

SILVER DIAMINE FLUORIDE USE IN Older Adults

THIS AGENT SHOWS PROMISE FOR PREVENTION
AND CARIES ARREST IN GERIATRIC PATIENTS

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EDUCATIONAL OBJECTIVES

After reading this course, the participant should be able to:

1. Explain the indications and contraindications for silver diamine fluoride (SDF), as well as the evidence for its efficacy in treating caries in the roots and crowns of older adults.
2. Safely apply SDF, and supervise auxiliaries applying the agent, and evaluate whether treatment is successful.
3. Discuss the precautions in handling SDF in order to protect patients, staff and the clinic environment.

Older adults are generally more susceptible to tooth decay than younger patients.¹ Medical complexity, physical frailty, psychological barriers and financial limitations commonly challenge caries management in this population. In combination with more older adults retaining their natural dentition, the rapid growth of the 65-and-older cohort is further taxing the U.S. oral health care system. In addition, systemic diseases, such as diabetes, and salivary dysfunction, including Sjögren syndrome and xerostomia (Figure 1), further complicate the clinical picture.¹ Strategies that increase access and improve outcomes for older adults are needed. This paper will address silver diamine fluoride (SDF), an agent that provides U.S. clinicians with an additional treatment modality that can help accomplish these goals.

Data show that a growing number of older adults are visiting the dentist. The percentage of older adults with at least one visit annually increased from 38% in 2000 to 42% in 2011, for example, while visits by adults ages 19 to 64 decreased from a peak of 41% in 2003 to 36% in 2011.² According to data from the U.S. Medical Expenditure Panel Survey, nearly 70% of privately insured older adults sought dental care. This substantially exceeds the rate among privately insured younger adults. Compared to a younger patient, the older adult also presents with more tooth surfaces that are



prone to decay. Although complete tooth loss has dropped to less than half of what it was in the 1950s, gingival recession, untreated decay and periodontal disease are common.³ Root dentin exposed from recession demineralizes at a less acidic pH than enamel, further increasing caries risk. A systematic review noted that 24% of older adults have untreated root caries.⁴ Compounding these issues, today's older adults are much less willing to have compromised teeth extracted than previous generations.¹

The patterns of disease for older adults also vary from those seen in younger individuals. A significant portion of tooth decay is recurrent disease associated with failing restorations. In fact, the majority of tooth decay in older adults is restoration failure at the gingival margin (Figure 2, page 32).⁵ These lesions can be difficult to diagnose and restore.¹ No materials have been shown to provide consistent long-term results, even when they contain and release fluoride. Although glass ionomers provide some benefit over composites in the xerostomic population, new lesions continue to develop.⁶

There is a strong association between general health and oral health, with chronic conditions — and the medications used to manage them — increasing the risk of dental and periodontal problems. In light of the oral/systemic connection, improvements in the oral health of older adults may offer some level of protection against systemic diseases, including pneumonia.³ Clearly, oral health care for older adults would benefit from a noninvasive, safe approach to preventing and arresting caries.

Aqueous silver has been used to treat tooth decay in the U.S. for more than a century. The founders of modern dentistry commonly used silver nitrate. In the last 20 years, dental researchers have more rigorously assessed the efficacy and safety of SDF. In the 1960s, SDF was created as an improvement to silver



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nitrate, and approved by Japan's Ministry of Health. Although widely used in other countries, the first SDF product cleared by the U.S. Food and Drug Administration became available in 2015. This is a colorless topical medicament containing 25% (w/v) silver, 8% ammonia and 5% fluoride.⁷ The silver acts as an antimicrobial, the fluoride promotes remineralization, and the ammonia stabilizes high concentrations in solution.⁸ Application involves drying the surface, and applying sparing amounts of the liquid to the tooth, with no special instructions for post application care. A layer of petroleum jelly can be placed to protect the gingiva prior to application in cervical areas. Treated lesions will discolor to black over the next week (Figure 3, page 32), and the lesions will harden.

