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The use of silver diamine fluoride in dentistry: A literature review

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Abstract

Dental caries is a microbial disease affecting hard tissue structures of the teeth. Silver is well known material with its antimicrobial properties. A conservative method for arresting caries and prevention of its progression is the silver diamine fluoride. Silver diamine fluoride was used for arresting dental caries for more than half a century with great success. In addition, there are other uses for this material in dentistry such as treatment of dentin hypersensitivity, indirect pulp capping and as intra-canal medicament in endodontic treatment. However, there are some drawbacks and concerns that need to be put into consideration before the use of such material.

Keywords: Addition, treatment, hypersensitivity

Introduction

Dental caries is considered the most common disease in children that is caused by bacteria affecting the mineralized tissue of the tooth ^[1]. Humans are highly susceptible to this condition, particularly in the wake of the industrial revolution and the sharp rise in the use of refined carbohydrates ^[2]. One of the traditional approaches for treating carious lesions involves surgically removing the caries and then restoring it—a process known as "the drill and fill concept". Compared to other preventive techniques, this notion of treatment is more expensive and needs more work ^[3-5].

In place of the conventional drill and fill method, a number of preventive methods are being investigated ^[6]. Silver diamine fluoride is one of the most modern techniques for stopping dental caries and preventing it from getting worse.

Silver diamine fluoride in human history

Silver's antibacterial qualities were well recognized in antiquity. Silver water containers were used by Alexander the Great. The Romans advised bandaging wounds using silver foil. To inhibit the growth of bacteria and algae in water barrels, American settlers placed silver coins inside of them ^[7].

In 1840, silver was first utilized in dentistry as silver nitrate, which was used to clean the cavity and stop the carious sores. This technique-dubbed the "toilet of the cavity-was eventually discovered to cause severe pulp irritation. Next, Australian kids were subjected to tests using silver fluoride as a rematerializing agent. The purpose of this study was to identify a minimally invasive technique that could replace the very-popular drill and fill approach. On the proximal and occlusal surfaces of primary molars, established carious lesions were treated with silver fluoride. The findings demonstrated that full remineralization was achieved without the need for any surgical intervention, and around 35% of the proximal lesions only required topical therapy for treatment ^[8].

These findings prompted more research on silver fluoride. The two-step method was created by topically applying stannous and silver fluorides. In around 74% of cases, this technique led to the arrest of carious lesions. Nevertheless, this technique revealed a number of issues, such as discoloration of teeth due to stannous fluoride, and it was subsequently discontinued ^[9].

At the University of Osaka in Japan, silver diamine fluoride was first used in 1969. The concept was based on the interaction between fluoride's anti-carcinogenic effects and silver's

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strong anti-microbial qualities. The outcomes demonstrated much more benefits from this chemical than were predicted. By obstructing the opening tubules, silver diamine fluoride was able to precipitate inside the dentinal tubules and significantly reduce dentinal hypersensitivity^[10].

Ultimately, in 2016 the Food and Drug Administration (FDA) regarded silver diamine fluoride as a breakthrough treatment because of its remarkable capacity to stop carious lesions in both adults and children. Given that the FDA now views oral diseases as serious illnesses, silver diamine fluoride was also designated as a medication to treat a serious illness^[11].

Since silver diamine fluoride was first used in dentistry, research has shown that it effectively prevents cavities by boosting tooth structure remineralization and reducing carious bacteria. It was taken into consideration for use in permanent and deciduous teeth^[12, 13].

Types of silver diamine fluoride

A topical solution called silver diamine fluoride is colorless and alkaline, and it contains both silver and fluoride ions. Silver fluoride and silver diamine fluoride are the two forms or chemical structures that are accessible for the combination of silver and fluoride. Australia was the first country to use silver fluoride to stop childhood carious lesions^[14].

Diamine silver fluoride, which is produced by combining silver fluoride with ammonia, is an ion that is more stable than silver fluoride and can stay stable in an alkaline solution for up to 28 days without undergoing a substantial change in composition^[15].

