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EFFECT OF PRETREATMENT OF SILVER DIAMINE FLUORIDE ON MICROLEAKAGE OF RESIN MODIFIED GLASS IONOMER CEMENT USING NOVEL FLUID FILTRATION MODEL AT DIFFERENT TIME INTERVALS.

Dentistry

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ABSTRACT

Background: Microleakage is one of the major cause for restorative treatment failure. Silver diamine fluoride (SDF) is a unique topical medicament having ability to arrest dental caries in young children. There is less information about the effect of SDF dentin pretreatment on microleakage between RMGIC cement and primary dentin. There are various methods used for testing leakage, however all present with inherent drawbacks. Fluid filtration model is a novel method for assessing leakage quantitative analysis over different time interval. **Materials and Methods:** 40 freshly extracted human primary anterior were obtained, Class V cavities were prepared, and then teeth were divided into two groups. GROUPA- Control Group: Cavities were treated with distilled water. GROUP B- Experimental Group: Cavities were treated with 38% SDF then cavity conditioner were applied followed by restoration using RMGIC and light cured for20sec. All the samples were subjected to thermocycling followed by evaluation of microleakage using fluid filtration model i immediately after treatment, after 3months and after 6 months. **Result:** The results of the study showed a significant decrease in microleakage and immediate, 3 months and 6 months of testing using fluid filtration model **Conclusion:** 38% SDF pretreatment of primary dentin improved the marginal seal.

KEYWORDS

Silver diamine fluoride (SDF), microleakage, resin modified glass ionomer cement, fluid filtration model.

INTRODUCTION

Microleakage refers to the microscopic leakage of fluids, ions, or bacteria along the interface between a dental restoration (such as a filling or crown) and the natural tooth structure. It occurs when there are small gaps or imperfections in the interface, allowing substances to pass through. Microleakage can compromise the integrity of the dental restoration and lead to various problems, including secondary tooth decay, tooth sensitivity, discoloration, and even the failure of the restoration itself.

Factors that contribute to microleakage include inadequate bonding between the restoration and tooth structure, improper cavity preparation, poorly adapted restorative materials, and thermal cycling (repeated expansion and contraction of the materials due to temperature changes in the mouth). Additionally, the type of restorative material used can affect the degree of microleakage.

Numerous techniques can be used to assess microleakage, such as chemical, bacterial, and radioactive tracers, dye penetration, dye extraction, electrochemical, neutron activation, and micro-computed tomography. However, each of these methods has inherent limitations. [4] Dye penetration is a commonly used method in microleakage studies, but it may overestimate the results because the diameter of the dye molecule is smaller than that of the dentinal tubules, allowing it to penetrate deeper. Some authors have reported fluid filtration method as one of the reliable technique in quantitative assessment of leakage as the samples are not destroyed, permits the evaluation of microleakage over time, operators bias and most importantly the results are accurate since very small volume is recorded .[5-6]

Silver diamine fluoride is well documented for its important role in the caries management protocols by AAPD [1]. Silver diamine fluoride (SDF) is effective in killing bacteria and hardening of tooth structure. It can be utilized to prevent and treat dental caries[2]. Silver-modified atraumatic restorative technique (SMART) involves gross caries removal without local anaesthesia, leaving affected dentin at the base of the cavity and sound dentin at the periphery. The affected dentin surface is first treated with SDF, and then a GIC restoration is applied during the same visit. Supporters of the SMART approach suggest that this method offers the advantages of both SDF and ART, and can be administered outside of a dental office (such as in nursing homes) and on patients who may be less cooperative (such as Pediatric patients).[3]

The impact of 38% SDF dentin pretreatment on the adhesive interface between RMGIC cement and primary dentin has not been extensively studied, and there is limited information available on this topic. This study aim to evaluate microleakage of RMGIC to primary dentin after SDF pretreatment using fluid filtration model. This study is first of its kind to report the leakage assessment of an immediate testing after restoration, 3 months and of 6 months testing of sample storage using fluid filtration model. The null hypothesis proposes that there is no significant difference in the microleakage of RMGIC to primary dentin when pre-treated with or without 38% SDF.

MATERIALS AND METHODS:

Forty freshly extracted primary anterior teeth were collected from department of Pediatric and preventive dentistry MA Rangoonwala College of dental sciences and research centre, Pune.. Teeth were disinfected with 1% chloramine-T solution, and stored in distilled water. A total of 20 teeth were allocated randomly into two groups (n=20) based on the evaluation method and type of dentin pre-treatment.

