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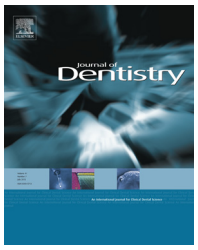

Inhibitory effect of silver diamine fluoride on dentine demineralisation and collagen degradation

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ABSTRACT

Objective: To investigate the inhibitory effects of 38% silver diamine fluoride (SDF) on demineralised dentine.

Methods: Human dentine blocks were demineralised and allocated to four groups: SF, F, S and W. The blocks in group SF received a topical application of 38% SDF solution (253,900 ppm Ag, 44,800 ppm F), group F received a 10% sodium fluoride solution (44,800 ppm F), group S received a 42% silver nitrate solution (253,900 ppm Ag) and group W received deionised water (control). They were subjected to pH cycling using demineralisation solution (pH 5) and remineralisation solution (pH 7) for 8 days. The surface morphology, crystal characteristics, lesion depth and collagen matrix degradation of the specimens were investigated by scanning electron microscopy (SEM), X-ray diffraction (XRD), micro-CT testing and spectrophotometry with a hydroxyproline assay.

Results: The surface morphology under SEM showed evident demineralisation with exposed collagen in groups S and W, but not in group SF. Clusters of granular spherical grains were observed in the cross-sections of specimens in groups SF and F. XRD revealed precipitates of silver chloride in groups SF and S. The mean lesion depths (±SD) of groups SF, F, S and W were 182 ± 32 μm, 204 ± 26 μm, 259 ± 42 μm and 265 ± 40 μm, respectively (SDF, F < S, W; $p < 0.01$). Groups SF and S had significantly less hydroxyproline liberated from the dentine matrix than groups F and W ($p < 0.01$).

Conclusion: The use of 38% SDF inhibited demineralisation and preserved collagen from degradation in demineralised dentine.

Clinical significance: SDF application positively influences dentine remineralization.

1. Introduction

A variety of chemical agents have been used in clinical trials or *in vitro* studies to arrest dentine caries. Some antimicrobial agents contain silver (Ag), which is bactericidal.[1] The first widely reported silver-containing agent for arresting dentine caries was silver nitrate ($AgNO_3$), and 25% silver nitrate is used to arrest carious lesions in the US.[2] Topical fluoride (F) agents such as sodium fluoride (NaF) and silver diamine fluoride (SDF) are also used for arresting caries.[3] A literature review for SDF concluded that it is effective in preventing and arresting coronal and root caries.[4] Another review concluded that SDF is a safe, effective, efficient and equitable caries-preventive agent that appears to meet the criteria of the WHO Millennium Goals and the US Institute.[5] While studies report clinical

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success with SDF in arresting dental caries,[5] laboratory studies have found that SDF has an intense antibacterial effect on cariogenic biofilm, and hinders caries progression.[6–9]

While Liu et al.[10,11] demonstrated that SDF increased the mineral density of demineralised enamel lesions in a mineralising solution, the inhibitory effect of SDF on demineralised dentine is yet to be studied. Acid attacks generate demineralised dentine. The acid can arise from bacteria (causing dental caries), food and beverages (causing dental erosion) or even from acid etching during dental procedures. Regarding dental caries, enamel caries are basically the dissolution of minerals by bacterial acids, whereas dentine caries are a complex progression involving both demineralisation and organic degradation.[12] The organic matrix is exposed once a dentine surface is demineralised. Fibrillar type I collagen accounts for 90% of the organic matrix while the remaining 10% consists of non-collagenous proteins. The remineralisation process should be controlled through the interactions of mineral crystallites with the collagen matrix. The remineralisation process requires not only a sufficient supply of calcium and phosphate ions but also the preservation of the integrity of the dentine collagen, which acts as a scaffold for mineral deposition.[13,14] Therefore, this study aimed to investigate the mechanism of SDF in the remineralisation of demineralised dentine from both mineral and collagen aspects. The null hypothesis was that there is no difference in the inhibitory effect on dentine demineralisation and collagen degradation of 38% SDF solution (253,900 ppm Ag and 44,800 ppm F), 10% NaF solution (44,800 ppm F), 42% $AgNO_3$ solution (253,900 ppm Ag) and deionised water.

