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Original Article

Evaluation of the Histology of Carious Human Primary Incisor after Treatment with 38% Silver Diamine Fluoride

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Abstract

Aim: The aim of the present study is to evaluate the histologic characteristics of carious human primary incisor after treatment with 38% silver diamine fluoride (SDF).

Objectives: The objectives of the study were as follows: (1) To evaluate the tertiary dentin formation after treatment with 38% SDF and (2) to evaluate the silver deposition in the dentinal tubules after treatment with 38% SDF.

Materials and Methods: As the study was an observational study and there was no comparative group present, we just observed the histologic changes that took place on the carious tooth surface with a sample size of 20. After the 38% SDF application on the carious tooth surface, they were decalcified with 10% nitric acid and subsequently stained with hematoxylin and eosin and observed under the light microscope.

Results: On histological examination, there was no pulp exposure seen. Tertiary dentin formation and silver deposition were noted in the dentinal tubules up to a depth of 1.2–1.5 μm.

Conclusion: The findings concluded that 38% SDF was advantageous in comprehensive and pre cooperative children.

Key words: 10% nitric acid, 38% silver diamine fluoride, Light microscope, Primary incisor

INTRODUCTION

Silver nitrate appears to be the first silver compound that was used to arrest dental caries without significantly affecting the dental pulp. The use of silver diamine fluoride (SDF) for the arrest of caries lesions, prevention of dental sensitivity, and prevention of the development of additional carious lesions is increasing in popularity during the past few years. SDF effect on the progression of dental caries is based on the fact that it combines the benefits of fluoride and silver; fluoride promotes remineralization and silver has an antimicrobial action.[1]

First documented usage of silver compounds in dentistry was reported by Stebbins in 1891, when he described the arrest of carious dental lesions by the application of silver nitrate. Silver was used in dentistry as early as the 1840s in the form of "nitrate of silver" (known as silver nitrate, $AgNO_3$). Percy Howe, then Director of the Forsyth Institute in Boston, added ammonia to silver nitrate making it more stable and effective as an antimicrobial for application to any infected tooth structure.[2]

In the past, several chemical and therapeutic agents have been used to arrest the caries formation. Many of the proposed remineralizing agents in the past are unable

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to arrest the caries and new dentin formation. However, very few studies have claimed the caries arresting efficacy of 38% SDF. Hence, the aim of the present study is to observe the histologic changes taking place on the caries during the treatment with 38% SDF. The two main components, fluoride and silver, are made soluble in water by the addition of ammonia. While metallic silver is inert, silver ions are broad-spectrum antimicrobial with high biocompatibility and low toxicity in humans. These act as tiny "silver bullets" that damage and degrade bacterial cell walls, disrupt bacterial DNA synthesis and replication, and disrupt intracellular metabolic activity, eventually leading to cell death.[1] The only disadvantage of the use of SDF is that it stains the treated lesion black.[2,3]

MATERIALS AND METHODS

A total of 20 pediatric patients between the age group of 6 and 9 years were selected for the study, with primary incisors having bilateral caries extending up to enamel/enamel and dentin on both the mesial and distal surfaces of the teeth.

A periapical radiograph of the tooth was taken to reveal the caries extent, tooth mobility, and periapical pathology of the tooth if present. Teeth with bilateral caries extending up to enamel/enamel and dentin, with Grade I or Grade II mobility, and without any pain and periapical pathology were selected [Figure 1].

Histological Evaluation of the Mesial Surface of the Teeth

The mesial surface of the teeth was treated with the application of 38% SDF with the purpose to arrest caries with a monthly follow-up for 6 months [Figure 2]. The teeth were judged at every monthly follow-up for its mobility and any other pain or periapical pathology. The teeth when attained a Grade III mobility were indicated for extraction with due consent of the patient. The teeth were then decalcified with 10% nitric acid. The decalcified tissues of the teeth were further tissue processed with the aim to remove water from tissues and replace with a medium that solidifies to allow thin sections to be cut.[4] First, the process of fixation was carried out, in which the specimen was placed in a liquid fixing agent (fixative), that is, 10% formalin which will slowly penetrate the tissue causing chemical and physical changes that will harden and preserve the tissue and protect it against subsequent processing steps.[5] This was followed by the routine steps of tissue processing. After paraffin embedding, 4–6 μm sections were cut on the microscopic slides and were stained with hematoxylin and eosin stain and then examined under light microscope.

