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Review Article

Silver Diamine Fluoride (SDF): Properties, Application and Mode of Action. (Review Article)

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Abstract

Objectives: The aim of this review article was to highlighted the properties, application and method of action of Silver diamine fluoride (SDF).

Materials and Methods: The following electronic databases have been searched: The Cochrane Oral Health Group Trials Register, Central Register of Controlled Trials, MEDLINE, EMBASE and PubMed. There will be no restrictions regarding language or date of publication. We also intend to search the reference lists of articles and contacted experts and organizations to identify any further studies.

Results: Collection of research is intended to be done by the six authors independently. Two independent authors will assess the risk of bias for each study which meets the inclusion and exclusion criteria.

The primary research method for this study is literature review and conceptual modeling. Causes identification and classification through a structured approach is the first step toward a full understanding of the Silver diamine fluoride issue. This study will also review various types Silver diamine fluoride and their characteristics. Based on this understanding a classification method will be developed to categorize this causes factors for the purpose of identification. Effect of the different type of the etiological factor will be examined and classified thoroughly in this review.

Keywords: *Silver Diamine Fluoride; Clinical Recommendations; Guideline; Anti-Infective Agents; Cariostatic Agents; Silver Compounds; Caries, Topical Fluorides*

Introduction

Properties: Importance and context

Early childhood caries (ECC) is defined as the presence of 1 or more decayed, missing due to caries, or filled tooth surfaces in a primary tooth in a child aged 71 months or younger [1]. The prevalence of ECC is high, with studies reporting dental caries among 50% of children aged between 5 and 9 years in the United States [2] and 47% of children aged between 25 and 30 months in Southeast Asia [3]. Conventional restorative treatment for ECC may not always be affordable or available and relies on the cooperation of the child for successful treatment. SDF may be a potential cost-beneficial and cost-effective alternative to restorative treatment for managing ECC in children. It has also been reported to be painless and simple to use for young children or patients with special needs with low risk of experiencing cross infection [4]. The caries does not have to be removed before its application. When SDF is applied on carious lesions, the fluoride

enhances remineralization and the silver ions act as an antibacterial agent and inhibit the growth of cariogenic biofilms [5]. SDF also preserves the dentin collagen from further degradation [6,7]. SDF at 38% has been used mostly in Argentina, Australia, Brazil, China, and Japan. The authors of this SR evaluated the clinical effectiveness of SDF at arresting caries among children. Strengths and weaknesses of the SR. The authors had a focused clinical question, clearly described inclusion and exclusion criteria, had descriptions of the included studies, and conducted the SR using accepted methods and standards [8]. The authors included only prospective studies. The authors performed study selection and data extraction in duplicate; however, it was unclear if the study selection was done independently by the 2 authors or if the risk of bias in each study was assessed independently and by how many authors. The authors also did not assess the interrater reliability or agreement among the study authors, such as with k statistics [9]. The authors did not define how active or arrested caries were each evaluated and how the evaluators differentiated between the 2 conditions. Without a valid method to differentiate between the 2 types of lesions to begin with, it was possible to have bias in studies in which the investigators were not blinded as to which lesions identified as active at baseline but arrested on follow-up were actually arrested at baseline from the beginning. The authors did conduct an extensive search in 7 databases in various languages along with supplementary searches in the references of included studies, but they did not search the gray literature or contact content experts. For the meta-analysis, the authors chose the random effects model so that the sample size of each study would have less influence on the overall results compared with the fixed-effects model. Though a meta-analysis was conducted on subgroups with different follow-up periods ranging from 6 to more than 30 months, the frequency of application with 38% SDF on primary teeth also varied within the studies in each subgroup from 1-off to repeated applications every 3, 6, or 12 months. Only 5 of the 8 trials in the meta-analysis had control groups. Thus, the results of the meta-analysis and the overall percentage of active caries that became arrested-81% (95% CI, 68-89%; P < .001)-may have been calculated from before-and-after data in just the intervention group, but not in comparison with a similar group that received either an alternative treatment, placebo, or no treatment. The authors declared they had no potential conflicts of interest to the publication of the SR. Strengths and weaknesses of the evidence. Except for the P value of heterogeneity (P ¼ .667) given in the forest plot of studies using 38% SDF on primary teeth, the authors did not include any actual discussion about or possible sources of heterogeneity in the included studies. In the meta-analysis with the subgroups with different follow-ups that used 38% SDF, all the studies with high concentrations of SDF (38%) applied to primary teeth reported a statistically significant caries-arresting effect on children, but specific data were not provided in some of the studies. The effectiveness of low concentration SDF (12% and 10%) has yet to be confirmed because the number of studies available was small. Not all the studies had control groups or used the same controls (such as glass ionomer cement or fluoride varnish). Without a control group, study authors cannot demonstrate that the lesion would have arrested on its own without any interventions applied. No meta-analysis was conducted strictly on the included studies that contained a control group, which would have provided information on the relative risk or probability of arresting the carious lesions by applying SDF versus leaving the lesions untreated. Not all the studies reported the sample size, random allocation, allocation concealment, and blinding. Selection bias, detection bias, and attrition bias were noted in some of the studies. The studies varied in sample size, outcome measures, and the number of teeth or tooth surfaces that served as the unit of analysis which could thus lead to clustered observations [10]. Calculating the proportion of arrested caries based on teeth versus tooth surfaces (because each tooth has more than 1 surface) leads to different percentage results. Some of the studies, particularly the earlier ones, may have had low reliability as they were conducted before the establishment of evidence based, minimum recommended reporting requirements for such studies as randomized clinical trials [11]. Considering the risk of bias noted in some of the studies, the authors mentioned, but did not formally assess, the possibility of publication bias with a funnel plot [12]. Besides staining the arrested caries of the treated tooth black, no significant complications, side effects, or adverse events were reported with the use of SDF even with the high fluoride concentration (38%, 44,800 ppm fluoride).

