

Comparison of Efficacy of Three Different Desensitizing Agents for Relief of Dentin Hypersensitivity

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Citation this Article: Dr Gaurav Rampuri , Dr Kavita Dube, Dr Shiv P Mantri, Dr Bonny Paul, Dr Pranalika Kanojiya, “Comparison of Efficacy of Three Different Desensitizing Agents for Relief of Dentin Hypersensitivity”, IJMSIR- May - 2020, Vol – 5, Issue -3, P. No. 158 – 167

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: The aim of this study is to compare the efficacy of three different desensitizing agents for the relief of dentin hypersensitivity: a four week clinical study.

Materials and Methods: A 4 weeks study was conducted on 45 adult patients with cervical abrasions leading to hypersensitivity of two or more teeth. Patients were divided into four groups. Group 1: Paste containing Potassium nitrate 5% and sodium monofluorophosphate 0.76% (Thermoseal RA), Group 2: Paste containing Pro-argin™ Technology (Colgate sensitive plus), Group 3: Paste containing CPP-ACP (Recaldent™) (GC tooth mousse), Group 4: Control group (placebo without desensitizing agent-pumice paste). Sensitivity was assessed at baseline,

immediately after application and after 1-week and 4 weeks. Tactile stimuli response using a visual analog scale and standard cold air blast using Schiff air sensitivity scale were used to compare the efficacies of pastes after a single application.

Statistical Analysis: The data collected was entered in Microsoft Excel and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS, IBM version 20.0). The level of significance was fixed at 5% and $p \leq 0.05$ was considered statistically significant. Kolmogorov - Smirnov test and Shapiro-Wilks test were employed to test the normality of data. Kruskal Wallis test and post hoc analysis was performed for quantitative variables.

Results: Visual analog scale and Schiff Sensitivity scores analysis: Group 1, Group 2 and Group 3 showed statistically significant reduction in DH after one week and one month when compared to baseline and post-operative scores. There was no reduction in dentine hypersensitivity in both tactile and air blast sensitivity assessment in control group (pumice paste). GC tooth mousse (0.744 ± 0.67) ($.86 \pm .52$) was significantly better than the other groups followed by Thermosteal RA ($1.31 \pm .77$) ($1.12 \pm .43$) followed by Colgate sensitive plus ($2.22 \pm .85$) ($1.44 \pm .54$) after 4 weeks period.

Conclusion: CPP-ACP creme was more effective than Potassium nitrate 5% with 0.7% sodium monofluorophosphate and Pro-ArginTM paste after one month of continued application.

Keywords : Dentin hypersensitivity ; CPP-ACP; Potassium nitrate; Pro-argin; sodium monofluorophosphate

Introduction

Dentin hypersensitivity (DH) is defined as ' short, sharp pain arising from exposed dentine in response to stimuli typically thermal, evaporative, tactile, osmotic or chemical that cannot be attributed to any other type of dental deficiency or illness.¹ Dentinal hypersensitivity is a prevalent clinical event and is often a major patient complaint. 10-20% of the general population is experiencing it. Premolars (68.8%) are the most commonly impacted teeth, followed by molars, canines and incisors.²

Faulty tooth brushing habits, nutritional erosion, and abrasive dentifrices expose the dentinal tubules in the cervical region. This area is responsible for more than 90% of hypersensitive surfaces. This painful reaction makes it hard for the individual to keep excellent oral hygiene and therefore exposes him to a future risk of

periodontal illnesses.³ The characteristics include an acute, non-spontaneous, short-lived or long-lasting pain that suddenly appears in a specified tooth area that cannot be ascribed to any other dental pathology.⁴

The products for the management of DH typically aim to control the hydrodynamic mechanisms of pain. Approaches to control the condition fall into two broad categories: agents or products that reduce fluid flow within the dentin tubules by occluding the tubules, thereby blocking the stimuli, and those that interrupt the neural response to stimuli.⁵ Potassium is thought to diffuse inside the dentinal tubules and lowers the excitability of the pulpal nerve fibres. Potassium based tooth pastes are often combined with other ingredients to increase the benefits.⁶ Thermosteal RA consists of 5% Potassium Nitrate and 0.76% Sodium monofluorophosphate, thus may act by both decreasing nerve excitation as well as by blocking dentinal tubules.⁶ A novel technology (Pro-Argin), consisting of 8% arginine and calcium carbonate, mimics the natural process of plugging patent dentin tubules. When applied to exposed dentin, the open dentin tubules are sealed with a plug that contains arginine, calcium, phosphate, and carbonate.⁷ This combination has been constituted in Colgate Sensitive Plus. Prof. Reynolds developed GC Tooth Mousse at Melbourne University in 1998. It is a commercial preparation containing ACP and casein phosphopeptide (CPP). The CPP-ACP combination localizes in plaque in the form of nano clusters and causes remineralization of enamel at a much faster rate than seen with ACP alone. Continuous stimuli lead to protective changes in dentin. It causes collagen fibers and apatite crystals to begin appearing in tubules, leading to blockage of tubules.⁸

