Effect of Nano-Silver Fluoride Pretreatment on Bond Strength

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INTRODUCTION

- Technological advancements and innovations in dental materials have transformed dental practice; however, dental caries remain a significant public health challenge. Minimally Invasive Dentistry (MID) emphasizes preservation of tooth structure and seeks to prevent caries progression, reverse demineralization, and facilitate dentin remineralization.
- Thirty-eight percent silver diamine fluoride (SDF) is a minimally invasive, antibacterial, and affordable approach that halts caries progression, promotes remineralization, and reduces the development of new lesions. Despite its clinical effectiveness, SDF may reduce the shear bond strength (SBS) of restorations and is limited by undesirable staining, even with attempts to mask discoloration.
- A non-staining chitosan-based nano-silver fluoride (CNSF) has become available; however, its effect on the SBS of subsequent restorations remains unexplored. This study aimed to investigate its influence on the SBS of resin composite and resin-modified glass ionomer restorations.

HYPOTHESIS

- The null hypothesis was that no difference would exist among groups in the SBS of both restorations.

PURPOSE

- To investigate the influence of chitosan-based nano-silver fluoride (CNSF) pretreatment of dentin on the shear bond strength (SBS) of resin composite (RC) and resin-modified glass ionomer (RMGI) restorations.

STUDY DESIGN AND METHODS

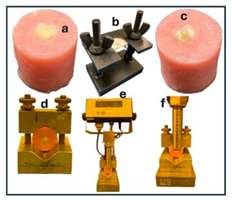

Figure 1. Experimental set-up and sequence. (**a**) Tooth sample embedded in auto-polymerizing polymethyl methacrylic (PMMA) resin and showing polished yellow dentin tissue exposed by flattening the buccal surface of the tooth sample. (**b**) The bonding clamp and the restoration mold (whitish structure) used for constructing the cylindrical restoration build-up. (**c**) Dentin surface with constructed cylindrical restoration build-up. (**d**) The PMMA base bearing the restoration build-up was positioned horizontally in a test-base clamp with the tooth root pointing upwards. (**e**) The UltraTester. (**f**) The notch of the UltraTester crosshead engaged the cylindrical restoration build-up at the bonding position.

- Ninety extracted human molars were collected.
- Specimens were randomly assigned to three dentin pretreatment groups (n = 30): Non-pretreated (NPT), Pretreated with silver diamine fluoride (SDF), Pretreated with chitosan-based nano-silver fluoride (CNSF)
- Each group was subdivided into two restorative subgroups (n = 15): Resin composite (RC), Resin-modified glass ionomer (RMGI)
- Pretreatment in the SDF and CNSF groups were performed according to manufacturer instructions.
- RC specimens were etched, chlorhexidine-treated, and bonded.
- RMGI specimens received cavity conditioner only.
- Cylindrical restorations (2.38 mm diameter × 2 mm height) were fabricated using a standardized mold and light-cured on all specimens.
- Specimens underwent 5,000 thermocycles between 5°C and 55°C with 30-second dwell times.
- Shear bond strength was measured using the Ultradent UltraTester.
- Data were analyzed using ANOVA with Tukey's post hoc comparisons (α = 0.05).

RESULTS

Table 1. Descriptive statistics of the shear bond strength of composite resin restoration on the three pretreatment conditions.

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound
Untreated	15	17.4800	3.95586	1.02140	15.2893	19.6707
Silver Diamine Fluoride	15	14.0267	6.56032	1.69387	10.3937	17.6597
Chitosan Nano-Silver Fluoride	15	18.3800	5.58585	1.44226	15.2867	21.4733
Total	45	16.6289	5.67465	0.84593	14.9240	18.3337
Model Fixed Effects			5.47383	0.81599	14.9822	18.2756
Random Effects				1.32680	10.9201	22.3376

- No statistically significant difference in SBS among untreated, SDF, or CNSF-treated dentin for resin composite restorations (ANOVA, F(2, 42) = 2.64, p = 0.08).
- For RC restorations, the null hypothesis was supported.

Table 2. Descriptive statistics of the shear bond strength of resin modified glass ionomer restoration on the three different pretreatment conditions.

