

Silver Diamine Fluoride : A Review

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Abstract: Silver diamine fluoride (SDF) is a solution containing ionic silver, fluoride and ammonia that arrests the progress of carious lesions and prevents the development of future caries. SDF has proven efficacy in preventing the incidence of new carious lesions. Application of SDF is painless and simple to use for young children or patients with special needs.

Keywords: Silver diamine fluoride, dental caries, demineralization, remineralisation.

1. INTRODUCTION

Dental caries is one of the most prevalent chronic diseases in the world, affecting people across all age groups and countries ^[1]. Dental fear, financial limitations, scheduling difficulties and transportation issues are among the significant barriers to children's dental problems reported by parents. These observations when coupled with the fact that current methods of early preventive care do not appear to inhibit caries development suggest the need for new or alternate approaches to control dental caries in children ^[2].

Silver diamine fluoride derives from the concentration of silver nitrate and fluoride. It reduces the growth of cariogenic bacteria, hampers degradation of collagen in dentin, inhibits demineralization and promotes remineralisation of both enamel and dentin. The application of SDF to dental surfaces is simple and inexpensive and complies with the concept of minimally invasive dentistry. Thus, treating caries lesions with SDF seems especially suitable for younger, less cooperative and more socially vulnerable children ^[2]. SDF solutions contain ammonia, silver and fluoride. When applied to teeth, SDF penetrates enamel and dentin, and 2 to 3 times more subsurface fluoride is stored in the tooth than with other fluoride solutions. The tooth then acts as a fluoride reservoir and may increase its long term effectiveness ^[3].

Treatment with SDF requires minimal instrumentation and application at less frequent intervals than other caries preventive materials ^[4]. SDF application can be an affordable way of managing dental decay in many children from low income or living in areas where dental service provider is limited.

History

Silver nitrate was first used to arrest caries in the 19th century. Rapid development to create more effective formulation occurred during 20th century starting with Howe' sammonical silver nitrate, followed by silver fluoride and later SDF^[4].

Silver compounds, especially silver nitrate have been used in medicine to control infections for more than a century^[5]. The first medicinal use for silver appears to have been around 1000 BC^[6]. The use of SDF for managing dental caries was pioneered by Nishino, Yamaga, and others in Japan in the 1960' s. Their original intent was for prevention: both [silver and fluoride] ions increase the resistance of enamel to dental caries^[7].

The Japanese used silver as tooth cosmetics to prevent dental caries since 1000 years^[8]. A study in 2018 found that SDF was successful in arresting active caries in primary teeth of young children in USA and was also received by their parents^[9].

Silver diamine fluoride solution

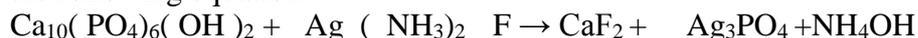
Silver diamine fluoride is an ammonia solution containing fluoride and silver ions. SDF contains approximately 24 – 28 % (weight / volume) silver and 5 -6 % fluoride (weight /volume)^[10-11].

Mechanism of action

Silver diamine fluoride (SDF) is capable of efficiently halting caries process. Yamaga et al (1972) suggested that the formation of calcium fluoride (CaF) and silver phosphate could be responsible for the prevention of dental caries and the hardening of a carious lesion^[12]. Apart from caries management, SDF is also used to treat tooth hypersensitivity and to sterilise infected root canals^[13].

Yamaga and his co-workers suggested that both fluoride ions and silver ions contribute to its mechanism of action. They proposed that fluoride ions mainly act on tooth structure and silver ions mainly act on the cariogenic bacteria. SDF reacts with hydroxyapatite in an alkaline environment to form calcium fluoride (CaF₂) and silver phosphate (Ag₃PO₄) as a major reaction products. CaF provides sufficient fluoride for the formation of fluoroapatite, which is less soluble than hydroxyl apatite in an acidic environment.