Safety Parameters Taken into Consideration

The study was being carried out under complete ethical considerations and clearance. The patients were asked to report as soon as possible if the tooth exfoliates physiologically before the span of 6 months and preserve it in a biocompatible material like their own saliva or milk available at home/store, until getting it to the hospital. They were kept under a monthly follow-up for 6 months and if any adverse event takes place before time, they were asked to report as soon as possible to the hospital for the same. They were priorly informed about the only disadvantage of the study that the material used in the study stains the treated lesion black. The study was carried out in an age group which is subjected to physiological exfoliation of teeth and therefore there was no such potential risk to the patient. The patients were provided with the written explanation of the study and an informed consent was taken. Anonymization of the patient data was strictly followed during the study.

RESULTS

The results after histologic examination showed evidence of tertiary dentin formation with no pulp exposure and inflammation. (1) A slight faded layer of irregular tertiary dentin was seen adjacent to the flattened odontoblastic layer [Figure 3]. (2) Silver deposition was noted to a depth of 1.2–1.5 mm in the dentinal tubules [Figure 4].

Figure 1: Clinical picture of teeth with bilateral caries involving enamel and dentin

Figure 2: Application of 38% SDF under cotton roll isolation

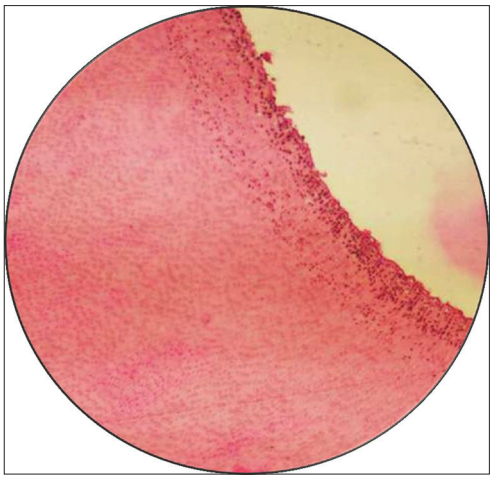

Figure 3: Low-power view demonstrating irregular tertiary dentin formation with minimal inflammation of the adjacent dental pulp (haematoxylin and eosin stain, original magnification 10×)

Figure 4: Medium-power view of dentinal tubules demonstrating black discoloration secondary to silver deposition (haematoxylin and eosin stain, original magnification 40×)

DISCUSSION

First research on SDF was conducted in 1969 at Osaka University in Japan. The powerful antimicrobial properties of silver with the benefits of a high dose of fluoride were combined and this formulation also resulted in a precipitate that occluded dentinal tubules and reduced the hypersensitivity.[6] This compound, AgF (NH3), is commonly misspelled or misinterpreted as SDF, however, the correct terminology is SDF as it contains two ammine groups (NH3), not two amine groups (NH2). The use of the term "diamine" became wide in use and has become the accepted form both in the scientific and marketing literature.[1]

Based on many studies all over world, a concentration of 38% SDF was found to be superior at arresting caries compared to lower concentrations of 10% or 12%. Stebbins successfully reported the usage of silver nitrate for arresting dental caries and reported a success (87 out of total 142 treated lesions were arrested) over 3-year period.[7] There have been various studies done previously on the microbial, histologic, and inhibition of demineralizing effects of SDF and silver fluoride on bovine enamel blocks, extracted human teeth with no caries, atraumatic technique using SDF followed with glass ionomer and non-carious dentin blocks, but not in extracted human carious teeth.[8-10]

A similar study was done by Enrique Bimstein and Douglas Damm in 2018, to describe the histological characteristics of a primary tooth with a 6-month follow-up after being treated with SDF.[11] They reported no carious pulp exposure tertiary dentin, a flattened odontoblastic layer adjacent to irregular tertiary dentin, dentinal tubules with silver deposits to a depth of 1 mm, and no bacteria. Kulnipa, Thanida, and Thansinee in 2017 did a study to investigate the remineralizing effect of 38% SDF and 1000 ppm fluoride toothpaste, where they concluded that 38% SDF enhances remineralization based on mineral density and depth compared to 1000 ppm fluoride toothpaste alone.[12] This study shows that SDF not only has an effect in arresting caries but also a remineralizing effect on the tooth.