Groups	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Untreated	15	15.9933	3.58737	0.92626	14.0067	17.9800
Silver Diamine Fluoride	15	14.2667	2.17146	0.56067	13.0642	15.4692
Chitosan Nano-Silver Fluoride	15	11.4467	5.47956	1.41482	8.4122	14.4811
Total	45	13.9022	4.32900	0.64533	12.6016	15.2028
Model Fixed Effects			3.98372	0.59386	12.7038	15.1007
Random Effects				1.32510	8.2008	19.6037

- A statistically significant difference in SBS among pretreatment groups for RMGI restorations (ANOVA, F(2, 42) = 4.98, p = 0.011).
- SBS was significantly higher in untreated dentin compared with CNSF-treated dentin.
- No statistically significant difference was observed between untreated and SDF-treated dentin or between SDF and CNSF-treated dentin.
- For RMGI restorations, the null hypothesis was not supported.

Table 4. Descriptive statistics of the shear bond strength of resin modified glass ionomer and composite restorations with the three dentin pretreatment conditions (untreated, SDF, and CNSF).

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Untreated Group								
Composite resin	15	17.4800	3.95586	1.02140	15.2893	19.6707	11.90	26.00
RMGI	15	15.9933	3.58737	0.92626	14.0067	17.9800	11.10	24.80
Total	45	16.2156	3.91402	0.58347	15.0397	17.3915	8.30	26.00
Silver Diamine Fluoride								
Composite with Adhesive	15	14.0267	6.56032	1.69387	10.3937	17.6597	6.10	30.80
RMGI without Adhesive	15	14.2667	2.17146	0.56067	13.0642	15.4692	11.20	18.70
Total	45	14.2756	4.73724	0.70619	12.8523	15.6988	6.10	30.80
Chitosan Nano-Silver Fluoride								
Composite with Adhesive	15	18.3800	5.58585	1.44226	15.2867	21.4733	10.10	29.50
RMGI without Adhesive	15	11.4467	5.47956	1.41482	8.4122	14.4811	4.80	20.40
Total	45	13.5711	5.97147	0.89017	11.7771	15.3651	4.80	29.50

- No significant SBS difference between RC and RMGI for untreated or SDF-pretreated dentin.
- With CNSF pretreatment, RC demonstrated significantly higher SBS (17.48 ± 3.96 MPa) than RMGI (15.99 ± 3.59 MPa).
- These results failed to support the null hypothesis at an alpha level of 0.05.

RESULTS *(cont.)*

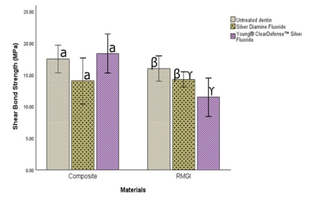

Figure 2. With composite, similar letters denote no statistically significant difference. With RMGI, similar symbols denote no statistically significant difference, while different symbols denote significant difference ($p < 0.01$).

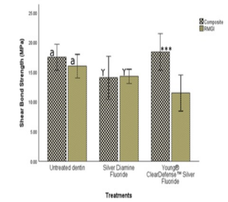

Figure 3. With either untreated dentin or pretreatment with SDF, similar letters or symbols denote no statistically significant difference. With CNSF pretreatment, *** denotes a statistically significant difference in SBS between composite and RMGI ($p < 0.001$).

DISCUSSION

- No statistically significant difference in SBS was observed among untreated, SDF-treated, or CNSF-treated dentin for resin composite restorations. In contrast, CNSF pretreatment resulted in reduced SBS for RMGI restorations compared with untreated dentin.
- Although CNSF contains chitosan, which has been reported to stabilize the adhesive interface and interact with collagen fibrils, higher concentrations may negatively affect bonding. The reduced SBS observed with RMGI following CNSF pretreatment may be related to interactions between chitosan and polyacrylic acid within the RMGI matrix.

LIMITATIONS

- Failure mode analysis (adhesive vs cohesive) was not conducted, limiting assessment of bond failure characteristics.
- Surface morphology following pretreatment was not evaluated using scanning electron microscopy.

CONCLUSIONS

- No difference in shear bond strength was observed for resin composite restorations regardless of dentin pretreatment with CNSF or SDF.
- Pretreatment with CNSF reduced the shear bond strength of RMGI restorations compared with untreated dentin.
- CNSF appears more compatible with resin composite restorations than with resin-modified glass ionomer restorations.

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