Microtensile Bond Strength of Resin Modified Glass Ionomer Restoration in Carious Primary Molars Pretreated With Silver Diamine Fluoride

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Abstract:

Objective: To evaluate microtensile bond strength of resin modified glass ionomer restoration in carious primary molars pretreated with silver diamine fluoride. **Materials and Methods:** forty carious primary molars were collected and divided into two equal groups (n=20) as the following: (Group I) the microtensile bond strength testing group and (Group II) the control group. Each main group subdivided into two subgroups (n=10): (Group I a) the microtensile testing comprised group of no caries excavation and (Group I b) group with caries excavation. (Group II a) the control comprised group of no caries excavation and(Group II b) group of caries excavation.The testing specimens were treated with 38% Silver diamine fluoride (SDF) while the control specimens were treated with deionized water. The specimens of all groups were stored in artificial saliva for 14 days at 37 oc. The carious cavities were conditioned and restored with GC Fuji II LC CAPSULE. After 24hours storage in artificial saliva, the specimens were prepared for microtensile bond strength testing and stressed in tension at one mm/minute until failure. The mean bond strengths were compared using the ANOVA test. **Results:** There was no statistically significant difference in microtensile bond strength between experimental and the control groups (P=0.145). **Conclusion:** Silver diamine fluoride does not adversely affect the bond strength between glass ionomer cement and carious primary dentin in vitro.

Introduction:

Caries management in primary teeth is a very common and a challenging problem in the pediatric population due to many reasons such as, need for managing the child behavior and definitive treatment until natural shedding of primary teeth. The World Health Organization has recommended the use of the atraumatic restorative technique (ART) for treatment of dental caries in children. However, in infants and toddlers, ART is more complicated than Silver diamine fluoride (SDF) application. The use of SDF is proposed in these very young children to arrest caries.[1]The American Dental Association encourages silver-modified atraumatic restorative treatment (SMART) for arresting carious lesions in cases of special needs dentistry, and the pre cooperative child. It is achieved by applying a caries arresting medicament and following with a restorative material.[2]

Silver diamine fluoride (SDF [Ag (NH3) 2F]) solution has been used clinically to prevent and arrest dental caries. SDF releases silver ions that inhibit Streptococcus mutans growth and reduce the metabolic activity of dental plaque. Furthermore, SDF was found to enhance tooth remineralization.[1] Clinical trials have demonstrated the efficacy of SDF in preventing caries in both primary and permanent dentitions.[3,4] Systematic reviews of the clinical effectiveness of SDF in arresting dental caries among children indicate that SDF is effective in arresting dentin caries in primary teeth and can be a promising strategy to manage dental caries in young children or those with special needs.[5-7] One significant limitation of SDF treatment is that it stains carious lesions black but not sound tooth surfaces.[1]

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As the children age and become more cooperative, glass ionomer (GI) restorations can be performed on the SDF-treated teeth. These offer the advantages of low cost and the possibility for application by dental personnel outside the traditional clinical setting, which may lead to an increase in dental service coverage.[1] Glass ionomer cement (GIC) is biocompatible, provides chemical adhesion to enamel and dentin in the presence of moisture, is resistant to microleakage with fluoride release, and rechargeable. To enhance the mechanical properties of glass ionomer cement, their constituents have been modified. Comparatively, resin-modified GI (RMGI) has a longer working time, faster setting, higher early strength, and improved appearance and translucency.[8]

Proper seal of the cavity and having a good bond to the tooth structure are main factors of the restoration to prevent secondary caries.[9] Therefore, evaluation of the bond strength of the restorations is important to assess its performance.

This study first sought to investigate if pretreating carious lesions with silver diamine fluoride (SDF) adversely affected adhesion of glass ionomer restorations to tooth structure. In addition, caries excavation had adverse effect on the bond strength of carious primary dentin pretreated with silver diamine fluoride. The two null hypotheses were rejected based on the findings of the current study. The results indicated no significant difference in the micro-tensile bond strength between the control groups and the experimental groups.

Materials and Methods:

The research protocol had been approved by the ethical committee of scientific research with code (A04140420) of Faculty of Dentistry, Mansoura University.

A total number of forty extracted maxillary second primary molars were collected from Pediatric Dental Clinic, Faculty of Dentistry, Mansoura University. Only primary molars with proximal caries that radiographically extended more than half the distance between the dentinoenamel junction and pulp chamber were selected.

The teeth were divided into experimental and control groups (n= 20).The experimental groups included application of SDF on carious primary dentin with and without caries excavation, then subjected to microtensile bond strength test. The control groups included the same procedure except for no SDF application.

Specimens grouping

Each main group was subdivided into two subgroups (n=10): The (Group I a) the microtensile testing group comprised group of no caries excavation and (Group I b) group with caries excavation. The (Group II a) control group comprised group of no caries excavation (Group II a; 10 teeth) and (Group II b) group of caries excavation

Procedure:

a) Teeth preparation:

In the test groups (Group I a): the carious cavity was rinsed with forced air for cleaning the debris followed by application of 38 percent SDF solution using a microbrush for three minutes, then a 30-second rinse with water. Then the specimens were stored in artificial saliva for 14 days at 37 degrees Celsius.

