(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 5, Issue 3, Page No: 483-491
May-June 2022

IJMSCR

The Effect Of Three Desensitizing Agents On Dentin Hypersensitivity: A Randomized Clinical Trial

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Aim: To investigate the effect of three different desensitizing agents on reduction of pain due to hypersensitive dentin lesions.

Materials and Methods: 30 patients aged 20-65 suffering from dentin hypersensitivity (DH) in at least one tooth in any of the four quadrants were selected. Each individual was randomly assigned to one of the three treatment groups based on the chit method. The desensitizing agents used were group A (n=10) - *Colgate Sensitive Pro-Relief Toothpaste*, group B (n=10) - *Sensodyne Rapid Relief* Toothpaste and group C (n=10) - *Vantej Toothpaste*. The sensitivity scores after evaporative and tactile stimuli by visual analogue score system (VAS score) were noted at baseline and after 15 days. The data were analysed using Kruskal Wallis Test. ($P < 0.05$ was considered statistically significant).

Results: There was a significant reduction in VAS scores from baseline in all the three groups at the given time interval ($P < 0.001$). *Vantej Toothpaste* showed significant reduction of hypersensitivity scores at 15 days compared to other groups ($P < 0.001$).

Conclusion: *Vantej Toothpaste* was proved to be better in reducing pain due to DH than *Colgate Sensitive Pro-Relief Toothpaste* and *Sensodyne Rapid Relief* Toothpaste after 15 days of application.

Keywords: Dentin hypersensitivity; desensitizing agents; pain score.

Introduction:

Dentine hypersensitivity (DH) and a possible cause for this condition were described first by Gysi in 1900 [1]. Dentin hypersensitivity represents a sharp, short pain arising from exposed dentin in response to stimuli that can be tactile, thermal, evaporative, chemical, or osmotic (Holland et al. 1997) [2]. The incidence of DH may affect patients of any age and reportedly peaks during the third and fourth decades of life [3] The condition may affect any tooth, but it most often affects canines and premolars [4]. DH can manifest if dentine is exposed by loss of enamel (due to abrasion, erosion or attrition), keeping the tubules open on the dentine surface. The constant action of acids or loss of structure such as cementum denudes the root surface, which is prone to removal by brushing or periodontal treatment, [5] or more commonly, by the association of two or more of these factors [6]. It may also be caused by gingival recession which physiologically occurs with ageing or pathologically due to chronic periodontal disease or the patient's deleterious habits [7]. A number of theories have been proposed over the years to explain the pain mechanism of dentinal hypersensitivity. An early hypothesis was the dentinal receptor mechanism theory which suggests that dentine hypersensitivity is caused by the direct stimulation of sensory nerve endings in dentine [8]. Also, odontoblast transducer mechanism theory proposed by Rapp et al.,[9] suggested that odontoblasts act as receptor cells, mediating changes in the membrane potential of the odontoblasts via synaptic junctions with nerves. Braennstroem and Astroem in 1964 proposed the 'hydrodynamic theory' which is widely accepted as the explanation of the pain caused by DH [10]. According to this theory, the movement of dentinal fluid inside the tubules may stimulate the pulp nerves due to the opening of dentinal tubules caused by loss of enamel and cementum in the cervical areas. This may result in the sensation of pain. Also, bacteria and their elements may diffuse from the oral cavity to the pulp through the open dentinal tubules, resulting in localized inflammatory response [11].

In the treatment and prevention of DH, two major approaches are currently used: tubule occlusion and nerve activity blockage. The tubular occlusion approach involves treating the tooth with an agent that occludes the dentinal tubules, resulting in a stoppage of pulpal fluid flow and a reduction in DH [12,13]. Treatment strategies such as lasers, dentine sealers or desensitizing agents and periodontal soft tissue grafting work on the same principle. When nerve activity is blocked, potassium ions depolarize the cellular membrane of the nerve terminal by concentrating on dentinal tubules, resulting in a refractory period with decreased sensitivity [14].

