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Comparative Evaluaton of Resin Based and Glass Ionomer Sealants-An Invitro Sem And Shear Bond Strength Study

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Abstract: *Pit and fissure sealants are an indispensable part of preventive dentistry. They prevent occulsal caries by cutting off the nutrient supply to the bacteria in susceptible pits and fissures.* ***Aim****: The purpose of the study was to compare the flow and adaptation of Fuji VII (Glass ionomer based sealant) with Fissurit F (Resin based sealant) and also to evaluate the difference in the shear bond strengths of the same materials.* ***Methodology****: 40 premolars extracted for orthodontic reasons were used for this study and they were divided into 6 groups. After accomplishment of the different treatments 5 teeth from each group were observed under SEM for adaptation and flow of the sealant, and 10 teeth each were tested for shear bond strength of the materials. The specimens were submitted to thermocycling process and used for the evaluation of the variables.* ***Results****: It was found that Fuji VII fared a little better than Fissurit F, when comparing the flow and adaptation. Significant differences were found between the shear bond strength scores ,with Fuji VII scores being lower.* ***Conclusion****: Of the two sealants tested in this in vivo study, Fuji VII and Fissurit F , Fuji VII performed better in the flow and adaptation evaluation and Fissurit F performed better in the shear bond strength testing.*

Key words: *preventive dentistry, pit and fissure sealants, glass ionomer.*

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I. Introduction

Pit and fissure sealants are an indispensable part of preventive dentistry. They prevent occulsal caries by cutting off the nutrient supply to the bacteria in susceptible pits and fissures. The first materials used as sealants were cyanoacrylates but they were not marketed. Bis-GMA based fissure sealants were first introduced as a way of preventing caries almost 35 years ago by Bowen et al [Nuva-seal 1971]. Bis-GMA is the base resin to most of the current commercially available sealants[1]. The apprehension regarding the leakage of estrogencbisphenol A from resin based sealants lead to a quest for alternatives[2].

Glass ionomer cements chemically adhere to the tooth they are radio opaque and biocompatible. The use of glass ionomer sealant has the advantage of continuous fluoride release and its preventive effect may continue with the visible loss of the material They are particularly useful as sealant materials in molars that are difficult to isolate due to a child's preco-operative behaviour and in partially erupted molars.The need for a sealant to be readily bondable to enamel and to be simple enough to be used in community based preventive programmes and the concern about bisphenol-A release from resin sealants, makes glass ionomer a sign post towards future sealant material development. Because questions exist regarding the strength and retention of glass ionomers, further study regarding their use is warranted.This study focuses on the properties of two fluoride releasing pit and fissure sealants. One being a recently introduced glass ionomer based sealant [Fuji-7] and the other being a Bis-GMA based sealant [Fissurit-F].

II. Materials And Method

The study was an in vitro study conducted in government dental college,Thiruvananthapuram in 40 non carious premolar teeth that were extracted for orthodontic reasons. The teeth were extracted from patients who reported to the oral surgery department of Government dental college, Thiruvananthapuram for pre molar extraction.

Inclusion critera:
Non carious healthy pre molars extracted for orthodontic reasons
Exclusion criteria:
1. Carious teeth

2. Teeth with developmental defects

Procedure methodology

The forty premolars were divided into two groups designated as group-I and group-II of twenty teeth each. Group-I was sub divided into four groups of five teeth each i.e. group-I a, group-Ib,group-I c and group-Id and were used for the SEM evaluation. The second group i.e. group-II was sub divided into two groups of ten teeth each i.e. group-II a and group-II b and were used for bond strength testing.

Group-I :

Group-I a(N=5) Fissurit-F Invasive technique
Group-I b (N=5) Fissurit-F Non invasive technique
Group-I c (N=5) Fuji-7 Invasive technique
Group-I d (N=5) Fuji-7 Non invasive technique

Group-II:

Group-II a (N=10) Fissurit-F Bond strength study
Group-II b (N=10) Fuji-7 Bond strength study

Methodology for SEM comparison

The teeth were placed in saline immediately after extraction and were used within one month of the extraction. Before placing the sealants, surface debridement using an ultra sonicscaler and cleaning of fissures with a polishing brush was done.