To systematically review the evidence, a literature review was designed to search PubMed with the following search terms: "33040-28-7" OR "1Z00ZK3E66" OR "SDF" OR "silver fluoride" OR "silver diammine fluoride" OR "diammine silver fluoride" OR "ammonical silver fluoride" OR "ammonical silver fluoride." The review turned up 12 published randomized clinical trials of at least 12 months duration that evaluated SDF for caries arrest and/or prevention, including studies that addressed root caries and focused on lesions in older adults.^{9,10} Two case studies document profound efficacy for treating severe caries resulting from chemo-radiation-therapy-induced xerostomia.^{11,12}

USE IN OLDER ADULTS

Six large randomized clinical trials demonstrated better caries prevention with SDF than any other noninvasive material except sealants, and nine demonstrated better caries arrest than any other noninvasive material (three studies overlap in evaluating both prevention and arrest).¹³ This material's performance in arresting caries was similar to atraumatic restorative treatment.¹³⁻¹⁵ When applied every six months, SDF arrests 91% of lesions within two years,^{14,16} and no significant benefit is found with excavation of caries prior to placement.¹⁷ Research shows that annual placement of SDF prevents more root caries in older adults than fluoride varnish or chlorhexidine varnish applied four times per year.¹⁰ In addition, more frequent placement appears to be safe and even more effective.^{14,18}

Annual application was shown to provide high preventive effects in two studies of older adults, although another study did not support these results. A recent paper showed preventive rates of 90% after 30 months,¹⁹ while an earlier study showed a 71% preventive rate at three years.¹⁰ A third study, however, reported a preventive rate of 25% after two years.⁹ Additional research is needed in this area.

Repeated application, at least annually, appears to be critical to prevention and arrest. A dose-dependent improvement in effectiveness is seen with more frequent application^{15,18} and higher concentration.^{18,20} A case series with three applications over two weeks showed success in arresting caries, thereby eliminating the need for general anesthesia for an entire large community clinic.²¹ The pattern of a dose-dependent response suggests more frequent applications, depending on caries risk. Similar to a double-strength "loading dose" prescribed at the beginning of antibiotic regimens for difficult infections (e.g., diffuse cellulitis), with severe caries lesions, it is logical to "load" the lesions more frequently at the beginning of treatment. A recent clinical trial of SDF in preschoolers verified a more rapid response from a loading-dose approach.²²

One of the greatest challenges that caries arrest poses is to continue monitoring lesions over years without jumping to operative treatment. The evidence supports patience. Studies show that with semiannual application, 44% of caries are arrested after six months, 61% after 12 months, 81% after

procedure billing code

The Code on Dental Procedures and Nomenclature Code Maintenance Commission has approved Code 1354 for "interim caries arresting medication application." The code definition is for "conservative treatment of an active, nonsymptomatic carious lesion by topical application of a caries arresting or inhibiting medicament and without mechanical removal of sound tooth structure." This is the Health Insurance Portability and Accountability Act standard code for billing purposes.

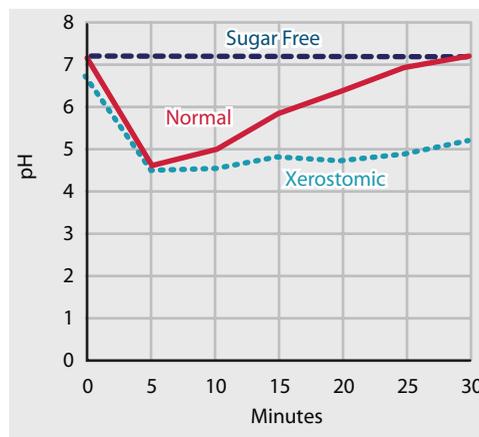


FIGURE 1. A graphic plot of pH in dental plaque after a 60-second rinse with 10% sucrose or sugar-free gum. The pH stays at demineralizing levels in patients with xerostomia for much longer than in patients with normal salivary function. Salivary dysfunction disables the neutralizing response to sugar-driven bacterial acid production, and defines severe risk for dental caries. It is common in older adults due to

physiology, disease, and the use of multiple prescription drugs. This indicates advanced interventions that may include the use of silver diamine fluoride.

