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Effect of SDF Application on the Bond Strength of Two Different Types of Composites, Used in the Restoration of Carious Primary Molars: An *In Vitro* Study

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Abstract

Dental caries is widespread over the world; however the prevalence and severity of the disease vary by country and area. SDF (Silver Diamine Fluoride) is a new substance that has proven to be superior. SDF slows the progression of caries and promotes caries arrest. It is a cost-effective treatment for cavitated carious lesions that is also patient-friendly.

Keywords: Silver Diamine Fluoride; Dental caries; Primary molars

Introduction

Dental caries is widely prevalent globally but the distribution and severity of dental caries varies across countries and regions. According to Global Oral Health Data Bank, prevalence of dental caries varies from 49% to 83% across different countries [1]. More than 40% of the children in India have shown dental caries in both primary and permanent teeth in the past 15 years [1]. Preventive measures such as fluoride gel and varnishes have been in use since ages but unfortunately have not contributed in the decrease of dental caries to a larger extent (Table 1). On the other hand, a recent material known as Silver Diamine Fluoride (SDF) has proved to have a superior edge. SDF halts the caries progression and promote caries arrest. It is unique in both killing the bacteria and hardening the teeth. It is usually recommended for children with a high risk of developing caries and those living in poor conditions with low socio-economic status [2]. SDF can also serve as an alternative approach to the conventional restorative treatment in young children who are uncooperative and where any other preventive and therapeutic treatment cannot be carried out.

It is a cost-effective treatment for arresting cavitated carious lesions in the most patient friendly way. Thus, the interest in the use of silver diamine fluoride has been growing. However, it has a major drawback of black discoloration and it is a big challenge to overcome this and restore the cavity. Therefore, GIC and composites have been used as intra-coronal restorations to restore such teeth with varying degree of success. The objective of adhesive dentistry is to establish an effective adhesion of dental material with teeth. Nano and hybrid composite materials have proved their efficacy so far in dentistry. However, there is hardly any study which compared the bond strength of Nano and hybrid composites on the restoration of carious primary teeth after SDF application. Thus, the aim of this *in vitro* study was to evaluate the bond strength of teeth treated with and without SDF followed by composite (Nano and hybrid) restorations.

Table 1: Prevalence of dental caries

Dental caries	Percent
Global prevalence	36% (49 to 83% in different countries)
School going children	60% to 90%
Children, India	40%

Materials and Methods

In this *in vitro* experimental study, eighty freshly extracted carious primary molar teeth were taken.

Inclusion criteria

- Carious primary molars with at least two surface involvements and minimum of one-third of root remaining

Exclusion criteria

- Single surface carious teeth
- Non-restorable teeth
- Teeth with coronal perforations were excluded from the study.

Procedure

The extracted teeth were stored in 10% formalin. Based on random allocation, teeth were then randomly divided into four groups which consisted of 20 teeth each. In group I, 38% SDF (Kids-E-Crown, kids-e-dental Llp, Mumbai) was applied on 20 extracted primary molars as per manufacturer's instructions,

they were air dried for 1 minute and then they were acid etched with 37% orthophosphoric acid for 15 seconds, washed with water and then dried. The bonding agent (VI generation; 3M ESPE) was applied and cured for 10 seconds according to manufacturer's instructions. Teeth were then restored with Nano composite (3M ESPE) restoration. In group II, 38% SDF was applied on 20 extracted primary molars, they were air dried for 1 minute followed by Hybrid composite (3M ESPE) restoration. In group III, hand excavation was done of 20 extracted primary molars and then they were restored with Nano composite restoration in group IV hand excavation was done of 20 extracted primary molars followed by Hybrid composite restoration. After the composite restorations, teeth were embedded in acrylic resin block. They were then fixed to universal testing machine and forces were applied at a speed of 1 mm/min at 30 degrees angle till the restoration fractured from the teeth. All the readings were noted and the data was statistically analyzed using independent/unpaired t-test keeping 0.05 p-value as statistically significant under Statistical Package for Social Science (SPSS version 20.0) software.

Table 2: Restoration methods of carious primary molars

Group	Treatment			Mean Force (at 1mm/min at 30°angle)
Group I	38% SDF (1 minute)	37% ortho phosphoric acid (15 Seconds)	VI generation; 3M ESPE (10 Seconds)	195.76 N
Group II	38% SDF (1 minute)	Hybrid composite (3M ESPE)		181.628 N
Group III	Nano composite restoration			252.659 N
Group IV	Hybrid composite restoration	Acrylic resin block		217.14 N

Results

The mean value of force at which the restorations deboned from the tooth for each group. The mean value was highest in the group III (252.659 N) where hand excavation was done followed by Nano composite restoration and it was least in group II (181.628 N) where SDF was applied followed by hybrid composite restoration.

When group I was compared to group II, the value of mean force to dislodge the restoration was 195.76 N which was non-significant (p=0.16). Insignificant difference was found (p=0.11) when group I was compared to group III, where mean value of force was 231.28 N. Similarly, when group I was compared to group IV, p value was 0.51 which was non-significant. Interestingly, when group II was compared to group III mean value of force was 217.14 N and p value was 0.02, which showed significant difference. When group II was compared to group IV and group III was compared to group IV again result was non-significant (p>0.05)(Table 3).