Standardized rectangular class V conventional cavities with dimension (2 mm × 1 mm × 0.8mm) were prepared using carbide burs No. 271 using a high speed with air/water coolant (W&H, SN 0012845) fig 1(B).Teeth were randomly assigned into two groups. Group A, referred to as the control group, involved the treatment of cavities with distilled water for a duration of three minutes, followed by a 30-second rinse. Group B, referred to as the experimental group, involved the treatment of cavities using a micro-brush to apply a 38% SDF solution (e-sdf) for a duration of three minutes.

A cavity conditioner (GC America Inc., Alsip, Ill., USA) was applied to both groups using a cotton pellet for a duration of 10 seconds, followed by a thorough rinse with water. Subsequently, the cavities were restored with RMGIC (GC, Tokyo, Japan) and light cured for 20 seconds using an LED light curing system (Ivoclar Vivadent, Germany). All procedures were performed in accordance with the instructions provided by the manufacturer. Following this, the specimens were stored in distilled water at a temperature of 37°C for 24 hours. The teeth were then subjected to 500 thermo-cycles, with 30 seconds of immersion in each water bath set at 5ºC and 55ºC, and a transfer time of 30 seconds between each conditioning cycle. Except for a 1 mm area around the restorative margins, the surface was coated with two layers of nail varnish.

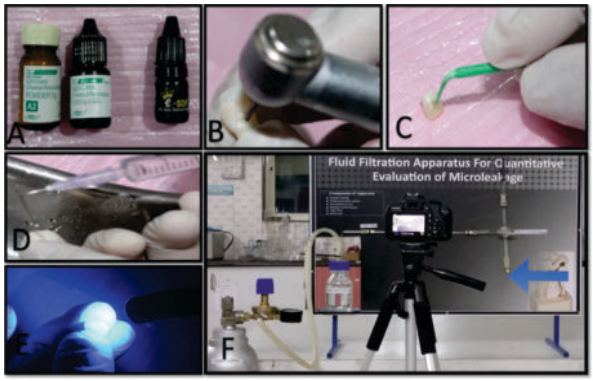

Figure 1: A – Materials used (Rmgic and sSdf), B- Class v cavity preparation, C- Sdf application D- Treating with distilled water, E – Restoration and curing, F- Fluid filtration model

Method of testing

The model used in this study is developed by Asiya et al fig 1(F) .This system involves the assessment of fluid movement in the model calculated through bubble displacement .[7]

RESULTS:

Microleakage evaluation: Table 1- group B showed less leakage (0.0025) compared to group A(0.003) on immediate testing.

Immediate	Mean	SD	Unpaired t test	P value, Significance
Group A	0.003	0.0007	t = 2.127	p =0.04* (significant statistical difference)
Group B	0.0025	0.0007		

On Intergroup comparison of microleakage values at immediate interval using unpaired t test, Group A had higher microleakage as compare to Group B and the difference was found to be of statistical significant difference ($p< 0.05$)

Table 2: Intergroup comparison of microleakage values at 3 months interval

3 months	Mean	SD	Unpaired t test	P value , Significance
Group A	0.0053	0.00073	t = 10.023	p < 0.001** (highly significant statistical difference)
Group B	0.0031	0.00069		

On Intergroup comparison of microleakage values at 3 months interval using unpaired t test, Group A had higher microleakage as compare to Group B and the difference was found to be of highly statistical significant difference ($p< 0.001$)

Table 3: Intergroup comparison of microleakage values at 6 months interval

6 months	Mean	SD	Unpaired t test	P value, Significance
Group A	0.0084	0.0005	t = 0.653	p = >0.05(significant statistical difference)
Group B	0.0064	0.0003		

On Intergroup comparison of microleakage values at 6 months interval using unpaired t test, Group B had less microleakage as compare to Group A and the difference was found to be of statistical significant difference ($p> 0.05$)

On Intragroup comparison of microleakage values at baseline, 3months and 6 months, highly statistical significant increase ($p< 0.001$) was observed in each group overall and in pairwise comparison between any two time intervals .

