

Comparative clinical efficacy of four different desensitising agents in relieving post-bleaching sensitivity

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Abstract

Aim: To clinically assess and compare the efficacy on hypersensitivity experienced post-bleaching as an elective cosmetic procedure using four different types of desensitizing agents at four different time intervals.

Materials and Methods: 100 patients were selected using the inclusion and exclusion criteria and were randomly divided into 5 groups of 20 each. Group I – Control group (placebo), Group II – Pro-argin (Colgate Pro-Relief), group III – Novamin (Vantej), group IV – Potassium nitrate 5% and sodium monofluorophosphate (RA Thermoseal), and group V – Anti-cay (Toothmin). The respective desensitizing agent was applied to each group after the bleaching procedure was conducted for 10 minutes in two sessions. Objective and subjective scales were used to assess post-bleaching sensitivity after 24 hours and 7 days.

Statistical Analysis: It was done using chi-square test, ANOVA and *post-hoc* Tukey's test.

Results: Using the both the scales, there was significant difference between sensitivity experienced by the control group vs all the other groups. Using the subjective scale, significant difference was found between control group and group IV initially and between control group and groups IV and V ultimately on day 14.

Conclusion: The desensitizing agents used in the study show effective reduction after an in-office vital tooth bleaching. There is insignificant difference amongst the desensitizing agents using the objective scale; however, some variation is seen at different time intervals using the subjective one.

Keywords: Bleaching treatments, Dentin sensitivity, Desensitizing agents, Sensitivity, Tooth bleaching, Toothpastes

Introduction

The colour of teeth is decided by a multitude of factors which can be broadly classified into intrinsic and extrinsic. The main intrinsic causes of discoloration are aging and necrosis of pulp, while those of extrinsic discoloration are pigments from common beverages and tobacco.⁽¹⁻⁴⁾ One of the commonest measures adopted to manage discoloured teeth is In-office vital tooth bleaching, because of its conservative approach and high success rate.^(1,2)

Hydrogen peroxide, at varying concentrations, is usually the chief ingredient in bleaching materials used for this purpose. Like most treatments, this method too comes with its share of side effects including sensitivity, changes to the tooth structure and effects on bonding.⁽⁵⁾

Hypersensitivity, the commonest side effect, occurs as generalized hypersensitivity to cold stimuli or as spontaneous sharp, short duration pain, limited to one or more teeth.⁽⁵⁾ It is usually short lasting and transient. This symptom typically manifests right after the treatment and decreases with time.⁽⁶⁾ A significant minority of patients (<14%) have been estimated to drop out in the midst of their bleaching sessions due to severity of the symptom.⁽⁷⁾

Furthermore, the application of hydrogen peroxide as a bleaching agent to teeth has also been known to reduce the microhardness of enamel.⁽⁸⁾

This leaves one with no doubt that effective and long-lasting treatment of dentin hypersensitivity is thus of paramount interest to both patient and clinician, and a number of toothpastes are available on the market claiming to reduce dentin hypersensitivity.⁽⁹⁾

The two chief mechanisms of the agents used are:

1. Reduction in the excitability of nerve fibers present in the pulp, and
2. Obliteration of dentinal tubules.⁽¹⁰⁾

A review by *Cummins D (2010)* provides an overview of various approaches to tubule occlusion.⁽¹¹⁾

Tubule occlusion occurs by either of the two ways:

1. Deposition of layer of fine particles
2. Induction of natural mineral formation *in situ*.

With so much of literature available about different bleaching methods and desensitizing agents, very few original studies have been conducted which simultaneously compare four different agents. Hence, the present study is about comparing the clinical efficacy of four different commercially available desensitizing agents with placebo and each other, in relieving post-bleaching sensitivity in patients using both objective and subjective scales, which is the first of its kind study as far as the authors' search for literature revealed.

Materials and Methods

Clearance was obtained from the Institutional Ethical Committee prior to the commencement of the study. 100 patients reporting to the OPD of the Department of Conservative Dentistry and Endodontics for undergoing bleaching treatment were screened using the inclusion and exclusion criteria (Table 1) and were randomly enrolled and allotted to five groups of 20 patients each.

