Australian Dental Journal
The official journal of the Australian Dental Association

SCIENTIFIC ARTICLE

Australian Dental Journal 2012; 57: 308–311

doi: 10.1111/j.1834-7819.2012.01700.x

Clinical evaluation of diamine silver fluoride/potassium iodide as a dentine desensitizing agent. A pilot study

GG Craig,* GM Knight,† JM McIntyre‡

*Dental Outlook, Camperdown, New South Wales.
†Private Practice, Brighton, Victoria.
‡Colgate Australian Clinical Dental Research Centre, School of Dentistry, The University of Adelaide, South Australia.

ABSTRACT

Background: The aim of the present study was to compare the efficacy of an experimental diamine silver fluoride/potassium iodide product with an oxalic acid-based preparation in reducing dentine hypersensitivity.
Methods: The study was conducted as a double-blind, randomized clinical trial. A total of 19 subjects with dentine hypersensitivity on both sides of their upper arch were selected. The most sensitive tooth in each quadrant was identified and received a cold stimulus. The response was recorded on a visual analogue scale (VAS). The tooth thus selected was treated with one of the treatment agents. One week later the level of dentine sensitivity was assessed. Participants were also asked for their subjective assessment of treatment effects.
Results: The mean difference between VAS at baseline and seven days for teeth treated with diamine silver fluoride/potassium iodide was greater than that for teeth treated with the oxalic acid-based preparation ($p = 0.0134$). The subjects' subjective assessment of changes in dentine hypersensitivity indicated that more obtained relief with the diamine silver fluoride/potassium iodide treatment ($p = 0.0129$).
Conclusions: It was concluded that an experimental diamine silver fluoride/potassium iodide product has potential as a treatment for dentine hypersensitivity.

Keywords: Clinical trial, dentine hypersensitivity, diamine silver fluoride, oxalates.

Abbreviations and acronyms: NSAIDS = non-steroidal anti-inflammatory drugs; VAS = visual analogue scale.

(Accepted for publication 14 November 2011.)

INTRODUCTION

Dentine hypersensitivity may occur on any exposed dentine surface. It is characterized by varying degrees of pain that can be initiated by thermal, evaporative, tactile, chemical or osmotic stimuli. The most accepted theory is that these stimuli can cause a displacement of the fluid in the dentinal tubules, either in the inward or the outward direction, and this mechanical disturbance activates intrapulpal nerve endings.[1,2]

According to a recent survey of Australian dentists, the problem of dentine hypersensitivity is most common in the 30–49 year age group.[3]

A number of different approaches have been used to alleviate dentine hypersensitivity. These include the use of corticosteroids, preparations that will depolarize nerve endings, protein precipitants, tubule occluding agents and tubule sealants.[4]

Oxalate-containing products are amongst the group of recognized tubule-occluding agents.[4] Various fluoride preparations have also been shown to reduce dentine permeability.[4]

An *in vitro* study showed that dentine permeability could be reduced further if potassium iodide was applied after an application of a fluoride solution: 38% diamine silver fluoride.[5] This suggests a possible role of diamine silver fluoride followed by potassium iodide as a means of blocking dentinal tubules *in vivo* and, in so doing, reducing dentine hypersensitivity.

This study was undertaken to compare the effectiveness of diamine silver fluoride followed by potassium iodide in treating dentine hypersensitivity compared with an oxalic acid-based proprietary product, designed for the same purpose.

METHODS

Participants

Volunteers in good general health were screened for the study. To be eligible participants were required to have

equal tooth sensitivity to cold stimuli on both sides of their upper arch and were not using any type of tooth desensitizer for one month prior to the study. No attempt was made at this screening stage to quantify the degree of tooth sensitivity. Excluded from the study were those with active caries or gingival inflammation and vital teeth which had been recently restored or had signs of pulpitis. Individuals taking prescription medication, non-steroidal anti-inflammatory drugs (NSAIDS), aspirin and pregnant or lactating females were also excluded.

