novamin). There was a significant reduction in dentinal hypersensitivity seen in just 2 weeks as well as in 4 weeks when compared to baseline. (p < 0.0001).

Table 3 - shows the results of the control group, i.e group C. There was no significant reduction in dentinal hypersensitivity even after 4 weeks when compared to the baseline.
### Comparison of three groups with baseline scores by ANOVA test

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### Discussion:

DISCUSSION:
Dentinal hypersensitivity, defined as an unpleasant sensation arising from exposed dentine, is a relatively common problem experienced in clinical dental practice. Therapeutic intervention by several desensitizing agents, in the form of dentifrices, mouthrinses, sealants and other therapeutic techniques, may provide only partial pain relief, and recurrence is common. Potassium nitrate is one of the many desensitizing agents that have been used and studied. Recently a new material called NovaMin i.e calcium sodium phosphosilicate is found to have tubule occluding properties. Hence a study was designed to determine the mode of action of NovaMin by studying its effect on dentinal tubules and a clinical study, to evaluate the efficacy of NovaMin over potassium nitrate.

Particulate BioGlass (NovaMin) is a bioactive material used in the repair of periodontal defects. This material undergoes a series of surface reactions in an aqueous environment which lead to osseointegration. NovaMin exerts an antibacterial effect on certain oral bacteria, possibly by virtue of the alkaline nature of its surface reactions. This may reduce bacterial colonisation of its surface in vivo.\textsuperscript{15}

The objective of this study was to evaluate the desensitizing efficacy and safety of a new dentifrice formulation, 7.5 percent calcium sodium phosphosilicate (Novamin), 3 percent potassium nitrate desensitizing dentifrices, a placebo dentifrice (0 percent potassium nitrate, 0 percent strontium chloride, 0 percent sodium fluoride).

The relative effectiveness of each desensitizing dentifrice was assessed. Results of this clinical trial demonstrate the dentinal desensitizing efficacy of the 5 percent calciumsodium phosphosilicate dentifrice (Novamin, which previously had not been clinically proven) was significantly higher when compared with clinically proven 3 percent potassium nitrate dentifrice (the positive control). These products were shown to be significantly superior to the placebo for both clinical measures (cold sensitivity and tactile sensitivity) after four weeks of product use.

Furthermore, participants' subjective assessment of pain reduction over the treatment period or these dentifrices mirrored results from clinical evaluations of product efficacy, thus demonstrating the direct relationship between objective (clinical) and subjective measurements. This relationship is not wholly unexpected, given that both types of assessments ultimately rely on participants' communicating the level of pain they experience. However, it should be noted that the clinical measurements of product efficacy are based on pain experienced at a single point in time in response to specific stimuli applied by the clinician, while the subjective assessment measures the level of "real life" pain each participant recalls experiencing during the period between examinations.

Novamin was shown in this study to be significantly efficacious compared with the placebo for cold air sensitivity after 2 weeks of product use and tactile sensitivity following 4 weeks of product use. However, unlike those in the 3 percent potassium nitrate dentifrice group, participants group never perceived a significant reduction in dentinal sensitivity via subjective assessment, compared with the placebo group. Although this study was not
designed to directly compare the onset of effects of 5% calciumsodium phosphosilicate vs. potassium nitrate, it is reasonable to speculate that the disparity in results between the novamin & 3 percent potassium nitrate dentifrices may be related to the differential mechanisms of action of these two active ingredients.

Thus the results of the present study suggested that NovaMin brought about a reduction in the dentinal hypersensitivity by occluding the dentinal tubules where as potassium nitrate did not do so. This could mean that there is a different mechanism of action such as may be, an alteration of the neural transmission at the dentino-pulpal junction and which could not be detected by this in vitro model.

A strong positive response to the placebo dentifrice (placebo effect) was apparent in this clinical trial, a phenomenon frequently observed in clinical studies of dentinal hypersensitivity. This could be related to one or a combination of reasons:
- a natural decrease in dentinal hypersensitivity over time;
- patient perception of a decrease in symptoms by virtue of participation in a clinical trial;
- placebo products actually providing some degree of relief from dentinal hypersensitivity.

In 2004 the Cochrane Collaboration published a systematic review of potassium nitrate toothpastes for the treatment of dentinal hypersensitivity based on clinical trials conducted up to the year 2000 involving KNO3 toothpaste compared to non-KNO3 toothpaste. This review focused on studies that incorporated similar methods in order to determine if KNO3 is an effective agent in reducing dentinal hypersensitivity. The results were obtained by measuring tactile, thermal, and air blast stimuli as well as patients’ subjective assessment of pain during every day life. The exposure periods ranged from six to eight weeks, reporting outcome measurements as mean change from baseline.

In 2004 Wara-aswapati et al. studied an experimental toothpaste containing 5% KNO3 and other active ingredients aimed at reducing plaque formation and inflammation, in addition to reducing sensitivity. The duration of the study was 12 weeks of home use and the design was double-blind, randomized, parallel group comparison of three toothpaste groups. This study supports previously reported outcomes that 5% KNO3 toothpaste effectively reduces dentinal hypersensitivity.

In comparison, results of some studies showed little or no effectiveness of KNO3. West et al. compared three commercially available dentifrices, including a potassium nitrate dentifrice for the alleviation of dentinal hypersensitivity using a conventional fluoride dentifrice as the control. The design included a four week lead phase utilizing the control product in an attempt to reduce the variability in pain reduction produced by previous dentifrice use and to provide information on placebo effects. The results of this study demonstrated a trend towards reduction of dentinal hypersensitivity over time for all variables (overall sensitivity score, tactile stimulus, and cold air stimulus) independent of treatment group. Although not
statistically significant, overall results indicated a trend towards reduction in sensitivity measured by all variables (tactile, cold air, and general sensitivity) for all three treatment groups.¹⁹

**Mechanism of action of NovaMin :**

The reaction of NovaMin particles begins when the material is subjected to an aqueous environment. Sodium ions (Na+) in the particles immediately begin to exchange with hydrogen cations (H+ or H3O+). This rapid release of ions allows calcium (Ca+) ions in the particle structure, as well as phosphate (PO₄³⁻) ions to be released from the material. This initial series of reactions occurs within seconds of exposure, and the release of the calcium and phosphate ions continues so long as the particles are exposed to the aqueous environment²⁰-²¹. A localized, transient increase in pH occurs during the initial exposure of the material due to the release of sodium. This increase in pH helps to precipitate the calcium and phosphate ions from the NovaMin particle, along with calcium and phosphorus found in saliva, to form a calcium phosphate (Ca-P) layer. As the particle reactions continue and the deposition of calcium and phosphorus complexes continue, this layer crystallizes into hydroxy carbonate apatite which is chemically and structurally equivalent to biological apatite²². The combination of the residual NovaMin particles and the newly formed hydroxy carbonate apatite layer results in the physical occlusion of dentinal tubules, which will relieve hypersensitivity.

**In vivo study:**

The results of our in vivo study demonstrated that a novamin containing dentifrices provides significantly more rapid relief from dentinal hypersensitivity in almost 4 weeks than did any two leading commercial active ingredients used in dentifrices formulations to treat dentinal hypersensitivity.

**Conclusion :**

In the in vivo it has been shown that there is considerable reduction in dentinal hypersensitivity in the subjects under the novamin group when compared with the control as well as the potassium nitrate group. There was reduction in hypersensitivity noticed by the subjects in about 4 weeks interval in the group B (i.e Novanim group).

**References:**


