UNIVERSITY OF ILLINOIS CHICAGO
College of Dentistry

The Effect of Silver Diamine Fluoride on the Mineral Properties of Hypomineralized Enamel: In Vitro Analysis

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BACKGROUND

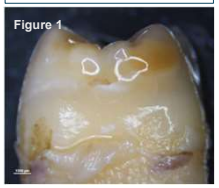
- Molar-Incisor Hypomineralization (MIH) is a developmental condition characterized by hypomineralized enamel defects of 1 to 4 of the first permanent molars (PFM), frequently associated with affected incisors.
- The opacities characteristic of MIH can vary in appearance, ranging from whitish to creamy yellow to brownish defects, with well-demarcated borders.
- Clinical complications associated with MIH include post-eruptive breakdown (PEB), rapid caries progression, hypersensitivity, and difficulty achieving profound anesthesia
- Silver diamine fluoride (SDF) was approved by the U.S. Food and Drug Administration (FDA) in 2015 for the treatment of dental sensitivity. Yet, it has proven transformative over the years in both managing sensitivity and arresting dental caries.
- Clinical management of affected molars presents challenges, often complicated by hypersensitivity, suboptimal oral hygiene, and difficulty achieving profound local anesthesia during restorative care
- Limited information exists on the biochemical and molecular characteristics of hypomineralized enamel following silver diamine fluoride (SDF) treatment.

OBJECTIVES

The aim of this study is to evaluate the mineral density, color change, and chemical characteristics of hypomineralized enamel treated with SDF when compared to intact, non-hypomineralized SDF-treated enamel through an in vitro analysis.

METHODS

Study was approved by UIC IRB (Protocol #STUDY2024-0741)



- Eighteen extracted PFMs (Control n = 8; MIH n = 10) were examined under standardized criteria (EAPD 2001) **(Figure 1).**
- Specimens were stored at −20 °C, cleaned, sectioned (Isomet 1000), and coated with acid-resistant nail polish, leaving a 3 × 3 mm enamel window.
- Samples received 38% SDF for 1 minute, air-dried without rinsing, incubated in artificial saliva at 37 °C for 1 week under remineralizing conditions prior to post-treatment analyses.
- Three experiments were conducted as in **figure 2, 3, and 4**

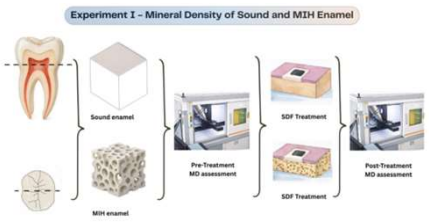


Figure 2. Experiment I assessed mineral density by micro–computed tomography (microCT) before and after SDF treatment.

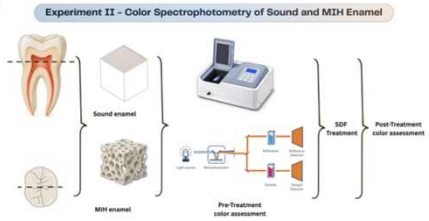


Figure 3. Experiment II assessed color by spectrophotometry before and after SDF treatment

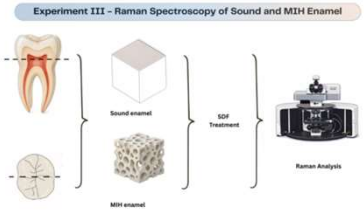


Figure 4. Experiment III assessed chemical composition by Raman spectroscopy after treatment (n = 3/ per group). Specimens were further subjected to a remineralization cycling consisting of 2 hours of demineralization and 22 hours of remineralization at 37 °C with no agitation for 4 days.

RESULTS

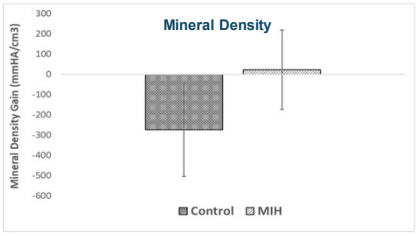


Figure 5. Mean and standard deviation values of mineral density gain (mmHA/cm3) of the Control and MIH groups after SDF treatment (p=0.036, Student's T-test)

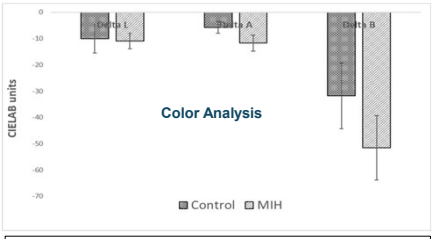


Figure 6. Mean and standard deviation of the total color changes (delta) of the color components (L*, a*, and b*) for the Control and MIH groups (a* and b* components, p=0.002 and p=0.011, respectively, Student's T-test)

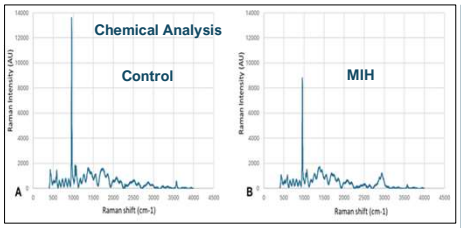


Figure 7. Superficial representative Raman spectra collected from SDF-treated Control (A) and SDF-treated MIH (B) enamel, showing the peaks phosphate (PO4): 958 cm-1; C–H stretching: 2800–3000 cm^{-1}; O–H stretching of HAp: 3570–3580 cm^{-1}.

Mineral Density

- The MD gain/loss had a statistically significant difference between groups (p=0.036). The Control group showed a decrease in the mean MD (-274 mmHA/cm3) after SDF treatment, and the MIH group showed an increase in the mean MD (22 mmHA/cm3) **(Figure 5)**

Color Analysis

- When total color differences across all components were compared, the t-test indicated statistically significant differences between the Control and MIH groups for the a* and b* components (p=0.002 and p=0.011, respectively) **(Figure 6)**

Chemical analysis

- Control enamel specimens exhibited higher intensity at 960 cm^{-1} and lower intensity at 2850–3050 cm^{-1} compared with the MIH Group **(Figure 7)**

CONCLUSION

- Although overall post-treatment mineral density did not differ significantly between groups, MIH enamel showed a tendency toward mineral gain, suggesting a stabilizing effect.
- Color changes were measurable but not clinically perceptible, with greater shifts in MIH enamel.
- Raman analysis confirmed inherent structural differences in MIH enamel that were not significantly altered by SDF, indicating primarily surface-level interactions. Overall, SDF supports mineral preservation and surface protection in hypomineralized enamel without restoring its underlying structure.