The aim of the study was to evaluate the effectiveness of three different pastes –Thermoseal RA, Colgate sensitive plus and GC Tooth Mousse in the treatment of dentin hypersensitivity (DH).

Materials And Methods

This in-vivo double blind study was done among 100 patients in Department of Conservative Dentistry and Endodontics in Hitkarini Dental College and Hospital, Jabalpur. A written Informed consent was obtained from each subject.

Inclusion Criteria

1. Patients with age group of 20-50 years were included.
2. Patients with minimum of two hypersensitive teeth (anterior or posterior) with buccal cervical abrasion or gingival recession were selected.
3. Teeth with less than 1mm loss of dentin in depth at the cervical margin were selected.

Exclusion Criteria

1. Patients with Gross oral pathology, chronic disease, advanced periodontal disease or hypersensitive teeth with mobility more than grade 1 was excluded from the study.
2. Subjects with existing medical conditions, pregnant or lactating women, patients allergic to milk.
3. Individuals, who used desensitizing dentifrice within the last 3 months, were not allowed to participate in the study.

Four groups were made (Group 1-4). For each patient selected, the patient was given a paste (1-4) randomly (Simple Random Method). The principal investigator was not involved in the randomization process nor was he aware of the assigned groups in any of the outcome evaluation. All these four pastes were dispensed in opaque containers. Baseline sensitivity values were recorded before starting the treatment by using the

tactile method and air blast stimuli. The recordings were repeated after treatment/post-operative, after 1 week, and 1 month.

Data Collection and Methods

Tactile sensitivity was assessed by using a blunt probe used under slight manual pressure in the mesio-distal direction on the hypersensitive areas of the tooth. The degree of hypersensitivity was reported according to Visual Analog Scale (VAS). Score was given on a 10 cm sensitivity VAS. Subjects with baseline values ≥ 4 on VAS were accepted into the study. **Air blast sensitivity** was assessed by directing a 1-2 s blast of air perpendicular to exposed dentin onto the buccal surface of the sensitive tooth, from a distance of one centimeter, using the air component of a dental air/water syringe. Adjacent proximal teeth were shielded from the air blast through the placement of two fingers. A score of 2 or 3 (Schiff Air Sensitivity Scale) was included in the study.

A pea size amount was applied to the isolated hypersensitive lesions using disposable micro applicators for 5s. Rotary cup was used at 1000 – 1500 rpm speed to polish the paste onto the sensitive areas for approximately 60s.

The patients were instructed to use the pastes twice daily for a total period of one month and recalled after one week and one month for sensitivity assessment.

Visual Analog Scale and Schiff Cold Sensitivity Scale scores were recorded at all intervals. This data was used for statistical analysis.

The decoding of the paste groups was done after statistical analysis was completed and they were as follows:

Results and Statistical Analysis

The data collected was entered in Microsoft Excel and subjected to statistical analysis using Statistical

Package for Social Sciences (SPSS, IBM version 20.0). The level of significance was fixed at 5% and $p \leq 0.05$ was considered statistically significant. Kolmogorov - Smirnov test and Shapiro-Wilks test were employed to test the normality of data. Kruskal Wallis test and post hoc analysis was performed for quantitative variables.

Table 1: Comparison of mean Visual Analog Scale scores at different time intervals

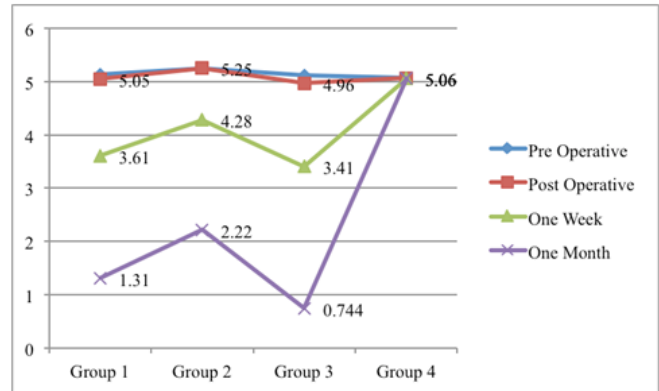
Groups N= 25	Group 1 Mean ±S.D.	Group 2 Mean ±S.D.	Group 3 Mean ±S.D.	Group 4 Mean ±S.D.	p value
Pre Operative	5.13±.964	5.25± .96	5.11±1.20	5.06±.81	.630
Post Operative	5.05± .97	5.25± .96	4.96±1.25	5.06±.81	.274
One week	3.61± 1.12	4.28±1.11	3.41±1.38	5.06±.81	.001*
One month	1.31±.77	2.22± .85	.744±.67	5.06±.81	.001*