DISCUSSION:

A microscopic gap commonly exists between the interface of the tooth and the restoration, which can lead to marginal breakdown of the restoration and the development of pulpal pathology, ultimately compromising the long-term success of the restoration. Failure of restorative treatment may occur due to the seepage of oral fluids and bacteria along the restoration margins. Thus, achieving a proper seal of the cavity and a strong bond with the tooth structure are critical factor. Therefore, it is crucial to assess the sealing ability and bond strength of restorations to evaluate their performance.

There are different commercially available concentrations of SDF used in dentistry 12%, 30% and 38%. The concentration of 38% was chosen for the present study according to Fung et al. [9] (2018) who concluded that 38% SDF was statistically significant in caries prevention and arrest in primary teeth in comparison to 12% SDF.[9]

The main disadvantage of Class V cavities is the leakage at the cervical margin which is a moisture sensitive area. Glass ionomer restoration is used in these areas that cannot be isolated which makes it the material for choice in class V cavities. [10] According to Stewardson et al. (2012)[11] class V cavities restored with glass ionomer had more survival rate than using any other restorative material. That is why class V cavity was chosen to test microleakage of RMGIC in the study.

In the present study there was a significant difference in the microleakage between teeth treated with SDF and the untreated teeth when tested immediately, 3 months and after 6 months

Several studies have demonstrated that pretreatment with SDF can reduce microleakage in dental restorations. For example, a study by Chibinski et al. (2019) compared the microleakage of composite resin restorations with and without pretreatment with SDF. The results showed that the SDF-treated group had significantly less microleakage than the untreated group.

Another study by Fathy et al. (2018) evaluated the microleakage of class V composite resin restorations with and without SDF pretreatment. The authors found that the SDF-treated group had significantly less microleakage than the untreated group. Overall, these studies suggest that pretreatment with SDF can be an effective way to reduce microleakage in dental restorations. In present study SDF treated teeth when tested immediately ,3 months and 6 month showed reduced microleakage as compared to control group with the result was in consistent with above mentioned studies.

In contrast to Gupta et.al, Soliman et.al (2019) observed no significant difference in microleakage between RMGIC and tooth structure in teeth that were pre-treated with silver diamine fluoride-potassium iodide (SDF-KI), compared to other groups in the study that were treated with chlorhexidine and distilled water. In 2013 study, Uzel et al. observed that there was no notable distinction in microleakage between permanent teeth that received treatment with 38% SDF (silver diamine fluoride) before resin composite application and teeth that were left untreated.

All the above studies report the leakage tested using dye penetration and immediately after restoration .This study is first of its kind to report microleakage using fluid filtration model and at three different intervals i.e. immediate 3 months and 6 months since in dye penetration method the samples are destructed long term evaluation is not possible .In fluid filtration method the samples are not destroyed and long term leakage assessment is possible this is an important point to be considered since it give an estimate to how long the material last and when an re-application should be done.

According to Taylor and Lynchdye penetration and dye extraction methods are destructive and also fails to demonstrate the nature and pattern of leakage. These techniques have additional drawbacks such as the size and type of dye used, as well as the potential cross-reaction with dentin. Alternative methods like three-dimensional micro-computed tomography, bacterial microleakage, and the utilization of metal-based substances like silver nitrate have not proven to be as effective, mainly due to the inability to conduct long-term assessments on the specimens using these approaches.

Oliver and Abott (2001) studied the clinical relevance of dye penetration method and concluded that the results were not relevant from a clinical point of view. [2-4] In 2005 study, Susini et al. examined microleakage by employing dye extraction and determined that while this approach is more applicable to dye penetration, it lacks the precision of standard methods such as fluid filtration.[12]

The present study showed some limitations. Being in vitro, it does not totally represent the intra-oral environment like changing ph. The method used for testing i.e. fluid filtration evaluate leakage quantitatively .The results of this study revealed that SDF application significantly reduces microleakage.

This suggests that the application of 38% SDF as a pretreatment in primary dentin can enhance the sealing ability of restorations and

reduce the likelihood of microleakage. It is important to note that the effectiveness of SDF may vary depending on the specific clinical situation, and further research may be needed to confirm these findings and explore the long-term effects of SDF pretreatment on microleakage.

CONCLUSION:

The study's findings indicated that utilizing 38% silver diamine fluoride (SDF) as a pretreatment for primary dentin resulted in an enhanced marginal seal, leading to a reduction in microleakage during immediate, 3-month, and 6-month testing. Particularly, a significant statistical difference was observed at the 3-month mark, with the SDF group exhibiting the lowest occurrence of microleakage when compared to the control group.

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