

REMINERALIZING INCIPIENT LESIONS IN PRIMARY TEETH: DEPTH-DEPENDENT MICROHARDNESS CHANGES

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BACKGROUND

- ❖ **Decalcification of enamel** is the earliest stage of caries formation. Without intervention, lesions can progress into dentin, leading to cavitation and potentially severe oral health consequences.
- ❖ **In primary teeth, enamel is less mineralized and more porous than permanent teeth**, making it even more important to detect and arrest incipient lesions before they become irreversible and require extensive restorations.
- ❖ **Fluoride Varnish (FV)** and **Silver Diamine Fluoride (SDF)** are commonly used minimally invasive treatments with remineralizing capabilities and antimicrobial properties.
- ❖ **Curodont™** is a low-viscosity liquid composed of self-assembling peptide (SAP) P11-4 monomers, that form a fibrillar scaffold when applied to a carious lesions. Calcium, phosphate, and fluoride ions from saliva precipitate within the peptide matrix, leading to *de novo* hydroxyapatite crystal formation and biomimetic enamel regeneration.

OBJECTIVE & HYPOTHESIS

Objective

To assess and compare, *in vitro*, the ability of silver diamine fluoride (SDF), 5% sodium fluoride varnish (FV; 3M™ Vanish™ 5% Sodium Fluoride White Varnish), and a self-assembling peptide (Curodont™ Repair) to remineralize incipient enamel caries lesions in primary teeth.

Hypotheses

H₀: There are no significant differences in the remineralization efficacy of Curodont™, 3M™ Varnish™, and 38% Silver Diamine Fluoride treatments on demineralized enamel surfaces in primary teeth.

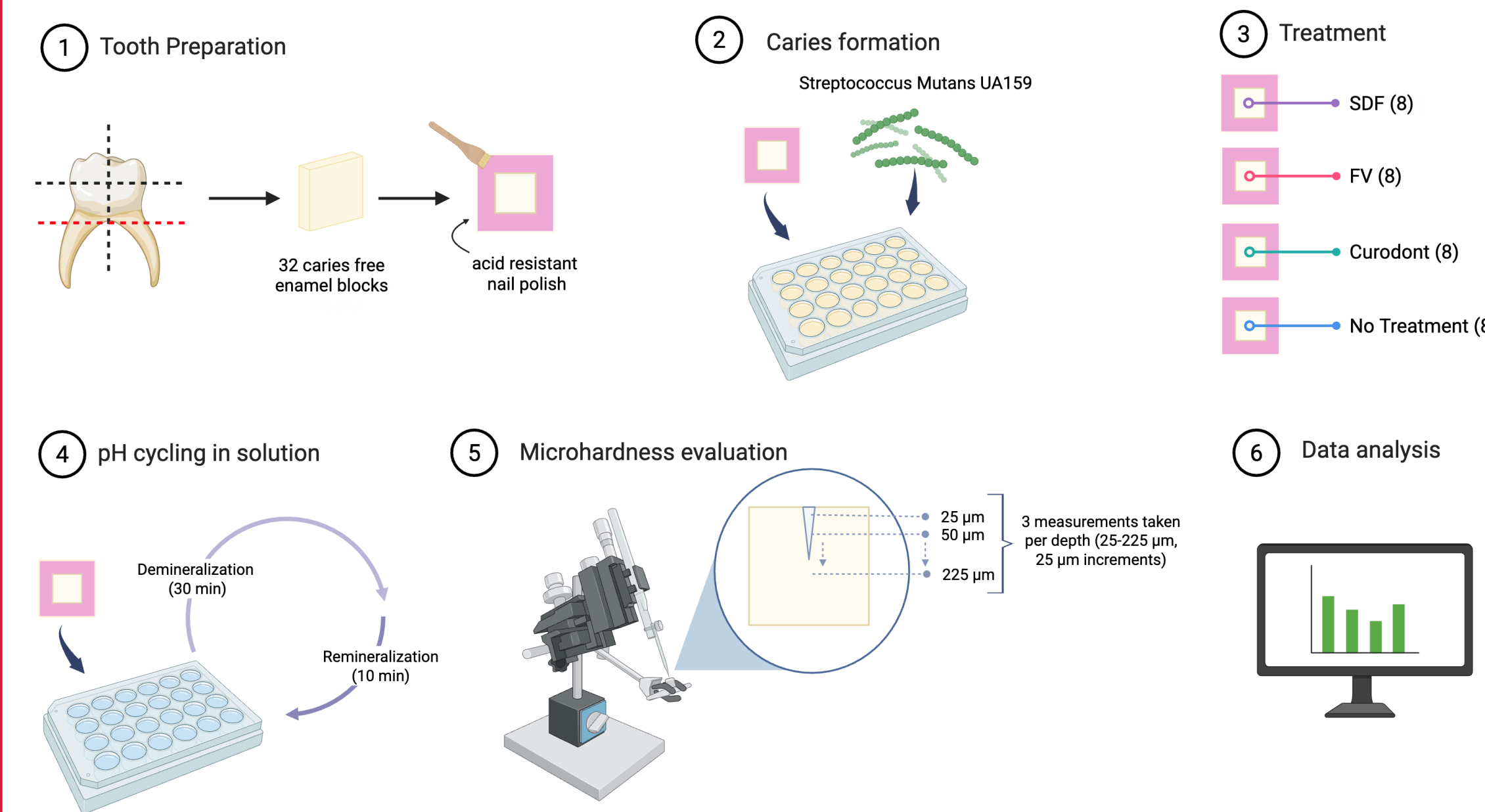
H₁: The remineralization efficacy of **38 % Silver Diamine Fluoride** is significantly higher than Fluoride Varnish and Curodont™ when used on primary teeth.

