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Effectiveness of Bioactive glass Containing Dentifrice on Dentin Hypersensitivity - A Systematic Review

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ABSTRACT

Objective: The aim of this systematic review was to evaluate and compare the effectiveness of dentifrices containing bioactive glass in reducing dentin hypersensitivity. **Search Strategy:** An electronic search was conducted on the PubMed, MEDLINE and Cochrane Database until June 2012. Hand searching included relevant journals and bibliographies of all relevant papers and review articles until June 2012. The search identified 13 publications out of which 4 were excluded after reviewing the title or abstract. Full articles were obtained for 9 studies, out of which 3 publications were excluded after reading the complete manuscript. **Selection Criteria**Randomized controlled trial in which the effect of dentifrice containing bioactive glass on dentin hypersensitivity was tested against other dentifrices. **Main Results:** A total of six trials that met all inclusion criteria involving 461 participants were reviewed. Owing to the heterogeneity of the studies, a meta-analysis was not performed. Included studies showed that dentifrices containing 5% and 7.5% bioactive glass caused significant improvement compared to baseline and were superior to the placebo and other negative control dentifrices. **Conclusion:** This systematic review indicates that the available data lacks evidence regarding the effectiveness of dentifrices containing bioactive glass against positive controls containing potassium nitrate or strontium chloride. Therefore, well designed randomized controlled trials with long term follow up must be performed to give concrete evidence on the long term effectiveness of dentifrice containing bioactive glass.

Key-words: Bioactive glass, Calcium sodium phosphisilicate, Systematic review, Dentin hypersensitivity, Dentifrices.

INTRODUCTION:

Dentin hypersensitivity may be defined as the pain arising from exposed dentine, typically in response to external stimuli, which cannot be explained by any other form of dental disease[1].

The main symptom of dentin hypersensitivity is sudden sharp pain of shorter duration in response to stimuli such as intake of hot or cold foods, but may also arise from tactile stimuli. It is a painful clinical condition with an incidence ranging from 4 to 74% [2,3]. The mechanisms of dentin hypersensitivity have not been fully explained but the most accepted hypothesis is the hydrodynamic theory put forth by Gysi and later modified by Brannstrom[4].

Pain is a main and consistent clinical symptom of dentin hypersensitivity[5]. *In vitro* studies have been used to characterize areas of sensitive and non-sensitive dentin[6]. Over the years, many treatment regimens have been introduced for dentin hypersensitivity. Traditionally, the therapy for management of dentin hypersensitivity is aimed at occluding dentinal tubules or making coagulates inside the tubules. Patients are often prescribed with over the counter (OTC) desensitizing agents. It takes usually about 2 to 4 weeks for the dentifrices therapy to provide symptomatic relief[7]. If there is no success in relief from dentin hypersensitivity, then in office treatment is generally initiated.

Though many over the counter (OTC) dentifrices are available, recently introduced bioactive glass has gained popularity in the last few years. Bioactive glass was first introduced as bone regenerative material by *Hench* in 1971 and in Dentistry it was introduced by *Dr. Len Litkowski* and *Dr. Gary Hack* at the Department of Restorative Dentistry, University of Maryland and by *Dr. David Greenspan* at NovaMin® Technologies Inc. It was based on the original 45S5 bioglass composition. Recently, it has been demonstrated that inclusion of bioactive glass particles in a suitably formulated vehicle may be an effective method for the treatment of dentin hypersensitivity[8]. Bioactive glasses of size <90µm, when incorporated into aqueous dentifrices have the ability to clinically reduce the dentin hypersensitivity[9]. It acts by precipitating hydroxycarbonate apatite on to the exposed tooth surface and it occludes the dentinal tubules. Silica is the basic component which acts as a nucleation site for precipitation of calcium and phosphate. A great number of in vitro studies concerning bioactive glass have been published since 2002 but only few clinical studies have been published since 2008. The aim of this study was to conduct a systematic, up-to-date review of the randomized controlled trials on the effectiveness of bioactive glass in the treatment of dentin hypersensitivity.

