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Original Research Article

Comparative evaluation of efficacy of two different desensitizing toothpaste in managing dentin hypersensitivity: A randomized controlled clinical trial

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Abstract

Aim and objective: This investigation aimed to determine and compare the impact of two types of desensitizing toothpaste on the management of dentin hypersensitivity (DH).

Introduction: A sudden, sharp pain in response to external stimuli due to exposed dentin is the hallmark of DH, a prevalent dental condition." Effective management typically involves tubule occlusion or nerve desensitization.

Material and Methods: A randomized, double-blind clinical trial methodology was employed over one month with 60 participants experiencing DH. Subjects were randomly assigned to Group I [nHA + KNO_3 toothpaste – Hydent Duo (Abbott Healthcare)] or Group II [NovaMin toothpaste – Sensodyne Repair and Protect (GSK Group)]. Dentin sensitivity was assessed using a digital electric pulp tester (EPT) at baseline, 5 minutes, 1 week, and 4 weeks. Participants brushed twice daily with the assigned toothpaste, and pain was measured based on the electrical current needed to elicit a VAS score of 4.

Result: Both dentifrices showed significant reductions in DH over time. However, the nHA plus KNO_3 group demonstrated a consistently greater and faster reduction at all intervals ($p < 0.05$).

Conclusion: Both dentifrices effectively reduced DH, but the nHA + potassium nitrate formulation demonstrated significantly greater efficacy.

Keywords: Dentin Hypersensitivity, Electric pulp tester, Hydent Duo, Nano-hydroxyapatite, NovaMin, Potassium nitrate, Sensodyne repair and protect

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1. Introduction

DH manifests as a brief pain from stimuli like temperature or acidity, often due to exposed dentinal tubules from enamel loss or gingival recession.[1] Diagnosis involves excluding other dental issues.[2] Brännström's hydrodynamic theory attributes pain to fluid shifts in tubules stimulating nerves.[3] Treatments aim to reduce nerve response or block tubules. Potassium nitrate reduces nerve sensitivity[4], while agents like NovaMin, oxalates, and nano-HAP aid tubule occlusion and remineralization.[4] So, this investigation aimed to determine and compare the impact of two types of desensitizing toothpaste [Hydent Duo (nano-HAP + potassium nitrate) and Sensodyne Repair and Protect (NovaMin)] on the management DH.

2. Material and Methods

The study targeted individuals experiencing DH, with participants recruited from patients attending the outpatient clinic in the Department of Conservative Dentistry and Endodontics. From this group, participants meeting specific inclusion criteria were selected for the study. Only individuals who provided voluntary consent and signed the informed consent form were included.

2.1. Clinical trial registry

A randomized, double-blind clinical trial methodology was employed for a one-month period following ethical clearance from the Institutional Ethics Committee No. [MGV/KBHDC/Cons/637] and registration with the Clinical Trials Registry of India (CTRI) REF NO.2025/07/109295.

Inclusion criteria: Participants eligible for inclusion were adults aged 18 to 60 years presenting with temporary sensitivity to cold stimuli or food lodgement, along with

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observable clinical signs such as hard tissue changes including erosion, cuneiform-type lesions, abnormal abrasive wear, or gingival recession.

Exclusion criteria: Patients were excluded in cases where they exhibited any of the following: active dental caries, pulpal or periodontal disease, post-restorative sensitivity, faulty or defective restorations, dental fractures or cracks, neuropathic pain conditions, or the presence of a pacemaker. Subjects with existing medical conditions and on medications for same, pregnant or lactating, enrolled in another clinical study, or had used or taken part in a study involving desensitizing toothpaste in the past three months.

2.2. Sample size determination

A total sample size of 60 was required (30 assigned to each group, total 2 groups) would yield an estimated power of 80.14% to detect significant differences between groups, assuming an effect size of 0.75 and a significance level (alpha) of 0.05.

2.3. Sample selection and intervention

Prior to enrolment, all participants were thoroughly informed about the treatment procedures, including the benefits, potential risks, and alternative options. Written informed consent was taken from each subject before commencing the study. Participants were randomly assigned to either Group 1 and Group 2 with a 1:1 allocation ratio. Randomization was performed using computer-generated random number blocks by a clinician not involved in the study to maintain allocation concealment. Both the principal investigator and participants were blinded to the assigned treatment by masking the dentifrices.