Group-I a Fissurit-F (Invasive technique): The occlusal fissure was opened up with a diamond tapering fissure bur such that the depth of the preparation was 1.5mm approximately and the width was 0.5-0.6mm at the occlusal surface. The teeth were etched with 37% Phosphoric acid gel for 20 seconds, rinsed thoroughly with water and air dried using a chip blower. Fissurit-f was placed on the fissure using a syringe needle tip and allowed to flow into the fissure. The sealant was then light cured for 30 seconds. After curing, the samples were placed in saline.

Group-I b Fissurit-F (Non invasive technique): The samples were prepared in the same manner as in group-1, except for opening the fissures. The fissures of samples in this group were not opened.

Group-I c Fuji-7 (Invasive technique): The occlusal fissure was opened up with a diamond tapering fissure bur such that the depth of the preparation was 1.5mm approximately and the width was 0.5-0.6mm at the occlusal surface. The teeth were conditioned using GC dentin conditioner for 20 seconds, rinsed thoroughly with water and gently air dried using a chip blower. Over drying was avoided. Fuji-7 was mixed according to manufacturers instructions and was applied on the fissure with a micro brush. The sealant was then light cured for 30 seconds. After curing, the samples were placed in saline.

Group-I d Fuji-7 (Non invasive technique): The samples were prepared in the same manner as in group-3, except for opening the fissures. The fissures of samples in this group were not opened.

The samples were thermo cycled at 55^0 C and 55^0 C for 250 cycles, with a dwell time of 30seconds.

Within a week of placing the sealants, the teeth were sectioned longitudinally through the fissure using a water cooled diamond disc. Before the SEM examination, the specimens were left exposed to the environment for 24 hours for drying. The dry specimens were mounted on copper stubs with silver glue and ion sputtered with gold palladium. The specimens were then examined under an acceleration voltage of 15KV and a magnification of 50X, under the SEM to determine the amount of flow to the base of the fissure and adaptation to the walls of the fissure.

Methodology for bond strength testing:

Bond strength tests are commonly used to assess in vitro performance of dental materials and predict their in vivo behaviour.

Twenty upper first premolars, extracted for orthodontic reasons, without caries, obvious defects or attrition were selected for this study and were used within one month of extraction. The roots of teeth were removed and teeth were stored in distilled water. For the study, the teeth were embedded in self cure acrylic resin in a mould such that the flattest surface of the enamel was parallel to the base of the moulded acrylic. The moulded teeth were stored in saline and randomly assigned to one of two groups.

Group-II a Fissurit-F Bond strength study: Before placing the sealant, surface debridement using an ultra sonicscaler and cleaning with a polishing brush was done. The teeth were etched using 37% Phosphoric acid gel for 20 seconds, rinsed thoroughly with water and gently air dried using a chip blower. Fissurit-F was filled using a syringe needle tip, inside a teflon ring of 4.0mm internal diameter and 1.5mm height, placed on the dried enamel surface. The teflon ring was held in place with firm finger pressure and light cured for 30 seconds from the top of the tube. After curing, the samples were stored in distilled water.

Group-II b Fuji-7 Bond strength study: Before placing the sealant, surface debridement using an ultrasonic scaler and cleaning with a polishing brush was done. The teeth were conditioned using GC dentin conditioner for 20 seconds, rinsed thoroughly with water and gently air dried using a chip blower. Over drying was avoided. Fuji-7 was mixed according to manufacturers instructions and filled inside a teflon ring of 4.0mm internal diameter and 1.5mm height, placed on the dried enamel surface. The teflon ring was held in place with firm finger pressure and light cured for 30 seconds from the top of the tube. After curing, the samples were stored in distilled water.

Both the Fuji-7 and fissurit-F groups were thermocycled at 5^0 C and 55^0 C for 250 cycles, with a dwell time of 30seconds.