2. Materials and methods

2.1. *Preparing specimens with artificial dentine caries*

This study was approved by the Institutional Review Board (IRB UW08-052). The flow chart in Fig. 1 summarises the protocol of this study. Extracted sound human molars were collected with patient consent. Teeth were stored in distilled water at 4 °C until use and were used within one month of extraction. Eighteen dentine blocks with the thickness of 2 mm were prepared from 18 molars. The surfaces of the blocks were polished using micro-fine 4000 grid sanding paper. The polished slices were examined using a stereomicroscope to exclude samples with cracks or other defects. Each slice was cut into four specimens for different treatments afterwards. Therefore, 72 specimens were prepared.

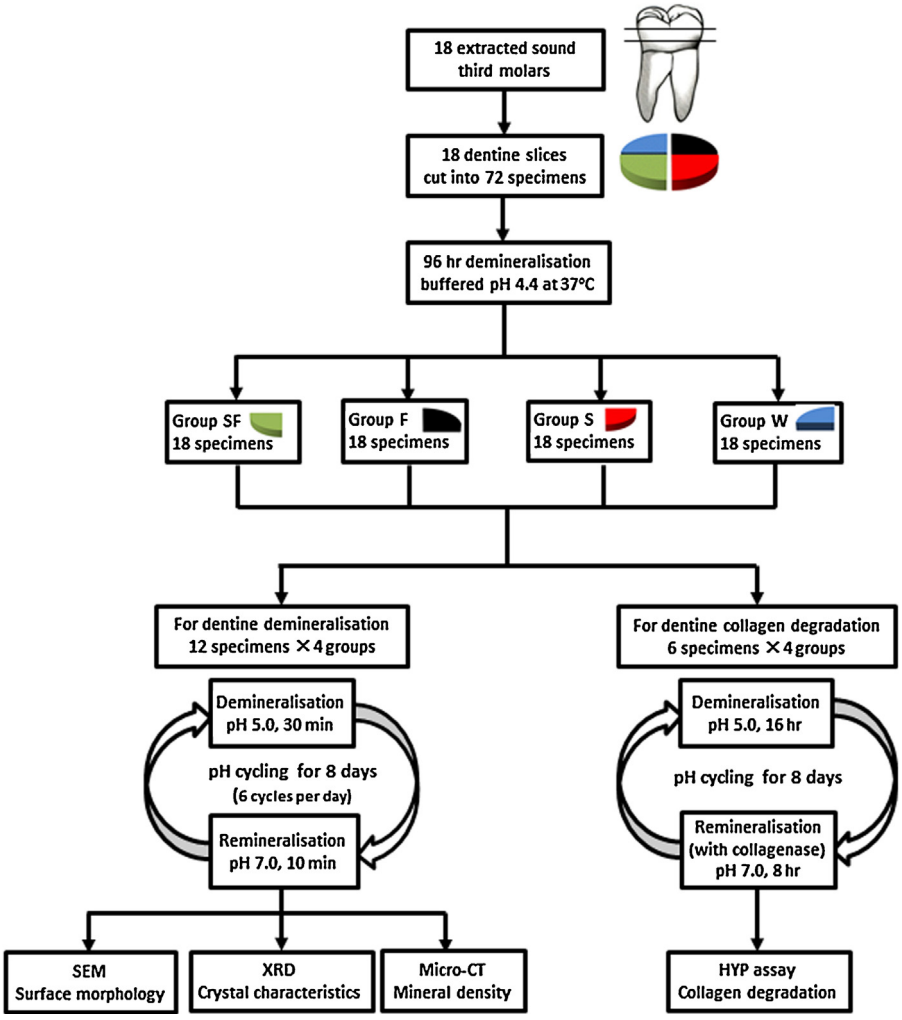

Fig. 1 – Flowchart of the experiment design.