H₂: The remineralization efficacy of **3M™ Varnish™** is significantly higher than Curodont™ and 38% Silver Diamine Fluoride when used on primary teeth.

H₃: The remineralization efficacy of **Curodont™** is significantly higher than 3M™ Varnish™ and 38% Silver Diamine Fluoride when used on primary teeth.

MATERIALS & METHODS

Figure 1. Study Design Overview. Figure made using Biorender.com.



- (1) Eight primary teeth extracted for surgical reasons were cut to prepare n=32 caries free enamel blocks.
- (2) White spot lesions were induced by inoculating the specimens with *Streptococcus mutans* and exposing them to sugar challenges 8x per day for one week.
- (3) Specimens were divided into 4 groups of n=8 and treatments were applied according to manufacturer instructions.
- (4) Specimens underwent pH cycling for one week.
- (5) Knoop microhardness values were measured and calculated (25 gf; 10 sec).
- (6) Statistical analysis was performed using a mixed linear effects model ($\alpha=0.05$).

RESULTS

Figure 2. Distribution of Enamel Microhardness Across Depths by Treatment Group

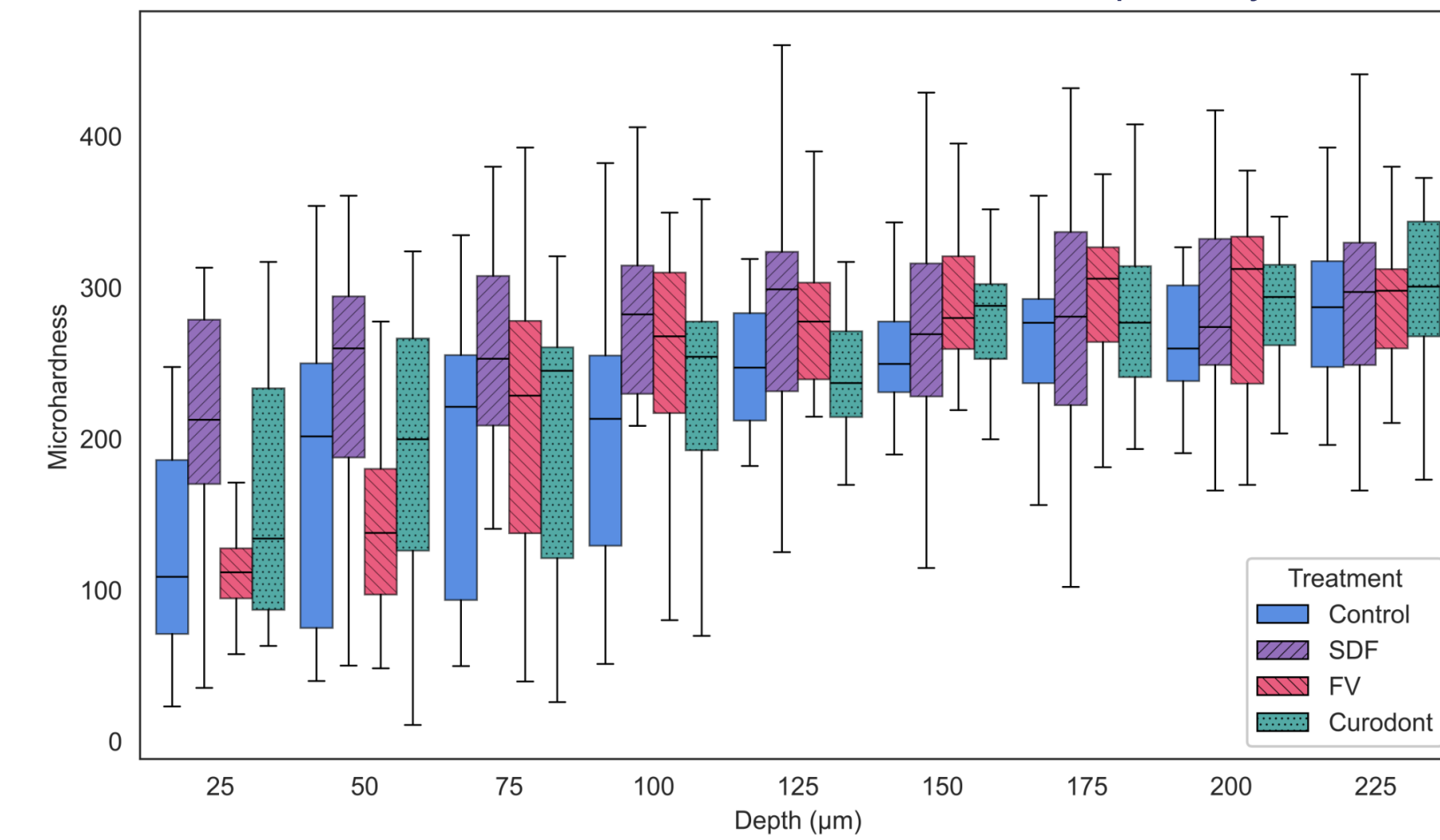


Figure 3. Line Plot Showing General Trends Across Depths by Treatment Group

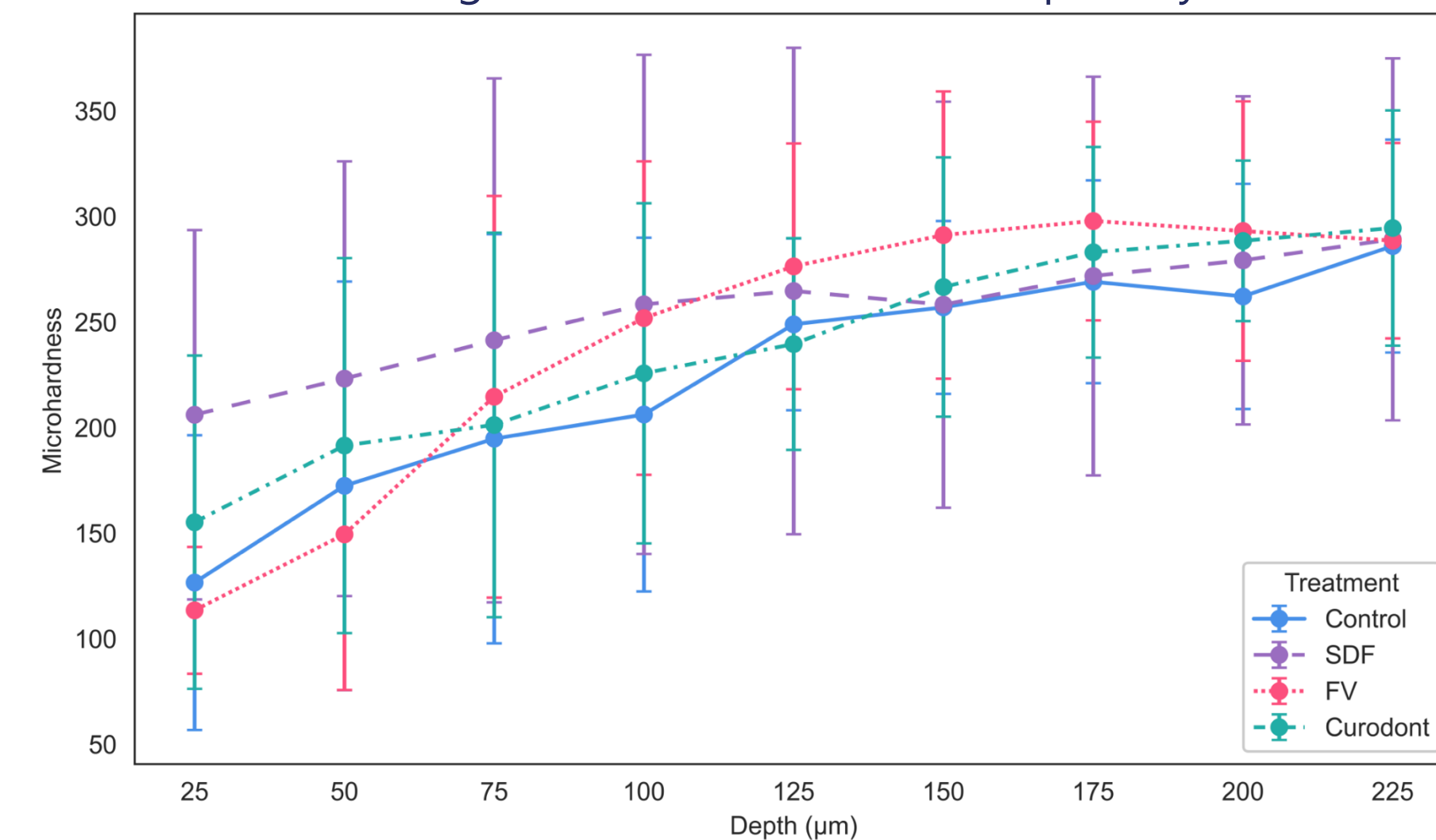


Table 1. Comparative p-values Across All Depths

	Comparative p-values		
	SDF	FV	CURODONT
CONTROL	0.2605	0.7201	0.8346
SDF		0.8581	0.7492
FV			0.9967

Table 2. Pairwise p-values Across All Depths

		Comparative p-values		
		SDF	FV	CURODONT
25 μm	CONTROL	0.0023	0.9347	0.5724
	SDF		0.0002	0.1027
	FV			0.2400
50 μm	CONTROL	0.1044	0.7290	0.8272