3. Diagnosis of DH

Eligibility was confirmed during the screening visit by evaluating a single tooth per participant. For patients presenting with multiple cervical abrasions, one tooth was randomly selected. The test tooth was isolated with cotton rolls, and two sensitivity tests were conducted five minutes apart:

1. Tactile test: Gentle exploration of the affected tooth surface using a dental explorer.
2. Air blast test: Application of a one-second air blast from a three-way dental syringe.

Participants rated the pain on a Visual Analog Scale (VAS), and only those reporting scores above four were included in the trial.

4. Intervention Groups

1. **Group I (n=30):** Used a dentifrice containing nano-hydroxyapatite (6.7%) combined with potassium nitrate (5%) -Hydent Duo.
2. **Group II (n=30):** Used a dentifrice containing calcium sodium phosphosilicate (NovaMin) -Sensodyne Repair and Protect.

5. Procedure for Assessing DH

The electrode of a digital electric pulp tester (Waldent Innovations Pvt. Ltd. New Delhi, India) was positioned on the selected tooth to measure the baseline current required to elicit a pain score of four on the Visual Analog Scale (VAS) before dentifrice application. **(Figure 1)** The tester was placed specifically to the abraded area in all participants. Following this, approximately one cm of the assigned toothpaste was applied directly to the tooth surface and gently massaged for two minutes, after which it was rinsed off. Five minutes later, the electrical stimulus required to provoke a VAS score of four was recorded again to evaluate immediate relief from DH. For longer-term assessment, patients were provided with their assigned dentifrices for home use over four weeks. During this period, no additional oral hygiene products were permitted. Participants were instructed to apply one cm of toothpaste directly onto the sensitive area of the designated tooth using a soft toothbrush, gently massaging for one minute, followed by brushing the entire dentition for two minutes twice daily. Instructions on maintaining oral hygiene, with emphasis on proper brushing methods, were reinforced. Follow-up measurements of the electrical stimulus necessary to elicit a VAS score of four were recorded at both the first and fourth weeks to assess the sustained effectiveness of the treatments.

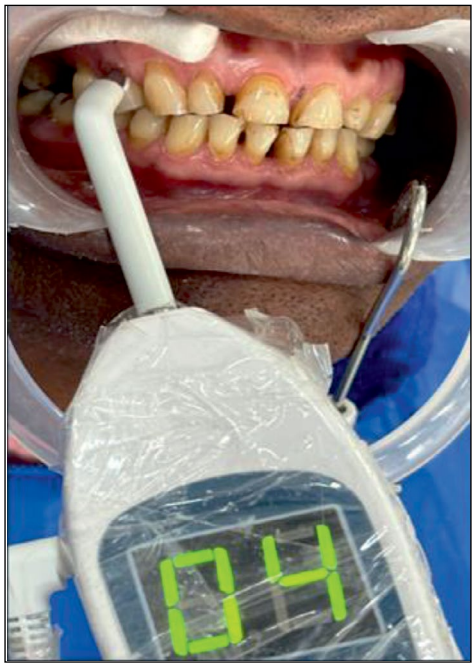


Figure 1: The electrode of the digital electric pulp tester placed on the abraded area of selected tooth

6. Results

This study evaluated the effectiveness of two toothpastes in alleviating DH. The reduction in DH was quantified by measuring changes in electrical stimulus amperage over time. The CONSORT flowchart illustrating participant progress throughout the study is presented in **(Figure 2)**. All 60 enrolled subjects completed the trial, and no harmful effects on either hard or soft oral tissues were detected during the study period.