The precipitated Ag₃PO₄ forms an insoluble layer over the tooth surface and acts as a phosphate ions reservoir to facilitate the transformation of hydroxyapatite to fluoroapatite. The overall reaction can be summarized by the following equation:^[14]



Clinical applications of SDF

SDF can be directly applied onto the tooth surface for prevention. SDF does not stain sound enamel. The teeth to be treated with SDF can be dried and isolated with cotton rolls. The caries should be removed before the application of SDF. Contact with soft tissue should be avoided by carefully applying the solution to only the lesion, using a rubber dam or cotton rolls or coating the gingival tissue with petroleum jelly to prevent gingival contact^[12]. One or

two drops of SDF solution will treat upto 5 lesions. The tooth surface should be kept dry during the application and isolated from tongue, cheeks with cotton rolls and gauge. The solution is applied with microbrush and allowed to absorb for 1 min. The excess is removed and rinsed with water. The formation of metallic silver from silver compounds results in staining carious tissue black. Initially, the caries remains the same color, but after a 2 to 3 weeks period, the carious tooth becomes dark brown to black. Light exposure increases the brown – black appearance of the carious lesion. To counter this effect, researchers have investigated applying a potassium iodide (KI) solution over the SDF. The KI is applied directly over the SDF and a white precipitate of silver iodide forms, which removes the excess silver ions. The KI is agitated until the solution turns clear and is rinsed and dried. KI is contraindicated in for pregnant or breastfeeding females ^[12-13].

Side effects and toxicity

Patient satisfaction is an important indicator for the quality of health care. Parent' s satisfaction may play a major role in affecting treatment adherence and success of intervention for young children ^[16]. SDF inhibited the degradation of dentine organic matrix, which mainly consists of Type 1 collagen ^[17].

The exact amount of silver and fluoride present in one drop of SDF is determined by the specific gravity of the liquid and the dropper used. Exposure to one drop of SDF orally would result in less fluoride ion content than is present in 0.25 ml topical treatment of fluoride varnish^[10].

Due to high concentrations of fluoride and silver, adverse effects of SDF are of concern regarding its use in young children. Pulpal and tissue irritation is a hypothesized side effect after SDF treatment. It results in metallic taste. There is prevalence of tooth and gum pain. Clinical trials suggested that SDF did not cause severe pulpal damage. However, a few cases reported a mild and painful white lesion on the mucosa. Gingival irritation may occur after SDF application and applying Vaseline at the adjacent gingiva was suggested to prevent irritation of gingiva ^[16-17].

Treatment of the disease is needed as it strengthens tooth, enhance the saliva and decrease sugar consumption ^[18].

Indications and usage

The simplicity and affordability of Silver diamine fluoride (SDF) treatment has gained much attention in the past decades. Recent systematic reviews of human clinical trials indicate that silver diamine is more effective anticariogenic agent than fluoride alone ^[19]. SDF can be used to strengthen dentin for caries progression ^[20]. Uses of SDF includes caries control, management of tooth, hypersensitivity and endodontic treatment ^[21]. It is mainly indicated for: Patients with high caries risk. Individuals presenting with behavioural or medical management challenges. Difficult to treat cavitated dental caries lesions. Patients without access to or with difficulty accessing dental care. Caries lesion with no clinical signs of pulp involvement^[20-21].

Contraindication

- Allergy to silver
- Ulcerative gingivitis

- Stomatitis
- Pregnancy ^[10]

2. CONCLUSION

Application of SDF is better than other minimally invasive treatment choices. The use of SDF as a preventive or therapeutic modality can prevent or delay dental treatment for all groups. SDF is an effective agent for blocking dentin tubules, reducing fluid conductance through tubules and decreasing cold sensitivity.