	SDF		0.0056	0.4839
	FV			0.2339
75 μm	CONTROL	0.1564	0.8072	0.9910
	SDF		0.6263	0.2746
	FV			0.9320
100 μm	CONTROL	0.0897	0.1700	0.8158
	SDF		0.9913	0.4574
	FV			0.6415
125 μm	CONTROL	0.8931	0.6046	0.9748
	SDF		0.9528	0.6703
	FV			0.3484
150 μm	CONTROL	0.9999	0.4139	0.9723
	SDF		0.4494	0.9818
	FV			0.6860
175 μm	CONTROL	0.9993	0.5666	0.9224
	SDF		0.6447	0.9574
	FV			0.9099
200 μm	CONTROL	0.8687	0.5047	0.6374
	SDF		0.9241	0.9757
	FV			0.9968
225 μm	CONTROL	0.9989	0.9995	0.9806
	SDF		1.0000	0.9951
	FV			0.9931

DISCUSSION

- ❖ **FV treated samples had the lowest average microhardness at 25 μm and 50 μm, performing statistically significantly worse than SDF at both depths.**
 - ▶ FV is known to improve resistance to acid challenges, with fluorapatite having a lower critical pH compared to hydroxyapatite (4.5 vs. 5.5).
 - ▶ However, once structural breakdown has occurred, fluoride varnish is unable to sufficiently remineralize lesions and recover microhardness.⁶
- ❖ **SDF treated samples demonstrated statistically significant microhardness recovery compared to the control at 25 μm and FV treated samples at 25 μm and 50 μm.**
 - ▶ SDF has a higher fluoride concentration compared to FV (44,800 ppm vs. 22,600 ppm) and has potent antimicrobial properties.
 - ▶ There are still some drawbacks such as staining which make it a less ideal treatment option, particularly for anterior teeth.
- ❖ **Curodont™ did not have statistically significant microhardness recovery at any depth compared to the control or other treatment groups.**