Statistical test employed: Kruskal Wallis test

$p \text{ value} \leq .05 =$ statistically significant

Table 1(Graph 1) shows the inter group comparison of mean Visual Analog Scale scores at different time intervals. A comparative evaluation revealed significant difference in the mean scores among different groups after one week ($p \text{ value} .001$) and one month time interval ($p \text{ value} .001$). The mean scores were found to be least in group 3 after one month time interval ($.744 \pm .67$) followed by group 1 and 2 whereas the highest mean scores after one month were seen in group 4.

Graph 1: Mean Visual Analog Scale scores at different time intervals



Post hoc analysis revealed no significant difference in group 1 and 3 ($p \text{ value} .599$) after one week; however, a statistically significant difference among was seen among all other groups at one week and in all the groups after one month time interval.

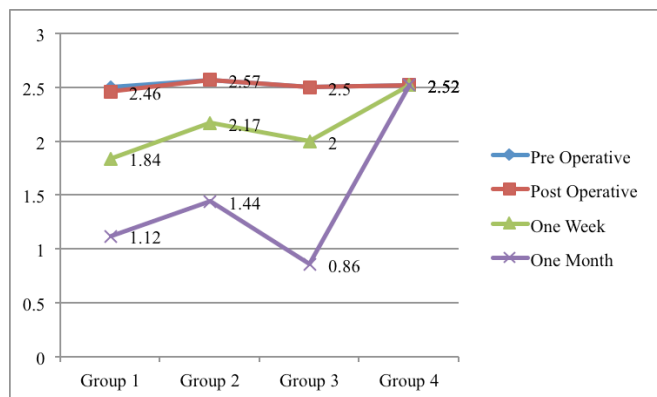
Table 2: Comparison of mean Schiff Sensitivity Scale scores at different time intervals

Groups z N= 25	Group 1 Mean ±S.D.	Group 2 Mean ±S.D.	Group 3 Mean ±S.D.	Group 4 Mean ±S.D.	p value
Pre Operative	2.50±.502	2.57± .49	2.50±.50	2.52±.50	.709
Post Operative	2.46± .52	2.57± .49	2.50±.50	2.52±.50	.481
One week	1.84± .63	2.17±.68	2.00±.58	2.52±.50	.001*
One month	1.12±.43	1.44± .54	.86±.52	2.52±.50	.001*

Table 2 (Graph 2) shows the inter group comparison of mean Schiff Sensitivity Scale at different time intervals. A comparative evaluation revealed significant difference in the mean scores among different groups after one week ($p \text{ value} .001$) and one month time interval ($p \text{ value} .001$). The mean scores were found to be least in group 3 after one month time interval ($.86 \pm .52$) followed by group 1 and 2 whereas the

highest mean scores after one month were seen in group 4.

Graph 2: Mean Schiff Sensitivity Scale scores at different time intervals



Post hoc analysis revealed no significant difference in group 1 and 3 (p value .291) and group 2 and 3 (p value .193) after one week; however, a statistically significant difference among was seen among all other groups at one week and in all the groups after one month time interval.

Discussion

The treatment of DH result in a decrease in the physical symptoms of pain and an increase in the physiological dimension of comfort and consequently an improvement in several parameters of the quality of life, thus justifying the benefit of performing clinical research.⁹

Absi et al. showed that in hypersensitive teeth the number of tubules were eight times higher and the size of tubules were twice as large in diameter and mostly opened as compared to non-sensitive teeth.¹⁰ In the present study tubule occluding materials have been used. However Thermoseal RA contains 5% Potassium nitrate also which acts by nerve desensitization. Short term relief of DH has been found when tooth paste containing anti-sensitivity agent is applied in a focused manner over sensitive teeth. This may be achieved by massaging a small amount of toothpaste into each

sensitive area via a finger-tip (the ‘dab-on’ technique) or by ‘focused brushing’ of the affected teeth, where the sensitive areas are brushed with toothpaste before the rest of the dentition. In this study we used the “dab-on” technique as GC tooth mousse was one of the test products used and it is a topical dental creme. However, the ‘focused brushing’ technique is of interest as it is easily incorporated into a normal tooth brushing routine.¹¹

