REVIEW ARTICLE

Enhancing Caries Management with Silver Diamine Fluoride: A Comprehensive Review

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Abstract

Silver diamine fluoride (SDF) has emerged as an essential, non-invasive tool in modern dentistry, particularly for arresting caries and preventing further decay. Its effectiveness in pediatric, geriatric, and special needs populations has contributed to its growing acceptance in both clinical and public health settings. This narrative review focuses on the structure of SDF, its mechanism of action, clinical efficacy, safety, and its integration into dental practice. This review synthesizes recent research, offering significant insights into the potential application of SDF as a cornerstone of preventive dentistry and its impact on the advancement of caries management globally. Various electronic data bases such as PubMed, Scopus, Google scholar and Saudi digital library were utilized to search articles. A comprehensive search was conducted utilizing relevant keywords. The full-text articles discussing various aspects of SDF published in English language were reviewed for its composition, mechanism of action, clinical efficacy, safety profile, and future directions of SDF in dental care, highlighting its potential for addressing global oral health disparities. The review finding suggests that SDF represents a transformative advancement in contemporary dentistry, offering a cost-effective, non-invasive, and efficacious method for halting dental cavities. Its utilization in the management of caries among various demographics, including children, the elderly, and individuals with special needs, highlights its significance as a resource in clinical and community health frameworks.

Key words: Caries arrest, dental caries, geriatric dentistry, pediatric dentistry, preventive dentistry, silver diamine fluoride

INTRODUCTION

Dental caries is among the most prevalent oral health conditions in the globe with the populations of all age groups and socioeconomic statuses exhibiting the condition. The World Health Organization (WHO) said that the most common health problem in the world is untreated dental caries in permanent teeth.[1] Conventional approaches to the control of caries, such as restorative procedures, are usually invasive, time-intensive, and expensive, which creates difficulties, particularly in underserved and at-risk groups, such as children, elderly adults, and those with special healthcare needs.[2]

Silver diamine fluoride (SDF) is a not so old but a ground-breaking caries management resource which solves these problems using a non-invasive, cost-effective, and inexpensive treatment. First applied in Japan more than 80 years ago, SDF is popular in different regions of the world especially due to its effect of stopping active caries and preventing the further progress of tooth decay. SDF has become popular in the pediatric, geriatric, and special needs dentistry because it is cheap and does not demand advanced dental facilities, which is particularly beneficial in low-resource environments.[3]

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The dual capability of SDF in arresting the caries and in augmenting the remineralization by the use of fluoride ions has increased its applicability as an alternative to the conventional dental interventions such as dental fillings and crowns. The usefulness of the material is not limited to the conventional context, with its usage in the field of community-based programs and public health dentistry that would combat the disparities in oral health care globally.[4] Moreover, SDF has been highly promising as an agent in the prevention of root caries, which is a major problem among the elderly, and the treatment of hypersensitivity, thus its increased use in preventive and general dentistry.[5]

In the U.S., adoption by the food and drug administration (FDA) of SDF in dentinal hypersensitivity in 2014 was a major step toward its use outside of Japan and Latin America. Its effectiveness in the management of caries has been confirmed by later reports especially when applied on a population that is intolerant or unable to access other traditional forms of restorative treatments, including children, people with disabilities, and the aged. Its ease of use and safety profile has seen the accumulation of a progressive body of research to learn more about the full potential of SDF in the modern dentistry field.[6]

This review is devoted to the structure of SDF, its action mechanism, clinical effectiveness, safety, and spreading its role within dental practice. The synthesis of the latest research allows this review to present profound insight into the ways SDF that might be used as the foundation of preventive dentistry and how it can influence the evolution of caries control in the world.