WHO consultation with public health experts

To the caries of early childhood

Since the adoption of World Health Assembly resolution WHA60.17 on oral health in 2007 [13] WHO has recommended Member States to formulate a national oral health plan - including integrated oral disease prevention and health promotion for young children. The suggestion is a motivation for governments to improve or change local dental health programs while the resolutions promotes international goals undertaken in recent times by the Dental health care programs of the WHO [14]. The incidence and prevalence in primary teeth is increasing fast in low- and middle-income states, and early childhood caries (ECC) is becoming a major health issue in those states with the most serious dental caries. Throughout many places of the globe this phenomenon of disease was observed in a simultaneous change to food system and shifting behaviors. In fact, the dental caries are frequently left untreated and then worsen to discomfort. This condition has a significant effect on oral health, overall health, physical development, and the standard of living of the individuals and society of young kids. However, evidence-based.

Silver diamine fluoride in primary teeth

Silver Diamine Fluoride or SDF (38% W/V AG(NH3)2F, 30% W/W), It's first reported use for dental purpose dates back to as old as 900 years back in Japan for cosmetic blackening of teeth. SDF has been in the market for arresting tooth decay in Japan, Brazil and Argentina for more than five decades. That's used in these countries to treat tooth extreme sensitivity. Japan was the founder of SDF study and in 1960 evaluated its effects on caries discontinuation. They tested SDF for its ability to halt caries progression and also prevent new caries by surface application of SDF.

Clinical method

According to American Dental Association - Non Restorative Treatments for Carious Lesions Clinical Practice Guideline (2018) [15] in order to arrest advanced cavitated lesions on any coronal surface of primary teeth, the expert panel recommends clinicians to prioritize the use of 38% SDF solution (biannual application) over 5% NaF varnish (application once per week for 3 weeks).

Clinical application

There is no known SDF application frequency, recommended child frequency ranges from Once to twice a year, apply it three times a week accompanied by yearly recall. Horst., *et al*. have determined that re-apply of SDF two times a year, caries has improved status.

Technique for use in SDF

In a dappen bowl, little amounts of SDF are distributed, taking into account the amount of dentition and surface area to be added. 1 drop is enough for 5 surfaces. The tooth or teeth to be managed are isolate with cotton rolls, then dry it with air-water spray. Using a microbush by submersion it in SDF liquid and then applying a wiping movement to the cavitated decay. Dry the liquid from the surface of the tooth so that it can act for one to two minutes with surface of the teeth and then wash with water.