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AIM:

The aim of this systematic review was to evaluate and compare the effectiveness of bioactive glass (calcium sodium phosphosilicate) containing dentifrice in the reduction of the dentin hypersensitivity.

STRUCTURED QUESTIONS:

- Is there a difference between dentifrice containing bioactive glass and other desensitizing dentifrices or placebo in reducing dentin hypersensitivity?
- Which concentration of bioactive glass is more effective in reducing hypersensitivity?

PICO ANALYSIS:

- **Population-** Subjects having dentin hypersensitivity
- **Intervention-**Bioactive glass (calcium sodium phosphosilicate/ Novamin) containing dentifrice
- **Comparison-** other desensitizing dentifrices or placebo
- **Outcome-** reduction in dentin hypersensitivity

MATERIALS AND METHODS:

Search strategy:

For identification of studies included or considered for this review, detailed search strategies were carried out on the following databases.

- PubMed (until June 2012)
- PubMed Advanced Search (until June 2012)
- MEDLINE
- Cochrane Database

No limits and language restriction were applied during the electronic search to include all the possible clinical trials in the potential relevant article search phase of the systematic review. No time restriction was applied. Reference list of the reviews and the identified randomized trials were also checked for possible additional studies.

PubMed search methodology:

((((((((((((odontalgia)) OR (pain)) OR (hyperalgesia)) OR (hyperpathia)) OR (hyperesthesia)) OR (hypersensitive)) OR (hypersensitivity)) OR (sensitivity)) OR (sensitive))) AND ((((((((((((((((((non carious cervical lesions)) OR (abfraction)) OR (erosion)) OR (abrasion)) OR (attrition)) OR (tooth wear)) OR (non carious tooth loss)) OR (cemental)) OR (cementum)) OR (pulpal)) OR (oral)) OR (cervical)) OR (root)) OR (dentinal)) OR (dentine)) OR (tooth)) OR (teeth)) OR (dentin)))) AND (((((((randomized trial)) OR (clinical trial)) OR (controlled clinical trial)) OR (double blind trial)) OR (single blind trial)) OR (placebo controlled trial))) AND (((((((novamin)) OR (bioactive glass 45S5)) OR (bioactive glass)) OR (calcium sodium phosphosilicate))) OR (Sio2-Cao-Na2O-P2O5-K2O glass))

Hand searching (from 2000 to 2012)

- Journal of Oral Sciences
- Journal of Periodontology
- Journal of Oral Rehabilitation
- Journal of Dentistry
- American Journal of dentistry

INCLUSION CRITERIA:

Criteria for considering studies for this review were

1.Types of studies:

Randomized controlled trials in which the effect on dentin hypersensitivity of dentifrice containing bioactive glass was evaluated against other dentifrices.

2. Participants:

Patients of age greater than 18 years having dentin hypersensitivity

3. Types of Interventions:

Dentin hypersensitivity evaluated after the daily home use of dentifrice containing bioactive glass versus other dentifrices.

4. Types of Outcome Measures:

Change in pain symptoms in response to tactile stimulus, cold water stimulus or air blast stimulus.

EXCLUSION CRITERIA:

The following studies were excluded

1. Case reports/case series
2. Animal studies
3. In vitro studies
4. Studies comparing dentifrice use to in office application
5. Studies having follow up less than three weeks
6. Review articles
7. Applications of Bioactive glass in conditions other than dentin hypersensitivity

Data Collection and Analysis:

Study Selection:

The title, keywords and abstracts of reports identified from electronic searching for evidence of following criteria were examined:

- Randomized control trials involving the use of dentifrices containing bioactive glass

Data Extraction:

Two reviewers independently (S.R AND N.S) screened the publications and assessed their quality using the standard extraction form. Data extraction form was piloted based on several papers and modified as required before use. All studies meeting the inclusion criteria then underwent quality assessment and data extraction. Studies rejected at this or subsequent stages were listed as excluded studies. For each trial the following data were recorded:

1. Year of publication and country of origin
2. Details of participants including demographic characteristics and criteria for inclusion
3. Details of the type of intervention
4. Details of outcome reported (Method of assessment and mean duration of study)

Quality assessment:

It was assessed according to Cochrane handbook for quality assessment[10]. The assessments for the four main methodological quality items and criteria are shown in (Table-1).

