ABSTRACT

An alternate technique of care to prevent, arrest and manage root caries using aqueous silver fluoride followed by stannous fluoride (AgF+SnF₃) in aged care is demonstrated by three case studies. With increasing age, the inability to maintain own oral care from dementia, illness or frailty and polypharmacy induced salivary gland hypofunction will result in dental caries becoming a progressively greater burden for the elderly. Future generations of elders will live longer and need to maintain many more teeth longer than earlier generations. Both silver diamine fluoride (SDF) and AgF+SnF₃ arrest and prevent caries and are easy to use in residential aged care facilities. Clinical differences between SDF and AgF+SnF₃ are discussed. However, in aged care, AgF+SnF₃ may offer advantages over SDF. AgF+SnF₃ used to arrest and prevent caries in children can be modified to provide effective but minimally invasive care for an ageing and frail population. These techniques are rapid, inexpensive and nonthreatening suited to treat frail elders, dementia patients exhibiting challenging behaviours and patients with multiple rapidly progressing decay. Silver fluoride, applied before placing glass-ionomer cement (GIC) restorations is an important adjunct to the atraumatic restorative technique and may retard caries reactivation more than GIC used alone.

KEY WORDS: silver fluorides, silver fluoride with stannous fluoride, root caries, arrest, prevention, dementia, aged care, minimally invasive

An alternate technique of care using silver fluoride followed by stannous fluoride in the management of root caries in aged care

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Background

Australia has an aging dentate population. Future generations will live much longer, have greater numbers suffering dementia and frailty and will retain and need to maintain many more teeth longer than any other earlier generation.¹ ²

A study involving 243 residents (mean age 83) from 19 Melbourne residential aged care facilities found a prevalence of 67.9% untreated coronal caries and 77.4% untreated root caries.³ In 2011, Australians diagnosed with dementia was 9% for those aged 65, more than 30% for those older than 85 years and is expected to triple by 2050.⁴

Elefon found people with Alzheimer’s disease had significantly higher root caries than those without dementia (mean 7.8 vs. 2.7).⁵ The relationship between oral health and systemic health, particularly aspirational pneumonia is well established.⁶ ⁷ Future generations of elderly will have a greater impact on medical, dental and community services as the absolute numbers of inadequately maintained mouths increases. Both developed and developing countries face a similar demographic challenges.⁸ ⁹

Strategies such as rescuing, distraction, bridging, chaining, busy boards and a familiar face can help manage older patients with cognitive impairment- or anxiety-related conditions when attempting dental interventions.¹⁰ ¹¹

However, these strategies are more suited to preventive interventions, such as assisted tooth brushing able to be stopped at any time without the likelihood of causing harm. Often early less complicated dental conditions are not treated if there is a possibility of having to abandon treatment mid-way through a procedure. These conditions are often left until an acute episode forces more invasive treatment later. This undesirable situation emphasises the need for a simple, effective form of preventive treatment implemented at an earlier stage.

Topical application of SDF or AgF+SnF₃ has the advantage of being a low-cost method with the potential of controlling dental caries involving minimal patient cooperation. The intervention does not require complex training and may have the potential to prevent and arrest caries in all teeth and all surfaces.¹² ¹³

Topical applications are rapid, nonthreatening and suitable for treating frail elders, patients with dementia exhibiting challenging behaviors and patients with multiple rapidly progressing decaying teeth. The use of silver fluorides require
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Figure 1. Inadvertent SDF chemical burn while using SDF+KI. First application of KI forms a white precipitate.

minimal equipment and can be easily used in RACFs. Silver fluorides, particularly AgF+SnF₂, provides an appropriate end of life palliative bedside management of dental caries in seriously ill individuals.

Clinical studies using silver fluoride preparations

To date the silver fluoride preparations used in clinical studies are either ammonia-based silver diamine fluoride (SDF) or water-based 40% silver fluoride (AgF).

Ammonia-based 38% silver diamine fluoride (SDF)

Several randomized clinical trials have shown topical SDF to be effective in arresting dental caries in high-risk children and preventing root-surface caries in high-risk adults.

In a randomized control study of institutionalised elders over a 3-year period, Tan et al. applied topical 38% SDF yearly in conjunction with individualized oral hygiene instruction (OHI) and found SDF had a greater effect on preventing root caries than applications of 1% chlorhexidine varnish 3 monthly and OHI, or 3 monthly applications of 5% sodium fluoride varnish and OHI alone.