18 months, and by 24 months 91% of lesions are arrested.^{14,18} Because some lesions keep growing, however, monitoring progress is critical. It may be best to cover some lesions with a restorative material, such as glass ionomer cement, at a subsequent visit.

METHOD OF ACTION AND INDICATIONS FOR OLDER ADULTS

Upon application of SDF to a decayed surface, silver reacts with bacteria and dentin collagen^{23,24} to create a sclerotic silver-protein layer that is resistant to degradation.²⁵ Hydroxyapatite and fluoroapatite form, along with metallic silver.²⁶ The darkened, treated lesion hardens over a few weeks, while the lesion depth decreases.^{26,27} The silver inhibits bacterial enzymes that break down the organic dentin matrix.^{25,26,28} All caries-causing bacteria are susceptible to the effects of the silver ion.^{24,29,30} The silver stays latent in the lesion, so it is available to kill reinvading bacteria.³¹ Numerous clinicians have reported less plaque near treated teeth, and this has been reproduced in the laboratory.^{32,33} More silver and fluoride soaks into carious or demineralized than sound dentin; as a result,

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FIGURE 2. This image shows treatment of caries at the margin of a gold crown. An exposed root surface at the margin of an otherwise serviceable restoration is an example of a possible off-label indication for treatment with silver diamine fluoride.

treated demineralized dentin is more resistant to caries bacteria.³⁴

Among this patient population, the primary indications for topical treatment with SDF are:

- Disease control for lesions in high-caries-risk patients at the diagnostic visit, regardless of the restorative plan
- Difficult-to-treat caries lesions, such as furcations and crown margins
- Prevention for vulnerable surfaces — for example, gingival margins of compromised restorations, roots exposed from recession, and overdenture or partial denture abutments
- Patients with extreme caries risk (e.g., individuals experiencing xerostomia from cancer treatment or using hyposalivatory medications)
- Individuals who cannot cooperate because of Alzheimer's disease or other forms of dementia, Parkinson's disease, and other neuropsychiatric challenges
- Patients living in nursing homes and other residential facilities with limitations on mobility and/or ability to seek care
- Individuals without insurance benefits and/or living on fixed incomes

In these patients, SDF can be an effective first-stage treatment, and a component of long-term treatment (by continuing application twice per year, or more frequently, as indicated). This may be especially true with older adults who have physical or cognitive limitations that impede oral hygiene, or whose limited mobility poses challenges to oral health.

CLINICAL APPLICATION GUIDELINES

Recently, a team at the University of California, San Francisco School of Dentistry formalized best practices for SDF based on evidence and clinical experience. According to these clinical guidelines,¹³ when a clinician determines that an older adult would benefit from treatment, and without removing restorations or carious dentin, the lesion(s) are gently rinsed, isolated with cotton rolls, air dried, and a fraction of a drop of SDF is applied with a microsp sponge. Dryness of the surface and frequency of reapplication are thought to have the most significant impacts on efficacy. Whether in a distinct cavitated lesion or at the margin of a compromised restoration, the reaction between the material and lesion is protected from saliva for one to three minutes. There may be temporary staining of the gingiva, which resolves over a few days.

Anecdotally, there have been reports of clinicians achieving even better results by covering the treated lesion immediately with a varnish or petroleum



FIGURE 3. Silver diamine fluoride was used to arrest primary and secondary root caries in this older adult. The balding of the tongue and caries resulted from xerostomia. The black, discolored surfaces do not show when speaking or smiling.

jelly without a rinse. As a fluoride product, most states allow placement by dental auxiliaries, facilitating reapplication at recall or in situations in which clinicians are working independently in residential facilities.