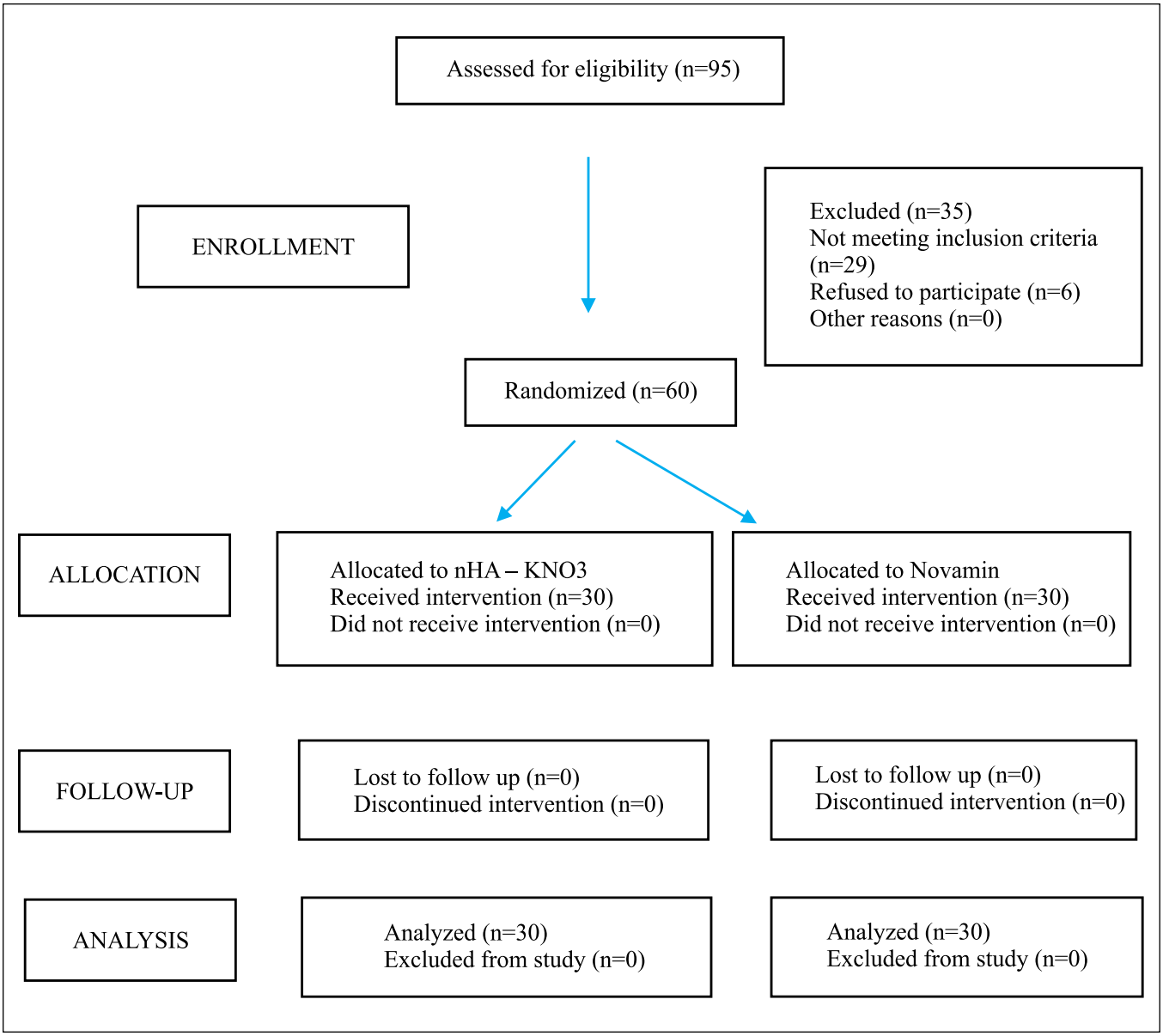


Figure 2: CONSORT diagram showing flow of participants through each stage of a randomized trial

Repeated measures analysis of variance (ANOVA) revealed a progressive raise in the electrical amperage threshold at all follow-up intervals within both treatment groups, indicating reduced sensitivity over time. The within-group changes in amperage in Group I (Nano-hydroxyapatite + Potassium Nitrate), a significant increase in mean amperage was observed after five minutes compared to baseline (mean = 3.06, $p < 0.001$), and further it increased by (mean = 1.96, $p = 0.021$) after 1 week compared to 5 min. However, the change from one week to four weeks was not significant ($p = 0.198$).