Silver diamine fluoride followed by potassium iodide (SDF+KI) has been proposed as a means of reducing staining from silver salts by forming silver iodide, a creamy white precipitate (see Figure 1). However, the only clinical trial to date has been its use in reducing cervical hypersensitivity.

Literature reviews by Rosenblatt et al., Peng et al., and Fung et al. confirm that SDF has been used more widely than other silver fluoride-based preparations.

Only one study was found comparing the effectiveness of SDF and AgF+SnF₂ directly. An in vitro study by Klein compared four anticaries agents AgF+SnF₂, SDF, silver nitrate and chlorhexidine and found AgF+SnF₂ the most effective at slowing artificial lesion depth progression.

Water-based 40% silver fluoride followed by 10% stannous fluoride (AgF+SnF₂)

Clinical evaluations of topical applications of water-based 40% silver fluoride followed by 10% stannous fluoride, used as a reducing agent, are limited to a few Australian cohort studies in children from the 1980s.

In a 1981 cohort study, topical AgF+SnF₂ was applied by Craig et al. to carious deciduous teeth in rural NSW in a minimal intervention study. After 2 years, 74% of the carious approximal surfaces and 90% of the carious occlusal surfaces remained unchanged. Topical AgF+SnF₂ has been shown to be effective in preventing pit and fissure caries in permanent first molars.

Green compared caries rates of children in one school treated with topical AgF+SnF₂ (2.9% new lesions) to children in a second school treated with SnF₂ (11.7% new lesions) over an 18-month period.

McDonald and Sheiham used AgF+SnF₂ on open carious lesions in a split-mouth approach applying either SnF₂, AgF+SnF₂ or no topical treatment onto minimally prepared lesions before placing composite restorations to randomly selected teeth. At 18 months, caries progression was 5% for lesions treated with AgF+SnF₂ plus composite compared to 11% for those restored with composite only. In contrast, unrestored lesions left open had caries progression of 46% where SnF₂ was used alone and 27% where AgF+SnF₂ used alone. (Note: this study has been incorrectly reported as using SDF when AgF+SnF₂ was actually used: private correspondence.)

Gotjamanos found favourable pulpal response in carious primary teeth when residual caries in deep lesions were treated with AgF and covered with GIC. Modifying AgF+SnF₂ techniques used in children’s dentistry may open a new approach in treating the elderly with minimally invasive clinically effective interventions.

Development of silver fluoride techniques suited to aged care

Some initial assessments by the author using various silver fluoride techniques were made to determine suitability for use in RACFs.

SDF alone

SDF is a clear liquid and readily runs off treated tooth surfaces. Several studies in children report SDF may cause gingival/mucosal irritation or a mild burn which heals spontaneously within 48 hours. This effect may be greater in older people with thinner biotype and when used over large areas if treating multiple carious teeth. Most studies recommend using SDF once a year to prevent caries. The author has found that caries may reactivate within the year if salivary function and oral hygiene is poor.

In the author’s opinion SDF less suited for “ringbark caries” or “rampant decay” situations where applications to multiple teeth may cause a gingival burn over a large area (see Figure 1).
SDF followed by potassium iodide (SDF+KI)

Potassium iodide is a clear liquid and can be applied after SDF to help reduce staining from silver salts. SDF is applied using a microbrush followed immediately by multiple applications of KI. The first application of KI forms a white precipitate (see Figure 1) and clears with subsequent KI applications leaving a surface able to accept GIC. Lesions should be restored with GIC restoration immediately after treatment which may however may slowly discolor over time.

SDF+KI may be more suited to treating aesthetically visible smaller lesions with distinct peripheral boarders as sound tooth structure is required for glass ionomer cement (GIC) bonding.

Silver fluoride with stannous fluoride (AgF+SnF2)

Aqueous 40% AgF and 10% SnF2 (Creighton Dental, NSW Australia) are both clear liquids. The major advantage of AgF+SnF2 over SDF is that AgF+SnF2 does not cause gingival/mucosal irritation, can be used over a wide area without causing discomfort, can be used on a 3 to 4 monthly basis in nonesthetic areas to prevent, arrest and manage single or multiple carious lesions in the elderly. AgF is best applied topically to a clean dry surface for 1 to 3 minutes followed by SnF2 which together causes an instant black surface precipitate. The precipitate is temporary on noncarious surfaces and can be polished away or simply left to wear away over a couple of days where cooperation is limited. Prior to treatment, patients and carers need to be advised that treated decay will remain permanently black and if need be, can be masked cosmetically with high-viscosity GIC. This effect is more likely to occur if the lesion is open and exposed to saliva. Patients with better salivary function will have better results and can be left unrestored for a longer period. Treated surfaces are restored later with a high-viscosity GIC without the need for hand or rotary excavation or may be simply left and monitored for possible reactivation.

