Original Article

Evaluate Efficacy of Desensitizing Toothpaste Containing Zinc-carbonate Hydroxyapatite Nanocrystals: Non-comparative Eight-week Clinical Study

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ABSTRACT

Objective: The aim of the study was to evaluate the clinical effectiveness of desensitizing toothpaste in reducing the dentine hypersensitivity (DH). **Materials and Methods:** The study was a before and after clinical trial conducted to evaluate the clinical efficacy of a desensitizing toothpaste containing zinc-carbonate hydroxyapatite nanocrystals (Zn-CHA) for controlling DH. The trial involved 72 patients with DH who were evaluated four and eight weeks after using Zn-CHA toothpaste. The sensitivity was assessed by airblast method using Schiff Sensitivity Scale. **Results:** Repeated measures analysis of variance test was used to compare baseline score with fourth and eighth week. Statistically significant differences were observed between sensitivity scores at baseline and those at four- and eight-week intervals ($P < 0.001$). **Conclusion:** The results suggested that the use of Zn-CHA nanocrystals dentifrice might become an effective therapy to reduce DH.

Keywords: *Biorepair sensitive toothpaste, clinical trial, dentine hypersensitivity, Schiff Sensitivity Scale, zinc-carbonate hydroxyapatite nanocrystals*

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Introduction

Pain due to dentin hypersensitivity (DH) is an increasing problem in clinical dentistry, desensitizing dentifrices are the best and are commonly used in reducing and controlling DH.[1] Many treatment modalities have been proposed for controlling DH, but still definite treatment is questionable.[2]

The oral care companies in the world have manufactured many dentifrices for this common problem of DH. These treatment modalities have been used over the years, and particular attention has been focused on home care use of dentifrices containing compounds, blocking either the hydrodynamic mechanism or the neural response.[3]

Enamel and dentin have no natural ability to heal when affected by caries, abrasions, erosion, or fractures because enamel contains no cells.[4] When enamel and dentin are exposed in oral cavity, they can be rebuilt with the help of alloplastic materials that make artificial restoration.[5] DH is diagnosed when stimuli such as fluids or cold air cause a short but severe pain, which arises from exposed dentin.[6] The etiology of DH is multi-factorial, with interactions between stimulus and predisposing factors causing its aggravation.[7] The exposure time between the tooth and the acid was found to be a more important risk factor for DH when comparing frequency of dietary acid intake or frequency of toothbrushing.[8]

Dentifrice containing 20% nano-sized carbonate apatite (n-CAP) was found most effective in occluding the dentinal tubules.[9] Carbonate-hydroxyapatite nanocrystals (CHA) have been used for remineralization of the altered enamel surfaces. Remineralization produced by the use of carbonate-hydroxyapatite involves in a deposition of a new apatite mineral over

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the eroded enamel surface.[10,11] CHA dentifrice was found to be very effective in reducing DH after four and eight weeks in a randomized controlled trial (RCT).[12]

The acceptance of these dentifrices by both the professional and the lay public requires scientifically documented clinical efficacy. The purpose of this clinical study was to evaluate the effect of desensitizing toothpaste containing Zn-CHA nanocrystals in reducing or controlling DH after eight weeks of treatment by means of the participating subject's response to the most common and validated stimuli test: airblast test Schiff Sensitivity Scale (SSS).[13]

Materials and Methods

This was a before–after clinical study design; the same outcomes were measured during intervention/exposure in one group (uncontrolled). This was an eight-week single center, before and after use of desensitize dentifrice. This study was conducted in the College of Dentistry, Qassim University, Kingdom of Saudi Arabia, and was approved by a Dental Ethics Committee of Qassim University under the Code no.: ST/55/2019, and informed consent was sought from all patients. Universal Trial Number (UTN) #: U1111-1237-7624 obtained from World Health Organization and Clinical Trial ID #: NCT04091256 from ClinicalTrial.gov. For transparent and good quality, reporting of clinical trials guideline of consolidated standards of reporting trials (CONSORT) 2010 was followed in this study. Without transparent reporting, the reliability and validity of study are questionable.[14] CONSORT 2010 was followed in the research protocol and methodology. A sample size of 72 subjects for the treatment of DH before and after using desensitizing toothpaste containing Zn-CHA nanocrystals would give 80% power to detect treatment change from baseline following four- and eight-week treatment as measured on the SSS scale.[13] Samples (participants) included in this study were suffering from DH and fulfill the inclusion criteria.