In Group II (Novamin containing), a significant increase was also seen after five minutes (mean = 2.23, $p = 0.003$) compared to baseline and after one week (mean = 1.6, $p = 0.049$) compared to 5 min., but not from 1 week to 4 weeks ($p = 0.579$).

Unpaired t-tests was used to compare the mean changes in amperage after treatment. however, Group I (Nano-hydroxyapatite + Potassium Nitrate) demonstrated consistently greater effectiveness compared to Group II (Novamin containing). At five minutes, the mean increase in amperage was significantly greater in Group I (3.06) than in Group II (2.23) ($p = 0.021$). This trend continued at one week (5.03 vs. 3.83; $p = 0.004$) and four weeks (6.36 vs. 4.63; $p < 0.001$), indicating superior and sustained desensitizing efficacy of Group I.

7. Discussion

DH is a prevalent painful condition affecting vital teeth with exposed dentin, impacting approximately 33% of the population and arising from multiple etiological factors.[5] Management strategies primarily follow two approaches: occlusion of open dentinal tubules to reduce fluid movement and hydraulic conductance[6], or nerve desensitization through ionic agents that decrease intra-dental nerve excitability by interrupting pain signal transmission.[7] Tubular occlusion is commonly achieved using agents such as varnishes, bonding

materials, and restorative resins. While therapy with laser has shown effectiveness, its complexity and high-cost limit widespread use.[8] Toothpastes remain a preferred option due to their affordability, ease of application, and suitability for home use. Recent advancements in dentifrice formulations aim to combine both mechanisms-tubule occlusion and neural desensitization-for improved management of DH.[9] In this study we evaluated and compare the efficacy of two desensitizing toothpaste in managing DH. Hydent Duo (Abbott Healthcare) is newly launched toothpaste mainly contains Nano-hydroxyapatite 6.7%, Potassium nitrate 5%, sorbitol solution (70%), purified water, dental silica, glycerin, Cocamidopropyl Betaine, PEG-400, sodium lauryl sulfate, sodium monofluorophosphate, titanium dioxide, mint flavor, xanthan gum, carrageenan, benzyl alcohol, and saccharin sodium.[10] The desensitizing action of nano-hydroxyapatite (nHA) is attributed to its rapid ability to occlude dentinal tubules by forming hydroxyapatite plugs within minutes, followed by the formation of remineralized layer.[4] Potassium nitrate works by altering nerve transmission; it depolarizes the nerve fiber membranes, preventing repolarization and thereby reducing sensitivity.[4] Sensodyne Repair and Protect (GSK Group) contains glycerin, hydrated silica, PEG-8, calcium sodium phosphosilicate, sodium methyl cocoyl taurate, Cocamidopropyl Betaine, flavoring agents, titanium dioxide, carbomer, sodium fluoride, sodium saccharin, limonene.[4] Upon contact with saliva, Novamin releases sodium ion, calcium ion, and phosphate ions, they interact with oral fluids to form a hydroxycarbonate apatite layer. This layer mimics natural tooth mineral in structure and composition and effectively seals the open dentinal tubules, contributing to reduced hypersensitivity.[4]

Pain assessment involved multiple stimuli[11], as different types can trigger varied pain responses, following the recommendation by Holland et al.[12] A dental explorer used as a tactile stimulus, inducing inward fluid flow and activating mechanoreceptors in the dentin.[13] Air blasts from a 3-way syringe (40 ± 5 psi) served as an evaporative stimulus, creating outward fluid flow that elicits pain.[14] An electric pulp tester provided an objective measure of DH by gradually increasing the current until participants sensed discomfort just before pain. Amperage readings were recorded at baseline, and at five minutes, one week, and four weeks post-application of dentifrices. To control for oral hygiene variability, all participants were instructed to use only the assigned toothpaste and a soft-bristled toothbrush, brushing twice daily for four weeks, as brushing habits are closely linked to DH.[15]