In aged care, AgF+SnF2 is an ideal method of caries control allowing management of multiple rapidly progressing carious lesions in different quadrants of the mouth. The author has found it is possible and preferable to arrest all caries at the patient’s first visit and allow time for treated soft caries to fall away. Chairside time at subsequent visits is greatly reduced as often the only preparation required is to clean the tooth with interproximal brushes and apply dentine conditioner. Multiple GIC restorations can be rapidly and more easily placed without preparation, minimizing stress to the patient. Where proposed treatment is complex or when consent is problematic, this delay allows time to plan treatment, consult with the patient, family and medical colleagues. The technique has very high patient acceptance and can achieve reasonable esthetic results by later masking black surfaces with GIC.

All images below (except Figure 3E) show lesions after plaque covering these surfaces had been removed using a slurry of pumice on interproximal micro-brushes.

Case presentation 1. AgF+SnF2 -Delayed Restorative Technique

Fearful, male aged 82 years, RACF resident diagnosed with dementia, obsessive compulsive disorders, benzodiazepem dependance, Parkinosns, depression, hypertension, urinary and facial incontinence and treated with polypharmacy (14 different medications). The patient has reduced mobility, limited ability to cooperate, accepts limited physical contact, exhibits challenging behaviours and is likely to exit the dental chair without warning if threatened. Figure 2(A) shows a large open carious lesion on the mesial aspect of tooth 14 extending subgingivally with no adjacent tooth.

Treatment objectives and purpose:

- Arrest caries; use a minimally invasive rapid procedure with no hand or rotary evacuation; limit physical contact to minimise the risk of challenging behaviours; delay placing a restoration to allow caries to fall away; place GIC restoration at subsequent appointment.

Treatment: Figure 2(B) shows application of AgF+SnF2. Operator contact involved a 2-second application of 40% AgF with a wetted microbrush left for 2 minutes, followed by a 2-second application of 10% SnF2 left for 1 minute. The patient remained in the dental chair for a further 1 to 2 minutes without any further operator contact. The total operator contact time was about 6 seconds in a 4- to 5-minute procedure. Chairtime could be further reduced if the patient seemed threatened or stressed.
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Figure 2(C): five weeks after application; treated soft carious tooth structure had fallen away leaving a typical hard matte black surface. Soft tissue health has improved with some retraction of the gingiva. Figure 2(D): hand moulded high-viscosity GIC (Fuji 9) was placed in a 2- to 3-minute procedure after treated surface was cleaned and dentine conditioned (Fuji Conditioner).

Result
Minimal operator contact, no hand excavation or rotary preparation, arrest of caries with effectively a chemical cavity preparation and without rotary GIC finishing.

Case presentation 2. AgF+SnF2-definitive treatment with regular monitoring
AgF+SnF2-definitive treatment with regular monitoring: Competent, cooperative female RACF resident now aged 93 years suffering from depression and anxiety, macular degeneration, hypertension, unsteady gait and on polypharmacy (12 to 15 medications). The patient was treated 4.5 years earlier when aged 89 years in a RACF dental clinic. At that time multiple early caries and demineralized lesions affecting lower anterior lingual root surfaces under her denture were evident. At her initial visit, the patient was assessed as having good salivary function, was shown how to better brush this area, a high-fluoride toothpaste was prescribed and the patient advised to leave her denture out at night. AgF+SnF2 was applied without hand or rotary preparation and the patient was to be recalled on a 4-monthly basis but failed to re-attend.

Treatment objectives and purpose:
definitive treatment with regular monitoring

Figure 3(A): the patient returned after 2.7 years with relatively minimal caries reactivation despite wearing her denture over night and not using high-fluoride toothpaste. Figure 3(B): AgF+SnF2 reapplied for the second time. Thereafter, AgF+SnF2 was applied within the RACF every 4 months. Figure 3(C) shows the appearance of the lesions at 3.7 years. Figure 3(D): no anterior esthetic deficiency evident despite multiple applications of AgF+SnF2 after 3.7 years. Figure 3(E) shows plaque accumulation on lingual surfaces at 4.5 years and typical of the limited plaque control over the previous 3 years. Figure 3(F) shows the appearance of the cleaned treated lesions and gingival tissues at 4.5 years.

Results and treatment considerations:
It is unlikely that multiple GIC restorations, if placed 4.5 years earlier, would have performed as well as AgF+SnF2. The likelihood of GIC dissolution under a denture would be high requiring regular maintenance that may not be possible in a RACF and would be a recurring additional cost.