After thermocycling, the specimens were stored in distilled water for twenty four hours at ambient temperature of 23 ± 1° C and relative humidity of 50 %. An Instron testing machine (Instron Corporation, Series IX Automated material system 1.09 Interface type 1011 series) was used for testing shear bond strength with 1KN load cell at a crosshead speed of 1 mm/ min.

Statistical analysis

The SPSS version 20 (SPSS Inc., Chicago, IL) was used to analyse the data. The student t test was used to determine the significance of the difference between the means of bond strengths.

III. Results

Evaluation of flow and adaptation using Scanning electron Microscope

Five teeth from each group were evaluated for flow and adaptation using scanning electron microscope. Scanning electron microscope study revealed that all the groups showed some degree of flow and adaptation failure. In the group I c and group I d (Fuji VII, invasive and noninvasive) it was seen that all the specimens showed a cohesive failure. Even though there was considerable gap seen, there was still some amount of the sealant attached to the tooth. So all the samples showing this thin layer of material on the tooth was considered as good adaptation.

The scoring of the observations were done as follows

1= good-- complete adaptation and penetration to all fissures

2= fair-- minor failure of adaptation or penetration

3= poor-- major failure of adaptation or penetration.

The mean scores observed for the following groups were

Group I a – Invasive technique	Fissurit F	1.2
Group I b – Non invasive technique	Fissurit F	1.6
Group I c – Invasive technique	Fuji VII	1.2
Group I d – Invasive technique	Fuji VII	1.4

The invasive technique of both the materials showed good flow and adaptation, with 4 samples each of samples giving a score of 1 (good) and 1 sample each being fair. Group I b (noninvasive Fissuritl-F) showed poor scores i.e. only one sample being good, 3 samples being fair and 1 sample being poor. Even though comparable scores were awarded to group I a and group I c, it was seen that there was much better flow into the depth of the fissure in group I d (Fuji VII non invasive). In all the non-invasive groups it was seen that there was plaque and debris sealed in in deep fissures. Figures 1-4 show the SEM images demonstrating the flw f the two materials in the invasive and non- invasive technique.Table1 shows the results of the SEM evaluation.

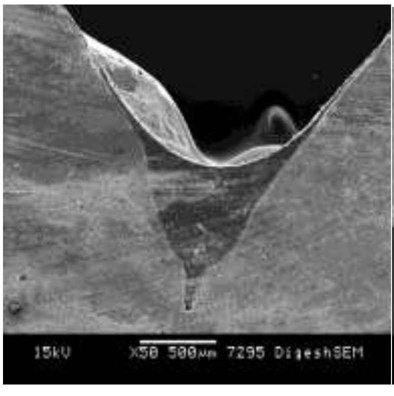

Fig 1: Invasive technique- Fissurit-F

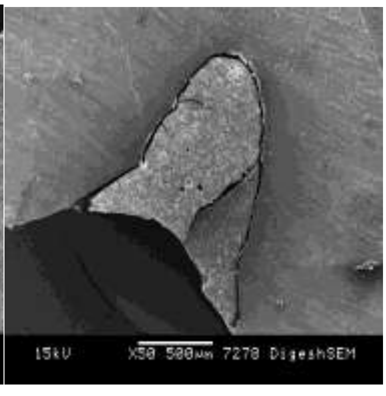

Fig 2: Invasive technique-Fuji VII

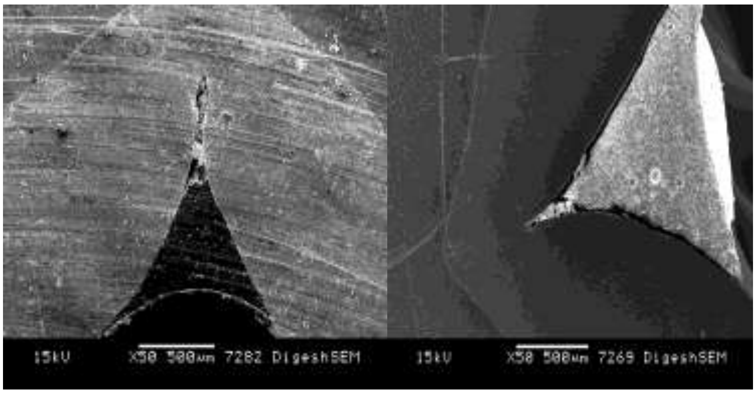

Fig 3: Non-invasive technique-Fissurit-F **Fig 4: Non-invasive technique- Fuji VII**