SDF HISTORICAL BACKGROUND

The history of using SDF in dental practice is not new since its use in Japan began more than 80 years ago. SDF first found application in the dental caries management in the public health practice in the prevention and prevention of the dental caries as well as arresting the caries in the underserved communities where the usual dental intervention is either inaccessible or prohibitively expensive.[7] The Japanese Ministry of Health accepted SDF as a caries management agent in 1960s and since then, it has become common in pediatric and adult dentistry in Japan.[8]

The outstanding evidence of arresting caries without being invasive made SDF to have international recognition, especially in low-resource areas. However, it did not happen until the 21st century that SDF started to come into serious consideration in the West. However, SDF was approved by the U.S. FDA in 2014, as a dental treatment for dentinal hypersensitivity, although its off-label application in the rapid arrest of caries became common among U.S. dentists.[9]

In Latin, America and other sections of Asia SDF was comparably well known as a game-changer in caries and management. In some nations, such as Philippines, SDF was implemented in the public health programs as a component of community dental health programs to deal with rampant early childhood caries (ECC), particularly in the less economic regions. The rise prevention in the application of SDF in Western nations such as the U.S., Europe, and Australia has been quite new but massive and is backed by an increasing amount of evidence on its effectiveness and safety in caries arrest. Although there was some reluctance toward using SDF at the beginning due to its cosmetic effects (e.g., black staining effect on treated teeth), it has become widely accepted in different groups of people, such as pediatrics and geriatrics.[3]

COMPOSITION AND MECHANISM OF ACTION

SDF is a water solution that contains silver (Ag), fluoride (F), ammonia (NH3), and water. The components have synergistic effects in arresting carious lesions and preventing the development of new lesions. Ag and fluoride are the two main active ingredients and they are important in its action as a caries arrest agent:

Ag

Ag ions have been extensively documented to have strong antimicrobial effect. When Ag ions are applied to a carious lesion, the bacterial cells are disrupted in a manner that causes the cell to die by interfering with the important bacterial functions including DNA replication.[10] This efficiently prevents the carious development of the lesions by neutralizing the bacteria which causes dental caries. Furthermore, the reaction of the Ag ions with hydroxyapatite in the tooth structure causes the formation of Ag phosphate, which contributes to strengthening the demineralized regions.[3]

Fluoride

Fluoride ions aid in the process of remineralization by enhancing the production of a more acid resistant variant of hydroxyapatite, fluorapatite which, in turn, strengthens the tooth enamel and causes it to be much more resistant to additional decay.[11] SDF contains fluoride that helps to prevent the onset of new carious lesions by treating caries and giving protection to the high-risk patients, especially children with ECCs.[12]

NH3

NH3 in SDF stabilizes the solution, making sure that the Ag ions do not precipitate rapidly, and the material does not become insoluble within the long-term. This enables it to

have longer shelf life and to be more predictable in its clinical efficacy on application.[3]

INHIBITING BIOFILM FORMATION

One of the key issues about the mode of action of SDF is that it prevents the development of biofilms. Biofilms are formations of bacteria and their extracellular products that are very important in the development of caries. It has been demonstrated that the Ag in SDF breaks down formation of biofilm, which leads to long-term caries-arresting effect of SDF.[12] This renders SDF a potent preventive measure of the recurrent caries particularly in high-risk groups like individuals with ECCs or adults with undermined oral conditions attributed to systemic illnesses.

SDF IN CLINICAL APPLICATIONS

SDF is commonly applied in clinical practice to a large number of dental procedures including but not limited to the management of caries, secondary caries prevention as well as caries of the root in elderly patients. The efficacy of SDF in preventing caries by arresting them has proven to be very effective especially in children as seen in clinical trials conducted on them. Systematic review of clinical trials of SDF has shown that 38% of SDF has been effective in arresting caries in more than 89% of lesions in the primary teeth that have been treated with the product, which is higher than the success rate of other fluoride varnishes and glass ionomer sealants.[3]

SDF is also especially useful in populations in which the availability of dental care is low or more invasive measures are not possible. In such cases, the non-invasive use of SDF offers a possible alternative to the arrest of dental decays and avoidance of large-scale restorative processes.[3] It has also been found to be very effective in the treatment of caries among children who may not tolerate the normal dental treatments due to the anxiety factor or even behavioral difficulties.[6]

COSMETIC AND SAFETY ASPECTS

Although SDF is a well-regarded agent with respect to its clinical efficacy, the major cosmetic side effect is the black stain, which it leaves on arrested carious lesions. The condition of the caries can be stained by deposition of Ag phosphate and this is an indication of a successful treatment but the discoloration can be an issue of concern especially when it is noticed in pediatric patients where the parents are concerned.[7] Nevertheless, research has revealed that advantages of caries arrest usually override the esthetic disadvantages especially in the high risk groups of dental caries.[9]