 - ▶ Curodont™ requires ideal concentrations of calcium and phosphate ions as well as optimal pH balance for correct peptide folding and in order to induce *de novo* hydroxyapatite synthesis.⁷
 - ▶ Optimal results from treatment with Curodont™ often requires several months and benefits from reapplication.⁸
 - ▶ *In vivo* studies conducted over longer periods of time have suggested Curodont™ is able to reduce the appearance and surface area of white spot lesions, which may make it a good alternative treatment to SDF especially for treatment of anterior teeth.^{9,10} However, more trials are needed.

CONCLUSIONS

- ❖ While FV may be an efficacious preventative therapy, it is not sufficiently able to remineralize lesions progressing past a certain degree of mineral loss.
- ❖ SDF is an effective method for arresting enamel caries, particularly in high-risk patients.
- ❖ Curodont™ did not have any statistically significant effect in this study, but the *in vitro* study design experienced limitations in experimental time and conditions.
- ❖ Future work is needed to investigate the efficacy of minimally invasive dental therapeutics and refine best practices for choosing treatments to manage incipient carious lesions in primary teeth.

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IRB APPROVAL

This study was conducted in the cariology research laboratory of the College of Dentistry, University of Illinois Chicago (UIC). The protocol was reviewed by the Institutional Review Board of the UIC (STUDY2024-0741) and determined to be exempt from the definition of human subject research.

REFERENCES