Desensitizing agents have been classified based on a variety of criteria, including whether they are reversible or irreversible, their mode of action, whether applied by the patient or a professional, and their physical and chemical properties. They can be made and delivered in the form of mouthwashes, gels, dentifrices, or topically applied agents such as resin composite, varnishes, glass ionomer cement, and periodontal membranes.

For the majority of patients, desensitising toothpaste is regarded as the simplest and most cost-effective treatment option. When compared to professional treatments, the advantage of using products available for home use is that they are immediately available for treatment. One disadvantage is that remission of symptoms takes longer (2–4 weeks), whereas those used in-office provide immediate relief.

Fluorides enhance the mineralization of hydroxyapatite[15] and may enhance hydroxyapatite formation within the dentine tubules, which blocks fluid movement and reduces pain. Fluorides such as sodium and stannous fluoride can reduce DH [16]. They precipitate calcium fluoride crystals in the dentinal tubules inlet, creating a barrier. The temporary action of the formed barrier may be due to its slow solubility in saliva [5]. Another fluoride, amine fluoride, has also been used in dentifrice to alleviate dentinal hypersensitivity [17].

Calcium sodium phosphosilicate, known as NovaMin, which is an inorganic, amorphous biocompatible glass compound contains calcium, sodium, phosphate, and silica. The active ingredient is calcium sodium phosphosilicate, an inorganic chemical. NovaMin precipitates calcium and phosphate and has been used to decrease hypersensitivity by occluding exposed dentinal tubules [18]. When this material enters the oral environment, it releases sodium, calcium, and phosphate ions, which interact with oral fluids to form a crystalline hydroxycarbonate apatite (HCA) layer that is structurally and chemically similar to natural tooth mineral [18]. Furthermore, it acts as a barrier against oral fluids preventing further DH.

A novel DH treatment technology (Pro-Argin), consisting of 8% arginine and calcium carbonate, mimics the natural process of plugging patent dentin tubules. This new technology relies heavily on arginine, an amino acid. Arginine, an essential amino acid, has been identified as a possible oral health benefiting ingredient. In recent years, a novel technology that uses an amino acid found in saliva (arginine) to block the pathway to pain in open dentin tubules has shown great promise for the treatment of dentin hypersensitivity [19]. Kleinberg [20] demonstrated in an early work that the combination of arginine bicarbonate and calcium carbonate can be deposited on exposed dentin surfaces to physically block and seal open dentin tubules. In vitro mechanism of action studies have shown that this technology works by occluding dentin tubules [21].

Considering the aforementioned findings, this study was conducted to investigate the effect of three different desensitizing agents on reduction of pain due to dentinal hypersensitivity.

Materials And Methods:

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The present study was a randomized and double masked clinical trial. The study protocol was approved by the ethical committee of Yogita Dental College and Hospital, Khed. About 30 patients who visited the Department of Periodontics, Yogita Dental College and Hospital, Khed, after satisfying the inclusion and exclusion criteria were recruited in the study. All the patients were given a detailed verbal and written description of the study, and they signed a written informed consent form prior to commencement of the study. These patients were randomly divided into three groups of 10 patients in each group.

- Group A (n=10) ---- *Colgate Sensitive Pro-Relief Toothpaste*
- Group B (n=10) ---- *Vantej Toothpaste*
- Group C (n=10) ---- *Sensodyne Rapid Relief Toothpaste*

Inclusion Criteria

• Aged between 18 and 65 years.

• Complaining of sensitivity in at least one tooth in any of the four quadrants.

Exclusion Criteria

• Dental pathology causing pain similar to DH.

• Active cervical caries, cervical abrasion, chipped tooth, erosion, or abfraction, recession.

• Used/using any type of desensitizing agent for last 6 months.

• On anti-inflammatory and analgesic medications.