Regarding safety concerns, systemic uptake of Ag through SDF application is insignificant and in clinical trials, there are no alarming adverse effects. SDF is said to be safe with children, adults, and elderly patients, even those with compromised immunity systems.[13] Furthermore, SDF does not cause allergic reactions with a low occurrence rate which, hence, is a safe and effective choice among a large group of patients including those with special healthcare needs.[3]

SDF AS A CLINICAL INTERVENTION IN THE PREVENTION OF CARIES

SDF is not a new product and many clinical trials have been conducted on this product with evidence of high efficacy in arresting carious lesions. SDF is well recognized in terms of its capability of preventing the onset of dental caries, particularly in at-risk groups in which those conventional restorative therapies are potentially inaccessible or not feasible due to cost, coercion, or care accessibility. SDF is a valuable instrument in pediatric and adult dentistry particularly in handling caries in high-risk populations due to its non-invasive nature and high success rate.

A number of pioneer studies highlight the effectiveness of SDF. The systematic review of clinical trials using SDF among pediatric groups indicated that SDF had an 89% success rate in caries arrest in primary teeth. This was in contrast to an arrest rate of 66% using glass ionomer sealants, which is a conventional preventive material common in the field of pediatric dentistry. The potential of SDF to perform better than the traditional materials such as glass ionomer as a caries arrest material emphasizes its applicability in clinical practice especially in the treatment of young children with ECCs or other.[3]

Further studies had indicated that SDF was effective in arresting caries in both primary and permanent teeth. Patients who had caries progression showed a significant decrease in caries progression in the studies that used SDF as compared to the experiment done on patients using fluoride varnish or sealant. As an example, a study by Rosenblatt, which is commonly known as the Ag-fluoride bullet, discovered that the use of SDF invariably prevented additional decay among a vast majority of individuals, a study that was corroborated by other research studies that followed the same methodology.[13,14] The review discovered that a single application of 38% SDF worked well to arrest the already existing carious lesions and to thwart the development of new lesions in both primary and permanent teeth. In a preschool population in Hong Kong, a randomized clinical trial established a statistically significant superiority of SDF to fluoride varnish in arresting caries in 77% of lesions treated with SDF and 33% of lesions treated with the fluoride varnish. Thus, the effectiveness of SDF was evident, which is why it has gained greater use in pediatric dentistry. The research highlighted the importance of SDF to use as a first-line treatment option in the management of

caries in young children especially those who might fail to tolerate other restorative methods that were already invasive in nature.[12]

The effectiveness of SDF in treatment of geriatric patients especially in the treatment of root caries also contributes to the success of SDF in the management of caries as SDF was able to prevent root caries in geriatric patients with a success rate of 71% after one treatment. SDF is an effective intervention to address the oral health of aging populations because older adults have a high risk of root caries, and the gingival recession and a lower salivary flow are among the leading contributing factors. The results indicate that SDF may play a critical role in geriatric care, which meets the rising public health demand with the aging of the world population.[5]

Besides being effective in other age groups, SDF is also very effective in the various socioeconomic strata. Research in low-income and underserved groups has demonstrated that SDF is especially helpful in the environments with a low access to dental care. It has also been pointed out that SDF has been incorporated into the national programs to improve the health of the rural population by reducing the burden untreated dental caries. The research observed that SDF was an effective and affordable way of treating rampant caries in kids, and thus, it was recommended to be used in government health initiatives in all parts of the world.[4]

These findings are consistent in various populations, which is why SDF has a wide scope of application in dental caries management. Although conventional restorative therapies can be efficient, such as fillings, crowns, and root-canals, they are very invasive, costly, and time consuming. Conversely, SDF constitutes a non-invasive, fast, and highly efficient alternative that can be effectively applied in cases when restorative care cannot be practiced, or the primary objective is not to restore functional or esthetic appearance but to halt disease progression.