TABLE- I

RESULTS OFTHE SEM EVALUATION OF FLOW AND ADAPTATION

	Good (Number of samples)	Fair (Number of samples)	Poor (Number of samples)
Group I a	4	1	0
Group I b	1	3	1
Group I c	4	1	0
Group I d	2	3	0

EVALUATION OF SHEAR BOND STRENGTH

Shear bond strength was calculated by evaluating the breaking load of the specimen. Uniform teflon rings of 4mm internal diameter and 1.5mm height were used for this study, grip distance was 4mm. Measurement of shear bond strength were recorded in Mpa and analysed. Table II shows shear bond strength of Fuji VII and table III shows shear bond strength of Fissurit-F.

Comparison of shear bond strengths of Fuji VII and Fissurit F were done using"t" test. The obtained "t" value was 3.808 which indicates that the calculated values were highly significant,($p<0.01$). Table IV shows the comparison of FujiVII and Fissurit F.

TABLE-II

SHEAR BOND STRENGTH OF FUJI VII

Load at Peak (N)	Surface Area (mm^2)	Stress at Break (Mpa)
54.3	12.56	7.69
70.3	12.56	9.95
99.6	12.56	14.10
42.13	12.56	5.96
79.53	12.56	11.25
113.26	12.56	16.02
54.08	12.56	7.65
64.69	12.56	9.15
*2 Values Excluded	Mean	10.22

TABLE-III

SHEAR BOND STRENGTH OF FISSURIT-F

Load at Peak (N)	Surface Area (mm^2)	Stress at Break (Mpa)
72.18	12.56	10.21
133.76	12.56	18.92
107.95	12.56	15.27
66.17	12.56	9.36
150.80	12.56	21.33
95.51	12.56	13.51
139.24	12.56	19.70
116.58	12.56	16.49

148.75	12.56	21.04
77.84	12.56	11.01
	Mean	16.68

TABLE- IV

t-TEST COMPARING SHEAR BOND STRENGTHS OF FUJI-VII AND FISSURIT F

Materials	N	Mean	SD	t-Value	P	Remarks
Fuji-VII	10	10.224	2.8602	3.808	<0.01	HS
Fissurit-F	10	15.584	3.5205			

IV. Discussion

Dental sealants have proved to be highly effective in preventing pit and fissure caries. Many individuals and groups stand to benefit from sealant placement.[3] Surfaces with pits and fissures continue to prove a major challenge in preventing caries and account for the majority of the caries experience in children and adolescents.

The concept of preventive programs for oral health concentrates on the enhancement of natural protection and provision of added protection against oral diseases, procedures to reduce the ability of the microorganism to produce disease and the modification of the behavior patterns to promote oral health and reduce disease.

In the long, run sealants prove to be a more cost effective measure than restorative procedures, especially in the developing countries. Yet sealants have not been as widely accepted in the developing countries as their advantages warrant. The major concern to this end being the deterioration of the material and the increased possibility of caries, in cases where the sealant has fractured or failed.

The sealants with the property of fluoride release might prove useful in such scenario; the anticaries effect of fluoride resulting in fissures which are more resistant to demineralization even after the sealant was lost.[4]

Two fluoride releasing sealants were usedin the present study- the first being a glass ionomer based sealant Fuji VII and the second being a resin based sealant Fissurit-F. Fuji VII has a pink shade when set and this contrast from the tooth structure enables inspection of the sealant. Another feature of FujiVII is the “command set” property. After application of the material, the setting time can be reduced by 30% by light curing. Unique feature regarding this is the absence of any resin component in the material to hasten the setting reaction. It speeds up curing by absorbing the heat energy from the light. Another advantage of Fuji VII is the fluoride releasing property which the manufacturers claim is the highest when compared to all Glass ionomers and resin based sealants.