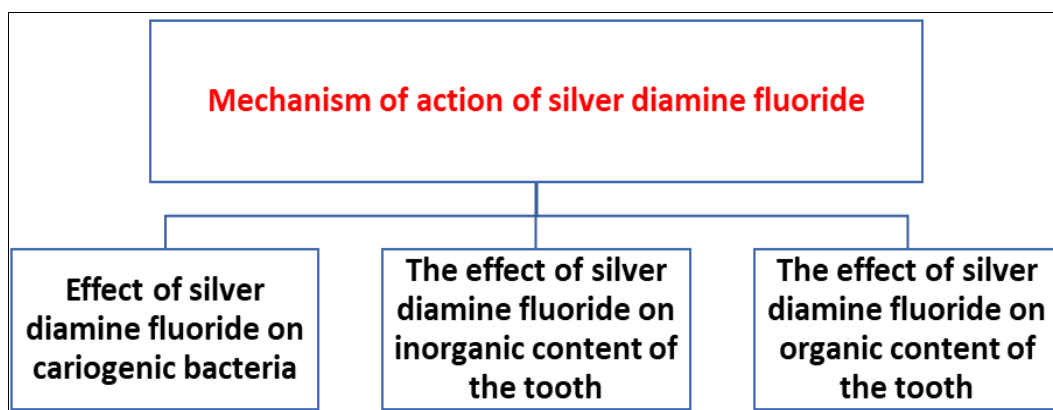
Advantage Arrest, a commercially available formulation with a concentration of 38%, is one example of silver diamine fluoride (Figure 1). Riva Star, Bioride, Fagamin, and Fluoroplat all have the same Advantage Arrest concentration. In addition, there are two concentrations of Cariestop (12% and 30%) and Saforide (3.8 and 38%), both of which are available^[16, 17].



Fig 1: A commercially available type of silver diamine fluoride.

The mechanism of action of silver diamine fluoride

There is uncertainty regarding the precise mode of action of silver diamine fluoride. Nonetheless, three primary categories can be used to categorize the mechanism of action (Figure 2)^[18, 19].



It was discovered that the silver ion is the primary antibacterial ingredient that both strongly prevents the formation of biofilm and has an antibacterial impact^[20]. The ability of the silver ion to rupture bacterial cell membranes and permanently alter the bacterial structure will ultimately result in the death of the bacteria^[21]. The capacity of the silver ion to block specific bacterial genes and their transporter systems was another antibacterial impact^[22].

Additionally, the synthesis of two significant compounds provided an explanation for the chemical process and the effects of silver diamine fluoride. These substances are silver phosphate and calcium fluoride. It is thought that calcium fluoride serves as a significant source of fluoride during the carious assault. It functions as a remineralizing agent, rapidly replenishing the calcium that has been lost from the tooth structure. Conversely, silver phosphate is thought to be a vital source of phosphate ions. Moreover, it has the capacity to

precipitate and form an insoluble protective layer on the tooth's surface^[23].

Furthermore, type I collagen, which makes up the majority of the organic matrix in both enamel and dentine, has been shown to be resistant to destruction by silver diamine fluoride. Its impact on the proteolytic enzymes responsible for this breakdown explains this^[24].

Additionally, it was shown that it can influence the organic matrix through a variety of methods, one of which is its capacity to create a collagen matrix that is more resilient and durable, able to endure the collagenolytic difficulties encountered during the caries formation process^[25].

Dental applications of silver diamine fluoride

Figure 3 illustrates the four primary applications of silver diamine fluoride in dentistry.

