

Human Primary Tooth Histology Six Months after Treatment with Silver Diamine Fluoride

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Objective: To describe the histological characteristics of a human primary tooth with deep caries next to the dental pulp 6 months after being treated with silver diamine fluoride (SDF). **Study design:** A tooth that was considered to be not restorable 6 months after being treated with SDF was examined with light microscopy. **Results:** the histologic examination revealed 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, and a pulp with no significant inflammation. **Conclusions:** The use of silver diamine fluoride as an interim treatment of deep caries on vital carious primary teeth of children, leads to histologic changes that prevent pain and pulp deterioration, and most likely facilitate pulp healing. These unique findings expand the knowledge about the effect of SDF on the human dental tissues.

Key words: caries, histology, silver diamine fluoride.

INTRODUCTION

Silver nitrate appears to be the first silver compound that was used to arrest dental caries without significantly affecting the dental pulp.¹⁻³ 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 last few years.¹⁻⁴ 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.² More specifically, SDF: a) precipitates on carious dentine tubules reducing their solubility and providing instant caries arrest; b) facilitates enamel and dentin remineralization; c) facilitates the formation of tertiary dentin; d) is antibacterial; e) involves an easy and simple procedure that does not require the use of local anesthetic, since it requires none to minimal caries removal; and f) is relatively inexpensive.^{1, 3-6} The disadvantage of the use of SDF is that it stains the treated teeth black.^{1, 3}

The aim of this report is to present the histologic findings of a primary human molar that was treated with 38% silver diamine fluoride 6 months before the tooth was extracted. The tooth was judged to be non-restorable and removed during comprehensive dental treatment under general anesthesia.

MATERIALS AND METHOD

A 4-year old female presented with severe early childhood caries. A periapical radiograph of the left mandibular first deciduous molar revealed extensive coronal decay that was approaching the pulp chamber. This tooth was treated with an application of SDF (Advantage Arrest Silver Diamine Fluoride 38%, Elevate Oral Care, Palm Beach Florida 33411) with the purpose to arrest the caries progress until an appointment for comprehensive dental treatment under general anesthesia could be obtained. At the time the SDF treatment was provided, the child was not in pain and remained without pain until the day of the comprehensive treatment. Six months later during the comprehensive dental treatment, the tooth was judged non-restorable (Figure 1) and was extracted. The tooth was placed in 10% buffered formalin and subsequently decalcified with 10% nitric acid. After embedding in paraffin, 6 µm sections were stained with hematoxylin and eosin then examined by light microscopy.

Histologic findings

The histologic examination revealed no pulp exposure, evidence of tertiary dentin formation and minimal pulpal inflammation (Figure 2 and 3). Adjacent to the irregular tertiary dentin was an intact but flattened odontoblastic layer (Figure 3). Numerous dentinal tubules demonstrated deposits of silver to a depth of 1mm with no bacteria noted in these tubules proximal to the silver deposition (Figure 4).

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Figure 1: Periapical radiograph of the left mandibular first deciduous molar demonstrating extensive coronal decay approaching the pulp chamber.

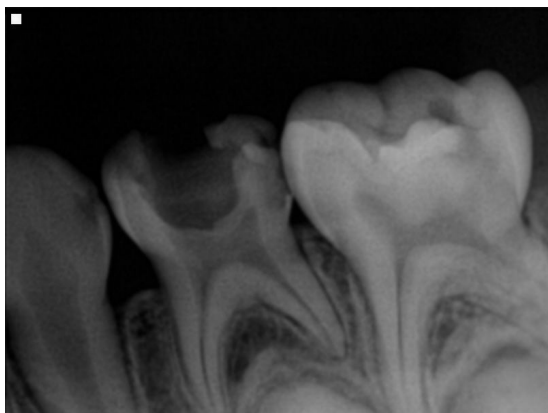


Figure 2: Low-power view demonstrating irregular tertiary dentin formation with minimal inflammation of the adjacent dental pulp (hematoxylin and eosin stain, original magnification 4X).

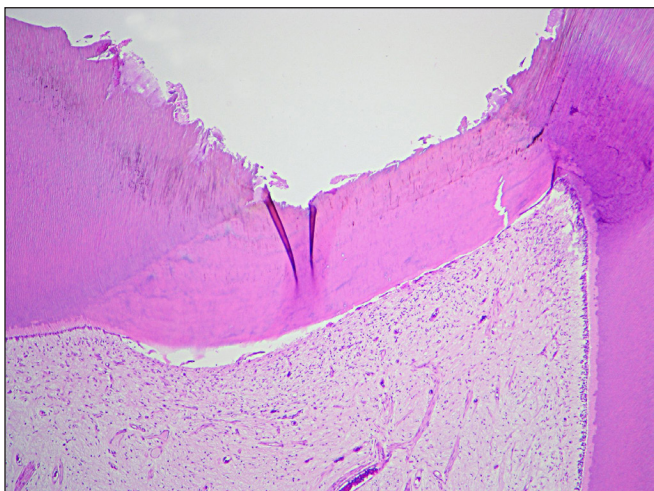


Figure 3: Medium-power view demonstrating irregular tertiary dentin with adjacent intact but flattened odontoblastic layer (hematoxylin and eosin stain, original magnification 10X).

