

Silver diamine fluoride treatment of active root caries lesions in older adults: A case series

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ARTICLE INFO

Keywords:

Older adults
Dental caries
Silver diamine fluoride
Dental caries arrest

ABSTRACT

Objective: The authors conducted a case series to determine arrest of root surface caries lesions in older adults when teeth were treated topically with 38 % silver diamine fluoride (SDF).

Methods: The study was a prospective, single center case series. The patients were 62 older adults (age >55 years) who sought treatment at a dental school clinic. To be included, a patient needed to have at least one active root caries lesion. Lesions were rinsed and then dried with air, isolated, and then 38 % SDF was applied for two minutes with a microbrush. Treated lesions were re-evaluated at 2–3 weeks. Treatment was repeated every six months. Survival analysis methods for clustered data were used to estimate the caries lesion arrest probability over time separately for root surfaces and at crown margins.

Results: Fifty-five participants returned for follow-up (44 % female, mean age (SD) 79.8 (7.4)). The probability of a lesion arresting with treatment ranged from 82.9 to 91.6%. Arrest rates at 18 months were slightly higher in root surfaces than around crown margins, 91.6 % (95 % CI 69.1–97.1) versus 89.8 % (95 % CI 71.6–96.3). All furcal lesions (n = 7) were arrested by 6 months, 100 % (95 % CI 59–100).

Conclusion and Clinical Significance: Repeated application of 38 % SDF at 6-month intervals was effective in arresting decay of root surface lesions and lesions around crowns in older adults. Study outcomes support SDF treatment for older adult patients who are frail and residing in nursing homes or dependent living facilities.

1. Background

Older adults are at higher risk for the development of dental caries lesions, especially in the root surfaces, in furcations, and at the margins of crowns [1]. In a meta-analysis of nine studies conducted in the United States and Canada and published after 1980, root caries incidence was eight times higher among individuals seventy-five years (55.9 %) and older compared to those 18–24 years old [2]. In the United States during the period 2011–2012, approximately 20 % of adults aged 65 and over were observed to have untreated dental caries [3]. Untreated dental caries was defined in this national survey as “Dental cavities (tooth decay) that have not received appropriate treatment”.

Root surface lesions are more common in patients who are taking multiple medications which contribute to dry mouth [4]. The dentin on root surfaces demineralizes at a higher pH (pH 6.2–6.4) than enamel (pH 5.5) making root surfaces more susceptible [5]. Silver diamine fluoride (SDF) 38 % has been shown to arrest the progression of decay on

exposed root surface [6,7]. Li and colleagues reported the results of a clinical trial in community dwelling elders where SDF treatment resulted in the arrest of root caries of 61 %, 82 %, and 90 % at 12, 24, and 30 months post treatment, respectively [8].

Case series have an integral role in describing clinicians' experience with new treatments in settings where other study designs may be ethically or practically inappropriate. The purpose of this case series was to determine the outcomes of treatment of root surface caries lesions in a population of community dwelling older adults when the teeth were treated topically with 38 % silver diamine fluoride (SDF).

2. Methods

This report follows an adaption of the PROCESS 2018 Statement guidelines for the reporting of case series in surgery [9]. The study registration number is NCT04370080. Institutional Review Board approval number is (1122117–4).

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<https://doi.org/10.1016/j.jdent.2020.103561>

Received 29 October 2020; Received in revised form 8 December 2020; Accepted 11 December 2020

Available online 18 December 2020

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2.1. Study Design

The study is a prospective, single center case series. The cases were consecutive. Participation was offered to every patient who qualified based on age and the presence of an active lesion in a root surface, in a furcation, or at the margin of an individual crown or crown abutment for a fixed prosthesis. A lesion was determined to be active if it was penetrable upon probing with an explorer. There was no attempt to rate the lesion size.