Thermoseal RA (ICPA Health) contains 5% Potassium nitrate and 0.7% sodium monofluorophosphate. Sodium monofluorophosphate ($\text{Na}_2\text{PO}_3\text{F}$) is an inorganic compound which interacts with hydroxyapatite and forms barrier in the dentinal tubule. Because of its odourless, colourless, and water-soluble properties it is being frequently used in tooth pastes. In Thermoseal RA, it has recently substituted stannous fluoride because it does not stain the tooth like latter did.¹² Potassium ions are thought to act by blocking the action of potential generation in intradental nerves.¹³ Occlusion of dentinal tubules may improve the delivery of potassium by slowing the outward flow of dentinal fluid. The beneficial effect of tubule occlusion may be explained by the fact that fluid flow through dentine varies with the fourth power of the radius whereas ion diffusion varies with the square of the radius.¹³ Several researches indicated the effectiveness of potassium nitrate in the management of dentinal hypersensitivity. Hodosh et al was the first to report that potassium nitrate was a “superiordesensitizer”.¹⁴ Tarbet et al in 1980 also concluded that potassium nitrate significantly desensitizes hypersensitive teeth.¹⁵ Tarbet et al performed another research on 5% potassium nitrate in 1981 and found that it does not cause pulpal alterations and is therefore secure to use as a tooth-desensitizing agent in this regard.¹⁶

Samuel B et al in his research reported that potassium nitrate works on the nerve receptor and sodium monofluorophosphate have a different mechanism, i.e. occluding the tubules and limiting the movement of the dentinal fluid.¹⁷ Also, based on the result of a study done by Shetty S et al reported that combination of potassium nitrate and sodium monofluorophosphate showed significant reduction in Dentin Hypersensitivity at the end of 8 weeks.¹⁸

Arginine is a naturally occurring amino acid which is also found in saliva. The mixture of arginine and calcium carbonate imitates the capacity of saliva to occlude and seal open dentinal tubules, resulting in a plug that makes the tooth surface resistant to acid and thermal assaults, thus decreasing the propagation of fluids.¹⁹ Kleinberg in 2002 introduced Pro-Argin technology which is a mixture of arginine bicarbonate, a pH buffer and calcium carbonate and used in commercial products for the first time in 2009.²⁰ C. Hirsiger et al. proved the increased effectiveness of arginine and calcium carbonate products in a study involving 273 subjects.²¹ This technology has been incorporated in Colgate sensitive plus.

GC tooth mousse is based on calcium phosphate remineralization technology which contains casein phosphopeptide - amorphous calcium phosphate (CPP-ACP) [Recaldent™].

Aaron S Posner first mentioned amorphous calcium phosphate (ACP) in the mid-1960s.²² ACPs are capable of remineralizing the tooth structure. ACP is a soluble compound of calcium phosphate that releases ions of calcium and phosphate which transform into apatite and remineralize the structure of the tooth when it comes into contact with saliva. ACP offers a reservoir of phosphate and calcium ions in the saliva forming on the enamel and within the dental tubules. Casein

phosphopeptide is a protein which is derived from milk that joins with the biofilm of the tooth and is used to stabilize ACP.²³

CPP is used as a vehicle to deliver and to preserve the supersaturation state of ACP near the tooth surface thereby decreasing enamel demineralization and enhances enamel remineralization. The efficacy of CPP-ACP on dentin tubule occlusion using scanning electron microscope has been shown to be very effective on reducing dentin permeability.²³

The placebo effect or even the Hawthorne effect has been described. In the case of placebo effect, after administration of an inert agent such as saline solution, respondents would present a physiological reaction. With regard to the impact of Hawthorne's effect, unpredictable results could be due to behavioural and emotional modifications in the respondents because they knew they were participating in a research or were subject to examiners observation. The existence of these placebo control groups can provide additional information on the effectiveness of the testing agents, enabling a better interpretation of the results.⁹

Pumice paste without desensitizing agent has been used in this study as the control group. It was made by mixing fine pumice powder, glycerine, flavour and water.

There was no reduction in dentine hypersensitivity in both tactile and air blast sensitivity assessment in control group (pumice paste).

In the present study a reduction in the mean Visual Analog Scale and mean Schiff Sensitivity scores was seen in all the three experimental groups with no significant difference between baseline and post-operative assessments. The effect of the three desensitizing agents was significant after one week and

one month when compared to baseline and post-operative scores.