Table 1. Grade scale for quality assessment of randomized controlled trials

Criteria	Yes	No	Unclear
Method of Randomization	Adequate as described in the text	Inadequate as described in the text	Unclear in the text
Allocation Concealment	Adequate as described in the text	Inadequate as described in the text	Unclear in the text
Assessors blinding	Adequate as described in the text	Inadequate as described in the text	Unclear in the text
Completeness of follow-up	Drop outs were explained	Drop outs were not explained	No dropouts

The study was assessed to have a "High risk" of bias if it did not record a "Yes" in three or more of the four main categories, "Moderate" if two out of four categories did not record a "Yes", and "Low" if randomization, assessor blinding and completeness of follow – up were considered adequate.

RESULTS:

Description of Studies

Figure 1 summarises the details of the process of study. The search identified 13 publications out of which 4 were excluded after reviewing the title or abstract. Full articles were obtained for 9 studies, out of which 3 publications were excluded after reading the complete manuscript (Table 2). Therefore, a total of 6 publications fulfilled all inclusion criteria and were further evaluated. (*Sharma et al.[18]; Salian et al.[19]; Litkowski et al.[20]; Narongdej et al.[21]; Pradeep et al.[22]; Du et al.[23]*).

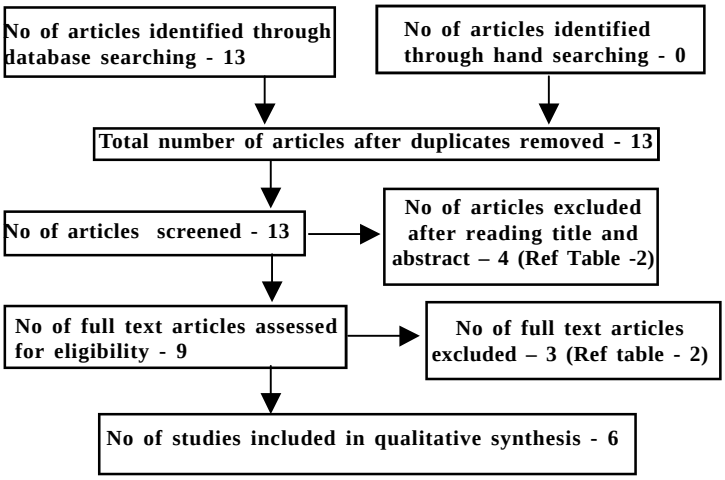

Figure 1: Search flow chart

Quality of studies:

Table 3 shows the quality of the included trials. All the studies included in this review are a randomized clinical trial which implies a level of evidence 2. Risk of bias for included studies shows that three trials [19, 20, 21] have high risk of bias, two trials [18, 23] have moderate risk of bias while one trial [22] has low risk of bias.

Table 3: Assesment of risk of bias

Study	Randomization	Allocation Concealed	Assessor Blinded	Dropouts described	Risk of Bias
Sharma et al. [18]	Unclear	No	Yes	Yes	Moderate
Salian et al. [19]	Unclear	No	Yes	No	High
Litkowski et al. [20]	Unclear	No	Unclear	Yes	High
Narongdej et al. [21]	Unclear	No	Unclear	Yes	High
Pradeep et al. [22]	Yes (lottery method)	No	Yes	Yes	Low
DU et al. [23]	Yes (computer generated randomization table)	No	Unclear	Yes	Moderate

Table 2: Characteristics of excluded studies

Author and Year	Reason for Exclusion
Jefferies SR et al [11]	Bioactive glass used as dental luting agent
Gendreau L et al [12]	Review about Novamin; not a clinical trial
Patsouri A et al [13]	Bioactive glass dentifrice compared with in office method of application.
Tirapelli C et al [14]	Bioactive glass Dentifrice compared with in office method of application.
Banerjee A et al [15]	Bioactive glass used as an air polishing powder
Jefferies SR et al [16]	Bioactive glass used as dental luting agent
Jefferies SR et al [17]	Bioactive glass used as dental luting agent