2.2. Study Setting

The study was conducted at a dental school clinic. The rationale for including a broader age range than those typically defined as elderly was that many adults age 55 and older share the same medications and other underlying conditions that impact tooth decay. The first patient was enrolled on January 1, 2017 and the last patient was enrolled on August 16, 2018. The last patient was evaluated at follow-up on November 21, 2019.

2.3. Participants

The patients were 62 older adults (age >55 years) who sought treatment at the clinic. The patients were examined clinically by trained faculty members and dental students. To be included, a patient needed to have at least one active root caries lesion according to the criteria for caries activity published by Nyvad and colleagues [1]. Patients were not excluded because of medical or psychological conditions in order to reduce selection bias and enhance the generalizability of the findings. SDF treatment was offered at no charge to the patient for the period of the study. Most enrolled lesions were deemed un-restorable and all patients chose the alternative treatment of SDF over extraction. Unrestorable lesions were defined as those where the probability of entering the pulp chamber during restoration was high or where retention of a restoration would not be possible. Also included were teeth where treatment might have required vitalizing the tooth, performing root canal therapy, and crown lengthening. Many of these teeth had highly calcified root canal spaces. Some individuals had more than one involved tooth and/or surface and each was included.

2.4. Examinations

The caries activity was assessed employing an adaptation of criteria developed by Nyvad and colleagues, which have previously been shown to be reliable [1]. To be scored as arrested, a root surface lesion had to be visible with the naked eye and feel hard with gentle pressure. There could be no pulpal involvement. Lesions were rinsed with air-water spray to remove debris before the exam. The faculty members and students were trained by the primary investigator (DBP) and co-authors (CM, HZ) using clinical photographs and then observed in the clinic under direct supervision to insure consistent lesion detection.

2.5. Interventions

The UCSF protocol for applying topical SDF was adapted for use with these patients [1]. Lesions were flushed with water and then dried with compressed air, isolated with cotton rolls, and then 38 % SDF (Advantage Arrest™, Elevate Oral Care LLC, West Palm Beach, FL) was applied repeatedly for two minutes with the manufacturer supplied microbrush applicator. The SDF was stored under the manufacturer's recommended conditions. If the patient (four patients) complained about the taste, the lesion was coated with sodium fluoride varnish (Enamelast™ Fluoride Varnish, Ultradent Products, South Jordan, Utah). There were no concurrent caries preventive or arresting treatments. Post-operative instructions were to avoid eating for 30 min but rinsing with water was allowed. There were no other restrictions. Patients were encouraged to

Table 1

Arrested probability for root and crown margins for lesions treated with 38 % Silver Diamine Fluoride (38 % SDF) based on the clustered survival analysis.

Location	Follow up Time	Arrested probability, % (95 % CI)
Root	6 months	88.9 (69.1–95.9)
	12 months	90.2 (69.5–96.8)
	18 months	91.6 (69.1–97.1)
Crown margins	6 months	82.9 (68.0–90.8)
	12 months	85.9 (70.3–93.3)
	18 months	89.8 (71.6–96.3)

* 21 participants contributed 1 or more root surface lesions for a total of 85 lesions. The median (IQR) number of root lesions = 2 (1–7).

** 39 participants contributed 1 or more crown margin lesions for a total of 122 lesions. The median (IQR) number of lesions = 2 (1–3).

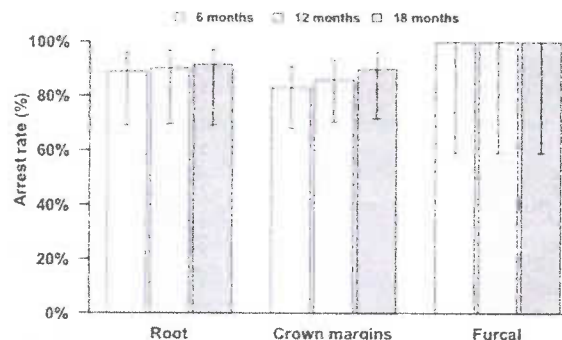


Fig. 1. Arrested rates for root, crown margins, and furcal lesions treated with 38 % Silver Diamine Fluoride (38 % SDF).

continue their regular oral hygiene including the use of a fluoridated dentifrice.