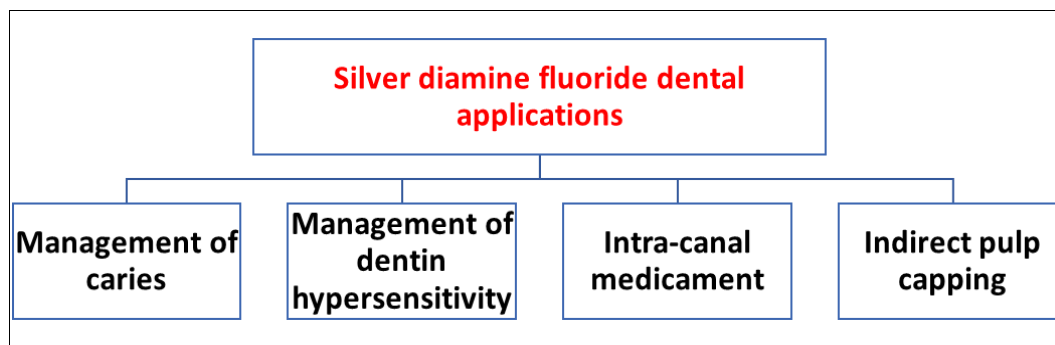


Fig 2: Dental applications of silver diamine fluoride

Management of caries

Silver diamine fluoride can stop carious lesions from developing in both permanent and primary teeth. After a 6-month follow-up period, it was discovered that silver diamine fluoride could benefit primary teeth with deep caries by reducing pulp degeneration and pain, even if the caries initially seemed close to the pulp [5, 26, 27].

It is commonly recognized that silver diamine fluoride can stop early childhood caries, or caries in young children's anterior deciduous teeth [24]. It was discovered that in kids with early childhood caries, it might harden and remineralize dentine [28].

Management of Dentin Hypersensitivity

More than 90% of patients with dentinal hypersensitivity in various age groups respond well to therapy with silver diamine fluoride, according to numerous studies. It was discovered to be most successful in treating dentinal hypersensitivity brought on by abrasion and erosion. Its application was advised to be done four times, one application every week [29, 16, 30, 31]. However, there isn't any conclusive proof that this quantity of applications is any more productive than any other quantity [9].

In order to take advantage of potassium iodide's ability to stop silver diamine fluoride from coloring teeth, silver diamine fluoride was also combined with potassium iodide solution, acting as a potent desensitizer [32, 33].

Intra-canal medicament

Enterococcus faecalis is one of the most difficult conditions to treat in a root canal and has been linked to a number of failures [31]. Numerous intracanal medications were created to address this issue. Silver diamine fluoride was found to be effective in eliminating *enterococcus faecalis* and the majority of other bacteria found in root canals because of the antibacterial characteristics of silver [34].

Additionally, it was discovered that the number of visits needed to finish the endodontic treatment was much reduced when silver diamine fluoride was used as a root canal irrigant [35]. However, due to the effect of dentine blackening induced by silver, which may compromise esthetics in anterior teeth, it was advised that the use of silver diamine fluoride as a root canal irrigant be restricted to posterior teeth. A 3.8 percent was the suggested concentration for usage as a root canal irrigant [36].

Indirect pulp capping

It was discovered that silver diamine fluoride has a good capacity to promote the production of tertiary dentin and to stop pulp necrosis and inflammation. Additionally, it was discovered that by promoting remineralization, which can help shield the pulp from irritation, it will hasten the pulp's

healing process [37].

Additionally, impacted carious dentin's micro-hardness might be greatly increased by silver diamine fluoride, compared to calcium hydroxide. There were two primary processes identified for this apparent increase. The first method involved the creation of fluorapatite crystals, which were discovered to have fewer vacancies and to be more packed than hydroxyapatite crystals. The second mechanism resulted from the silver phosphate deposit [38-40].

However, it was noted in several tests that silver diamine fluoride had a detrimental effect on the pulp. It was discovered to inflict some pulpal damage, which could result in irreparable pulpitis. However, this could be the result of poor case selection, which could have led to some pulpal irritation before silver diamine fluoride was applied [41, 42].

Advantages of silver diamine fluoride

The primary benefit of silver diamine fluoride lies in its ability to halt dental cavities and promote remineralization without requiring tooth extraction or the use of local anesthetic [43]. Another key benefit is its ease of use, which enables many healthcare providers to utilize it with little training and greatly enhances the dental health of both adults and children (Table 1) [44].

Furthermore, this strategy is a great way to improve oral health for the general public in underdeveloped nations because of its low cost of care due to its shortened treatment duration and minimal intervention procedure [45].

The fact that children with specific health care requirements may find it difficult to cooperate during intricate restoration procedures, which may be necessary to cure carious cavities, is another benefit of silver diamine fluoride [43, 46].

Furthermore, the use of silver diamine fluoride is now thought to be superior to fluoride, chlorhexidine digluconate, and amorphous calcium phosphate in the prevention of root caries in adult patients [47, 48]. However, in order to raise the caries arrest rate, it is advised that silver diamine fluoride be applied every six months [49].