Group I – Control group (placebo without desensitizing agent- pumice powder),

Group II – Pro-argin Technology (Colgate Pro-Relief, Colgate Palmolive company, New Jersey, USA),

Group III – Novamin crystals (Vantej, Dr. Reddy's company, India),

Group IV – Potassium nitrate 5% and sodium monofluorophosphate 0.7% (RA Thermoseal, ICPA Health Products, Ltd), and

Group V – Anti-cay Technology (Toothmin, Abbott Healthcare Pvt Ltd).

Patients in all the five groups were age and sex matched.

Table 1: Inclusion and exclusion criteria⁽¹⁾

Inclusion	Exclusion
<ul style="list-style-type: none"> • Presence of all six maxillary teeth equal or darker than shade D2 in the Vita Classical Guide in the value order • Candidates must be willing to sign a consent form • Candidates must be at least 18 years and less than 30 years of age • Absence of any kind of dental pain • Candidates must be able to return for next session • Candidates must be non-smokers • Absence of cervical lesion and root exposure • Candidates with good oral health using Simplified Oral Hygiene Index (OHI-S) • Absence of dental hypersensitivity to cold and/or heat before bleaching 	<ul style="list-style-type: none"> • Presence of restoration in the six anterior teeth, involving the labial surface or labially passing the contact area from the lingual surface • Candidates with gross pathology within the oral cavity • Pregnant or lactating women • Presence of calculus or heavy stain on the study sites • Candidates who recently used or currently use drugs, alcohol or over-the-counter pain relievers • Candidates who recently used or currently use desensitizing toothpaste or over-the-counter desensitizers

Methodology

Maxillary anterior teeth were isolated using rubber dam and wedges. Bleaching agent used was 35% hydrogen peroxide (Pola office, SDI Innovative Dental

Products, Australia) according to the manufacturer's instructions. The agents designated to each group were applied on the labial surfaces of the bleached teeth of the respective group and the teeth were left for 10 min followed by scrubbing the surface with a rubber cup for 20 sec. The procedure was repeated after an interval of 1 week. The patients were also given the respective agents in unlabelled tube for regular use at home during the entire duration of the study.

Two scales were used to compare the clinical efficacy of the four different desensitizing agents:

1. Objective scale
2. Subjective scale

Objective Scale: Sceffe's scale was used here.⁽¹²⁾ A calibrated examiner (RK) who is blinded about the study groups recorded tooth sensitivity perceived by the patient by using the air-blast technique as per the ADA recommended guidelines⁽¹³⁾ also used in previous studies.⁽¹⁴⁾

Scores given were:

- 0 = Absence of pain, but perceiving stimulus.
- 1 = Slight pain (mild sensitivity).
- 2 = Pain during the application of stimulus (moderate sensitivity).
- 3 = Pain during the application of stimulus and immediately thereafter. (severe sensitivity).

Subjective Scale: VAS (Visual Analogue Scale) was used here (Image 1). This represented a self-assessment by the patient to record unstimulated tooth sensitivity after the bleaching procedures. The patients were blinded about the study group. Scores were given by each patient daily for a week following each session. A printed sheet containing a continuous scale of 0 to 10 points i.e. VAS was provided for the benefit of the patients. A score of 0 referred to the absence of tooth pain at rest and a score of 10 referred to the highest level of tooth pain imaginable. The participants were instructed to mark a point along the scale corresponding to the level of tooth sensitivity perceived on daily basis.

Statistical Analysis: The statistical analysis was done using chi-square test, analysis of variance (ANOVA), and *post hoc* Tukey's test using Statistical Package for Social Sciences (SPSS v. 20, Chicago, IL, USA).

P value was set at 0.05.

Results

There was a 0% dropout rate achieved as the inclusion criteria for the study clearly stated a return clause. All the subjects were available for recall at Day 7, 8 and 14th from the first session.

Intergroup comparison for incidence and intensity of sensitivity for experimental and control groups using objective scale at Day 1, 7, 8 and 14 has been tabulated in Tables 2-5 and using the subjective one in Table 6, Graph 1.