In the present study, a single investigator did the preparation of the samples and the evaluation was undertaken with the help of a supervisor to reduce the chances of error and remove any bias. As not many studies have been done comparing invasive and non-invasive techniques, this study was designed to evaluate the effect of these techniques on marginal adaptation and shear bond strengths of the materials. In the non-invasive technique, the fissures were mechanically cleansed using polishing brush without the use of pumice or any other abrasive. This was done to remove the superficial debris in the fissures. The usage of pumice has been discouraged by Asquinazi and Jasmin et al as it tends to be partially retained in the fissures[5].This retained pumice is difficult to remove and might affect acid etching procedure ,thus in turn affecting the retention of the sealant. For the invasive technique a tapered fissure bur was used for all the teeth to ensure standardization widening the fissures. After application of the sealant the teeth were stored in normal saline. Thermocycling was then done within the range of 5-55ºC for 30 seconds as suggested by Ballard, Lemnfelder and Russel. Thermocycling was done for 250 cycles in order to subject the materials and teeth to the extremes in temperature as seen in the oral cavity thus simulating the natural environment.[6]

The use of scanning electron microscope provides a means of direct visual observation the adaptation of the restorative materials to the cavity margins because of its magnification and depth of focus. Depending on the flow and adaptation of the sealant as seen through the scanning electron microscope, the specimen were scored as good fair and poor as suggested by Cooley and Mc Court.[7]

The invasive technique proved to have better flow and adaptation to the fissures when compared to the non-invasive technique. This was similar to the study done by Vineet and Tandonwherein both resin based sealant and glass ionomer showed better results with the invasive technique[6].

In our study the invasive technique showed better flow and adaptation to the fissures when compared with the non-invasive technique. This is in agreement with the study conducted by Vineet and Tandon, [6]wherin both resin based sealant and glass ionomer sealant showed better results in the invasive technique. N the non-invasive technique it was seen that all the samples did not flow deep into the fissure even though there was good adaptation to the walls. This was similar to the results of the study done by Cooley and Mc Court[7] where though the sealant penetrated deep into the fissures, they did not consistently reach the bottom of the fissures. All specimen in the study showed bubbles and gaps of different sizes and shapes in the base of the fissures. Fuji VII flowed deeper into the fissures when compared to Fissurit-F.

Shear bond strength of Fuji VII, a glass ionomer based pit and fissure sealant and Fissurit-F, a resin based pit and fissure sealant to the enamel of pre molar teeth were compared. The shear bond strength of Fissurit-F(15.684) was superior to the shear bond strength of Fuji VII(10.2224) and the difference was found to be statistically significant($p<0.01$.)

In the current study glass ionomer sealant showed a cohesive failure and a detachment of the sealant left a layer of sealant covering the enamel fissure. The fracture of the sealant above this layer and cracks in this layer presumably occurred as a result of low cohesive strength and preparation fault,i.e., forces applied to the tooth during cutting and desiccation prior to the SEM study. These findings were similar to those described by Lucia Birkenfeld and Allan Schulman[8] wherein cohesive failure of glass ionomer and fracture of material was seen in all specimens. Fissurit-F did not show any cohesive failure as the material is resin based and unlike glass ionomer is less moisture sensitive.

The results of the SEM evaluation showed that Fuji VII performed equally, if not better than Fissurit-F. In group Ib and group Id (non-invasive technique) it was seen that the plaque and debris was still retained in the deep portions of the fissures. This goes to prove that simple mechanical cleaning and acid etching is not sufficient for complete cleansing of the fissure.

V. Conclusion

This study gives us an insight that invasive technique is a good method of improving the flow and adaptation of the sealant. Both FujiVII and Fissurit-F show good flow and adaptation in the invasive technique when compared to the non-invasive technique.

Fuji VII shows better flow and adaptation into the fissures when compared to Fissurit-F.

The shear bond strength study shows that Fissurit –F has a better bond with the tooth than Fuji VII.

The fluoride release property of Fuji VII makes it desirable in caries prevention. Further studies to ascertain longevity and cariostatic effect of FujiVII should be carried out so as to recommend Fuji VII as a better sealant over Fissurit –F.

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