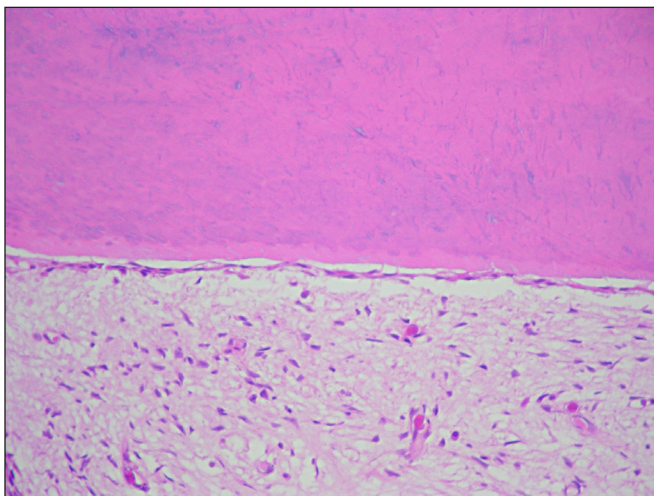
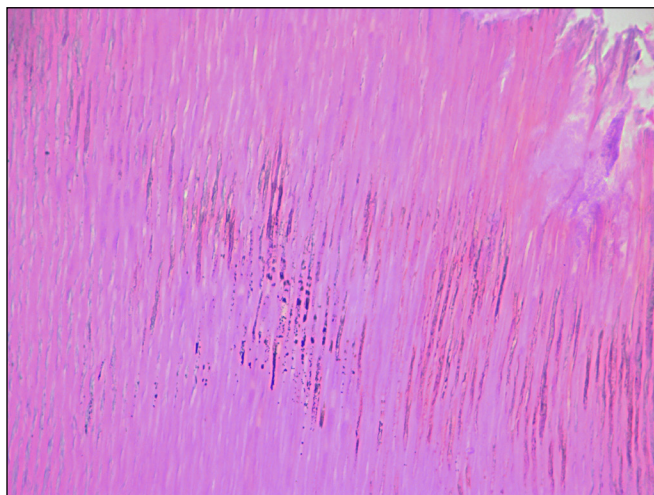


Figure 4: Medium-power view of dentinal tubules demonstrating black discoloration secondary to silver deposition (hematoxylin and eosin stain, original magnification 20X).



DISCUSSION

Despite of the limitation of this brief communication reporting the findings from only one tooth, the present findings expand the knowledge about the effect of SDF on the human dental tissues. Moreover, the opportunity of histologically examine a human tooth 6 months after application of SDF is singular and cannot purposely planed in advance.

SDF indications include children with extreme caries risk, behavioral or medical management complications, carious lesions that may not-be treated within a reasonable period of time, and lack of access to comprehensive dental care.^{1,7} Numerous publications demonstrating successful utilization of SDF have been associated with an increased clinical utilization and the incorporation of this technique into the curriculum and clinical education of many universities.¹ In the present case, the use of SDF was elected due to the severity of the early childhood caries in the patient, the patient's inability to cooperate in a regular clinical setting, and the long period of time before an available appointment for comprehensive treatment under general anesthesia could be obtained.

Previous studies on the microbial, histologic and inhibition of demineralization effects of SDF and silver fluoride have been done on bovine enamel blocks, extracted human teeth with no caries, atraumatic technique using SDF followed with glass ionomer and non-carious dentine blocks, but not in extracted human carious teeth.⁴⁻¹¹ The present report is unique since it describes histologic findings from an extracted human primary tooth 6 months after being treated with SDF with the purpose to arrest deep caries progression until an appointment for comprehensive dental care. These extraordinary circumstances provided an unusual most likely non-reproducible event. The present evidence of silver deposits to a depth of about 1 mm in the dentinal tubules was unexpected, since previous reports indicate that silver and fluoride penetrate ≈10 microns in enamel, and between 50 to 200 microns in dentine.⁷ The difference being most likely due to the fact that in the present tooth the SDF was placed in very close proximity to dentinal tubules already affected by the caries process.

Since the presence of bacteria inside the dental tubules adjacent to deep caries is normal,^{12, 13} it was unique that in the present tooth no bacteria was seen inside the dentinal tubules adjacent to the deep caries lesion, this being most likely the result of the anti-bacterial 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.^{7, 14} It is also outstanding that despite of 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.

The present findings are consistent with a previous study that indicated that SDF placed in deep class V cavities of non-carious premolars and extracted 6 weeks later due to orthodontic reasons, facilitated the production of tertiary dentin and did not induce pulp inflammation.¹⁵ From the patient point of view, the benefit of the use of SDF was that the histologic dental changes elicited by the use of SDF lead to a relatively long period of waiting time until the comprehensive treatment with no pain.

CONCLUSION

The use of silver diamine fluoride on vital carious primary teeth of children, as an interim treatment until comprehensive treatment is available, leads to dental histologic changes that prevent pain, pulp exposure, pulp deterioration, and most likely facilitate pulp healing.

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