The aims of the study and clinical protocols were explained to all participants and signed consent was received by each participant prior to commencement of the study. The clinical protocol was approved by the University of Adelaide Ethics Committee (Project Number: H-027-2011) prior to commencement of the study.

Study design

This study was conducted as a double-blind randomized clinical trial with a split-mouth design where a selected tooth on one side of the upper arch received one treatment and a selected tooth on the contralateral side received another. Assessments of sensitivity were made by one investigator, assignments of treatments were made by coin toss by a third party and the application of treatment agents was carried out by another investigator. Neither investigator was aware of the activities of the other.

Details of treatments and results were only released upon the completion of the sensitivity assessment at the end of the study.

Treatment agents

The treatment agents were an experimental silver fluoride/potassium iodide product (SDI Limited, Melbourne, Australia) which contains 38% (w/v) diamine silver fluoride and a saturated solution of potassium iodide and an oxalic acid-based product (SuperSeal, Phoenix Dental Inc, Fenton, MI, USA) which contains oxalic acid, potassium salt and water.

Procedure

At the commencement of the study, subjects were seated in a dental chair set up using recognized infection control guidelines for a dental examination. The most sensitive tooth in each quadrant was identified by a brief one-second application of a cold cotton bud that had been sprayed at a distance of 5 cm for 10 seconds with a cooling spray (Miracold Plus, Hagerwerken, Duisburg, Germany). The tooth thus identified then received a three-second application of a new, freshly cooled cotton bud. The subject was asked to record his or her response on a visual analogue scale (VAS) graded from 1 to 10.

After the initial VAS measurement, participants were seated in one operatory in a dental chair set up for a dental inspection using recognized infection control guidelines. A second dentist, in a separate operatory in the same location, applied AgF/KI to the relevant tooth in one quadrant and potassium oxalate to the relevant tooth in the other as dictated by the random allocation.

After isolating a quadrant with cotton rolls, the area to be treated was gently dried with air from a triplex syringe and the allocated preparation was applied with a disposable microbrush. The oxalic acid-based preparation was applied and then gently dried according to the manufacturer's directions. Silver fluoride was applied and followed immediately with application of potassium iodide in accordance with the manufacturer's directions. The area was then gently dried until no moisture was visible.

Clinical digital photographs of teeth and gingivae were taken prior to application of the preparations.

After treatment, the participants were dismissed with instructions to avoid food or drink for one hour and were given contact information should they experience any discomfort from the application of the desensitizing agents. Each participant was contacted by phone 24 hours later to determine if there had been any post-application discomfort.

The participants were recalled one week later and the VAS recorded after application of the cold stimulus on the same teeth that were initially tested. Participants were further asked which side of their mouths they felt gave them the most relief from the treatment and if they had experienced any post-application discomfort from either of the treatments.

Clinical photographs were then taken of each quadrant before the patient was dismissed.

Statistical analysis

Analysis of the differences in VAS between baseline and seven days was performed using a paired samples *t*-test with the SAS Statistical Package (SAS Institute, Cary, NC, USA). The sign test for the subjects' subjective assessment of sensitivity changes was performed using GraphPad Software (GraphPad Software, La Jolla, CA, USA).

RESULTS

A total of 19 adults (11 females and 8 males) met the criteria for inclusion in the study. Their mean age was 38.7 years (range 23 to 60 years).

Table 1 shows the mean VAS for treated teeth at baseline and after seven days and the mean difference in

Table 1. The mean difference between VAS at baseline and 7 days for treated teeth

	Treatment (no. of subjects = 19)			
	DSF/KI† (no. teeth treated = 19)		OA‡ (no. teeth treated = 19)	
	Mean VAS	SD	Mean VAS	SD
Baseline	7.54	1.54	6.87	1.93
7 days	5.83	2.08	6.18	2.16
Change	−1.71	1.62	−0.69	1.55

†DSF/KI = diamine silver fluoride/potassium iodide product.
‡OA = oxalic acid-based preparation.