Table 1: Descriptive statistics of amperage values

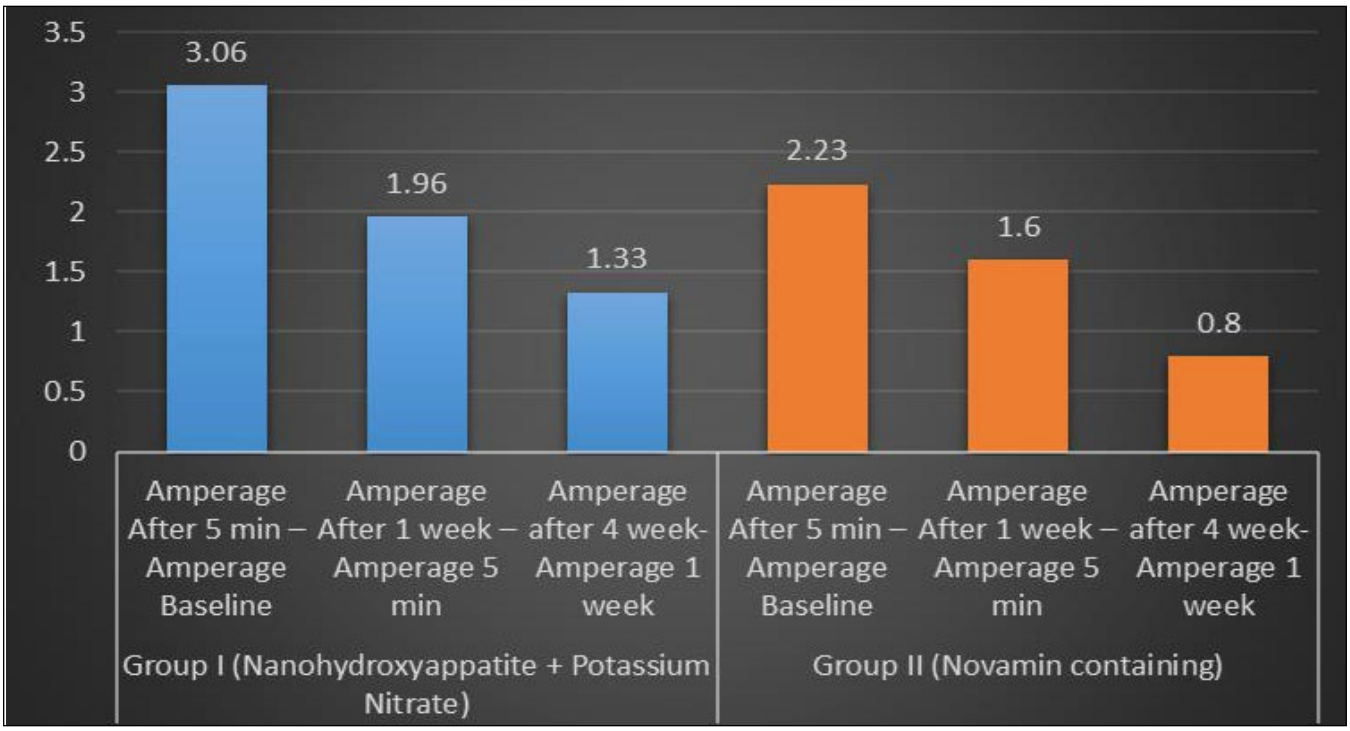
	Group I (Nanohydroxyapatite + Potassium Nitrate) Mean (SD)	**Group II (Novamin containing) Mean (SD)**
Baseline	5.83 (2.47)	5.53 (2.38)
After 5 min.	8.9 (2.52)	7.76 (2.38)
After 1 Week	10.86 (2.63)	9.36 (2.45)
After 4 week	12.2 (2.73)	10.16 (2.46)