When silver diamine fluoride and sodium fluoride varnish were compared, it was discovered that applying a 38% silver diamine fluoride solution annually was noticeably more effective than applying a 5% sodium fluoride varnish every three months in stopping carious dentin in early childhood caries [50].

Drawbacks of silver diamine fluoride

Like any dental material, silver diamine fluoride has significant drawbacks that could prevent it from being used in specific therapeutic settings. The main drawback is that it can discolor teeth black, which can be particularly problematic for anterior teeth and make some patients feel negatively about this kind of treatment. Discoloration brought on by silver diamine fluoride was discovered to be irreversible, in contrast to fluoride varnish. Silver phosphate, which is normally

yellow in color but turns black when decreased in the oral cavity, is the source of this black coloring [43, 51]. Some research suggested adding potassium iodide as a solution to this issue. This results in the creation of a white, creamy precipitate of silver iodide rather than the dark precipitate of silver phosphate [52, 53]. Although the method's efficiency was first demonstrated to be satisfactory, more research is required to prove its acceptability for clinical application. There have also been reports of endodontically treated teeth developing a permanent tint following silver diamine fluoride irrigation. Few studies have addressed this issue, though, as the advantages of using it - particularly in posterior teeth - far exceed the drawbacks [16].

The potential for staining skin if administered carelessly to

the patient's face with contaminated hands is another documented drawback of silver diamine fluoride. Additionally, if the solution was dropped on the patient or the dentist by accident, both of their clothes might get discolored. Its metallic taste, which many patients may find unpleasant, and its propensity to irritate the mucosa and gingiva if it happens to come into contact with these areas by accident are two more significant drawbacks. Mucosal and gingival irritation, however, normally goes away after two days, so it's not a serious problem. Patients who are allergic to silver compounds should not use silver diamine fluoride because it might cause localized hypersensitivity reactions in locations that are opposite the application site [51].

Table 1: Advantages versus disadvantages of silver diamine fluoride.

Advantages	Disadvantages
<p>Can stop tooth decay and improve remineralization without requiring tooth extraction. No local anesthetic is required. Simplicity with a protocol requiring little intervention. Suitable for both adults and children. Low treatment cost. Shorter duration of treatment.</p>	<p>Cause teeth discoloration to turn black. If black discoloration is present in the patient's anterior teeth, it could have an impact on their psychology. Teeth that have had endodontic therapy permanently stained following irrigation. If administered carelessly to the patient's face with contaminated hands, the skin may get stained. Taste of metal.</p>

Concerns regarding the use of silver diamine fluoride in dentistry

Concerns about safety of silver diamine fluoride is related mainly to four categories illustrated in Table 2.

Table 2: Concerns regarding the use of silver diamine fluoride in dentistry.

Concerns about the use of silver diamine fluoride			
Dental fluorosis	Irritation of soft tissue	Irritation of pulp	Cytotoxicity around the periapical area
<p>Some commercially accessible items have fluoride ion concentrations that are twice the maximum recommended dosage of 59900 parts per million. Children should no longer use these highly concentrated fluoride products [54].</p>	<p>It was documented when silver diamine fluoride unintentionally came into touch with the oral mucosa. The oral lesion manifests as a painful, white, inflammatory region that is swallowed. Topical local anesthetic can be used to treat this injury, which is reversible [55].</p>	<p>Six days following the administration of silver diamine fluoride, only a moderate degree of irritation inside the pulp was observed [56].</p>	<p>A strong antibacterial agent that works well in endodontic therapy is silver diamine fluoride. Apical periodontitis patients can also be treated with it. However, chemically induced cytotoxicity could also result from it [57].</p>

Conclusion

Silver diamine fluoride treatment is an effective, simple, fast and relatively safe method for many dental treatments such as management of caries, dentine hypersensitivity and indirect pulp capping in addition to its use as intracanal medicament. Despite its recent popularity in dentistry, more researches are needed to minimize its side effects, especially its ability to cause discoloration and staining of teeth and skin.

Conflict of Interest

Not available

Financial Support

Not available

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