INTERPRETATION OF RESULTS:

General information of these included trials was listed in Table-4. A total number of 461 participants were included in this review. They fall under the age group of 18 to 70 years. Among the total participants, 181 participants were males; 220 participants were females and gender of 60 participants in the trial [21] was not mentioned. In three studies, the experimental toothpaste contained 5% bioactive glass[19, 22, 23] whereas in the remaining studies experimental toothpaste contained 7.5% bioactive glass[18, 20, 21]. However in the *Litkowski et al.*[20] trial, both 7.5% and 2.5% concentrations were used. All six studies had a parallel group design; two studies ran for 4 weeks, two studies were followed up for 6 weeks, one study was conducted for 8 weeks and another ran for 12 weeks.

The patients in all the six trials were instructed to brush twice daily. Dentinal hypersensitivity was measured using tactile stimulus, cold water stimulus or air blast test. In all the trials, assessments were measured using 10cm VAS scale except in study by *Litkowski et al.*[20] where assessments were made by 100mm VAS scale.

A total number of 4 trials compared bioactive glass with potassium nitrate; 3 trials compared bioactive glass with placebo (same ingredients as experimental group without bioactive glass); 1 trial each compared bioactive glass with strontium chloride, stannous fluoride and sodium monofluoro phosphate respectively. In all the included trials, dentifrices containing 5% and 7.5% bioactive glass performed better than the other compared dentifrices. All the studies reported either the mean change in scores or percentage reduction from baseline (Table-5).

Table 4: General information of included articles

S.No	Author and Year	Study design	Country	Setting	Sample size	Age
1	*Sharma et al.* [18]	Randomized, double blind, parallel group design	India	Medical centre	120 subjects	20 to 50 years
2	*Salian et al.* [19]	Randomized, double blind, parallel group controlled clinical trial	India	University	30 subjects	20 to 50 years
3	*Litkowski et al.* [20]	Randomized, double blind, controlled clinical trial	USA	University	66 subjects	38.8 (mean age)
4	*Narongdej et al.* [21]	Randomized, double blind, controlled clinical trial	Bangkok	University	60 subjects	26 to 70 years
5	*Pradeep et al.* [22]	Randomized, Triple masked, controlled clinical trial	India	University	110 subjects	20 to 60 years
6	*DU et al.* [23]	Randomized, double blind, controlled clinical trial	China	University	75 subjects	18 to 65 years

S.No	Materials used		
	Test group	**Control group**	**Variables evaluated**
1	7.5% BAG	5% KNO_3,0.4% SnF.	Air blast test, cold water stimulus. (VAS)
2	5% BAG	5%KNO_3, SMFP.	Tactile stimulus, Air blast test, cold water stimulus. (VAS)
3	7.5% BAG, 2.5% BAG.	Placebo	Tactile stimulus, Air blast test (VAS) Cold stimulus, tactile stimulus (VAS)
4	100% BAG powder with 7.5% BAG dentifrice (Group 1), a placebo powder with 7.5% BAG dentifrice (Group 2).	Placebo powder with KNO_3 dentifrice (Group 3).	Air blast test, cold water stimulus. (VAS)
5	5% BAG	5% KNO_3, placebo.	Air blast test, cold water stimulus. (VAS)
6	5% BAG	$SrCl_2$, placebo.	