Lesions were initially visually re-examined by the same clinician two to three weeks after the first intervention and the teeth retreated if the lesion appeared to be incompletely treated or darkened by the SDF. All of the lesions were reevaluated for arrest about every six months and retreated regardless of their arrest status. No other treatment was done at that time.

The procedures were performed by dental students in their third or fourth years of training under the direct supervision of trained clinical faculty members in order to assure adherence to the protocol.

Clinical findings were entered into AxiUm by the examining student using the SOAP format and approved by clinical faculty. Data were then abstracted from patient electronic records by one author (DBP) and entered into Excel (Microsoft Excel for MAC, version 16.37).

2.6. Statistical Analysis

Survival analysis methods for clustered data were used to estimate the caries arrest probability over time separately for root and crown margin surfaces. The survival analysis accounts for the varying follow-up time between patients and the clustering of multiple surfaces with a patient [1,2]. Due to a very small number of furcation surfaces (n = 7), which were all arrested after six months, furcation surfaces were not included in the survival analysis. All statistical analyses was performed using R statistical software [3].

3. Results

3.1. Participants

Fifty-five of 62 (88.7 %) of the participants returned for follow-up: 24 females (43.6 %); mean age (SD) 79.8 (7.4) y. The typical participant was taking 4 medications (IQR 1–6) with 54.5 % taking ≥ 4

Table 2

Characteristics of the Participants in the Case Series of Treatment of Older Adults with 38 % Silver Diamine Fluoride at Enrollment. N = 62.

Characteristic	N (%) or Mean (SD) Range
Sex, female	29 (47 %)
Age, years	78.4 (SD = 8.6) Range 58–94
Number of teeth	19.3 (SD = 5.8) Range 3–28
Number of active root surface lesions	1.4 (SD = 2.8) Range 0–13
Number of active furcation lesions	0.1 (SD = 0.4) Range 0–2
Number of active lesions under crowns	2.2 (SD = 2.5) Range 0–11
Number of prescribed medications	3.6 (SD = 2.9) Range 0–13

medications and 14.5 % taking none. The participants who did not return were predominately female (5/7), younger (mean age (SD) 67.3 (9.9) y) and took fewer medications (median (IQR) 1 (0–3)).

The crude lesion arrest rates over the entire follow-up period for the 55 participants were 85.9 % (73/85) for root surface lesions, 86.6 % (103/119) for lesions at crown margins, and 100 % (7/7) for lesions in the furcation. Median (IQR) follow-up periods were 13.4 (6.3–19.6) months for root surface lesions, 12.6 (6.0–19.6) months for lesions at crown surfaces, and 17.9 (6.0–18.6) months for lesions in furcations. [Table 2](#) and [Fig. 1](#) give the arrested probability for root and crown margins lesions treated with 38 % SDF based on the clustered survival analysis. All furcal lesions (n = 7) were arrested by 6 months, 100 % (exact 95 % CI 59–100), and followed for 18 months.

No adverse or unanticipated effects of the treatments were either observed at follow-up examinations or reported by participants. No patient was lost to follow-up because of concerns about, or adverse effects from the treatment. ([Table 2](#), [Table 3](#)).

4. Discussion

In this case series of fairly typical older adult patients with active root surface lesions treated repeatedly with 38 % SDF, caries lesion arrest rates were very high and were stable over lengthy periods of follow-up. This suggests that topical treatment with SDF may be sufficient to maintain most individuals in their later years even when the patients are taking substantial numbers of prescription drugs that have been associated with decreased salivation and higher caries risk.

