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Silver Diamine Fluoride
Research Review

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How does silver diamine fluoride work?

Arresting Dentine Caries with Silver Diamine Fluoride: What's Behind It?

Abstract

Unlike other fluoride-based caries preventive agents, silver diamine fluoride (SDF) can simultaneously prevent and arrest coronal and root dentine caries. The profound clinical success of SDF has drawn many clinicians and researchers to study the mechanism of SDF in arresting dentine caries. This critical review discusses how silver and fluoride contribute to caries arrest, in terms of their effects on bacteria as well as on the mineral and organic content of dentine. Silver interacts with bacterial cell membrane and bacterial enzymes, which can inhibit bacterial growth. Silver can also dope into hydroxyapatite and have an antibacterial effect on silver-doped hydroxyapatite. Furthermore, silver is also a strong inhibitor of cathepsins and inhibits dentine collagen degradation. Early studies proposed that silver hardened caries lesions by forming silver phosphate. However, recent studies found that little silver phosphate remained on the arrested dentine lesion. The principal silver precipitate was silver chloride, which could not contribute to the significant hardening of the arrested lesions. On the other hand, fluoride enhances mineral formation by forming fluorohydroxyapatite with reduced solubility. A significant increase in microhardness occurs with an elevated level of calcium and phosphorus but not silver on the surface layer of the arrested dentine caries lesion following SDF treatment. Fluoride also inhibits matrix metalloproteinases activities and therefore inhibits dentine collagen degradation. The combination of silver and fluoride in an alkaline solution has a synergistic effect in arresting dentine caries. The alkaline property of SDF provides an unfavorable environment for collagen enzyme activation. Understanding the mechanisms of SDF in arresting dentine caries helps clinicians to develop appropriate protocols for the use of SDF in clinical care.

https://pubmed.ncbi.nlm.nih.gov/29768975/

Silver diamine fluoride for the treatment of sensitivity.

The short-term effects of diamine silver fluoride on tooth sensitivity: a randomized controlled trial

Abstract

Tooth sensitivity is a common clinical problem. This multi-center randomized clinical trial assessed the effectiveness and safety of topical diamine silver fluoride. From two sites (Lima and Cusco, Peru), 126 adults with at least one tooth sensitive to compressed air were randomly assigned to either the experimental treatment or sterile water, and pain was assessed by means of a 100-mm visual analogue scale at 24 hours and 7 days. The diamine silver fluoride reduced pain at 7 days at both sites. At the Lima site, the average change in pain scores between baseline and day 7 for the silver fluoride group was -35.8 (SD = 27.7) mm vs. 0.4 (SD = 16.2) mm for the control group ($P < 0.001$). In Cusco, the average change in pain scores for the silver fluoride group was -23.4 (SD = 21.0) mm and -5.5 (18.1) mm for the control group ($P = 0.002$). No tissue ulceration, white changes, or argyria was observed. A small number of participants in the silver fluoride group experienced a mild but transient increase in erythema in the gingiva near the tooth. No changes were observed in the Gingival Index. We concluded that diamine silver fluoride is a clinically effective and safe tooth desensitizer.

https://pubmed.ncbi.nlm.nih.gov/21118796/

Silver diamine fluoride for arresting caries among children.

Clinical Trials of Silver Diamine Fluoride in Arresting Caries among Children: A Systematic Review

Abstract

This review aims to investigate the clinical effectiveness of silver diamine fluoride (SDF) in arresting dental caries among children. A systematic search of publications was conducted with the key words "silver diamine fluoride," "silver diamine fluoride," "silver fluoride," "diamine silver fluoride," or "diamine silver fluoride" as well as their translation in Chinese, Japanese, Portuguese, and Spanish in 7 databases: PubMed (English), Embase (English), Scopus (English), China National Knowledge Infrastructure (Chinese), Ichushi-web (Japanese), Biblioteca Virtual em Saude (Portuguese), and Biblioteca Virtual en Salud Espana (Spanish). Duplicated publications were deleted. The title and abstract were screened and irrelevant publications were excluded. The full text of the remaining publications was retrieved. Prospective clinical studies of SDF that reported a caries-arresting effect among children were included. Meta-analysis was performed for quantitative analysis. A total of 1,123 publications were found, including 19 publications of clinical trials. Sixteen clinical trials studied the caries-arresting effect on primary teeth, and 3 clinical trials were on permanent teeth. Fourteen studies used 38% SDF, 3 used 30% SDF, and 2 used 10% SDF. Meta-analysis was performed on extracted data from 8 studies using 38% SDF to arrest caries in primary teeth. The overall percentage of active caries that became arrested was 81% (95% confidence interval, 68% to 89%; $P < 0.001$). Apart from staining the arrested lesion black, no significant complication of SDF use among children was reported. SDF was commonly used at 38%. It was effective in arresting dentine caries in primary teeth among children. Knowledge Transfer Statement: This systematic review found that 38% silver diamine fluoride (SDF) can effectively arrest caries among children. SDF treatment is noninvasive and easily operated. It can be a promising strategy to manage dental caries in young children or those who have special needs.

https://pubmed.ncbi.nlm.nih.gov/30931743/

Silver diamine fluoride for the treatment of root caries.