Legends:BAG – Bioactive glass,KNO_3 – potassium nitrate,SnF – Stannous fluoride,SMFP – Sodium MonoFluro Phosphate,$SrCl_2$ - Strontium chloride

Table 5: Outcome in the included studies

Sno	Author & year	Outcomes evaluated	Longest Follow up period	Study groups	Outcomes at the longest follow-up period		
					Air blast stimuli	Cold water stimuli	Tactile stimuli
1.	*Sharma et al.* [18]	Mean ± S.D change from baseline (10cm VAS score)	12 weeks	7.5% BAG	0.73±0.78 (87%)	0.53±0.68 (91%)	_
				5% KNO_3	0.95±0.88 (84%)	1.20±0.97 (79%)	_
				0.4% SnF	0.75±0.93 (87%)	0.85±0.86 (85%)	_
2.	*Salian et al.* [19]	Mean ± S.D (10cm VAS score)	4 weeks	5% BAG			
				B	5.77±1.02	6.85±1.14	3.96±0.80
				4 weeks	1.99±1.22	2.37±1.20	0.96±0.81
				5% KNO_3			
				B	5.70±0.58	6.92±0.80	3.57±0.70
				4 weeks	4.60±0.41	5.43±0.50	2.90±0.89
				SMFP			
				B	5.67±1.24	6.36±1.51	3.55±0.81
				4 weeks	5.41±1.29	5.97±1.52	3.35±0.79
3.	*Litkowski et al.* [20]	Mean ± S.D change from baseline (100mm VAS scores)	8 weeks	7.5% BAG	27.4 ±3.3	_	36.0±3.1
				2.5% BAG	15.5±4.7	_	17.6±5.4
				placebo	14.5±3.6	_	16.5±3.3
4.	*Narongdej et al.* [21]	Mean change from baseline (10cm VAS score)	4 weeks	Group 1	_	6.85	6.30
				Group 2	_	5.00	5.10
				Group 3	_	2.50	2.80
5.	*Pradeep et al.* [22]	Change in mean sensitivity score from baseline (10cm VAS score)	6 weeks	5% BAG	-72%	-68.7%	_
				5% KNO_3	-42.7%	-47.4%	_
				Placebo	-39.2%	-36.8%	_
6.	*DU et al.* [23]	Change in mean sensitivity score from baseline (10cm VAS score)	6 weeks	5% BAG	-34.8%	-37.6%	_
				$SrCL_2$	-10.9%	-20.6%	_
				Placebo	-21.3%	-19.7%	_

Legends:BAG – Bioactive glass,KNO_3 – potassium nitrate,SnF – Stannous fluoride,SMFP – Sodium MonoFluro Phosphate,$SrCl_2$ - Strontium chloride**,**B – Baseline scores,Group 1 - 100% Novamin powder with 7.5% Bioactive glass dentifrice ,Group 2 - Placebo powder with 7.5% Bioactive glass dentifrice ,Group 3 - Placebo powder with 5% potassium nitrate dentifrice

In the trial by *Narongdej et al.*[21] prior to the start of at-home treatment, the teeth were treated with 100 percent by weight Novamin powder in Group 1 and placebo group (sodium bicarbonate) in Group 2 & 3. This was done to check whether the application of Novamin powder enhances the effectiveness of Novamin containing dentifrice and they concluded that the application of 100 percent Novamin powder enhanced the effectiveness of the Novamin containing dentifrice.

In the trial by *Salian et al.*[19], in addition to the clinical trial a companion scanning electron microscopy (SEM) evaluation was performed to demonstrate whether or not the test products occlude open dentin tubules *in vitro.* They concluded that qualitative examination of the dentinal tubules observed by SEM revealed tubule occluding properties for the 5% Novamin dentifrices as early as ten minutes. Further, partial to complete occlusion was observed after 120 min of brushing with dentifrice.

All the trials reported safety. None of the trials reported any adverse reactions except in the trial by *Litkowski et al.*[20] where minimal treatment related adverse reactions were reported and they also concluded that twice daily brushing with bioactive glass caused no noticeable increase in calculus formation. In *Litkowski et al.*[20] trial, compliance was also monitored by weighing the toothpaste tubes after collection and calculating paste usage rate. There was no significant difference in the amount of dentifrice used among the treatment groups.

ASSESSMENT OF INDIVIDUAL PARAMETERS:

COLD WATER STIMULUS ASSESSMENT:

Five clinical trials included in this review evaluated the reduction in dentin hypersensitivity in patients treated with bioactive glass dentifrice by application of a cold water stimulus[18, 19, 21, 22, 23]. In all the trials, cold water was delivered using the micropipette except in the trial by *Narongdej et al.*[21] where cotton pellet soaked in ice water was applied to the exposed root surface. In all the trials, bioactive glass showed significant difference with other compared dentifrices at all the time points (Table-5, 6).