Table 2. Analysis of VAS change over 7 days between treatment modalities

N	Mean difference	Standard error	Lower 95% CI	Upper 95% CI	DF	*t*-value	*p*-value
19	1.0105	0.3686	0.2362	1.7849	18	2.74	0.0134

Table 3. Participants subjective assessment of changes over 7 days

Preference	No. of patients
DSF/KI† better than OA‡	12
OA better than DSF/KI	2
No difference	5

†DSF/KI = diamine silver fluoride/potassium iodide product.
‡OA = oxalic acid-based preparation.
Sign test: Two-tail *p*-value = 0.0129.

VAS between the two intervals. At baseline there was no significant difference in mean VAS between the 19 teeth treated with diamine silver fluoride/potassium iodide and the corresponding number of teeth treated with the oxalic acid-based preparation (7.54 vs. 6.87, p = 0.191).

The mean difference between VAS at baseline and seven days for teeth treated with diamine silver fluoride/potassium iodide was −1.71 compared to −0.69 for teeth treated with the oxalic acid-based preparation. Table 2 shows that this difference was statistically significant (p = 0.0134).

Presented in Table 3 are the results of the non-parametric sign test based on the patients' subjective assessment of changes in dentine hypersensitivity over seven days.

The number of subjects obtaining greater relief with the diamine silver fluoride/potassium iodide treatment was significantly greater (p = 0.0129) than those who obtained relief with the other treatment.

The before and after clinical photographs of each quadrant showed that there were no observable changes in inflammation or other changes in the gingival tissues and no staining was observed on any of the teeth.

Of the 19 subjects that were contacted regarding changes in gingival sensitivity 24 hours after treatment, 11 reported a transient change that ranged from a mild sensitivity to slight tingling of the gingivae. These observations were all associated with the quadrants where diamine silver fluoride/potassium iodide had been applied.

DISCUSSION

The quantitative data presented in Table 1 show that the treatment with diamine silver fluoride/potassium iodide produced a significantly larger reduction in dentine hypersensitivity (p = 0.0134) than experienced when the oxalic acid-based preparation was used.

These findings are supported by the subjective assessment of improvement given by subjects in the study as shown in Table 3 where the two-tail *p*-value was 0.0129.

Why the oxalic acid-based product failed to show a significant reduction in dentine hypersensitivity in this study is not known. Oxalic acid has a pH of around 2.3 and has been shown to be acidic enough to etch dentine, liberate calcium ions and form calcium oxalate crystals.[6,7] Although these crystals can occlude open dentinal tubules they may not persist due to dislodgement and a gradual solubilization in oral fluids.[8] Whether this occurred in the current study and any initial desensitizing effect was lost over the seven days of the trial is not known. These findings are in contrast with those of an earlier four-week study where it was found that SuperSeal was effective in reducing cervical hypersensitivity and was equivalent to the effect seen with a varnish containing 5% sodium fluoride.[9]

There are a number of constituents in the diamine silver fluoride/potassium iodide preparations that could have contributed to the significant reduction in dentine hypersensitivity observed in this study. Silver ions can precipitate proteins in the dentinal tubules and have a long history of use as a dentine desensitizing agent.[10] Fluoride ions can react with free calcium ions to form deposits of calcium fluoride that can block dentinal tubules.[11] Also, the formation of silver iodide from the reaction between diamine silver fluoride and potassium iodide may have been sufficient to contribute further to a reduction in dentine tubule patency.

Recently, a Peruvian study showed that an application of diamine silver fluoride alone can reduce dentine hypersensitivity.[12] Whilst direct comparisons with the present study are not valid because of the different protocols followed, the findings regarding the effect of diamine silver fluoride on gingival tissues are of interest. In that study a small number of participants experienced a mild but transient increase in erythema in gingiva near the treated tooth. In this study, any sensitivity experienced after application was

minor and transient, and there were no adverse side effects to gingival tissues or staining of teeth surfaces observed.