Inclusion criteria

All male and female subjects were 20–70 years of age in good health and having two teeth with DH; only incisors, canines, and premolars were included with the exposed cervical dentin (facial surfaces). All participants of the study having SSS score[13] of 2 and 3 were included in this clinical evaluation of desensitizing toothpaste.

Exclusion criteria

Subjects with deep carious teeth, defective restorations, any pathological lesion, periodontal disease, mobile teeth, cracked enamel, orthodontic appliances, and periodontal pockets >4 mm were not included in the study. Subjects using pain control medicines, sensitive toothpaste, and pregnant or lactating women were excluded from the study.

At baseline, four trained examiners, with a Kappa score (0.83) for intra-examiner reliability, performed the clinical examination and recorded the data. Sensitivity was assessed by airblast sensitivity, using SSS described as follows[13]:

0 = Subject does not respond to air stimulus
1 = Subject responds to air stimulus but does not request discontinuation of stimulus
2 = Subject responds to air stimulus and requests discontinuation or moves from stimulus
3 = Subject responds to air stimulus, considers stimulus to be painful, and requests discontinuation of the stimulus

At baseline, all subjects were instructed to brush their teeth twice a day (Bass Technique) with Zn-CHA nanocrystals toothpaste (Biorepair, Coswell, Bologna, Italy) and a new toothbrush (Soft, Biorepair Curve soft toothbrush, COSWELL SPA Italy) for 1–2 min.

All participants of the study were instructed to report after four weeks for first follow-up. At first follow-up, oral soft tissue examination was carried out in order to assess the safety of the products and to reevaluate the SSS at this stage. Participants were instructed for second follow-up after four weeks. At second follow-up, SSS was reevaluated along with soft tissue examination to assess the safety of the products.

Statistical analysis

IBM Statistical Package for the Social Sciences (SPSS) software, version 22 (IBM, Chicago, Illinois) was used for data analysis. Mean value ± standard deviation (SD) was calculated to present quantitative data such as age and SSS score. Frequency (%) was measured for categorical data such as gender. Repeated measures analysis of variance (ANOVA) test was applied; further, multiple comparisons were also performed, for that Bonferroni test was used to compare SSS score at baseline score, at fourth, and at eighth week. P value ≤ 0.05 was considered as significant.

Results

The average age of the 72 participants was 51.63 ± 9.65 (29–69) years. There were 40 (56%) males and 32 (44.4%) females. Proportion of males was higher than females. Of the total subjects, 27 (37.5%) subjects had age less than or equal to 50 years and 45 (62.5%) subjects had more than 50 years of age. Most of the

study subjects were from >50 years of age group [Table 1].

Distribution of SSS score at baseline, at fourth, and at eighth week was presented, it showed that 24 (33.3%) subjects had SSS score of 2 and 48 (66.7%) subjects had SSS score of 3 at baseline [Table 2]. After four weeks, 3 (4.2%) subjects had SSS score 0, 44 (61.1%) had SSS score 1, and 25 (34.7%) had SSS score 2, whereas on the last follow-up after eight weeks of treatment, most of the subjects, that is, 48 (66.7%) had achieved improvement in controlling DH with SSS score 0, 23 (31.9%) subjects still had SSS score 1, whereas only 1 (1.4%) had SSS score 2 [Table 2].