THERMAL AIR STIMULI ASSESSMENT:

Five clinical trials included in this review evaluated the reduction in dentin hypersensitivity in patients treated with bioactive glass dentifrice by application of a thermal air stimulus[18, 19, 20, 22, 23]. In all the clinical trials, air from a standard air/water syringe with a pressure of 45psi to 65 psi was directed towards the sensitive portion of tooth, along the perpendicular long axis of the tooth at a distance of 0.1 to 0.5 cm.

Sharma et al.[18] showed that there was a significant difference between bioactive glass and other dentifrices at 2 and 4 weeks, but there was no significant difference with treatment groups at 12 weeks in air VAS score. *Salian et al.*[19] and *Du et al.*[23] showed that bioactive glass group was significantly better at all time points when compared to other dentifrices. *Litkowski et al.*[20] showed that there was a significant difference between 7.5% and 2.5% bioactive glass group at 8 weeks whereas there was no significant difference between 2.5% bioactive glass group and placebo at any of the time points. In the trial by *Pradeep et al.*[22], bioactive glass was found to be significantly better in reducing VAS score compared to KNO_3 group at 2 and 6 weeks and the placebo group at 6 weeks (Table-5, 6).

TACTILE STIMULI ASSESSMENT:

Three clinical trials included in this review evaluated the reduction in dentin hypersensitivity in patients treated with bioactive glass denti-

Table 6: Interpretation of variables of interest

SNo	Author & Year	Cold water stimulus	Air blast stimulus	Tactile stimulus
1.	*Sharma et al.* [18]	Bioactive glass dentifrice was more effective than other two dentifrices at all time points.	Bioactive glass dentifrice reduced sensitivity significantly more than the others at two and four week time points. At 12 weeks, scores between the groups were not significant.	_
2.	*Salian et al.* [19]	Bioactive glass dentifrice reduced sensitivity significantly more than the other two groups at all time points.	Bioactive glass dentifrice showed significant difference between other groups at all time points.	Bioactive glass dentifrice reduced sensitivity significantly more than the other two groups at two and four weeks
3.	*Litkowski et al.* [20]	_	Significant difference between 7.5% group and placebo at all times. A significant difference between 2.5% and 7.5% groups at week eight for air stimulus	Significant difference between 7.5% group and placebo at all times. 7.5% bioactive glass was significantly better than 2.5% at 8 week.
4.	*Narongdej et al.* [21]	Group I showed significant difference than other two groups at all time points.	_	Group 1 showed significant improvement compared with groups 2 and 3, except for response to tactile stimulus at four weeks with group 2.
5.	*Pradeep et al.* [22]	Bioactive glass dentifrice reduced sensitivity significantly more than the others at all time points.	Bioactive glass dentifrice reduced sensitivity significantly more than the others at all time points.	_
6.	*DU et al.* [23]	Bioactive glass dentifrice was more effective at reducing sensitivity compared with other two dentifrices.	Bioactive glass dentifrice was more effective at reducing sensitivity compared with other two dentifrices at 6 weeks.	_

frice by application of a tactile stimulus[19, 20, 21]. *Litkowski et al.*[20] and *Narongdej et al.*[21] used 40g of force applied using Yeaple probe and explorer respectively for tactile stimuli assessment whereas *Salian et al.*[19] used explorer for tactile stimuli assessment.

In *Salian et al.*[19], bioactive glass group was significantly better at all time points when compared to other dentifrices**.** *Litkowski et al.*[20] observed that there was a significant difference between 7.5% and 2.5% bioactive glass group at 8 weeks whereas there was no significant difference between 2.5% bioactive glass group and placebo at any time points. In *Narongdej et al.*[21] Novamin powder with Novamin containing toothpaste showed significant difference between other groups at all time points, except the fourth week (Table-5, 6).