• Undergone any periodontal surgery in last 6 months.

• Allergy to contents of toothpaste.

Patients were instructed to perform at-home brushing for about 15 days, two times per day using modified bass brushing technique. The subjects response to dentin hypersensitivity was recorded at baseline and at 15 days respectively by air blast stimulation and visual analogue scale (VAS).

Air Blast Stimulation:

To assess tooth sensitivity, a controlled air stimulus was used. Tooth sensitivity was assessed first by using controlled air pressure from a standard dental syringe at 40 to 65 psi at ambient temperature, directed perpendicularly and at a distance of 1 to 3 mm from the exposed dentine surface while adjacent teeth were protected with gloved fingers to prevent false-positive results.

Sensitivity Scoring:

Sensitivity was scored using a 10 cm VAS score, with a score of zero being a pain-free response and a score of 10 being excruciating pain or discomfort.

Statistical Analysis:

Descriptive statistics were expressed as mean ± standard deviation (SD) for VAS Score value. Before and after comparison was done by Paired 't' test. Three groups were compared for Mean Change in VAS score by Kruskal Wallis Test.

Simple/Multiple Bar charts; were used for data presentation.

In the above tests, p value less than or equal to 0.05 ($p<0.05$) was taken to be statistically significant.

The data was entered in to Microsoft Excel 2010. All analyses were performed using SPSS (Statistical Package for Social Sciences) software version 20.

Results:

Throughout the study, there were no adverse events on the oral soft or hard tissues of the oral cavity observed by the examiner or reported by the participants when questioned. The use Vantej toothpaste was found to significantly reduce dentin hypersensitivity ($p<0.05$).

The mean VAS score for Pro-Argin at baseline and posttreatment was 4.60 ± 0.548 and 3.20 ± 0.447respectively. The mean VAS score for Novamin at baseline and posttreatment was 3.83 ± 0.408 and 1.50 ± 0.548 respectively. The mean VAS score for Stannous Fluoride at baseline and posttreatment was 4.67 ± 0.516 and 2.67 ± 0.516 respectively. The mean difference between the three groups was statistically significant when intra-group comparison was done ($p < 0.001$) (Table 1 and Graph 1).

The mean VAS score for Pro-Argin was 1.400±0.54772. The mean VAS score for Novamin was 2.33 ± 0.81650. The mean VAS score for Stannous Fluoride was 2.00 ± 0.63246. (Table 2 and Graph 2).

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Using **Kruskal Wallis Test**, we found statistically significant differences in the score between the three desensitizing toothpastes. Also, there was a statistically significant difference between the baseline and follow-up scores done for 15 days for individual toothpastes.

Discussion:

DH is one of the most common and painful chronic tooth problems, as well as one of the least successfully treated. Because of their low cost and ease of use for home application, toothpastes have been widely used in the treatment of dentin hypersensitivity. A desensitising toothpaste's mechanism of action is either nerve depolarization or the obliteration of dentin tubules by the precipitation of insoluble deposits on the dentin surface.

The present study compared three commercially available dentifrices Colgate Sensitive Pro-Relief Toothpaste to Vantej Toothpaste and Sensodyne Rapid Relief Toothpaste. Pro Argin and Novamin are two new technologies that have been proposed to physically adhere to the exposed dentin surface and dentinal tubules to mediate the formation of calcium and phosphate rich minerals [22]. A review of the literature by Gendreau et al. [23], based on randomised controlled clinical trials, supports the use of NovaMin in toothpaste formulations to alleviate pain caused by dentin hypersensitivity. A comparative study by Parkinson and Willson [24] concluded that calcium sodium phosphosilicate imparts significant level of dentinal occlusion with durable occlusive deposits following four days of twice daily brushing in vitro. Kleinberg and Sensistat [25] demonstrated in early studies that applying arginine calcium carbonate in office desensitising paste to teeth with sensitivity following dental prophylaxis resulted in immediate pain relief that lasted for 28 days after a single application.

