Effects of LED Curing Light on Silver Diamine Fluoride Penetration into Dentin

Cerezal G, Crystal YO, Rabieh S, Janal MN, Hu B, Hmadeh N, Bromage TG

New York University College of Dentistry, NY

Background/Objective

Silver Diamine Fluoride (SDF) is a liquid that combines the antibacterial properties of Silver and the remineralizing properties of Fluoride in a stabilized solution of ammonia that has proven to arrest dentinal caries.
SDF has been adopted in Pediatric Dentistry as a non-surgical option when restorative treatment is not feasible as in children who are uncooperative for treatment and special needs populations.
Recommended application time is at least 1 min, which is challenging in these vulnerable populations. Preliminary data suggest that exposure to a curing light after SDF application promotes immediate darkening of the tissue that is indicative of caries arrest.

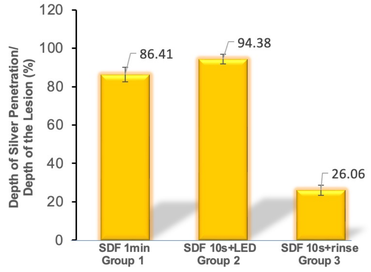
AIM: The aim of this study was to compare the depth of SDF penetration into deep carious lesions of primary teeth following the standard protocol, 1 min exposure, to that produced by 10 sec application of SDF, with and without immediate exposure to an LED curing light.

Methods

Twenty-four extracted primary teeth with deep carious lesions were allocated into 5 groups and treated within 5 minutes after extraction:
Group 1: Treated with 1 drop of SDF for 1 min followed by 10 sec rinse with tap water (n=6);
Group 2: Treated with 1 drop of SDF for 10 sec and exposed to LED light for 20 sec followed by 10 sec rinse with tap water (n=6);
Group 3: Treated with 1 drop of SDF for 10 sec followed by tap water rinse for 1 min (n=6);
Group 4: Untreated (Control group, n=3);
Group 5: Untreated but exposed to LED light for 20 sec (Control group, n=3).
Samples were prepared, embedded, sectioned and the depth of silver penetration and total lesion depth were measured at 5 locations using quantitative backscattered scanning electron microscopy (qBSE-SEM) and energy-dispersive X-ray spectroscopy (EDS) analysis. All measurements were completed in an area of each lesion that was surrounded by sound dentin. The proportion (%) of the lesion depth occupied by silver was compared between groups with ANOVA and post-hoc tests.
Element tracing was identified to verify silver (Ag) presence in the dentin using *ESPRIT version 2.2 software*.

Results

Graph shows the mean depth of silver penetration as a % of total lesion depth (+/- 95% confidence limits) for each of groups 1, 2 and 3. Groups 1 and 2 were statistically significantly different from group 3.



Images below represent one sample from each group in rows. The first two columns in each row correspond to qBSE-SEM, and the second two correspond to EDS analysis.

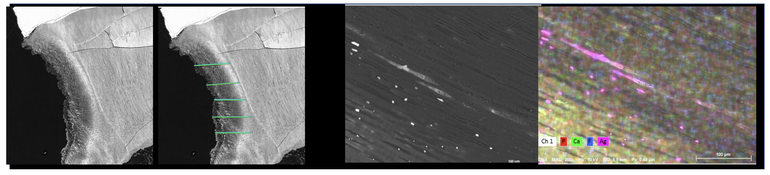


Figure 1: Sample of group #1 (SDF 1 min)

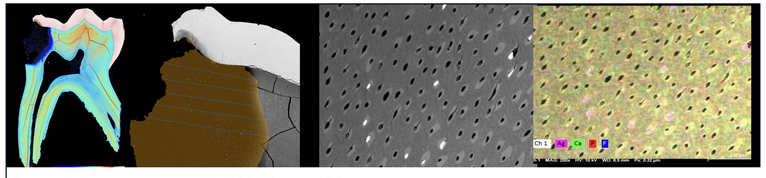


Figure 2: Sample of group #2 (SDF 10 sec + LED light)

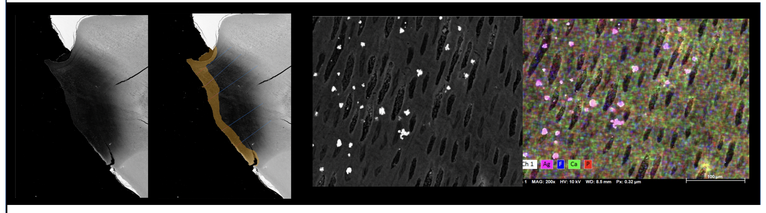


Figure 3: Sample of group #3 (SDF 10 sec + Rinse)

All samples from groups 1, 2 and 3 showed a highly mineralized area as shown in the figure 1, as well as silver penetration. Control groups 4 and 5 showed no silver.
The median total lesion depth was similar for each of the three groups. The mean depth of silver penetration was: 86.4% in group 1, 94.3% in group2, 26.1% in group 3.

Discussion

The mechanism of action of SDF is still not fully understood, but silver penetration could be a marker for how deep into the lesion or dentinal tissues would the antibacterial and remineralizing effects of SDF take effect.
In only one of the 24 samples, we saw blockage of the dentinal tubules in a small area close to the surface, which could be because the sample at that depth was sliced exactly parallel to the direction of the dentinal tubules. In the rest of the samples, complete tubular blockage was not seen, and the pattern of penetration was irregular, with silver present in some areas of the dentinal tissue.

Conclusions/Summary

The use of LED curing light for 20 sec after 10 sec of SDF application seems to facilitate silver penetration, making it comparable to a 1-min SDF application with no light.
LED curing light exposure after application could be an important aid in SDF use, making the silver penetration with short application times comparable to 1 min application. This would be helpful in the clinical management of young children and patients with special health care needs.
Clinical studies are needed to determine the correlation of silver penetration and sustained arrest of dentinal caries lesions, as well as laboratory studies to determine the mechanism by which LED light promotes penetration of silver into dentinal tubules and tissue.

References

Gao SS, Zhao IS, Hiraishi N, Duangthip D, Mei ML, Lo ECM, et al. Clinical Trials of Silver Diamine Fluoride in Arresting Caries among Children: A Systematic Review. JDR Clin Trans Res. 2016;1(3):201-10.
Crystal YO, Marghalani A, et al. Use of Silver Diamine Fluoride for Dental Caries Management in Children and Adolescents, Including Those with Special Health Care Needs. Pediatr Dent. 2018;40(6):152-61.
Mei ML, Ito L, Cao Y, Lo EC, Li QL, Chu CH. An ex vivo study of arrested primary teeth caries with silver diamine fluoride therapy. J Dent. 2014;42(4):395-402.
Crystal YO, Niederman R. Silver Diamine Fluoride Treatment Considerations in Children's Caries Management. Pediatr Dent. 2016;38(7):466-71.