There was a study done by Fung *et al.* in 2018, where they compared the effectiveness of two concentrations (12% or 38%) of SDF on a 30-month randomized clinical trial. They concluded that SDF at a concentration of 38% is more effective than that of 12% in arresting active caries in primary teeth and the application of 38% SDF semi-annually alone is more effective than that of 12% in arresting caries in primary teeth.[13] The results of this study are quite similar to our study and evidently shows the effect of 38% SDF applied over a period of 6 months, which is the concentration used in our study.

Since the presence of bacteria inside the dental tubules adjacent to deep caries is normal, it was unique that in the present study, the teeth showed no bacteria inside the dentinal tubules adjacent to the deep caries lesion, this being most likely the result of the antibacterial properties of SDF that include the "zombies effect:" When bacteria killed by silver ions are added to living bacteria, the silver kills the living bacteria.[14] It is also outstanding that despite the deep carious cavity minimal to none, signs of pulp inflammation were evident suggesting that the caries arrest, remineralization, and formation of tertiary dentin under the SDF may lead to pulp healing of reversible pulpitis.

CONCLUSION

The use of SDF to arrest deep caries in children until comprehensive treatment is available, leads to the

formation of the tertiary dentin and penetration of the silver ions in the dentinal tubules causing destruction of the bacteria. The use of this material will also be beneficial in reducing the morbidity and mortality rate in children due to pharmacological techniques of behavior management who are in still in their cognitive stage of development.

SDF is getting popularity for medical management of dental caries, but still there is a question on its parental acceptability on staining of the tooth. Further, research is needed to have a broader understanding of these values and of the decision-making factors related to parental acceptability of SDF.[15]

REFERENCES

1. Marwah N. Textbook of Pediatric Dentistry. Silver Diamine Fluoride. 4th ed. New Delhi: Jaypee Brothers; 2019. p. 1014-8.
2. Chu CH, Gao SS, Li SK, Wong MC, Lo EC. The effectiveness of the biannual application of silver nitrate solution followed by sodium fluoride varnish in arresting early childhood caries in preschool children: Study protocol for a randomised controlled trial. Trials 2015;25:426.
3. Shah S, Bhaskar V, Venkatraghan K, Choudary P, Ganesh M, Trivedi K. Silver diamine fluoride: A review and current applications. J Adv Oral Res 2014;5:25-35.
4. Rolls G. An Introduction to Specimen Processing; 2019.
5. Hopwood D. Fixation and fixatives. In: Bancroft J, Stevens A, editors. Theory and Practice of Histological Techniques. New York: Churchill Livingstone; 1996.
6. Russell AD, Hugo WB. Antimicrobiological activity and action of silver. Prog Med Chem 1994;31:351-70.
7. Stebbins EA. What value has argenti nitras as a therapeutic agent in dentistry? Int Dent J 1891;12:661-70.
8. Nelson T, Scott JA, Crystal YO, Berg JH, Milgrom P. Silver diamine fluoride in pediatric dentistry training programs: Survey of graduate program directors. Pediatr Dent 2016;38:212-7.
9. Horst JA, Ellnikiotis H, Milgrom P. UCSF protocol for caries arrest using silver diamine fluoride: Rationale, indications, and consent. J Calif Dent Assoc 2016;44:16-28.
10. Knight GM, McIntyre JM, Craig GG, Mulyani, Zilm PS, Gully NJ. Differences between normal and demineralized dentine pretreated with silver fluoride and potassium iodide after an *in vitro* challenge by *Streptococcus mutans*. Aust Dent J 2007;52:16-21.
11. Bimstein E, Damm D. Human primary tooth histology six months after treatment with silver diamine fluoride. J Clin Pediatr Dent 2018;42:442-4.
12. Punyanirun K, Yospiboonwong T, Kunapinun T, Thanyasrisung P, Trairatvorakul C. Silver diamine fluoride remineralized artificial incipient caries in permanent teeth after bacterial pH-cycling *in vitro*. J Dent 2017;69:55-9.
13. Fung MH, Duangthip D, Wong MC, Lo EC, Chu CH. Randomized clinical trial of 12% and 38% silver diamine fluoride treatment. J Dent Res 2018;97:171-8.
14. Wakshlak RB, Pedahzur R, Avnir D. Antibacterial activity of silver-killed bacteria: The "zombies" effect. Sci Rep 2015;5:9555.
15. Gordon NB. Silver diamine fluoride staining is acceptable for posterior primary teeth and is preferred over advanced pharmacologic behavior management by many parents. J Evid Based Dent Pract 2018;18:94-7.

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