BENEFITS OF SDF OVER ALTERNATIVE FORMS OF TREATMENT

Clinical effectiveness of SDF is not confined to the caries arresting effect. A major benefit of SDF is the fact that it is very applicable, and therefore, it would be very useful in the population that might not be capable of accessing regular dental services. This encompasses children, the elderly, people with special needs, and those in the low resource environment where dental practitioners might be incapable of delivering normal restorative services. Furthermore, the use of SDF does not require local anesthesia, drilling, or complex equipment, thus greatly decreasing time spent and pain experienced by the patient during the treatment process.[6] SDF also presents a possibility of preventing secondary caries around the existing restorations. Research is being conducted into the possibility of lowering the incidence of secondary decay in the teeth that have already been restored with composite or amalgam fillings by incorporating SDF in preventive dental care plans. The initial results are encouraging as it can be stated that SDF can be used as a supplementary solution to prevent recurrence of caries as it is a frequent issue with conventional restorative procedures.

APPLICATION PROTOCOLS AND TECHNIQUES OF SDF

Application of SDF has been noted to be non-invasive and simple. The treatment process does not take much preparation and the procedure can be carried out within a short period of time thus very efficient to the dentist especially in dealing with children or people with special healthcare requirements. It includes applying a micro brush or any other form of applicator with the SDF onto the carious lesion. The major advantage of SDF is that it does not need a massive chiseling of the degenerated tooth substance. Rather, this is aimed at catching the caries on its initial stages and avoiding the subsequent stages of development.[9] This is a very beneficial conservative method, especially to the patients who might not be able to undergo the normal dental procedures or in cases where the restorative treatment cannot be done immediately.

PREPARATION AND APPLICATION PROTOCOLS

The carious lesion is usually debrided with food debris and plaque before the application of SDF; however, substantial mechanical elimination of decayed tissue is unnecessary. A micro brush is then used to apply the SDF solution to the lesion and the solution is allowed to sit on the tooth in 1 min and afterward it is rinsed or dried. Clinical procedures recommend the use of cotton roll or gauze to isolate the tooth to avoid touching soft tissues because SDF may result in temporary mucosa staining. Following the application, the dentist may choose either not to treat the lesion or temporarily/permanently restore it, depending on the clinical scenario.[15]

A number of guidelines have been formulated to maximize the utility of SDF in the treatment of caries. To illustrate, the American Academy of Pediatric Dentistry (AAPD) advises on re-application of SDF after every 6–12 months, particularly in high-risk patients with a previously established record of various carious lesions or the ones that could not undergo restorative procedures.[15] When SDF is used on regular basis, it increases its long-term effectiveness in arresting caries, as evidenced in various studies in which the use of SDF was done after every 2 years with good results.[3]

POST-TREATMENT CONSIDERATION: RESOLVING ESTHETIC ISSUES

A permanent black stain on arrested carious lesions is one of the main esthetic issues with regards to SDF. This results in black discoloration in the form of Ag phosphate formed as a result of the reaction between the Ag ions and the organic and the inorganic elements of the tooth. Although such staining suggests that caries has been arrested, this may be a cosmetic issue particularly to the parents of pediatric patients or patients with visible anterior teeth having the caries.[7]

It has come up with various strategies to deal with this problem. One of the methods that are widely used is the use of potassium iodide (KI) following the usage of SDF. The KI treatment is used to reduce or prevent the black staining by precipitation of Ag iodide which is less visually prominent as compared to Ag phosphate. Although this technique does not negate the chances of staining, it was found that it has the potential to diminish aesthetic effects of SDF treatment that is significant. Nevertheless, the introduction of KI into practice has not been popular in every clinical practice due to the extra complexity and cost of the process.[16]

SDF APPLICATION IN PEDIATRIC DENTISTRY

SDF is a rapidly gaining popular treatment in the field of pediatric dentistry, where the problem of dealing with ECC is a major challenge. Uncooperative, fearful, or intolerant children can be treated using the non-invasive SDF treatment since it cannot be used in conventional restorative dental treatments. It has been proven by many studies that SDF use can effectively prevent caries in primary teeth without local anesthesia and drilling, and therefore, it is a perfect first-line therapy of ECC among young children.[6] The other research discovered that the SDF is more effective than fluoride varnish in caries arrest of primary teeth. Therefore, it is believed that SDF is the preferred type of treatment among high-risk children, particularly children who are unable to receive routine dental treatment. In addition to this, parents are willing to accept the treatment as long as they are well informed on the advantages and esthetic results that may be achieved.[17]