Correlation between different assessment times was computed pair wise, SSS score at baseline and at fourth week showed 0.56 (P = 0.001) correlation, which was moderately positive; SSS score at baseline and at eighth week showed 0.253 (P = 0.032) correlation, which was weak but positive; and SSS score at fourth and eighth week showed 0.677 (P = 0.001) correlation, which was also moderately positive; all pairs showed significant results with $P < 0.05$ [Table 3].

The mean SSS score at baseline was 2.67 ± 0.475, at fourth and at eighth week, the mean SSS score was 1.31 ± 0.547 and 0.35 ± 0.508, respectively. Repeated measures ANOVA test was applied to determine the statistical significance of the difference between baseline SSS score and those after four and eight weeks of treatment with toothpaste. As compared to baseline, after four and eight weeks, clinically SSS scores were reduced significantly (P = 0.001) [Table 4, Figure 1]. Multiple comparisons also showed significant improvement in SSS score, improvement was statistically significant from baseline to eighth week with P = 0.001 [Table 5].

Table 1: Demographic characteristics

Patient characteristics		Frequency (*n*)	Percentage (%)
Age (in years) mean ± SD (range)		51.62 ± 9.65 (29–69)	
Age groups	≤50 years	27	37.5
	>50 years	45	62.5
	Total	72	100.0
Gender	Female	32	44.4
	Male	40	55.6
	Total	72	100.0

Discussion

de Melo Alencar *et al.*,[15] in a systemic review, concluded that desensitizing dentifrices containing nano-hydroxyapatite (n-HAP) are effective for the relief of DH in both at-home and in-office treatments when compared with other desensitizing dentifrices.

Poggio *et al.*[16] showed in an *in vitro* study that both toothpastes tested (Pronamel and Biorepair Plus) offered an amount of shield from erosive drinks, without statistical difference, but shielding effect was more apparent for Biorepair. Anand *et al.*,[17] in double blind RCT, evaluated the effects of nano-hydroxyapatite (n-HA) toothpaste compared with 8% arginine-containing toothpaste in the treatment of DH.

Orsini *et al.*[18] conducted three-day study on three desensitizing dentifrices. They concluded that all tested desensitizing dentifrices reduced DH on a short-term basis, with a comparable level of overall efficacy and no adverse effects. Zn-CHA dentifrice was found to be clinically better due to rapid relief from DH. Anti-sensitivity dentifrice (ultralow abrasivity) containing 5% sodium tripolyphosphate was also found to be effective in reducing the extrinsic dental stains.[19]

Ayad *et al.*[20] concluded in a clinical study that a desensitizing dentifrice provides statistically significant reduction and control in DH when used as an adjunctive with daily home care hygiene procedures. Verma *et al.*[21] used two different desensitizing agents, BisBlock, BISCO, Schaumburg, IL USA, an oxalate-containing desensitizer, and GLUMA, Kulzer South Bend, Indiana USA, a glutaraldehyde-containing desensitizer, in an RCT, and they found that BisBlock significantly reduced DH.

Alessandri Bonetti *et al.*[22] concluded that the use of a Zn-CHA-containing toothpaste was found to be able to protect stripped enamel surfaces from demineralization

Table 2: Distribution of Schiff Sensitivity Scale score at baseline, fourth, and eighth week

SSS score	Baseline score		Score at fourth week		Score at eighth week	
	n	%	*n*	%	*n*	%
0	--	--	3	4.2	48	66.7
1	--	--	44	61.1	23	31.9
2	24	33.3	25	34.7	1	1.4
3	48	66.7	--	--	--	--
Total	72	100	72	100	72	100

in vitro. Use of fluoride in the form of toothpaste, gel, and varnishes was considered as the gold-standard method to reduce the incidence of demineralization and in the prevention of early lesions in the enamel.[23,24]

Table 3: Pair-wise correlation of Schiff Sensitivity Scale score

SSS score	*N*	Correlation (*r*)	*P* values
At base line	72	0.560	0.001
At 4 week			
At base line	72	0.253	0.032
At 8 week			
At 4 week	72	0.677	0.001
At 8 week			