Table 3: Restoration strength comparison among different groups of extracted primary molars

Group name	P value	Statistical analysis
Group I *vs.* Group II	p=0.16	non-significant
Group I *vs.* Group III	p=0.11	non-significant
Group I *vs.* Group IV	p=0.51	non-significant
Group II *vs.* group III	p=0.02	Significant
Group II *vs.* Group IV	p>0.05	non-significant
Group III *vs.* Group IV	p>0.05	non-significant

Discussion

Silver compounds, especially silver nitrate, have been used in medicine to control infections for more than a century [3]. In dentistry, use of silver nitrate is well documented for caries inhibition [4]. There was an old custom in Japan where ladies used to dye their teeth black for expressing their status as married. Though it was regarded as a tooth cosmetic, it had anti caries activity. This practice of dying teeth was abolished by the beginning 20th century [3]. Before the twentieth century, silver nitrate was firmly entrenched in the profession as a remedy for "hypersensitivity of dentin, erosion, pyorrhea, as a sterilizing agent and caries inhibitor in deciduous as well as in permanent teeth [5]. The relationship of fluorides and caries prevention had already been well-established through epidemiologic observations, chemical studies, animal experiments, and clinical trials beginning in the early decades of the twentieth century. Dr Nishino and Yamaga in Japan pioneered the use of ammonia Cal silver fluoride for the arrest of dental caries [6] and developed it to combine the actions of F and Ag which led to the approval for the first SDF product, Saforide (Bee Brand Medico Dental Co, Ltd, Osaka, Japan) in 1970 [7].

SDF has emerged as a boon to pediatric dentistry as a preventive measure. However, the only disadvantage of using SDF is the black staining caused to the tooth structure. Thus, esthetic restorations are needed to overcome this drawback of SDF staining. Various studies have already showed the success rate of GIC after the pre-treatment of dentin with SDF. But with a general trend towards the increased preservation of healthy, natural tooth structure and increased demand for aesthetics, the concept of bonding to tooth structure has led to major modifications in cavity preparation and restorative material choice. Thus, composite restoration is the most commonly used restorative material used in clinics due to its high aesthetics and strength.

Enamel consists of 96% inorganic material (Hydroxyapatite), only a small amount of organic matter and 4% H_2O . In oral environment, the organic pellicle covers the enamel surface reducing the surface energy of enamel to 28 dynes/cm, which creates a complex surface for bonding [8]. This enamel surface is cut during cavity preparation which removes the organic pellicle but it does not increase the surface energy. Thus, to increase the surface energy from 28 to 72 dynes/cm etching is required which creates a more homogeneous structure with higher

inorganic content and higher surface energy rending enamel a more predictable structure for bonding. Dentin on the other hand is composed of 65%-90% of inorganic content and 30%-35% of organic content which makes bonding less predictable compared to enamel. In order to avoid this problem dentin bonding agents have been introduced in the field of dentistry.

It has also been noted that hydrofluoric acid generally has a detrimental effect on resin bond strength to dentin. Etching with phosphoric acid after exposure to hydrofluoric acid tends to result in higher bond strengths [9]. In a laboratory study by May [10] to investigate the use of 38% Silver Diamine Fluoride (SDF) as a treatment for preventing secondary caries in Glass Ionomer Cement (GIC) and Composite Resin (CR) restorations, it was seen that conditioning with 38% SDF increased the resistance of the glass ionomer cement and composite resin restorations to secondary caries. The authors also concluded that at a concentration of 38%, SDF can be incorporated into restorative therapy to improve the success rate of direct restorations in terms of longevity. SDF reacts with the tooth mineral hydroxyapatite to release calcium fluoride and silver phosphate which are responsible for the prevention and hardening of dental caries.

Since in uncooperative and especially abled children the success of traditional restorative treatment is difficult to achieve. Thus, this *in vitro* trial was attempted to check whether the bond strength was altered after SDF application or not. The result of this study suggests that there was insignificant difference in terms of bonding between Nano and hybrid composite restorations both when SDF and hand excavation was done. This could be justified by the fact that the bonding is not altered by the type of restoration, but the bonding agent and its penetration into the dentinal tissues are more viable responsible factors.

Furthermore, the results of this study also showed that there was an insignificant difference between SDF and hand excavation irrespective of the type of composite restoration used. It was observed that though SDF did not adversely affect the bond strength of composite restorations but it was reduced; however, these differences were statistically insignificant. The possible reason for this may either be that micro tags are not formed or that SDF might have interfered with their formation. However, SDF seems to offer the ability to chemically control or eliminate the spread of the disease in a frank cavity. This property may reduce the need to use a hand piece or hand instrument to mechanically remove highly infected dentin. Though there was significant difference between group II and III, which can be due to the variable sample selection or error during sample selection. Similar results were shown by Uchil, that the application of SDF with or without acid etching does not affect the bond strength of resin modified GIC to carious dentin of primary teeth [11].

However, a contradictory statement was given by Fröhlic in a systematic review, that the prior application of silver diamine fluoride significantly decreased the bond strength of composite restorations [12]. Thus, the result of the present study suggests that the pre-treatment with SDF irrespective of caries excavation may be considered for uncooperative and especially abled children as it does not interfere with the bonding of either Nano or hybrid composite to carious dentin in primary teeth.

Conclusion

Within the limitations of this study, it can be concluded that-

- SDF did reduce bond strength of composite restorations; however, these differences were statistically insignificant.
- Bond strength of Nano composite restorations following hand excavation was highest whereas restorations with hybrid composite following SDF application showed least bond strength.
- Bond strength is not much affected, if caries is not excavated properly. The observed bond strength of each group was in descending order as group III> group IV> group I> group II.

Thus, pre-treatment with SDF irrespective of caries excavation may be considered as a potential treatment protocol for uncooperative and especially abled children.

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