Silver Diamine Fluoride: Game Changer in Dental Public Health: A Review

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Abstract

A major part of the world population is affected with carious teeth, among which the number of children affected is maximum. Carious lesions are more common in susceptible, uninsured and financially weak populations. Caries which are not treated for a very long period along with no utilization of available services in both developing and underdeveloped countries pose an essential public health question. Children have limited adaptive capacity which may also lead to difficulty in some treatment procedures. Hence, the need for an efficient and affordable approach for dental caries treatment was required in areas that have a finite access to oral health care services like the school children. Nowadays, Silver Diamine Fluoride (SDF) is very much in demand as it can control caries progression and is very less technique sensitive. This approach does not require caries excavation using instruments, in addition silver has many antimicrobial properties and fluoride helps in remineralization.

Keywords: *Silver Diamine Fluoride, Dental caries, Fluoride.*

Introduction

Early Childhood caries (ECC) present a high prevalence worldwide according to various research papers. Patient cooperation is very important for a desirable outcome that cannot be satisfied by conventional restorations available for the treatment of ECC.[1] After referring to the 2015 Global Burden of Disease Study, it is the most prevalent condition that affected 560 million children with primary dentition.[2] Caries which are not treated for a long time increases the risk of infection in other permanent and deciduous teeth, which leads to a decrease in school attendance, discomfort, expensive emergency treatments and the need for general anesthesia and limitation of growth and development.[3] Children have limited adaptive capacity which leads to difficulty in some treatment procedures.[4] The World Health Organization (WHO), the FDI World Dental Federation (FDI) and the International Association for Dental Research (IADR) jointly convened the Global Consultation on Dental Health through Fluoride, in Geneaon November 2006 declared that "prevention by using fluoride is the only realistic way of reducing this burden (of dental caries) in populations".[5] In 2007, at the 60th World Health Assembly, WHO proposed the governments "to promote oral health in schools, aimingat developing healthy lifestyles and self-care practices in children". In the Beijing conference in 2007, there was an announcement that was collectively summoned by the WHO, the FDI, the IADR and the Chinese Stomatological Association (CSA) that said "fluoride dentifrice remains the most widespread and significant form of fluoride used globally and the most rigorously evaluated vehicle for fluoride use".[6,7] In recent times,

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SDF is used because it stops caries formation and its progression is arrested simultaneously. This approach does not require caries excavation using instruments, in addition silver has many antimicrobial properties and fluoride helps in remineralization. In 2014, the US Food and Drug Administration introduced SDF for the management of tooth hypersensitivity.[8] Many in vitro studies have proven SDF as caries arresting and antimicrobial agent that destroys the activities of S.mutans and dentinal biofilm.[4]

History: Since 1000 years silver has been used as tooth cosmetics to prevent dental caries in Japan.[9] Due to their caries inhibition properties in 1891, silver amalgam and nitrate were used.[10] It was directly applied on carious surfaces as silver niraefor caries prohibition and it was called as Howe's solution.[11] At school dental care services in Western Australia 40% silver fluoride (AgF) was used to treat dental caries of deciduous teeth.[12]

Other parts of the world did not have much idea about SDF use till the late 1960s and the 1970s as SDF use was restricted to Japan. The Central Pharmaceutical Council of the Ministry of Health and Welfare in Japan in the 1960s established it as a therapeutic agent for treating dental caries. Australia and China have also used SDF to prevent caries progression in the last few decades.[13,14] Argentina, Brazil and Spain have used SDF for various public health events in different concentrations; and public health events were planned for sub-Saharan Africa and for different parts of Africa.[15] In Southern California 1995 there were reports that children with early childhood caries were treated with SDF to inhibit caries process as published by an American Journal at that time.[16,17] The US Food and Drug Administration approved SDF for treatment of dentinal hypersensitivity in 2014, which had the molecular formula as Ag(NH3)2F which is Silver diamine fluoride (38%).[8] Since then it was used as a very efficient caries arresting agent in Japan. Different in vivo studies done by Chu et al., Llodra et al., and Yee et al., mentioned that SDF was reducing dental caries in primary teeth as well as effective in arresting caries and also as a treatment substitute for other technique sensitive restoration method.[18-20] In vitro trials done by Knight et al., found that dentinal discs treated with silver diamine fluoride (SDF) showed a reduction in Streptococcus mutans counts.[12]

Silver Diamine Fluoride and Glass Ionomer Compound (GIC): The dark colour of the arrested of caries surface is not one of the most pleasing outcomes of SDF use. For better aesthetics there is a requirement for another effective treatment. Glass ionomer has been used as a restorative material with benefits of releasing fluoride which helps in remineralization. The release of a high concentration of fluoride ion prevents new dental caries development. Moreover, for anterior teeth restorations the tooth color of GIC makes it an obvious choice.[21]

Silver Diamine Fluoride Compared with Atraumatic Restorative Treatment: For school children having finite reach to oral health services, it is necessary to look for an affordable and atraumatic restorative material. There is increased demand all over the world for conservative caries treatment options. So, Atraumatic Restorative Treatment (ART) was introduced first in Tanzania in the mid-1980s and this is a pain-free, minimal intervention approach that is not technique sensitive and where less skill is required along with only hand instruments used to remove carious tooth substance. The conventional, self-hardening Glass Ionomer Cement (GIC)is used to restore the tooth and then used to seal any adjacent enamel fissures.[22] This procedure is largely pain-free and is well preferred by children and GICs demonstrate sustained fluoride release, pulpal biocompatibility, and chemical adhesion to the tooth surface.