USES OF SDF IN THE GERIATRIC DENTISTRY AND IN PATIENTS WITH SPECIAL NEEDS

Besides its effectiveness in the pediatric groups, SDF has been useful in the management of root caries in the elderly, especially those in long-term care or those with little access to routine dental services. Root caries, which are more prevalent in the elderly as a result of recession of the gums and a dry mouth that is the result of medication, are difficult to treat. It has been shown that SDF is really effective in arresting root caries and a 71% success rate was observed in geriatric patients following application of SDF just once. This renders SDF a vital provision in the maintenance of oral hygiene among the elderly, particularly when restorative solutions requiring more invasiveness are inapplicable owing to frailty or medical issues.[5] Furthermore, SDF is especially effective when patients are cognitively or physically disabled and cannot tolerate invasive dental operations. The simplicity of the application, as well as non-invasive character of the treatment, ensure that SDF is a feasible method of caries management in patients with special needs, with the minimum usage of the general anesthesia or sedation.[15]

LONG-TERM FOLLOWING UP AND EFFECTIVENESS

Some of the long-term studies have revealed that SDF can be effective when applied periodically. Randomized trial established that children with biannual application of SDF were much less likely to develop carious lesions in 2-year period compared to children who were not treated with SDF application.[18] On the same note, SDF application was effective in the arresting of caries in not only primary teeth but also permanent teeth and subsequent visits ensured that the treatment was effective even after several years of use.[13]

Although no single guideline is applicable in relation to the frequency of SDF reapplication, the literature suggests that high-risk patients be treated with SDF after every 6–12 months to make sure the caries are continuously arrested, and new lesions are not formed.[15] This adaptable method enables dental professionals to adjust the frequency of the treatment to the requirements of the separate patients, which explains why it can be used as a preventive measure in multiple clinical practices.

SDF: SIDE EFFECTS AND SAFETY

SDF is a substance that has been widely researched on its safety and effectiveness in caries management. Although the efficacy of using SDF in arresting dental caries is well-reported, there are side effects in relation to using SDF with the most notable being the black staining of teeth that are being treated. Irrespective of these fears, SDF has a high safety profile, and thus, is a critical treatment between pediatric, geriatric, and special needs population. In this section, known side effects of SDF are mentioned; its general safety character and the measures to address aesthetic issues are discussed.[19]

BLACK STAINING OF ARRESTED CARIOUS LESIONS

The black permanent staining of the demineralized or carious tooth surfaces is the most reported side effect of SDF. Such staining happens as a result of the precipitation of Ag phosphate in the reaction of SDF with hydroxyapatite in demineralized dentin.[7] The black discoloration is usually viewed in a negative way by patients and caregivers especially when SDF is applied on the front teeth or high areas when smiling. However, this discoloration is another clinical evidence that the caries has been arrested and this indicates that the lesion is no longer active.

The prevention of this staining has been directed toward other treatment regimens and after-treatment measures. Applying SDF followed by the use of KI is one of them. KI when used after SDF produces Ag iodide which is not as dark as Ag phosphate, thereby lowering the amount of discoloration.[16] However, KI does not completely inhibit the black staining but only reduces its strength. The protocol is usually reserved to patients whose esthetics are highly demanded like when they require treatment to be done in the anterior part.[6] Furthermore, other clinicians employ esthetic restorations such as glass ionomer or composite material to cover the staining on top of the arrested lesions. This solution, however, may be expensive and complicated to the treatment process.[3]

SYSTEMIC ABSORPTION AND TOXICITY ISSUES

Systemic absorption of Ag and possible toxicity has been considered a concern based on the fact that Ag is used as the active antimicrobial agent in SDF. It has, however, been discovered that the quantity of Ag absorbed at the time of treatment remains very small and far less than the accepted standards in regards to Ag exposure safety. The WHO recommends that the acceptable daily intake of Ag be 0.05 mg/kg body weight and research on SDF applications has concluded that, using multiple applications does not lead to any accumulation well below that level in the body system.[13]

Furthermore, research articles by Horst *et al*. and Rosenblatt *et al*. affirm the insignificance of Ag toxicity due to SDF. The insignificant traces of Ag that do get absorbed during the dental procedures are rapidly expelled by the body through normal biological excretion. There has been no major systemic side effects, even in the high-risk groups of the population, including young children, the elderly, and those with a weakened immune system.[7,13]