Table 2: Incidence and intensity of sensitivity among various groups using objective scale at day 1

Groups	Sensitivity			
	0	1	2	3
Group 1	4 (20%)	8 (40%)	6 (30%)	2 (10%)
Group 2	8 (40%)	7 (35%)	4 (20%)	1 (5%)
Group 3	9 (45%)	8 (40%)	3 (15%)	0 (0%)
Group 4	10 (50%)	9 (45%)	1 (5%)	0 (0%)
Group 5	6 (30%)	11 (55%)	2 (10%)	1 (5%)
Chi-square=12.33, P-value=0.419				

Table 4: Incidence and intensity of sensitivity among various groups using objective scale at day 8

Groups	Sensitivity			
	0	1	2	3
Group 1	3 (15%)	9 (45%)	5 (25%)	3 (15%)
Group 2	7 (35%)	8 (40%)	4 (20%)	1 (5%)
Group 3	9 (45%)	7 (35%)	3 (15%)	1 (5%)
Group 4	8 (40%)	11 (55%)	1 (5%)	0 (0%)
Group 5	7 (35%)	12 (60%)	1 (5%)	0 (0%)
Chi-square=15.46, P-value=0.217				

Table 3: Incidence and intensity of sensitivity among various groups using objective scale at day 7

Groups	Sensitivity		
	0	1	2
Group 1	9 (45%)	8 (40%)	3 (15%)
Group 2	13 (65%)	6 (30%)	1 (5%)
Group 3	15 (75%)	3 (15%)	2 (10%)
Group 4	16 (80%)	3 (15%)	1 (5%)
Group 5	14 (70%)	5 (25%)	1 (5%)
Chi-square=7.78, P-value=0.455			

Table 5: Incidence and intensity of sensitivity among various groups using objective scale at day 14

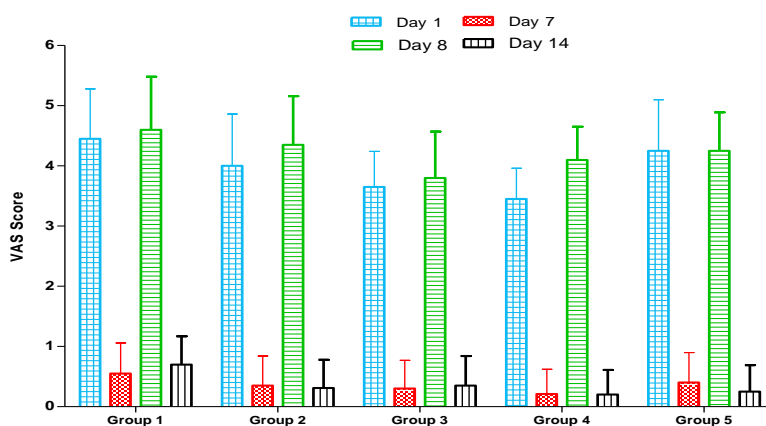
Groups	Sensitivity		
	0	1	2
Group 1	13 (65%)	6 (30%)	1 (5%)
Group 2	16 (80%)	3 (15%)	1 (5%)
Group 3	17 (85%)	3 (15%)	0 (0%)
Group 4	16 (80%)	4 (20%)	0 (0%)
Group 5	15 (75%)	4 (20%)	1 (5%)
Chi-square=4.09, P-value=0.848			