Ethical clearance – Not required since it is a review article

Source of funding – nil

Conflict of interest – nil

3. REFERENCES

- [1] NassarSeifo, Heather Cassie, John R. Radford and Nicola P.T. Innes: Silver diamine fluoride for managing carious lesions: an umbrella review. 2019.
- [2] J. O. Burgess, P.M. Vaghela: Silver diamine fluoride: A successful anticarious solution with limits. 2018.
- [3] BrancaHeloisa Oliveira, AnjanaRajendra, Analia Veitz – Keenan, Richard Niederman: The effect of silver diamine fluoride in preventing caries in the primary dentition: A systematic review and meta- analysis. 2019.
- [4] AmrutaD.Hendre , George W.Taylor, Elisa M.Chavez, Susan Hyde : A systematic review of silver diamine fluoride : Effectiveness and application in older adults .2017
- [5] Yasmi O .Crystal , Richard Niederman : Evidence – BasedDentistry update on silver diamine fluoride : 2019
- [6] Shalin Shah, Vijay Bhaskar, KarthikVenkatraghavan, Prashant Choudhury, Ganesh M, and Krishna Trivedi: Silver diamine fluoride: A review and current applications .2014.
- [7] Jeremy A. Horst, NasahiroHeima: Prevention of Dental Caries by Silver diamine fluoride .2019.
- [8] Yamaga R, Nishino M, Yoshida S: Silver diamine and its clinical applications.
- [9] Clevens J, Gold J, Chaffin J: Effect and acceptance of SDF treatment on dental caries in primary teeth. 2018.
- [10] YasmiO.Crystal , Abdullah A. Marghalani , Steven D. Ureles , John Timothy Wright , Rosalyn Sulyanto , KimonDivaris , Margherita Fontana , Laurel Graham : Use of silver diamine fluoride for dental caries management in children and adolescents, including those with special health care needs.2017.
- [11] Yasmi O. Crystal, Richard Niederman: Silver diamine fluoride treatment considerations in children caries management.
- [12] Sherry Shiqian Gao, Kitty Jieyi. Chan, DuangpornDuangthip, May Chun Mei Wong, Edward Chin Min Lo and Chun Hung Chu: Preventing Early childhood caries with silver diamine fluoride: study protocol for randomised clinical trial.2020.

- [13] M. L. Mei, F. Nudelman, B.Marzec , J.M.Walker , E.C.M. Lo, A.W.Walls , C.H. Chu : Formation of fluorohydroxyapatite with silver diamine fluoride : 2017.
- [14] Irene Shuping Zhao, Sherry Shiqian .Gao , NorikaHiraishi, Michael Francis Burrow , DuangpornDuangthip , May Lei Mei , Edward Chin-May Lo , Chun – Hung Chu : Mechanism of silver diamine fluoride on arresting caries : A literature review . 2018.
- [15] Marcus H. T. Fung, May C.M. Wong, and Edward C. M. Lo: Arresting early childhood caries with silver diamine fluoride: A literature review.2013.
- [16] D. Duangthip, M.H.T. Fung, M.C.M. Wong, C.H.Chu, E.C.M.Lo: Adverse effects of silver diamine fluoride treatment among preschool children. 2017.
- [17] M.H.T. Fung, D.Duangthip, M.C.M. Wong, E.C.M Lo, and C.H. Chu: Arresting dentine caries with different concentration and periodicity of silver diamine fluoride. 2016.
- [18] J. A. Horst: Silver fluoride as a treatment for dental caries: 2018.
- [19] Chun Hung Chu, Lei Mei, ChamindaJayampathSeneviratne, and Edward Chin Man Lo: Effects of silver diamine fluoride on dentine carious lesions induced by streptococcus mutans, actinomycesnaeslundu biofilm: 2011.
- [20] May L .Mei, Q.L. Li, C.H. Chu, Cynthia K.Y. YIU, Edward C.M.: The inhibitory effects of silver diamine fluoride a different concentration on matrix metalloproteinases: 2012.
- [21] May L.Me, Edward Chin – Man Lo, Chun – Hung: Clinical use of SDF in dental treatment. 2016.