Child/primary teeth efficiency

A Studies conducted by Chinbinski AC, Wambier LM, Fetrin J, Loguercio AD, Wambier DS, Reis A (2017) [16] reported that SDF is much more helpful in improving or arrested tooth decay in primary teeth compared to traditional management of caries that is normally Atraumatic restorations in such situations. Results also revealed that the use of SDF in an overall study is up to 89 percent [49 percent - 138 percent] better successful than other procedures, placebo or no procedure.

Silver diamine fluoride: A caries "silver-fluoride bullet"

With a wealth of fluoride-based caries-preventive agents, why might one be interested in yet another fluoride delivery system? The solution lies in the hypothesized capacity of silver diamine fluoride (SDF) to inhibit the

Caries develop and prevent new caries from forming at the same time. This hypothesized ability is thought to derive from the combined effects of: silver salt-stimulated sclerotic or calcified dentin formation [17] silver nitrate's potent germicidal effect [18] and fluoride's ability to reduce decay [19]. [Dentists called the silver nitrate "Howe's solution" following Percy Howe, who recorded using it to prevent caries. Howe was the first research director of the Forsyth Institute, and the Forsyth Library is called after him] main focus in SDF centers it around 5 presumed properties [20]: discomfort and infectious prevention, simplicity and efficiency of use, material cost and availability, minimum staff time and training requirements (one min., one time a year) Since it is non-invasive in this import. The need for agents including the SDF is often best described in terms of the World Health Organization Millennium Development Goals for Health [21] and in specific the oral health priorities (SDF has the ability to be a "silver-fluoride bullet") [21,22]. The suggested route to achieving this objective is to provide an essential oral health package consisting of: emergency treatment, prevention, and cost-effective treatments, within this attempt [23]. To reach this objectives, the using of easy techniques to 'scale up' will be needed to increase accessibility to dental treatment at a much reduced costs. At a same period, all such preventive measures would have to be based on actual evidence. With the rapid increase in population and the declining number of dentists providing emergency treatment and rehabilitative treatments, the most likely route to health of mouth would depend primarily on preventive. This need can be filled in part by silver fluoride material.

Brief history

First medical use of silver for water supplies seems to have been approximately 1000 BC [24]. Recent clinical use of silver around the use of silver nitrate, silver foil and silver sutures to prevent ocular and surgical infection [25]. Von Naegeli [26] revealed how silver was able to destroy spirogyra and showed that different types of silver had various effects, with silver nitrate became a very efficient antimicrobial.

Silver diamine fluoride usage and application

This paper offers evidence-based advice about use of 38% silver diamine fluoride (SDF) for prevention of dental caries in children and teenagers, even those with special health need. A guideline team established by the American Academy of Pediatric Dentistry provided standards and evidence-based advice on the use of 38% SDF to avoid cavitated caries in primary teeth. Types of studies evaluated: The recommendation for the guidelines is based on research from that of an established scientific assessment "Silver diamine fluoride clinical studies to inhibit caries in child: A systematic review." (JDR Clin Transl Res 2016;1[3]:201-10) [27]. A Systematic searches were performed in PubMed®/MEDLINE, Embase®, Cochrane Central Registry of Controlled Trials and Gray Literature Databases to classify randomized clinical trials and scientific papers reporting on the efficacy of silver diamine fluoride, and resolve related complication such as side effects and cost. A Grading of Recommendations Assessment, Development and Evaluation (GRADE) strategy has been used to evaluate the strength of the evidence and to establish an advice using the evidentiary-to-decision framework.

Outcomes: The review made recommendations concerning by use of 38% SDF as part of the overall caries preventive plan to inhibit cavitated caries in primary teeth. Taking account the few treatment costs and the caries diseases, the committee members were sure that the positive effects of SDF application in the population groups outweighs the potential its potential adverse effects. the used suggestion, given weak quality index, according to GRADE.

Conclusion and Practical Application

The recommendation seeks to perform clinical procedures involving the use of 38% SDF to achieve a better response of caries controlling in children and teens, and those with special needs. To date, the medically recommended amount is 38%, which is based on the reliable references for the SDF application included in appendix II.

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