Lesions change color within a week as they arrest, and eventually look similar to naturally arrested caries lesions. Upon application, patients will note a metallic taste, which resolves without intervention. Treated lesions harden to gentle probing over the course of a few weeks.

SAFETY CONSIDERATIONS

Cleared for marketing in the U.S. in 2014 and made available the next year, SDF's regulatory parameters parallel that of fluoride varnish, as both are cleared for treating hypersensitivity, but are commonly applied in off-label use for caries management. After approval of SDF in Japan more than 45 years ago, no adverse events have been reported.³⁵ Silver allergy — often confused with nickel allergy — is the only contraindication, but it is rare. Adults can tolerate considerable silver consumption chronically. With reasonable caution to use sparing amounts, this acute fluoride exposure does not present a safety concern.^{36,37}

The relatively high concentration of ammonia appears to be the primary safety consideration. Using microliter volumes that are absorbed mainly into lesions, the cautious clinician will do no harm. If there is a breakdown of the protective barrier formed by gingiva or mucosa, the area should be protected with a thin layer of petroleum jelly. Universal precautions should be followed when using SDF. Topical application to the oral mucosa or skin can leave a temporary tattoo that will disappear without treatment in approximately two weeks.

In addition to darkening caries lesions, SDF can stain countertops and floors, although ammonia-based commercial cleaning agents or simply salt with a little water have been seen to remove stains not cleared by standard clinical disinfectants.

CONCLUSION

Newly available to U.S. clinicians, SDF is an evidence-based technology that offers an effective approach to caring for older adults. Indications include treating caries and recurrent decay, particularly in hard-to-access areas, such as furcations. Its indications as a preventive agent are based on high caries risk, and risk of caries due to the complexities of other therapies.

Cognitive disabilities (such as Alzheimer's disease), physical disabilities (such as Parkinson's disease or multiple sclerosis), and situational challenges (such as a lack of mobility or residing in long-term care facilities) often limit older adults' access to traditional dentistry. The use of SDF provides an alternative treatment modality that is consistent with the principles of caries balance. In addition, it does not interfere with other professional or self-care activities needed to restore and maintain caries control. Adding SDF to the armamentarium makes caries arrest practically feasible and enables extension of care to vulnerable populations. ■

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CE QUESTIONS

The answer sheet and further instructions are located on the tear-out card that appears on page 37, or take the test online at DecisionsInDentistry.com.

1. Older adults are generally more susceptible to tooth decay than younger patients.
True
False
2. According to a systematic review of the literature, what percentage of older adults has untreated root caries?
A. 24%
B. 35%
C. 48%
D. 51%
3. The majority of decay in older adults is found in which tooth surfaces?
A. Occlusal surfaces
B. Premolars
C. Anterior teeth and canines
D. Restoration failure at gingival margins
4. The ammonia component of silver diamine fluoride (SDF) accomplishes which of the following?
A. Acts as an antimicrobial
B. Supports salivary production
C. Stabilizes high concentrations in solution
D. Helps prevent hypersensitivity
5. Studies have shown that when applied every six months, SDF arrests 90% of caries lesions.
True
False
6. When used to prevent and arrest caries, what is the minimum recommended application interval for SDF?
A. Nine months
B. Annually
C. 18 months
D. Two years
7. The silver component of SDF inhibits which of the following?
A. Salivary gland hypofunction
B. Bruxing and tooth wear
C. Bacterial enzymes that break down the organic dentin matrix
D. Formation of hydroxyapatite and fluoroapatite
8. In general, what is the duration of possible gingival staining from the application of SDF?
A. A few days
B. Two weeks
C. Three to four months
D. None of the above
9. Caries lesions treated with SDF will harden to gentle probing over the course of which time span?
A. Two days
B. A few weeks
C. Two to three months
D. Six months or longer
10. Indications for SDF therapy in older adults include which of the following?
A. Arresting caries lesions
B. Treating recurrent decay
C. Caries prevention
D. All of the above