A Systematic Review on Caries Status of Older Adults

Abstract

The aim of this systematic review was to provide an update on caries prevalence in older adults aged 60 years or above around the globe. Two independent reviewers performed a systematic literature search of English publications from January 2016 to December 2020 using Pubmed, Scopus, Embase/Ovid and Web of Science. The MeSH terms used were “dental caries”, “root caries”, “DMF index”, “aged” and “aged 80 and over”. Further searches in Google Scholar retrieved eight additional publications. The epidemiological surveys reporting the prevalence of dental caries or root caries or caries experience using DMFT (decayed, missing and filled teeth) and DFR (decayed and filled root) in older adults aged 60 years or above were included. Quality of the publications was assessed using the JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data. Among the 5271 identified publications, 39 articles of moderate or good quality were included. Twenty studies were conducted in Asia (China, India, Vietnam, Singapore and Turkey), ten in Europe (Ireland, Norway, Finland, Germany, Portugal, Poland, Romania and Kosovo), three in North America (USA and Mexico), one in South America (Brazil), two in Oceania (Australia) and three in Africa (Malawi, Egypt and South Africa). The prevalence of dental caries ranged from 25% (Australia) to 99% (South Africa), while the prevalence of root caries ranged from 8% (Finland) to 74% (Brazil) in community dwellers. The situation was even worse in institutionalised older adults of which the mean DMFT score varied from 6.9 (Malawi) to 29.7 (South Africa). Based on the included studies published in the last 5 years, caries is still prevalent in older adults worldwide and their prevalence varies across countries.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8535396/

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

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.

https://pubmed.ncbi.nlm.nih.gov/33347946/

Parental perceptions about silver diamine fluoride staining.

Parental perceptions and acceptance of silver diamine fluoride staining

Abstract

Background: The caries arrest that can be achieved by using silver diamine fluoride (SDF) offers a minimally invasive and inexpensive alternative to traditional restorative caries treatment. The authors evaluated how the dentinal staining that is associated with SDF influences the acceptance of this treatment among parents of young children in the New York City metropolitan area.

Methods: The authors invited the parents of children who had experienced dental caries and who had appointments at the New York University Pediatric Dentistry Clinic and at several private clinics in New Jersey to participate in a Web-based survey designed to assess parents' demographics, perceptions of photographs of SDF-treated carious teeth, and acceptability of treatment in different behavior management scenarios.

Results: Ninety-eight mothers and 22 fathers from diverse backgrounds participated. Most parents (67.5%) judged SDF staining on the posterior teeth to be esthetically tolerable, but only 29.7% of parents made this same judgment about anterior teeth ($P < .001$). In the absence of their child having behavioral barriers to conventional restorations, 53.6% of parents reported that they were likely to choose SDF to treat their child's posterior teeth, but only 26.9% of parents were likely to choose SDF to treat their child's anterior teeth. As the number of children's behavioral barriers increased, so did the parents' level of acceptance. In extreme cases, in which parents had to decide whether their children should undergo general anesthesia during treatment, parents' acceptance rate of SDF as a treatment method increased to 68.5% on posterior teeth and to 60.3% on anterior teeth. Parents' acceptance of the treatment also varied according to their socioeconomic status.

Conclusions: Staining on posterior teeth was more acceptable than staining on anterior teeth. Although staining on anterior teeth was undesirable, most parents preferred this option to advanced behavioral techniques such as sedation or general anesthesia.

Practical implications: Clinicians need to understand parental sensitivities regarding the staining effect of SDF to plan adequately for the use of SDF as a method of caries management in pediatric patients.

https://pubmed.ncbi.nlm.nih.gov/28457477/

Light curing silver diamine fluoride into cavitated carious lesions.

Effect of Light Curing on Silver Diamine Fluoride in Primary Incisors: A Microscopic Ex Vivo Study

Abstract

Purpose: To determine the effect of a dental curing light on the penetration depth of silver diamine fluoride (SDF), dentin hardness, and silver and fluoride ion precipitation into cavitated carious lesions. Methods: SDF was applied on 16 primary incisors extracted due to caries extending into dentin. Teeth were divided into two groups: (1) control group, was not light-cured; and (2) test group, was light-cured. A scanning electron microscope, and OmniMet software were used to measure penetration depth, dentin hardness, and ion precipitation. Wilcoxon's ranksum test was used for statistical analysis. Results: All samples in both groups showed SDF penetration beyond the carious lesion and into sound dentin. The penetration depth into sound dentin was 70 μm further without the dental curing light it ($P<0.001$). Silver precipitation in infected dentin with the dental curing light was approximately 2.6 times greater than without it ($P=0.02$). Dentin hardness of infected dentin was 26 percent more with the dental curing light ($P=0.04$). Conclusions: Applying a dental curing light during silver diamine fluoride treatment of carious lesions induces more silver ion precipitation in infected dentin, increases its hardness, and, perhaps because more silver stays in the infected dentin, less SDF penetrates into sound dentin.

https://pubmed.ncbi.nlm.nih.gov/33662250/

Light curing silver diamine fluoride into non-carious primary molars.