According to literature, very few studies have been done to compare the reduction efficacy clinically between the Pro-Argin, Novamin technology and Stannous Fluoride. Hence, the interest of the present study was to compare among the three commercially formulated desensitizing toothpastes, respectively.

All the three test desensitizing toothpastes have rapid relief action; hence comparison was done between the baseline and 15 days. The results demonstrated a reduction in symptoms for all treatment groups from baseline to 15 days for measures of sensitivity in both intra-group and inter-group comparison. However, results revealed that the calcium sodium phosphosilicate group showed a higher degree of effectiveness at reducing DH than commercially available Pro-Argin and stannous fluoride dentifrices for sensitivity measures. The superior efficacy of Vantej Toothpaste was confirmed by the air blast sensitivity test results. A study done by West et al.,[26] found that Novamin was superior at occluding patent dentinal tubules when compared with 8% Arginine under acid challenges. As a result, Novamin proved to be more effective over a longer period of time.

Calcium sodium phosphosilicate, originally developed as a regenerative bone material, has been shown to be effective at physically occluding dentinal tubules [27,28]. Clinical evaluations of calcium sodium phosphosilicate for the treatment of DH have recorded statistically significant and clinically positive results [29,30]. It has been shown that the innovative bioactive glass-containing toothpaste occludes dentinal tubules and resists acid challenge [31,32]. Moreover, it has demonstrated a strong antimicrobial behaviour in vitro, [33] which reduces symptoms of DH by preventing bacteria to induce pulpal response.

Fluorides such as sodium and stannous fluoride reduce DH [16]. The application of fluorides seems to deposit calcium fluoride crystals which form a barrier at the inlet of dentinal tubules. High-fluoride products, such as varnishes, produce calcium fluoride, which can occlude dentine tubules and alleviate sensitivity. Low fluoride products, such as dentifrices and mouthwashes, on the other hand, do not provide significant sensitivity relief. Stannous fluoride, on the other hand, works by depositing insoluble stannous compounds that also occlude tubules to provide sensitivity relief.

Although most clinical trials evaluating the efficacy of desensitizing toothpaste considered 8 weeks to be a suitable duration, some studies have stated that the optimal time course for different agents varies depending on their action. The duration of our study was 15 days with sensitivity measured at baseline and at 15 days based on a previous clinical trial conducted for assessment of calcium sodium phosphosilicate as a desensitizing agent [34].

In this study, to assess tooth sensitivity, the most common and validated stimuli test, air blast stimulus was used for sensitivity assessment [35]. The 0-10 numerical rating VAS has been shown to be a more efficacious, simpler in the application and patient comprehension [36]. In the present study, all the three groups reported greater reduction in mean sensitivity scores over time.

The mechanism of desensitization to arginine and calcium carbonate is occlusion, which is based on the naturally occurring biological process of tubule occlusion by salivary glycoproteins. Saliva transports calcium and phosphate in proximity to dentin tubules to induce occlusion and formation of a protective salivary glycoprotein with the calcium and phosphate a process favoured under alkaline pH conditions. The results of the present clinical trial demonstrated that desensitizing of hypersensitive dentin with Vantej was effective compared to other two dentifrices.

However, a limitation of the present study is the small sample size along with 15 days follow-up time, which could be regarded as rather short.

Conclusion:

Therefore, within the limitations of the study, we found statistically significant difference in the efficacy of the three desensitizing toothpastes. After 15 days of clinical evaluation, all treatments showed lower VAS sensitivity values compared with baseline. Under clinical trial conditions, the calcium sodium phosphosilicate group showed better results compared to stannous fluoride and Pro-Argin dentifrice in reducing DH symptoms. With Vantej outperforming Colgate Pro Argin technology in the long run, it could be considered an effective treatment modality. When used twice daily, Colgate Sensitive Pro-Relief Toothpaste significantly reduces dentin hypersensitivity and outperforms Sensodyne Rapid Relief Toothpaste and Crest Cavity Protection Toothpaste. To find the gold standard treatment for DH, well-designed multicenter, prospective, long-term clinical trials with scanning electron microscope evaluations should be conducted.