DISCUSSION:

Mostly systematic reviews perform a meta-analysis, which involves the statistical pooling of data from individual studies when the studies are similar. A meta-analysis can yield a more precise overall estimate of the treatment effect. However, meta-analysis may not be appropriate in many situations. Owing to the heterogeneity among the studies such as different dosages of bioactive glass and follow-up periods, we were not able to perform a meta-analysis to summarize the data of included studies. Hence, a descriptive evaluation of data has been provided.

Systematic review should be based on randomized clinical trials because this follows robust design and gives more precise conclusion. In our systematic review, all the included articles were randomized controlled clinical trials (level of evidence – 2). But out of the six included articles, three trials[19, 20, 21] have high risk of bias and two trials[18, 23] have moderate risk of bias. Out of six included studies two are 'pilot studies' [17] or 'proof of principle' studies[20]. This implies that results should be interpreted with caution.

Bioactive glass showed significant improvement from baseline and also showed significant improvements at all time points when compared with placebo/negative control. With the use of bioactive glass, the percentage reduction of sensitivity scores ranging from 18 to 50% at early visits and 30 to 75% reduction after six to eight weeks. Long term follow up (12 weeks) revealed 91% percentage reduction of sensitivity from baseline. Bioactive glass performs better than positive control dentifrices such as potassium nitrate, strontium chloride and stannous fluoride. This is because potassium nitrate acts by blocking interdental nerves but potassium ion induced effects are considered to be transient and reversible[22]. Strontium chloride and stannous fluoride act by precipitation of strontium or tin/flouride on dentin surface and occlude the tubules. Superior efficacy of bioactive glass in comparison to the positive control dentifrices is attributed to its mechanism of action which involves formation of hydroxycarbonate apatite layer that occludes the dentin tubules. This layer is similar or equivalent to the apatite crystals in enamel and dentin[21].

In vitro studies confirm that bioactive glass concentration of 5% or higher are needed for effective action[24]. In all the included trials, 5% and 7.5% bioactive glass perform better. However the comparatively poorer performance of 2.5% concentration may be due to the lesser availability of bioactive glass in this formulation which in turn may not be high enough to maintain the therapeutic range needed to be effective for occlusion of tubules[20].

Even though bioactive glass shows significant difference at 4 to 8 weeks with other compared dentifrices, long term follow up at 12 weeks shows no significant difference with other dentifrices for air stimulus assessment. This may be due to a floor effect; that is at 12 weeks the other products shows similar reductions with no room on the measurement scale to show further improvement[18].

INFERENCE:

Implications for practice:

Dentifrices containing bioactive glass can be used in the treatment of dentin hypersensitivity because it performed better than other compared dentifrices. However, professionals should be aware of the fact that the evidence generated by this review is based on small number of subjects and the effect also varies with methods applied for assessing the sensitivity.

Implications for research:

Further studies must be performed with standard study procedures and larger or adequate sample size to give concrete evidence on the effectiveness of dentifrice containing bioactive glass. Furthermore, there is a need for evaluation of longer observation periods, say a follow up of at least 12 weeks.

CONCLUSION

With the available evidence, this review concludes the following:

1. The availability of limited number of studies and the multiplicity of comparators amongst studies makes it difficult for the authors to draw hard and fast conclusions.
2. Data available suggests that dentifrices with bioactive glass shows significant improvement compared to the baseline status and probably also versus a negative control. But data is severely limited versus other positive dentifrice controls.
3. Available dose response data is limited, but suggests that 5% and 7.5% bioactive glass may be optimal. Further studies are needed for confirmation in this regard.
4. The "immediate effects" with bioactive glass powder may be promising, but further studies are required to confirm.
5. Available data shows that dentifrices containing bioactive glass cause minimal treatment related adverse reactions and therefore they are well tolerated.

Even though all the studies included in this review have high level of evidence, three studies have high risk of bias and two studies have

moderate risk of bias. Therefore, properly designed randomized controlled studies with long term follow up must be performed to give concrete evidence on the long term effectiveness of dentifrice containing bioactive glass.

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