Table 6: Showing comparison based on VAS score among various groups

		Day 1	Day 7	Day 8	Day 14
Group	Group 1	4.45±0.83	0.55±0.51	4.60±0.88	0.70±0.47
	Group 2	4.00±0.86	0.35±0.49	4.35±0.81	0.31±0.47
	Group 3	3.65±0.59	0.30±0.47	3.80±0.77	0.35±0.49
	Group 4	3.45±0.51	0.21±0.41	4.10±0.55	0.20±0.41
	Group 5	4.25±0.85	0.40±0.5	4.25±0.64	0.25±0.44
P-value ^{\$}		<0.001*	0.218	0.016*	0.007*
Inter group Comparison	1 v/s 2	0.314	0.677	0.823	0.052
	1 v/s 3	0.008*	0.467	0.008*	0.119
	1 v/s 4	<0.001*	0.149	0.214	0.007*
	1 v/s 5	0.913	0.858	0.569	0.020*
	2 v/s 3	0.569	0.997	0.139	0.997
	2 v/s 4	0.140	0.858	0.823	0.958
	2 v/s 5	0.823	0.997	0.993	0.997
	3 v/s 4	0.913	0.964	0.703	0.838
	3 v/s 5	0.086	0.964	0.313	0.958
	4 v/s 5	0.008*	0.677	0.968	0.997

*Statistically Significant Difference (P-value<0.05), \$: One-way ANOVA with post hoc Tukey's test

Graph 1



Statistically insignificant difference was found on all days between the groups using the objective scale. (Tables 2-5)

On **day 1**, Overall performance of Group IV i.e. RA Thermoseal was found to be the best which is expected due to its claim to be rapid in action. Relatively least effective in controlling the sensitivity was Group V i.e. Toothmin.

On **day 8**, Group III i.e. Vantej fared better than other overall in this session.

On **day 14**, Group III i.e. Vantej again fared relatively better as compared to the groups II (Colgate Pro-relief) and IV (RA Thermoseal) which were a close second followed by group V i.e. Toothmin.

Using the subjective scale, significant findings were observed on Days 1, 8 and 14. (Table 6)

On **day 1**, significant difference was found between the control group (placebo) and group III (Vantej); between the control group (placebo) and group IV (RA Thermoseal); and between group IV (RA Thermoseal) and group V (Toothmin).

On **day 8**, significant difference was found between the control group (placebo) and group III (Vantej).

On **day 14**, significant difference was found between the control group (placebo) and group IV (RA Thermoseal); and between the control group (placebo) and group V (Toothmin).

Discussion

Mechanism of action of the bleaching agent (Hydrogen peroxide): Hydrogen peroxide (H_2O_2) mediates the bleaching mechanism by penetrating tooth structure viz the property of its possessing low molecular weight.⁽¹⁾ Perhydroxyl (HO_2^-) and other free radicals oxidize the chromophores present on the surface of the teeth, breaking them down into less complex molecules which reflect more light.⁽¹⁵⁾

Mechanism of Sensitivity: The most accepted explanation for tooth sensitivity is Brännström's hydrodynamic theory which states that the sensitivity symptom is elicited by fluid movement inside the dentinal tubules.⁽²⁾ It has been hypothesized, that sensitivity after bleaching differs from tooth sensitivity due to thermal and tactile insults, which are usually associated with dentin exposure.⁽¹⁶⁾

A chemosensitive ion channel called TRPA1 (transient receptor potential cation channel with ankyrin domain-type 1) which is associated with the pain caused by oxidants, (including hydrogen peroxide) has been theorized to be responsible for sensitivity after whitening. Since the afferent fibers of primary dental pulp contain TRPA1, it is possible that direct TRPA1 activation of nerve fibers is involved in the pain caused by tooth bleaching.⁽¹⁶⁾

Constitution of the different desensitization agents used were:

1. Colgate Sensitive Pro-Relief (Colgate-Palmolive, Sao Paulo, Brazil) containing arginine and calcium carbonate (1450 ppm of fluoride).⁽¹⁾
2. Vantej containing Novamin technology i.e. chemically termed as calcium sodium phosphosilicate (CSSP).⁽⁹⁾
3. RA-Thermoseal contains Potassium Nitrate 5% w/w in Toothpaste/gel base. Sodium monofluorophosphate 0.7% w/w (Available fluoride content 917 ppm when packed).⁽¹⁷⁾
4. Toothmin based on Anticay Technology.⁽¹⁸⁾ This unique technology has been commercialized by Biodental Remin, an Australia based biotechnology company. Anticay is a mixture of calcium sucrose phosphates and inorganic calcium phosphates consisting of 10-12% calcium and 8-10% phosphorous by weight.^(19,20)