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Figure 1: The Desensitizing Agents Used

Figure 2: Air Blast Stimulation

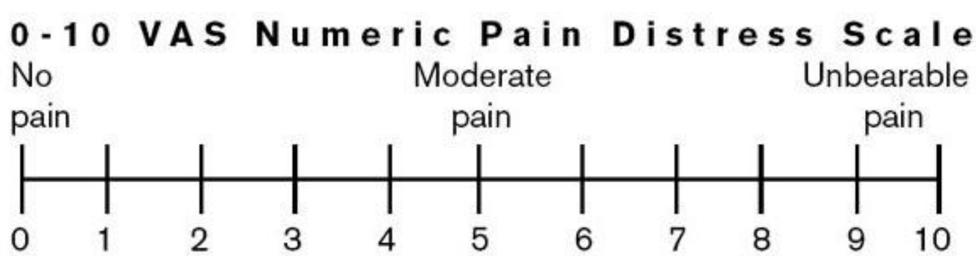


Figure 3: Visual Analogue Scale (VAS Score)

Table 1: Intra group comparison of VAS score at Baseline and 15th Day by Paired t Test.

VAS Score	Baseline (Mean ± SD)	15th day (Mean ± SD)	Mean Difference	p Value *Paired t Test*
Group A (n=10)	4.60 ± 0.548	3.20 ± 0.447	1.400	**0.005***
Group B (n=10)	3.83 ± 0.408	1.50 ± 0.548	2.333	**0.001***
Group C (n=10)	4.67 ± 0.516	2.67 ± 0.516	2.000	**0.002***

***Statistically Significant**

There is statistically significant difference among intra group (before and after) comparison with p=0.005 (Group A), p=0.001 (Group B), p=0.002 (Group C)

Graph 1: Mean C.R.P. Values at Baseline and 15th Day among Group A and Group B and Group C