ALLERGIC RESPONSES AND MUCOSAL STAINING

There have also been reported allergic reactions to SDF though it is rare. These responses are usually local in nature and may include mild irritation or inflammation of the mucosa provided the SDF gets in contact with soft tissues. Mucosal staining in most instances can be observed in case the solution accidentally touches the gums, tongue, or other soft tissues when applied. It is a temporary type of staining and normally heals in a couple of days when the tissue regenerates.[15] Clinicians can use cotton rolls or gauze to isolate the treated tooth to reduce chances of mucosal staining and irritation caused by SDF application.[6]

There have been no reports of anaphylaxis and severe allergic reactions associated with SDF. An examination of clinical trials in which thousands of patients were treated globally has not demonstrated any serious adverse events that can be directly related to SDF.[3] Nonetheless, with any dental intervention, clinicians need to be aware of the allergy or sensitivity of the patient to any of the elements of SDF, especially the NH3 contained as a stabilizing agent in the solution.

SAFETY IN VULNERABLE POPULATIONS LONG-TERM SAFETY PROFILE

Various long-term studies have focused on the safety of SDF in vulnerable groups of the population, including children, the elderly, and people with disabilities. A randomized clinical trial report that revealed no significant adverse effects that are related to the use of SDF in the primary and permanent teeth of children.[5] Moreover, a systematic review by Gao *et al*. verified the long-term safety of SDF in geriatric patients especially when it comes to the management of root caries. According to these studies, SDF could be a good choice in terms of managing caries in the population where more invasive treatment is possible to be a higher risk or impractical due to underlying health condition.[3]

In children, the AAPD has supported the application of SDF and that it serves as a first-line therapy in high-risk children who are unable to receive conventional restorative treatments, in particular those who are unable to tolerate the conventional methods of restoration.[15] The long-term safety history in addition to the capability of the SDF to prevent the development of ECCs justifies its further use in the dental care of children, including those who are very young in age.[6]

SAFETY IN PATIENTS WITH SPECIAL HEALTHCARE NEEDS

SDF has been well known in patients with special healthcare needs who might not be in a position to receive the conventional restorative dental procedures. This encompasses people who have physical, mental, or behavioral issues, which complicate their collaboration with traditional dental treatment. The nature of the SDF application as non-invasive and the capability to arrest caries without anesthesia or

drilling makes the application a perfect choice in treatment of the population.[15] Research has always demonstrated that SDF is highly tolerated and efficient in caries progression management in persons with special needs as well as contribute to its popularity as a secure and necessary instrument in contemporary dentistry.[6]

THE PROLIFERATION OF THE SDF USE IN DENTISTRY

Although the most common use of SDF in the dental field is the prevention of the dental caries, studies are constantly revealing some more potential uses of this flexible agent. The new uses highlight the increasing significance of SDF in minimally invasive and preventive dentistry. In addition to its effectiveness in caries management, SDF has also shown promise in other fields of dental hypersensitivity treatment, molar-incisor hypomineralization (MIH), enamel hypomineralization, and even in dental erosion. These results suggest that the role of SDF can be quite broad in clinical practice, which it was not originally designed to do.

DENTINAL HYPERSENSITIVITY

Treatment of dentinal hypersensitivity is considered to be one of potential uses of SDF. This is a problem that arises due to the exposure of the dentinal tubules and results in discomfort or pain when stimuli such as cold, heat, and pressure of the teeth are applied on the affected tooth. It has been demonstrated that SDF is an effective way to decrease the dentinal hypersensitivity due to its ability to block dentinal tubules.[20] The SDF Ag component acts by precipitating proteins in the dentinal tubules and makes nerve fibers conducting the pain impulses less excitable.[21] There was a clinical trial that evaluated the effect of SDF in reducing the sensitivity of patients with exposed dentin with a 6-month follow-up. It was discovered that the Ag ions in SDF were superior to any other form of treatment based on fluoride in occluding dentinal tubules so it can be used as a possible long-term treatment in patients with hypersensitivity.[20]