Table 2: Statistical analysis of within group comparison

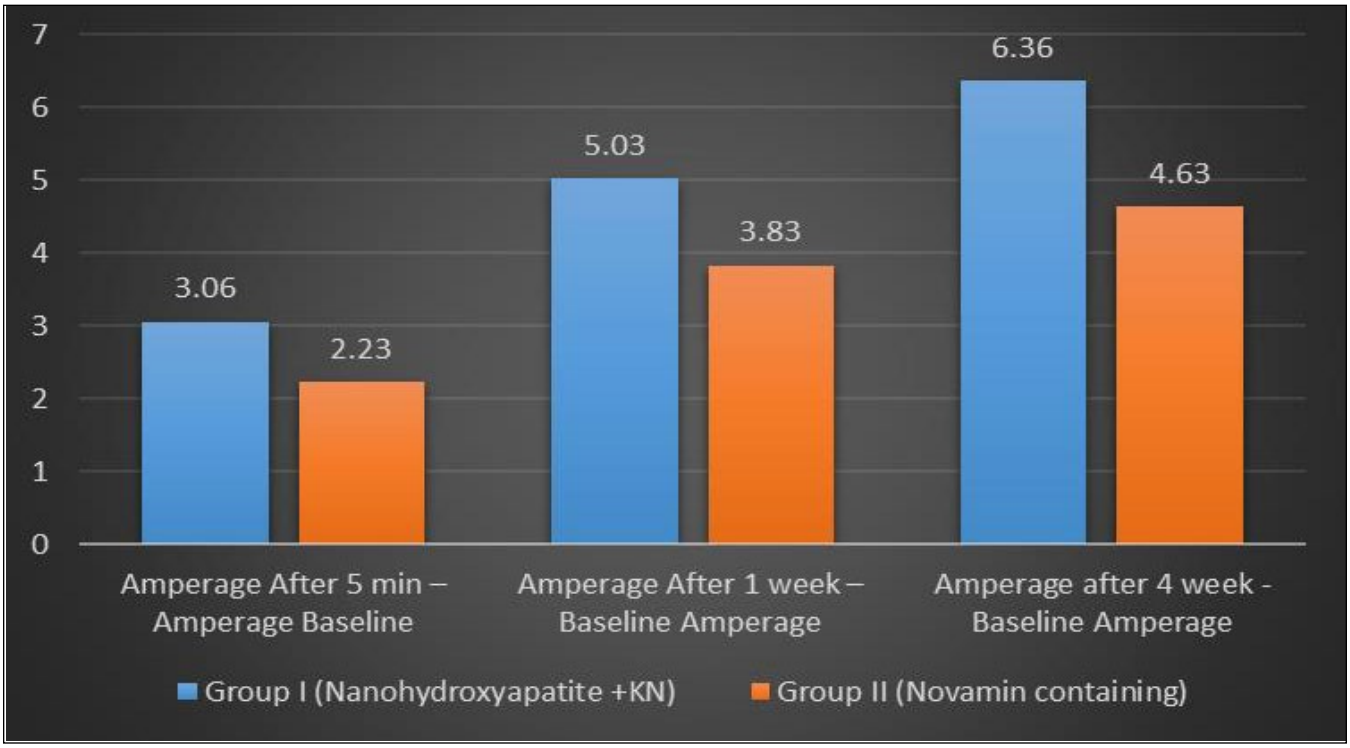
Group	**Paired differences**	**Mean**	**Confidence interval lower bound**	**Confidence interval upper bound**	**Sig.**
Group I (Nanohydroxyapatite + Potassium Nitrate) (F = 34.085)	Amperage After 5 min – Amperage Baseline	3.06	1.32	4.81	p<0.001**
	Amperage After 1 week – Amperage 5 min	1.96	0.22	3.71	p = 0.021*
	Amperage after 4 week – Amperage 1 week	1.33	0.41	3.07	p = 0.198 (ns)
Group II (Novamin containing) (F = 21.309)	Amperage After 5 min – Amperage Baseline	2.23	0.6	3.86	p = 0.003*
	Amperage After 1 week – Amperage 5 min	1.6	-0.03	3.23	p = 0.049*
	Amperage after 4 week – Amperage 1 week	0.8	0.831	2.431	p = 0.579

Table 3: Statistical analysis for intergroup comparison

	Group I (Nanohydroxyapatite + Potassium Nitrate) Mean	SD	Group II (Novamin containing) Mean	SD	Unpaired t-test value	Significance
Amperage after 5 Min – Baseline	3.06	0.87	2.23	0.57	t = 10.98	p = 0.021*
Amperage after 1 week – Baseline	5.03	1.87	3.83	1.26	t = 13.87	p = 0.004*
Amperage after 4 weeks – Baseline	6.36	2.65	4.63	2.01	t = 17.98	p < 0.001**