Other clinical studies have shown that diamine silver fluoride is free of adverse side effects after applications over extended periods.[13–15]

The current results confirm the short-term effects of a diamine silver fluoride/potassium iodide treatment on dentinal hypersensitivity.

ACKNOWLEDGEMENTS

The authors thank Thomas Sullivan of the Data Management and Analysis Centre (Discipline of Public Health, The University of Adelaide, South Australia) for his statistical analysis of the data. This study was partially funded by Southern Dental Industries, Bayswater, Victoria.

DISCLOSURE

Two of the authors (GGC and GMK) are named on a process patent for the application of silver fluoride followed by potassium iodide.

REFERENCES

1. Brannstrom M, Astrom A. The hydrodynamics of the dentine: its possible relationship to dental pain. Int J Dent 1972;2:219–227.
2. Markowitz K, Pashley DH. Discovering new treatments for sensitive teeth: the long path from biology to therapy. J Oral Rehabil 2008;35:300–315.
3. Amarasena N, Spencer J, Ou Y, Brennan D. Dentine hypersensitivity – Australian dentists' perspective. Aust Dent J 2010;55:181–187.
4. Parolia A, Kundabala M, Mohan M. Management of dentinal hypersensitivity: a review. J Calif Dent Assoc 2011;39:167–179.
5. Knight GM, McIntyre JM, Craig GG, Mulyani, Zilm PS, Gully NJ. An in vitro model to measure the effect of a silver fluoride and potassium iodide treatment on the permeability of demineralized dentine to Streptococcus mutans. Aust Dent J 2005;50:242–245.
6. Kerns DG, Scheidt MJ, Pashley DH, Horner JA, Strong SL, Van Dyke TE. Dentinal tubule occlusion and root hypersensitivity. J Periodontol 1991;62:421–428.
7. Gillam DG, Mordan NJ, Sinodinou AD, Tang JY, Knowles JC, Gibson IR. The effects of oxalate-containing products on the exposed dentine surface: an SEM investigation. J Oral Rehabil 2001;28:1037–1044.
8. Gillam DG, Khan N, Mordan NJ, Barber PM. Scanning electron microscopy (SEM) investigation of selected desensitizing agents in the dentine disc model. Endod Dent Traumatol 1999;15:198–204.
9. Merika K, Heftit AF, Preshaw PM. Comparison of two topical treatments for dentine sensitivity. Eur J Prosthodont Restor Dent 2006;14:38–41.
10. Greenhill JD, Pashley DH. The effects of desensitizing agents on the hydraulic conductance of human dentin in vitro. J Dent Res 1981;60:686–698.
11. Thrash WJ, Jones DL, Dodds WJ. Effect of a fluoride solution on dentinal hypersensitivity. Am J Dent 1992;5:299–302.
12. Castillo JL, Rivera S, Aparicio T, *et al*. The short-term effects of diammine silver fluoride on tooth sensitivity: a randomized controlled trial. J Dent Res 2011;90:203–208.
13. Chu CH, Lo EC, Lin HC. Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese pre-school children. J Dent Res 2002;81:767–770.
14. Llodra JC, Rodriguez A, Ferrer B, Mendardia V, Ramos T, Morato M. Efficiency of silver diamine fluoride for caries reduction in primary teeth and permanent first molars of school children: 36 month clinical trial. J Dent Res 2005;84:721–724.
15. Tan HP, Loe EC, Dyson JE, Luo Y, Corbet EF. A randomized clinical trial on root caries in elders. J Dent Res 2010;89:1086–1090.

Address for correspondence:
Dr Graham G Craig
PO Box 275
Camperdown NSW 1450
Email: dentaloutlook@bigpond.com