MIH

SDF has also been explored in treating MIH, a developmental disease that entails enamel of the first permanent molars and incisors. The features of MIH are enamel defects that may cause sensitivity, rapid caries, and cosmetic problems. Due to a hypomineralized enamel, teeth with MIH are more likely to be destroyed during masticatory forces, and thus, not easily treated using standard intervention strategies such as fillings or crowns. SDF could apply some protection cover on hypomineralized enamel to decrease the likelihood of additional degradation. The SDF contains fluoride, which enhances remineralization, and the Ag ions, which provide antimicrobial effect, which are necessary in the treatment of the clinical effects of MIH. Furthermore, SDF having caries arresting properties, it is especially effective in preventing the additional decay in hypomineralized teeth that are highly vulnerable to carious lesions.[22]

ENAMEL HYPOMINERALIZATION: DENTAL EROSION

Other than in MIH, SDF has demonstrated potential in the treatment of other causes of enamel hypomineralization and dental erosion prevention. Hypomineralization of enamel, which is caused by impairs in the formation of enamel, exposes the tooth surface to wear and degeneration. SDF has the potential to induce remineralization and build a protective layer on demineralized enamel, and thus, it is a possible solution to the management of these defects.[3]

Acidic food, drink, or gastroesophageal reflux disease which causes dental erosion may result in the loss and thinning of enamel. SDF can potentially control the erosion, as it creates a protective coating and contributes to the remineralization process. Although the studies in this field are still in their infancy, the initial results point out that frequent usage of SDF may prove to be an effective preventive measure among patients with high risk of erosion.[22]

APPLICATION IN THE PREVENTION OF SECONDARY CARIES

SDF is also being considered with respect to its ability to prevent secondary caries especially in the area surrounding existing restorations. One of the most common causes of restoration failure and possibly the need to replace the restoration is secondary caries which form at the edges of the fillings or crowns. The caries arresting and antimicrobial effects of SDF have prompted studies into its use as an adjunctive therapy during restorative treatments to halt the onset of the recurrence of caries. It has been demonstrated that the use of SDF on the restorative margins can decrease the number of secondary caries. Months of restorations and subsequent interventions could be reduced by preventing the colonization of such vulnerable sites by bacteria, which would increase restoration longevity (SDF). This result is especially applicable in high-risk caries and limited follow-up dental treatment populations.[18]

PRACTICES IN PUBLIC HEALTH AND COMMUNITY DENTISTRY

Since it is simple and effective, SDF is finding its way into the public health programs to ease the dental caries burden

on underserved populations. The sensitivity of SDF to caries, its minimal cost, simple implementation, and the potential to prevent the development of caries make this product an ideal option in community-based dental programs, especially in low-resource conditions. Such programs as those which are applied in the Philippines where SDF is administered as one of the school-based caries prevention programs have demonstrated encouraging outcomes. It has been established that the children under the SDF care recorded considerably reduced rates of caries progression compared to those under traditional care such as fluoride varnish or ART (atraumatic restorative treatment) sealant care.[4] These results demonstrate that SDF can be used to minimize oral health care disparities as a low-cost intervention to address caries in the frail population.

FUTURE DIRECTIONS

Due to the ongoing researchers in the applications of SDF, there is an increased interest in the study of how SDF can be included into the holistic caries management programs, such as SDF combined with conventional restorative therapies and preventive interventions. As an example, the use of SDF and fluoride varnish, sealants, or minimal intervention strategies can make SDF more effective and result in more individualized care in dentistry.[3] Furthermore, there is continuous research on how to enhance the esthetic results of the SDF treatments, especially in the anterior area where black stain can be an issue. Techniques to overlay composite or glass ionomer materials on top of SDF-treated lesions or to add KI to reduce staining attempts have been explored as part of trying to broaden the clinical acceptability of SDF.[16]

CONCLUSION

SDF is the new game-changer in the modern-day dentistry, and it is an affordable, non-invasive, and effective way of arresting dental caries. Its application in the control of caries in the different groups of people, such as children, the elderly and those with special needs, underscores its importance as a tool in clinical and community health systems. Although there is an issue of the black staining of the treated teeth, most patients are more likely to have their teeth treated with SDF, due to its high effectiveness and ease of use. With the ongoing research on new applications, and enhancements, the role of SDF in preventative dentistry may continue to increase and it will become an invaluable resource in the management of caries and in general oral health of the world.

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