Graph 1: Statistical analysis of within group comparison



Graph 2: Statistical analysis for intergroup comparison

A progressive increase in amperage values was observed at each follow-up interval in both groups, as shown in **(Table 1)** and **(Table 2)**. This trend indicates that both nHA with KNO_3 and NovaMin-containing dentifrices effectively reduced DH, likely due to enhanced tubular occlusion over time.[4] **(Graph 1)**

Within-group comparison of amperage readings of EPT revealed statistically significant improvements in both the groups, indicating effective reduction in DH over time. The consistent increase in amperage values suggests a cumulative desensitizing effect of both toothpastes. Notably, the most substantial relief occurred immediately after application, with a reduced difference in amperage values between subsequent follow-ups. This suggests that most of the hypersensitivity relief is achieved in the early phase of treatment.

This result was according to study of Suresh A et al[1] showed the progressive raise in amperage values with time after applying desensitizing toothpaste.

In intergroup comparison the nanohydroxyapatite plus potassium nitrate containing toothpaste **(Table 3)** showed consistently more reduction in DH at each of the time intervals than the novamin containing toothpaste group. **(Graph 2)** This difference was statistically significant.

Efficacy of potassium nitrate (KNO_3) in reducing DH (DHS) is well-documented, particularly when combined with nano-hydroxyapatite (nHA).[16,17] KNO_3 reduces sensitivity by depolarizing nerve fiber membranes, making them unresponsive to stimuli[18], though its effects typically accumulate over several weeks.[19] In contrast, nHA provides a mechanical barrier by forming hydroxyapatite plugs and mineral layers that seal dentinal tubules.[20] It also serves as a calcium-phosphate reservoir, promoting sustained mineral deposition and acting as a scaffold for crystal growth[21,22,23]. This occlusion reduces fluid movement in the tubules—the main trigger for DHS pain.[24] The current study supports previous findings, confirming that nHA is effective in reducing DHS. When combined with KNO_3, as in Hydent Duo, the formulation offers dual-action relief—nHA occludes tubules while KNO_3 targets nerve activity—resulting in enhanced desensitizing efficacy.

In this study, toothpaste containing silica-based bioglass (calcium sodium phosphosilicate, CSPS) was used as the standard for DHS management, given its well-documented efficacy in previous studies[25,26] CSPS works by releasing sodium ions, calcium ions, and phosphate ions upon contact with saliva, leading to the formation of a hydroxycarbonate apatite layer which mimics natural tooth mineral.[27] While CSPS was expected to outperform nano-HAP formulations, its effectiveness may be delayed due to the protective glass matrix encasing the calcium and phosphate ions. These ions require release through localized trapping of glass particles, which can slow the occlusion process.[28] This delayed mechanism may explain why CSPS toothpaste showed significantly lower effectiveness compared to the nano-HAP and KNO_3 combination in reducing DHS in the present study.

The results of this study were according to the Amaechi et al[4], Martin CC et al[16] and Low et al[17] who showed that nanohydroxyapatite plus potassium nitrate containing toothpaste showed more reduction in DH than the CSPS containing toothpaste.

The limitation of the study was as follows

Changes in EPT readings may not solely reflect dentinal tubule remineralization. Using a positioning jig could have ensured consistent probe placement. Individual variations in pain response may have affected results. Additionally, the Hawthorne effect could have influenced participant behaviour during the trial.

8. Conclusion

With the limitations of study, it could be concluded that both nanohydroxyapatite plus potassium nitrate and novamin containing toothpastes play a beneficial role in managing DH. Future research should employ larger sample sizes and focus on patient-centered, quality-of-life outcome measures to evaluate the efficacy of products management of DH used for treating DH.

9. Ethical Committee Approval

Ethical clearance from the Institutional Ethics Committee and registration with the Clinical Trials Registry of India (CTRI) REF NO.2025/07/109295.

10. Source of Funding

None.

11. Conflict of Interest

None.

12. Acknowledgement

None.

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