Group 2 containing arginine and calcium carbonate did not stand out in the study probably because patients with root exposure were not included. The reason for this finding may be attributed to the fact that the main mechanism of action of this dentifrice involves the obliteration of exposed root dentin tubules which is not applicable to the cohort studied. This is in accordance with the research of Thiesen et al.⁽¹⁾

Group 3 containing Novamin or CSSP represents a method of tubule occlusion consisting of oxides of calcium, sodium, phosphorus ions and help in the formation of hydroxycarbonate apatite (HCA), which is similar in composition to minerals of teeth and bone.⁽²¹⁾ This was found to be significantly effective in reducing post-bleaching sensitivity on the first day of both sessions using the subjective scale.

Group 4 included RA Thermoseal as the dentifrice. This is the first study, to the best of our knowledge, in which RA Thermoseal has been used to manage post-bleaching sensitivity. A reduction in the excitability of nerve fibers could occur due to the diffusion of potassium salt (small cation) through the enamel and dentine. These salts can reach the nerve terminations, affecting transmission of nerve impulse⁽³⁾ resulting in the reduction/deletion of pain perception.⁽¹¹⁾

Group 5 utilized Toothmin. Calcium sucrose phosphate decreases tooth enamel demineralization and further promotes enamel remineralization. It also inhibits the formation of plaque.⁽²²⁾ The calcium and phosphate ions rapidly adsorb onto the enamel surface and due to the common ion effect, rate of acid solubility of enamel decreases with increase in rate of remineralization. Further, sucrose phosphate ions adsorb onto the enamel surface and decrease the rate of acid dissolution. Consequently, the drop in pH at the tooth surface is less. Anticay also acts as a complement to fluoride.⁽²³⁾ It is clear that Toothmin is predominantly for remineralization and not for hypersensitivity which is reflected in the insignificant findings in the present study.

Two out of the four agents used were fluoridated i.e. Group 2 (Colgate Pro-relief) and Group 4 (RA Thermoseal). The role of fluoride as a desensitizing agent has been found to be highly controversial. X-ray photoelectron spectroscopy investigations showed that sodium fluoride in hydrogen peroxide gel induced the formation of fluoridated hydroxyapatite and calcium fluoride crystals on the tooth surface, aiding enamel remineralization.⁽²⁴⁾ Jorgensen reported that the application of fluoride had no benefit in the management of bleaching related tooth sensitivity. The use of a “whitening solution” with 0.11% fluoride resulted in 68% of the participants experiencing tooth sensitivity. This percentage of participating patients experiencing sensitivity was comparable to that found in other studies, using carbamide peroxide without any desensitizing agents.⁽²⁵⁾

So, far as literature search revealed, no study has ever simultaneously evaluated four different commercially available desensitizing dentifrices, to the best of our knowledge and extensive literature search. Furthermore unlike other studies,⁽¹⁴⁾ the subjects enrolled in ours were specifically instructed to use the same agent which was designated to them.

Similar studies in the future with larger sample sizes and more agents are warranted to validate the results from our study and contribute further to our knowledge of this field.

Conclusion

The desensitizing agents used in the study show effective reduction after an in-office vital tooth bleaching. There is insignificant difference amongst the desensitizing agents using the objective scale; however, some variation is seen at different time intervals using the subjective one. This may be due to their differing constitutions which govern the mechanism and onset of action and resultant performance at different time intervals. RA Thermoseal showed the quickest onset of action from day 1 and in the longer run Vantej was found to be relatively, although statistically insignificantly, more effective.