In the test groups (Group I b): the carious cavity was excavated to remove soft caries followed by application of 38 percent SDF solution using a microbrush for three minutes, then a 30-second rinse with water. Then the specimens were stored in artificial saliva for 14 days at 37 degrees Celsius.

In the control groups (Group II a): the carious cavity was rinsed with forced air for cleaning the debris followed by application of deionized water for three minutes. Then the specimens were stored in artificial saliva for 14 days at 37 degrees Celsius.
In the control groups (Group II b): the carious cavity was excavated to remove soft caries followed by application of deionized water for three minutes. Then the specimens were stored in artificial saliva for 14 days at 37 degrees Celsius.

b) Restoration:

The GC cavity conditioner was applied using a disposable brush for 10s and rinsed three times with a moist cotton pellet and the specimens were allowed to dry.

The GC Fuji II LC CAPSULE was activated and mixed according to the manufacturer's instructions. The RMGIC was inserted into the cavities directly through the capsule adapted to a metal applicator. Next, the restoration was condensed, contoured using a plastic filling instrument, and cured for 40 s. The restoration was light cured for 40 s using a visible light curing device according to the manufacturer's instructions. The specimens of all groups were stored in artificial saliva at 37 degrees Celsius for 24 hours.

c) Finishing:

Final finishing and polishing of the restorations were performed using white finishing stones and Sof-Lex discs (3M ESPE AG) in a slow-speed hand piece on a micro-motor. The samples were stored for 24 h at 37°C in distilled water.

Specimen Evaluation:

Microtensile bond strength test:

The assigned teeth were sectioned using a slow-speed water-cooled diamond saw to obtain slices approximately 0.7 mm thick, which were trimmed and prepared into an hour-glass shape with a cross-sectional area of one mm2 using a tapered diamond bur. The SDF blackened dentin/GIC interface were at the hour-glass shape middle. The specimens were kept wet during the shaping and testing procedures.

Each specimen were placed in the testing jig of a universal testing machine and stressed in tension at a crosshead speed of 1mm/ minute until bond failure.

Statistical analysis:

Data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 21). The normality of data was first tested with one-sample Kolmogorov-Smirnov test.

Qualitative data were described using number and percent. Continuous variables were presented as mean ± SD (standard deviation) for normally distributed data. The following tests were used ANOVA test: Compare more than two means (parametric).

Level of significance:

For all above mentioned statistical tests done, the threshold of significance is fixed at 5% level.The results was considered significant when $p \leq 0.05$. The smaller the p-value obtained, the more significant are the results.

Results:

Results of this in-vitro study showed that, no statistically significant difference was observed between studied groups regarding bond strength (P value > 0.05). Mean bond strength was 19.95±4.74 in group Ia ranged from 14.47 to 27.51 as compared to 18.86±7.11 ranged from 10.58 to 35.36 in group Ib, 17.49±2.73 ranged from 14.13 to 19.91 in group IIa and 14.55±3.37 ranged from 10.18-18.70 in group IIb. (Table 1and Figure 1).

Table (1): Comparison between the studied groups regarding Bond Strength (Mpa)

Groups	Bond Strength (Mpa)		ANOVA test	P value
	Mean ± SD	Min-Max		
Group I a (n=10)	19.95±4.74	14.47-27.51	F=1.93	0.145
Group I b (n=10)	18.86±7.11	10.58-35.36		
Group II a (n=10)	17.49±2.73	14.13-19.91		
Group II b (n=10)	14.55±3.37	10.18-18.70		

GI a : Experimental group with no caries excavation , GI b : Experimental group with caries excavation, GII a : Control group with no caries excavation , GII b : Control group with caries excavation

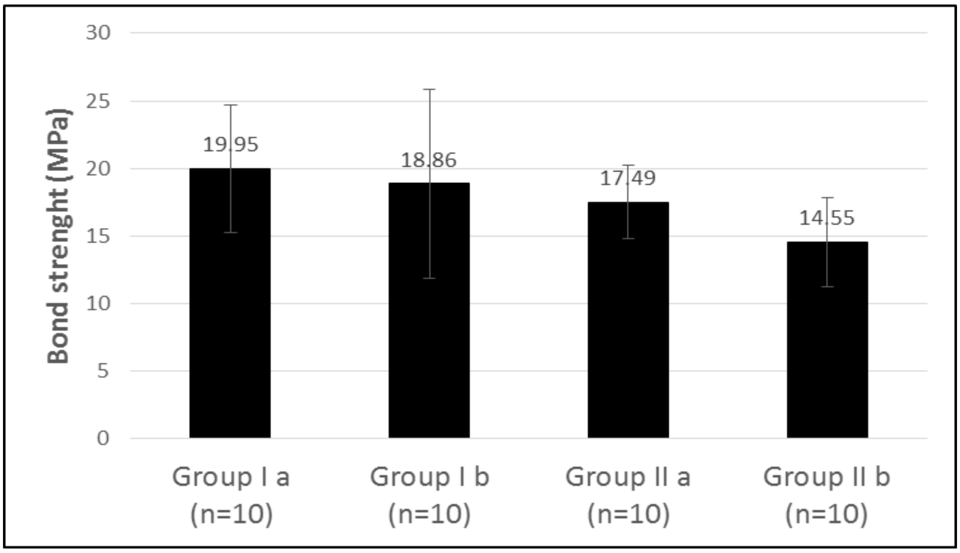

Figure (1): Bond Strength (Mpa) among the studied groups

Discussion:

According to the results, the null hypothesis of this study was rejected, as the bulk-fill RCs resulted in less cuspal deflection values, however the fracture resistance value was a material dependent.