Table 4: Comparison of repeated Schiff Sensitivity Scale score

SSS score	Mean	Std. deviation	P value
Baseline	2.67	0.475	0.001
At 4 week	1.31	0.547	
At 8 week	0.35	0.508	

Repeated measures analysis of variance (ANOVA) test applied

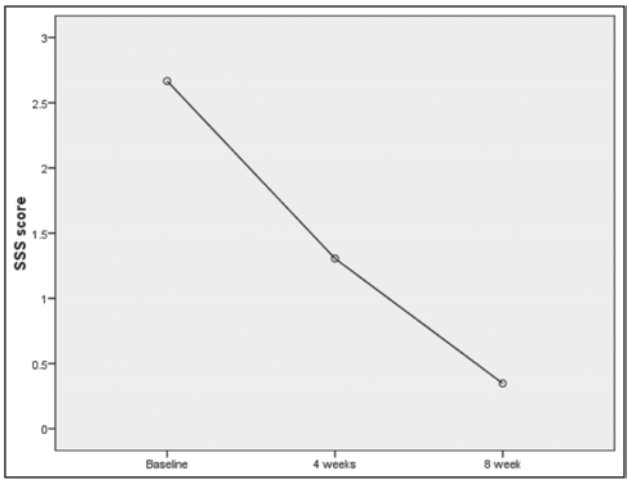

Figure 1: Comparison of SSS score at baseline, fourth, and eighth week

Dentifrices containing Zn-HAP lead to significant enamel remineralization of enamel showing that these toothpastes can be beneficial pertinent to enamel erosion.[25]

New desensitizing toothpaste containing 15% n-HA crystals and Remin Pro, VOCO Germany can provide effective tubule occlusion and reduce the pain and control DH.[26]

Vano *et al.*[27] in a double-blind RCT concluded that the use of n-HA in gel dentifrices is an effective desensitizing material that controls pain and reduces DH.

In our eight-week study, it was also concluded that dentifrice based on Zn-CHA nanocrystals is capable of remineralization and reducing or controlling DH. Drop in the SSS score was achieved using desensitizing toothpaste containing zinc-carbonate hydroxyapatite (Zn-CHA).

In this study, hypothesis was that Zn-CHA nanocrystals–containing toothpaste controlled DH. This study proved that using the Biorepair toothpaste containing Zn-CHA nanocrystals reduced the DH very well.

Limitation and recommendation: Adequate scientific literature for the support of product is not available. This was merely one group (uncontrolled) quasi-experimental single center study. Considering the results of this study, it is suggested that in future RCT design should be performed in multicenter for further clinical evaluation of this sensitive toothpaste.

Conclusion

The use of the desensitizing toothpaste containing Zn-CHA in patients with DH provides significant rapid relief from DH. Results appear clinically relevant as the toothpaste can be safely prescribed to patients with DH for home use. The toothpaste being fluoride free is also safe for younger children in case of ingestion.

Table 5: Multiple comparison of Schiff Sensitivity Scale score

SSS score		Mean difference	Std. error	*P* values†	95% Confidence interval for difference**	
					Lower bound	Upper bound
Baseline	At 4th week	1.361*	0.057	0.001	1.221	1.501
	At 8th week	2.319*	0.071	0.001	2.146	2.493
At 4th week	Baseline	1.361*	0.057	0.001	1.501	1.221
	At 8th week	0.958*	0.050	0.001	0.835	1.081
At 8th week	Baseline	2.319*	0.071	0.001	2.493	2.146
	At 4th week	0.958*	0.050	0.001	1.081	0.835

*The mean difference is significant at the 0.05 level

†*P* value from repeated measures analysis of variance (ANOVA)

**Adjustment for multiple comparisons: Bonferroni test

Ethical policy and institutional review board statement

This study was approved by the dental ethics committee at Qassim University: Code #: ST/55/2019.

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Conflicts of interest

There are no conflicts of interest.

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