Case presentation 3
AgF+SnF-palliative care: Same patient as in case presentation 1 following a deterioration in his physical and cognitive capacities. Figure 4(A): the patient is now unable to maintain his own oral hygiene and wears an overlay denture covering six carious anterior root stumps. No satisfactory treatment options were available due to poor patient cooperation making any
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Successful attempt at sealing root stumps unlikely while extractions would probably involve a general anesthetic.

Treatment objectives and purpose: palliative care.

Figure 4(A) shows the appearance of the overdentures. Figure 4(B) shows six lower carious anterior root stumps. Figure 4(C) shows first application of AgF+SnF$_2$. Figure 4(D) shows clinical appearance at 4 months. Caries had arrested, however the intensity of the black matte surface was not uniform. Figure 4(E): at 7.5 months, repeated 3 monthly application results in an increased intensity of the black matte colour. Figure 4(F) shows the appearance 1.5 years after the first AgF+SnF$_2$ application. Oral hygiene was now very poor, gingival health had deteriorated, gingival hyperplasia present with no active decay. Calculus formation over the treated root stumps was an unexpected finding.

Results

Arrested carious roots have now been maintained for over 2.5 years, however cooperation for further photographs is now lacking.

Discussion

In the author’s hands, clinical results after topical applications of AgF+SnF$_2$ may vary. Carious lesion shape, location and salivary function are important parameters in understanding and selecting the appropriate AgF+SnF$_2$ technique and effectiveness over time.

Open lesions

Open lesions are saucer shaped with the periphery of the lesion wider than their base (see Figure 5A). Open lesions usually occur on buccal, lingual and proximal surfaces where there is a space between the next adjacent tooth. Open lesions generally require minimal or no hand or rotary excavation and have the most effective, consistent and predictable arrest of caries results. This response is better where there is better salivary function (see also Figure 5A and case presentation 1).

Closed lesions

Closed lesions have their periphery narrower than their base and are “c” shaped in cross-section (Figures 5B and C). Closed lesions do not respond as well as open lesions and generally require some hand or rotary excavation to allow greater penetration of the AgF+SnF$_2$.

An open lesion located interproximally near other adjacent teeth will generally behave as a closed lesion and have a poorer potential to arrest caries progression due to plaque and debris filling interproximal spaces limiting salivary flow into the area. These lesions respond better with some hand excavation prior topical application of AgF+SnF$_2$.

Subgingival lesions

Subgingival lesions may respond as open or closed lesions depending on the extent and type of gingival coverage. Root caries near gingival margins may progress subgingivally or inflammatory gingival tissues may overgrow into a lesion. Lesions progressing subgingivally act as closed lesions and require more hand excavation prior to topical AgF+SnF$_2$ application. Gingival tissues
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Summary

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<th>AgF + SnF₂</th>
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<td>Location of lesion</td>
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<td>Nonesthetic areas, elderly may accept compromise anteriorly</td>
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<td>No yes, if gingival burn</td>
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High-viscosity GIC due to its ability to adhere to contaminated tooth structure, remineralise tooth surfaces and slow caries progression. The disadvantage of GIC is its susceptibility to dissolution under prolonged acid challenge and dehydration. Unfortunately, both these conditions are commonly found in frail older people where poor oral hygiene, increased frequency of eating sweet foods and polypharmacy induced salivary gland hypofunction is common. AgF techniques are an important adjunct to ART particularly suited where fearful patients show resistance to hand excavation or physical contact. In the author’s opinion, AgF+SnF₂ applied before GIC, appears to retard caries reactivation more than if GIC was used alone (see case presentation 3).

Conclusion

The incidence of caries will progressively rise as the absolute numbers of elders grow with each future generation. Many will be unable to maintain their own oral health yet need to maintain their oral health longer simply because they will live longer. New methods of delivering treatment and preventive care need to be developed tailored for the elderly living in RACF and in the community. There is an urgent need for clinical trials, including trials on AgF techniques and how to best deliver this care. Both SDF and AgF+SnF₂ can arrest and prevent caries in the elderly, however AgF+SnF₂ has advantages over SDF in that it can be applied more frequently over a wider area without causing discomfort. Delaying restoration of treated lesions allows further development of new minimal intervention techniques. The use of AgF+SnF₂ shows promise as an alternative technique in the prevention, management and treatment of caries in the elderly and as an important adjunct to the atraumatic restorative technique.

Disclosure

The author has no conflicts of interest to declare.

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