References

1. Thiesen CH, Filho RR, Prates LHM et al. The influence of desensitizing dentifrices on pain induced by in-office bleaching. *Braz Oral Res.*, 2013 Nov-Dec;27(6):517-23.
2. Charakorn P, et al. The effect of preoperative ibuprofen on tooth sensitivity caused by in-office bleaching. *Oper Dent.* 2009 Mar-Apr;34(2):131-5.
3. Haywood VB. Treating sensitivity during tooth whitening. *Compend Contin Educ Dent.* 2005 Sep;26(9 Suppl 3):11-20.
4. Costa JB, et al. Comparison of at-home and in-office tooth whitening using a novel shade guide. *Oper Dent.* 2010 Jul-Aug;35(4):381-8.
5. Po LH, Wilson NW. Effects of different desensitizing agents on bleaching treatments. *Eur J Gen Dent* 2014;3:93-9.
6. Mokhlis GR, et al. A clinical evaluation of carbamide peroxide and hydrogen peroxide whitening agents during daytime use. *J Am Dent Assoc* 2000;131:1269-77.
7. Al-Musa H. Clinical evaluation of bleaching agents of different concentrations. *Smile Dent J* 2008;3:24-7.
8. Van der Reijden WA, Buijs MJ, Damen JJ, Veerman EC, ten Cate JM, Nieuw Amerongen AV. Influence of polymers for use in saliva substitutes on de- and remineralization of enamel in vitro. *Caries Res* 1997;31(3):216-23.
9. Rao A, et al. The reduction efficacy of dentinal hypersensitivity by two commercially available desensitizing toothpastes: Vantej and Colgate Pro- Argin. *Saudi Endod J* 2014;4:7-12.
10. Sowinski J, et al. Comparative investigations of the desensitising efficacy of a new dentifrice. *J Clin Periodontol.* 2001 Nov;28(11):1032-6.
11. Cummins D. Recent advances in dentin hypersensitivity: Clinically proven treatments for instant and lasting relief. *Am J Dent* 2010;23:3A-13A.
12. Gunjekar T, et al. Methods for the evaluation of the pain associated with dentinal hypersensitivity. *JIDA* 2012;6:57-9.
13. Strassler HE. Clinical Update: Professionally dispensed vital tooth bleaching. ADA C.E.R.P. 2011. Available from: <https://www.dentalaegis.com/id/2010/03/professionally-dispensed-vital-tooth-bleaching>. [Last accessed on 2016 Nov 30].
14. Nanjundasetty JK, Ashrafulla M. Efficacy of desensitizing agents on postoperative sensitivity following an in-office vital tooth bleaching: A randomized controlled clinical trial. *J Conserv Dent* 2016;19:207-11.
15. Joiner A. The bleaching of teeth: a review of the literature. *J Dent.* 2006 Aug;34(7):412-9.
16. Markowitz K. Pretty painful: why does tooth bleaching hurt?. *Med Hypotheses.* 2010 May;74(5):835-40.
17. RA Thermoseal. Available from: <http://www.icpahealth.com/product/ra-thermoseal/> [Last accessed on 2016 Nov 30].
18. Craig GG. The use of a calcium sucrose phosphates-calcium orthophosphate complex as a cariostatic agent. *Br Dent J* 1975;138:25-8. Back to cited text no. 11
19. Toothmin Toothpaste Cream - Composition and Active Ingredients. Available from: <http://www.tabletwise.com/toothmin-toothpaste-cream/composition-ingredients> [Last accessed on 2016 Nov 30].
20. Kaur G, Sanap AU, Aggarwal SD, Kumar T. Comparative evaluation of two different remineralizing agents on the microhardness of bleached enamel surface: Results of an in vitro study. *Indian J Dent Res* 2015;26:176-9.
21. Filgueiras MR, La Torre G, Hench LL. Solutions effects on the surface reactions of three bioactive glass compositions. *J Biomed Mater Res* 1993;27:1485-93.
22. Reema SD, Lahiri PK, Roy SS. Review of casein phosphopeptides-amorphous calcium phosphate. *Chin J Dent Res* 2014;17:7-14.
23. Rogerson MJ. The role of a calcium sucrose phosphate-calcium orthophosphate complex in the reduction of dental caries. *Aust Dent J* 1973;18:160-6.
24. Tanizawa Y. Reaction characteristics of a tooth-bleaching agent containing H₂O₂ and NaF: In vitro study of crystal structure change in treated hydroxyapatite and chemical states of incorporated fluorine. *J Cosmet Sci* 2005;56:121-34..

25. Jorgensen MG, Carroll WB. Incidence of tooth sensitivity after home whitening treatment. *J Am Dent Assoc* 2002;133:1076-82.