At the end of one week on VAS scale groups treated with Thermoseal RA, Colgate sensitive plus and GC tooth mousse showed significant reduction in dentin hypersensitivity when compared to the control group. There was no significant difference in VAS score of Thermoseal RA group and GC tooth mousse group. However, patients treated with Thermoseal RA showed significantly lower scores than Colgate sensitive plus. Also, scores of group treated with GC tooth mousse were significantly better than those treated with Colgate sensitive plus.

At the end of one week air blast sensitivity was recorded on the Schiff scale. There was significant reduction in sensitivity in groups treated with Thermoseal RA, Colgate sensitive plus and GC tooth mousse when compared to the control group. There was no significant difference in the Schiff scores of groups treated with Thermoseal RA when compared to those treated with GC tooth mousse. Also there was no significant difference between the Schiff scores of groups treated with Colgate sensitive plus when compared to those treated with GC tooth mousse. However this Schiff scores with patients treated with Thermoseal RA were significantly better than those treated with Colgate sensitive plus. Azar mallik et al in their study on effect of desensitizing agents on post bleaching sensitivity showed that RA thermoseal had the quickest onset of action from day one.²⁴

At the end of one month, there was a remarkable decrease in the VAS and the Schiff scores of groups treated with RA thermoseal, Colgate sensitive plus, and GC tooth mousse which were significantly better than the scores of the control group. GC tooth mousse was

significantly better than the other groups followed by Thermoseal RA followed by Colgate sensitive plus.

RA thermoseal contains 5% KNO_3 and K^+ ion is responsible for causing conduction block. However potassium induced effects are transient and reversible.³ The blocking effect of K^+ from KCl and KNO_3 was found to be reversible within 10 min. however repeated application tended to produce cumulative effect.²⁵ In the present study, RA thermoseal showed better results than Colgate sensitive plus at the end of one week and one month. However, Kar et al showed tooth paste containing 8% arginine more effective than potassium salt tooth paste.²⁶ Elias Boneta et al showed significant desensitizing efficacy of 8% arginine tooth paste over potassium salt containing tooth paste.²⁷

Berkathullah et al investigated the bioactive characteristics of potential remineralizing agents to decrease dentin permeability over seven days of artificial saliva immersion with following citric acid immersion for 3 minutes through tubule occlusion. Colgate sensitive pro relief application showed dentin permeability reduction.²⁸ This was similar to the study done by Souro et al. in this study there was a remarkable decrease in tactile and air blast scores in group in which Colgate sensitive plus was administered but the scores were significantly lower than those obtained for RA thermoseal and GC tooth mousse.²⁹

The result of our study is similar to the results of Konekeri et al who concluded that CPP-ACP is significantly more effective than Potassium nitrate in reducing cervical dentinal hypersensitivity.³⁰ A study by Mahesuti et al also showed that CPP-ACP had a greater sustained action in decreasing dentin hypersensitivity than Potassium nitrate.³¹ Rosaiah K et al compared the efficacy of GC tooth mousse on reduction of DH. GC tooth mousse proved to have a more long lasting

desensitizing effect with rapid and sustainable reduction in sensitivity, achieving a very high level of patient satisfaction.³² Jitendra Saraf et al showed that CPP-ACP had immediate action on hypersensitivity.⁸ CPP-ACP was found to be more effective in reducing dentin hypersensitivity in both tactile and air blast sensitivity assessment than all the other groups after one month evaluation.

Patient's pain threshold has an influence on the measurement of sensitivity and this study is subject based. Despite randomisation, blinding and stratification effects to homogenise sample characteristics, enrolled volunteers often try to please clinicians. Furthermore, positive emotional and motivational behavioural responses can activate the body's central pain inhibiting system, which can modulate painful stimuli from the periphery through the release of endorphins centrally.³³

Another short coming was the lack of control for the influence of nutrition as tubule occlusion has to withstand the daily dietary challenge. Dietary habits differ from one individual to another and thus impact the efficacy of the study product.²¹ Diet was not standardized in our study. Correcting the factors which lead to sensitivity in the first place can prevent recurrence. It is important to customize treatment plan for patients to suffer from dentin hypersensitivity.

Conclusions

Thermoseal RA, Colgate sensitive plus and GC Tooth Mousse, all were effective in reducing dentin hypersensitivity. Thermoseal RA and GC Tooth Mousse performed better than Colgate sensitive plus, after one week of application. However, GC Tooth Mousse creme was more effective after one month of continued application.

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