The action of SDF on the carious tooth surface:

These could be the available mechanisms of action of SDF in arresting caries:

1. The first step isthe occlusion of dentinal tubules with silver. When SDF is applied the dye permissibility of dentine is decreased and electric resistance strengthened. It is also said that the products formed by silver from SDF use to halt the diffusion of acid and entry of microbes into the dentinal tubules. Further growth of microorganisms is inhibited the by oligodynamic action of silver. The surface area of dentin is decreased by the obturation of the dentinal tubules. The use of 38% SDF preserves collagen from degradation in demineralized dentin and suppresses demineralization.
2. The protection of dentin towards the activity of acid which leads to decreased access of acid into deeper parts of dentin is accelerated by the presence of fluoride. The fluoride ions released goes to a depth of 50–100 μ. in vivo conditions when SDF is applied

to dentin. Also SDF (Ag(NH3)2F) reacts with hydroxylapatite (HA) of a tooth to release calcium fluoride (CaF2) and silver phosphate (Ag3PO4) resulting in hardening of affected dentine.

This is chemically interpreted as:

$Ca10(PO4)6(OH)2 + Ag(NH3)2 \rightarrow CaF2 + Ag3PO4 + NH4OH$

$CaF2 \rightarrow Ca^{++} + 2F^-$

$Ca10(PO4)6(OH)2 + 2F^- \rightarrow Ca10(PO4)6F2 + 2OH^-$

The Ag3PO4 that is formed on the tooth is insoluble to acid attacks. The CaF2 formed as a reaction product becomes a pool of fluoride ions for the formation of fluorapatite (Ca10(PO4)6F2. It has also been proved that fluoride ions enhance calcification of tooth, and restores lattice imperfection and improves the crystallinity of HA.

3. The anti-enzymatic actions of the reaction products between Ag(NH3)2F and organic component of the tooth can be the next mechanism of action for caries arrest. Its antibacterial properties arise from inhibition of the enzyme activities and dextran-induced agglutination of cariogenic strains of Streptococcus mutans. Resistance of dentin to trypsin increased when SDF is applied on the tooth surface. Also,a study reported resistance to collagenase and trypsin for dentin protein increased after treating the tooth with SDF.[4]

Principles of selecting tooth for Silver Diamine Fluoride applications include:

SDF can be used in:

- Patients having active cavitated caries lesions with high caries risk in anterioror posterior teeth.
- Patients diagnosed with medical and behavioral challenges.
- The ones with a greater number of carious lesions cannot be treated in a single sitting.
- Carious lesions with complicated treatment plans; and those withdifficulty in accessing oral health care.
- There should be no signs of spontaneous painor acute/chronic pulpal inflammation.
- The use of radiographs to assess the depth of infection
- The carious lesions should be checked for accessibility of the applicator brush.(To gain access in proximal lesions orthodontic separators can be used.)
- As part of caries control therapy, SDF can be used before restoration placement.[23]

Clinical Applications of SDF are:

- Xerostomic patients, who are more susceptible to dental caries.
- For the treatment of caries in mentally disturbed young children.
- Caries management of the anterior deciduous teeth.
- Children whose guardians do not have time for long operative procedures.
- This is a great atraumatic option along with minimal use of equipment.
- No anesthesia is required for the procedure.

Method of applying SDF:

- One drop of SDF is dispensed into a dappen dish.
- The affected tooth surface is isolated and dried.
- Petroleum jelly is applied then on all the adjacent mucosa of the affected tooth.
- It is then applied with a micro brush or an applicator tip.
- The excess is removed with cotton gauge and then left for 2 minutes.
- Rinse with water.
- The tooth can be restored with restorative material like GIC.
- The restoration is evaluated every six months.[21]

SDF is advantageous because:

- Control of pain and infection as the caries is arrested in its initial stage.
- The simplicity of its use as it is like painting/ applying on the affected surface with a microbrush.
- The material is quite affordable which is around 100 applications per 5ml bottle and is available in most parts of the world.

- The requirement of skill is less as it is not technique sensitive.
- It is non-invasive and atraumatic nature.
- Duration of treatment is shorter than other restorative procedures.

The available concentrations of SDF are 10%, 12%, 30%, and 38%. Review articles and original studies related to SDF have suggested the use of 38% SDF for dental caries(8,20). A review by Contreras et al.(24) proposed that SDF for arresting caries was more efficient at concentrations of 30% and 38%.

Disadvantages of SDF: Pulpal irritation, dental staining, and oral soft tissue irritation are the main adverse events associated with SDF applications. Skin pigmentation is for short duration as silver does not enter the dermis. When keratinocytes are shed over 14 days desquamation of the skin with pigmentation occurs. The dental pulp is at lesser risk by the use of SDF. One of its demerits is the blackish discoloration that appears after the SDF application.[4]

Public Health Significance: Silver diamine fluoride arrests more than 80% of the caries when used twice per year. It is a source of powerful indirect prevention of dental caries. Hence, it is a game-changer in the field of dental public health as it is affordable in comparison with other expensive dental procedures and saves a lot of time, requires a lesser amount of skill, not technique sensitive and can be used in field settings like a school-based programmes by both dental auxiliaries and dentists. The benefits of SDF far outweigh the risks. Hence emerging as an effective public health tool.[4,21]

Conclusion

The application of SDF once in every 6 months is preferred to other minimally invasive techniques. SDF as a primary preventive material is better and convincing than other materials for restorations, excluding dental sealants which are >10 times expensive and requires more skill and technique. If it is used as a preventive or curative procedure, it can prevent or postpone the requirement of caries treatment in both children and adults. The use of fluoride varnish for caries cessation can be replaced in patients with SDF. It is a potent public health tool especially in low-income countries in the fight against dental caries.

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