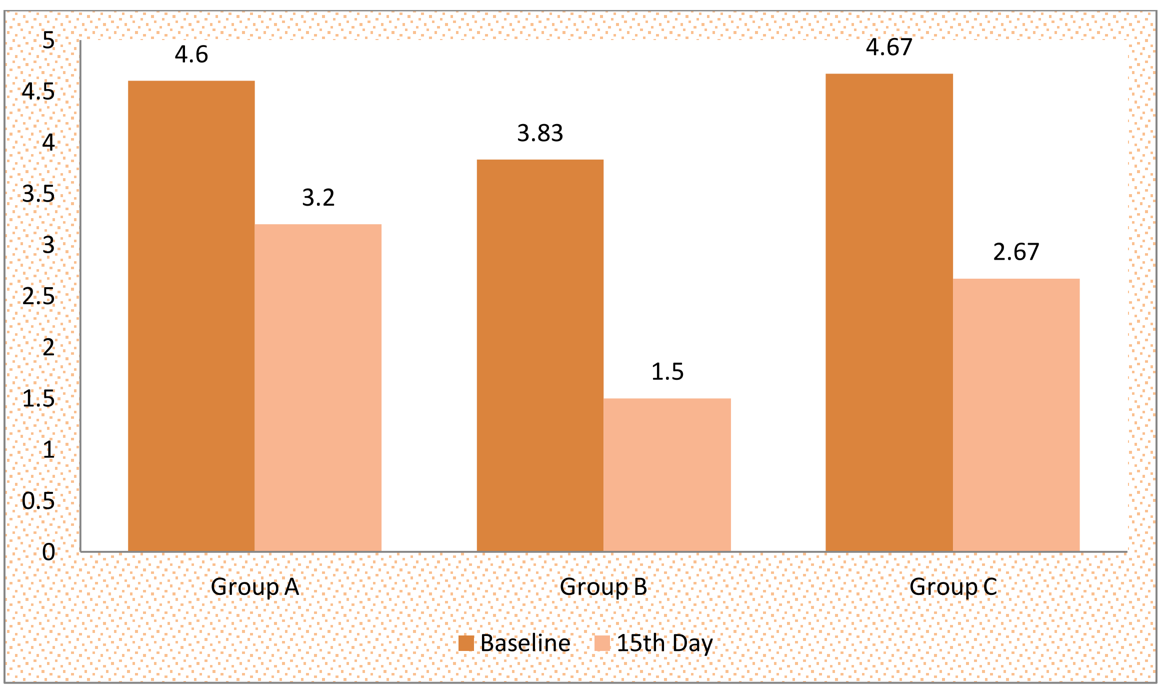


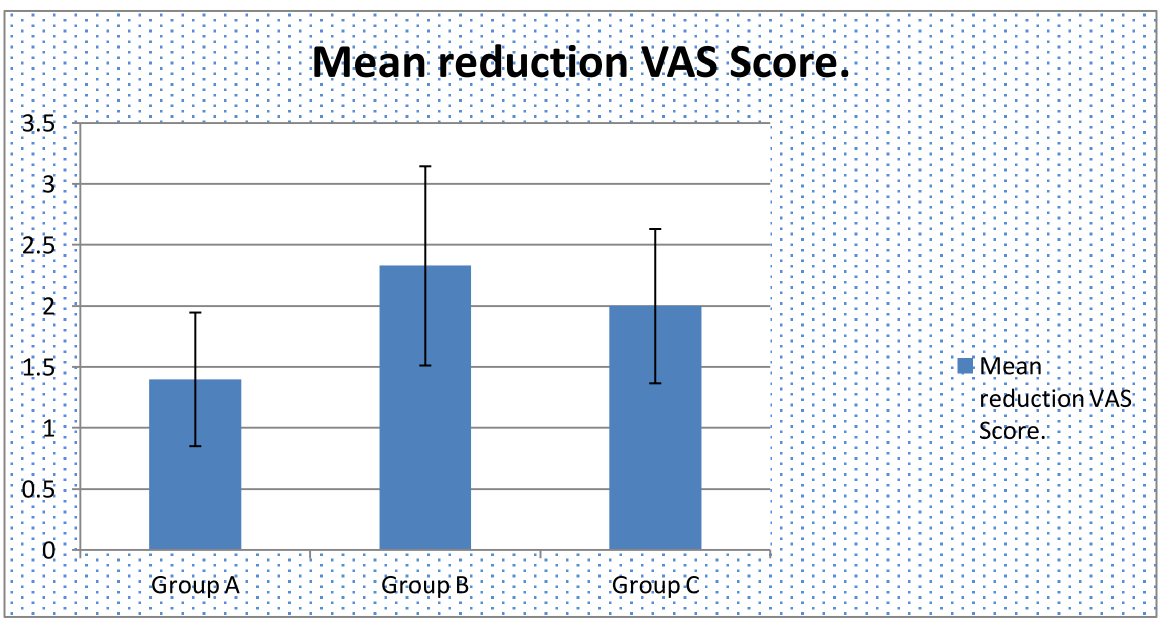
Table 2: Comparison of mean reduction of VAS score among 3 groups by Kruskal Wallis Test

VAS Score	Mean Reduction of VAS score (Mean ± SD)
Group A (n=10)	1.400±0.54772
Group B (n=10)	2.33 ± 0.81650
Group C (n=10)	2.00 ± 0.63246
p value	**0.001***

***Statistically Significant**

There is Statistically significant difference among three groups for reduction of VAS score after 15 days

Graph 2: Mean reduction of VAS score from baseline to 15th Day among Three groups



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