In an attempt to minimize over many decades traditional control of carious lesion is done through drilling of caries and placement of restoration. The last two decades biological modality managing early carious lesion has been the treatment of choice through various materials. One of the key elements of a biological method is the application of remineralizing agents to the tooth structure that control the demineralization/remineralization cycle, depending upon the microenvironment around the tooth.[10]

Silver-modified atraumatic restorative treatment (SMART) is encouraged for arresting carious lesions in very young children and those of special needs. It is achieved by applying a caries arresting medicament then restorative material.[2]

The aim of this study were to evaluate microtensile bond strength of resin modified glass ionomer restoration in carious primary molars pretreated with silver diamine fluoride.

Silver diamine fluoride [SDF] is a colorless solution[8,9] containing diamine-silver ion and fluoride ion.[11] Silver diamine fluoride has been receiving more and more attention due to its low cost and simplicity in treatment. SDF's ability to halt the caries process and to simultaneously prevent the formation of new caries makes SDF different from other caries-preventive agents. The advantages of caries treatment with SDF include its attributes of pain and infection control, ease of use, low material costs, non-invasive nature of the treatment procedure, and minimal requirement for personnel time and training.[12]

Regarding the selected restorative material, Resin-modified glass ionomer restoration was used to restore form and function. Mei et al.[14] and Zhao et al.[14,15] have demonstrated ex vivo this benefit, which further supports SDF-modified atraumatic restorative treatment to prevent restorative failure. RMGICs have good bond strength, it releases fluoride which can aid in inhibiting dentine demineralization and arresting the carious lesions.

Many researchers carried out their studies on sound extracted human molars that were demineralized to create artificial carious lesions.[16-18] On the other hand, in the present study natural carious lesions of primary molars were used to mimic the clinical scenario.

Traditionally managing dental caries is based on mechanically removing carious lesions before filling the cavity with a proper restorative material to eradicate the bacteria present in the lesion. In our study, SDF was applied on carious primary dentin with caries excavation and others without caries excavation. The need of excavation prior to SDF application is facing an intriguing challenge. From a biological view, it is reasonable to conduct the excavation because infected dentine is highly demineralised and physiologically not remineralisable based on the current evidence.[19] Nevertheless, there is evidence showing that removal of soft carious lesions may not be necessary. A clinical trial reported that no significant differences were found in the number of arrested tooth surfaces for children who had caries excavation prior to application of SDF compared with those that did not have caries removal.[20]

Furthermore, different from previous studies in which the SDF-treated dentin surface was polished with a 600-grit silicon carbide paper,[1,21] the SDF-treated surface in the present study was simply cleaned with water without any polishing before GIC bonding to mimic the clinical situations.

In the present study, the SDF-treated samples were placed in artificial saliva for 14 days at 37oC to provide an environment high in calcium and phosphate ions for remineralization[20] and to simulate the clinical situation. In these two weeks, SDF was allowed to penetrate into the dentinal tubules and also form a hardened layer on the surface comprised of silver oxide conjugates.

The present study used the microtensile bond test method. The mTBS test has several advantages over the traditional TBS test, such as a greater percentage of adhesive failures and higher possibility of measuring a high bond strength value.[23]

According to the results of this study, it was found that pretreatment of carious primary lesions with SDF raised the mTBS between RMGIC and carious primary dentin, but this finding was not statistically significant. Puwanawiroj et al.[1] tested microtensile bond strength of GIC and SDF treated carious primary dentin. Their results were comparable to data obtained in this study, showing a non-statistically significant trend of higher bond strength in the SDF treatment group. This is in agreement with Gupta et al.[23] and Soliman et al.[24] who found that primary dentin pretreatment with 38% SDF raises the shear bond strength between them.

This may be due to the fact that GIC adheres chemically to tooth structure. The precipitate of silver deposits and silver ions resulted from SDF pretreatment could improve the ionic bond to GIC. Silver phosphate (Ag3PO4) and calcium fluoride (CaF2) are formed by the reaction of SDF with calcium hydroxyapatite. Silver phosphate may react with the carboxylic group of RMGIC increasing the bond between it and primary dentin. Moreover, Fixation of the organic content leads to contraction of the organic substance inside dentinal tubules increasing interlocking between dentinal tubules which may also be a cause of the increased bond strength.[24]

Conclusion:

From the results of this in vitro study, we can conclude that:

1. Silver diamine fluoride raises the bond strength between resin modified glass ionomer and SDF-treated primary carious lesions. However, it was not statistically significant.

2. This study does not support the excavation of caries before application of SDF.

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