Interestingly, lesion arrest rates were similarly high in unrestored root surface lesions, lesions in furcations, and those under crowns. Clinicians treating older adults often face difficult to access lesions such as those in furcations and around and under crowns or where the gingival aspect of the dental caries lesion makes the tooth difficult or impossible to restore; thus, the uniformly high arrest rates are encouraging. This study did not address the question of whether fewer or less frequent treatments would yield similar or different results. Future studies should address this question. The initial high arrest rates for root surfaces were significantly higher than those reported by Li and colleagues while the final arrest rates were similar [7].

4.1. Strengths and limitations of the study

The arrested probabilities estimates are based on clustered survival analysis. A limitation of the data is the small sample sizes which resulted in wide 95 % confidence intervals around the estimated probabilities. A strength of this case series study is that patients with pre-existing

medical conditions were not excluded thereby increasing the representativeness of the study population; and thus, enhancing the external or clinical validity of the findings. Another important study strength was the use of established international criteria for caries lesion arrest. Some variation was introduced by the use of multiple examiners, but all were trained and supervised directly. Finally, four patients had treated lesions covered with fluoride varnish following the placement of SDF. We did not analyze the results of treatment of these patients separately as infrequent fluoride varnish treatment has not been shown to be very effective in arresting root surface lesions. There is no evidence that topical fluoride varnish helps retain the silver diamine fluoride in the lesion [11].

5. Practical implications

Treatment with SDF is simple, and highly effective if repeated at regular intervals. The decision to provide palliative, atraumatic versus restorative dental care can be difficult. Nevertheless, even if an older patient is able to tolerate extensive dental treatment, the option of SDF treatment should be considered as a practical and inexpensive alternative [14,15]. SDF may be especially appropriate for patients who are frail and residing in nursing homes and other independent or dependent living facilities. With SDF treatment as a viable alternative to comprehensive restorative care, and the ability to preserve teeth potentially indefinitely, the quality of life with respect to oral function can be maintained or even enhanced while sensitivity is reduced. Repeated application of 38 % SDF at 6-month intervals was highly effective in arresting and maintaining the stability of active lesions at root surfaces, at the margins of crowns, and in furcations in older adults in a clinical setting.

Clinical Trials Registration

NCT04370080

Additional Information

The authors declare that they have no conflict of interest. Funding for this research was provided by the Roseman College of Dental Medicine and a grant from Colgate-Palmolive Company, USA (A-2020-0442-OC).

CRedit authorship contribution statement

Chelsea Mitchell: Methodology, Investigation. Andrew J Gross: Conceptualization, Investigation. Peter Milgrom: Writing - review & editing. Lloyd Mancl: Software, Formal analysis. David B Prince: Conceptualization, Methodology, Validation, Data curation, Writing - original draft, Supervision, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 3

Number of months of follow-up (N = 62 patients enrolled).

	Number enrolled	Did not return after initial treatment	≤6 months	6–12 months	12–18 months	18–24 months	24–30 months
Patients N (%)	62	7 (11.3)	13 (21.0)	10 (16.1)	12 (19.3)	15 (24.2)	5 (8.1)
Teeth N (%)	173	16 (9.2)	46 (26.6)	30 (17.3)	29 (16.8)	37 (21.4)	15 (8.7)
Surfaces N (%)	230	16 (7.0)	66 (28.7)	40 (17.4)	41 (17.8)	46 (20.0)	21 (9.1)

Teeth and Surfaces N include all root lesions, crown margin lesions, and furcation lesions.

Acknowledgments

The members of the Silver Diamine Fluoride Treatment Committee, Roseman University CODM were Hiba Zaku DMD, Zachary Hansen DMD, Justine Miranda DMD, Cherish Dunshee DMD, Monica Ghandi DMD, Mean Kim DMD, Chet Matsuura DMD, Julie Hanna MPH, Joell Chen MS, Bo Kwok BS, Jungweon V. Park MS, Heather Nicholas BS, Jennifer Yates BS, Sara Moazzami BS, and Breanna Buckman BS.

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