Effect of surface preparation and light curing on penetration of silver particles from 38% silver diamine fluoride in dentin of primary teeth: An in vitro evaluation

Abstract

Purpose: To evaluate the effect of light cure, as well as various dentin surface treatment approaches, on the penetration depth of silver precipitating from 38% silver diamine fluoride into primary dentin tubules.

Methods: The occlusal dentin surfaces of 42 non-carious primary molars were exposed and then sectioned into halves bucco-lingually. The halves from each tooth pair were randomly split in two mega-groups, and each mega-group was divided randomly as follows into six experimental groups: prepared by either carbide bur (G1, G2), ceramic bur (G3, G4), or erbium laser (G5, G6). SDF was then applied to all prepared surfaces, and finally even-numbered groups (G2, G4, G6) were light cured. One mega-group was assigned to quantitative evaluation of silver penetration depth along the axial wall, and the other mega-group was reserved for qualitative observation of relative silver distribution on the occlusal surface, both via scanning electron microscope.

Results: No significant difference was observed in silver penetration depth between light cure and non-light cure groups (P= 0.8908). There was a statistically significant association between tooth preparation method and depth of silver penetration (P< 0.000001); laser-treated groups had significantly deeper silver penetration (1,148.9 µm G5, 1160.4 µm G6) than carbide bur (P< 0.05; 184.7 µm G1, 301.8 µm G2) or ceramic bur (P< 0.05; 184.1 µm G3, 131.0 µm G4) groups. A significant difference (P< 0.05) was noted in percentage occlusal surface coverage of particles between laser (51.4% G5, 35.8% G6) and carbide groups (21.1% G1, 19.3% G2). Light cure had no significant effect on the depth of silver penetration from 38% SDF in the dentin of primary teeth. Laser preparation resulted in deeper silver penetration than carbide or ceramic bur.

Clinical significance: Exposure of 38% silver diamine fluoride-treated dentin to light cure did not affect the depth of penetration of silver particles into the dentin tubules of primary teeth. Rather, tooth preparation approaches that reduce the smear layer, like laser ablation, resulted in the deepest penetration of silver into the tubules. Clinical application of these findings will depend on scenario and treatment aim.

https://pubmed.ncbi.nlm.nih.gov/33544988/

Bonding sound dentin and silver diamine fluoride.

Effect of Silver Diamine Fluoride (SDF) Application on Microtensile Bonding Strength of Dentin in Primary Teeth {prior to resin restoration, when removal of affected dentin is indicated}

Abstract

Purpose: The purpose of this study was to investigate the effect of silver diamine fluoride (SDF) on the microtensile bonding strength of resin composite to the dentin of primary molars. Methods: Twelve primary molars were randomly assigned to either the control or the SDF groups, and microtensile bonding strength (mTBS) was measured. The surface morphology was evaluated by visual inspection and scanning electron microscopy (SEM) imaging. Results: The mean±(SD) value of mTBS in the control and SDF group was 162.09±81.08 and 139.85±88.53, respectively (P=0.402). SEM images showed that, in the control group, the majority of the fractures occurred at the adhesive-dentin conjunction, while in the SDF group failure mostly occurred within the adhesives. Conclusions: Pretreating dentin with 38 percent silver diamine fluoride does not affect the bonding strength of composite resin to dentin. The fracture patterns observed suggest that bonding strength might be stronger between the adhesive and the SDF-applied dentin. Our data suggest that SDF can be used as a dentin pretreatment prior to resin restoration potentially contributing to secondary caries prevention in primary teeth.

https://pubmed.ncbi.nlm.nih.gov/27097864/

Bonding carious primary dentin and silver diamine fluoride.

Microtensile Bond Strength Between Glass Ionomer Cement and Silver Diamine Fluoride-Treated Carious Primary Dentin

Abstract

Purpose: The study objectives were to investigate the effect of silver diamine fluoride (SDF) on the microtensile bond strength between glass ionomer cement and carious primary dentin and evaluate the mode of restoration failure. Methods: Forty carious primary molars were sectioned in half through the middle of the carious lesion and randomly allocated to test and control groups. The test specimens were treated with 38 percent SDF, and the control, deionized water. The samples were stored in artificial saliva for 14 days at 37 degrees Celsius, and the dentin surfaces were conditioned and restored with Fuji IX GP Extra. After 24 hours in artificial saliva, the specimens were prepared for microtensile bond strength testing and stressed in tension at one mm per minute until failure. Mean bond strengths were compared using the paired t test. The failure mode was assessed with a stereomicroscope under 40X magnification. Results: The mean microtensile strength for the test group was 7.4 MPa (SD=±5.1) and 6.3 (±4.6) for the control group (P>0.05). Most common failure mode was the mixed failure mode in both groups. Conclusion: Silver diamine fluoride does not adversely affect the bond strength between glass ionomer cement and carious primary dentin in vitro.

https://pubmed.ncbi.nlm.nih.gov/30345969/