Original Article

Comparison of Microleakage, Bond Strength, and Fracture Strength of No Etch No Bond Novel Flowable Composite as a Pit and Fissure Sealant in Comparison to the Conventional Sealants: An *In vitro* Study

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Abstract

Background: Resin-based sealants are most commonly used in the clinical practice. With the introduction of self-etch self-adhesive flowable composite, their efficacy as a sealant needs to be evaluated as they can be of great help render preventive care, especially in very uncooperative child. **Aim:** To evaluate the various parameters and compare the efficacy of the new material to the conventional sealant. **Materials and Methods:** Seventy-six noncarious primary molars were randomly assigned into two groups, Fissurit F (Group A) and Constic (Group B). Each group was further subdivided into four groups: G_1 – Microleakage (n = 18), G_2 – Fracture strength (n = 18), G_3 – Tensile strength (n = 20), G_4 – Shear strength (n = 20). The parameters were evaluated and compared to check the efficacy of the two groups. **Results:** Nonparametric tests Kruskal–Wallis and Mann–Whitney tests were applied to the values obtained to compare microleakage and fracture strength and comparison of shear and tensile bond strengths is done by independent t-test. Microleakage and fracture strength of Constic were found to be better, but bond strength of Fissurit F (tensile strength – 14.30 ± 4.49; shear bond strength – 6.12 ± 2.84) was more than that of Constic (tensile strength – 6.33 ± 1.47; shear bond strength – 2.06 ± 0.635). **Conclusion:** Use of a flowable composite without bonding agent is a good alternative for sealing pits and fissures; however, further *in vitro* and *in vivo* studies are necessary.

Keywords: Bond strength, primary teeth, sealant

Introduction

The prevalence and incidence of smooth surface dental caries have declined remarkably in the last few decades with the introduction of various preventive measures. However, occlusal caries incidence is significantly seen as they are most susceptible sites for dental caries because of their specific anatomy and inability to provide adequate plaque elimination.[1] With the advancements in dentistry, especially the adhesive materials, greater emphasis is now laid on preventive dentistry.[2]

Pits and fissures that are successfully sealed prevent or arrest early developing occlusal lesions.[3] Resin-based sealants are most commonly used in the clinical practice.[4] However, in case of resin-based sealants, owing to multiple steps procedure and technique sensitivity, especially in young apprehensive or uncooperative children, a need was felt for developing sealants which could be applied in a single step. Hence, this article aims to study the properties of Constic a self-etch self-adhesive flowable composite material as a sealant in comparison to conventional sealant in primary molars.

Materials and Methods

Two pit and fissure sealants were used in this study. The conventional sealant Fissurit F and Constic which is a

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flowable composite were used as sealants (Constic, a self-etch and self-adhesive flowable composite was compared with a conventional sealant) [Figure 1]. Seventy-six freshly extracted noncarious human primary molar teeth which are near to the exfoliation were selected for this study. All the collected teeth were obtained from children after taking informed consent from the parents. After extraction, the teeth were stored in thymol 2% for 24 h. The teeth were later randomly divided into four study groups in such a fashion that:

- 20 teeth were used for used to evaluate and compare the shear strength
- 20 teeth were used to evaluate and compare of tensile strength
- 18 teeth were used to evaluate and compare the microleakage
- 18 teeth were used to evaluate and compare fracture strength of the study materials.

Procedure for application of Fissurit F and Constic to evaluate microleakage and fracture strength

For comparison of microleakage (G_1) and fracture strength (G_2), 36 teeth were divided into two groups with 18 teeth in each group; each group was further subdivided into Group A (Fissurit F) and Group B (Constic). Enameloplasty was performed on the selected teeth using a cone-shaped bur as described by De Craene *et al*.[5] Just before sealing, the teeth were cleaned with a brush in a low-speed micromotor handpiece without pumice, and a dental explorer was used to clean debris from the pits and fissures.

Application of Fissurit F

Occlusal surface of the teeth was etched with 37% phosphoric acid for 30 s and rinsed with water and dried thoroughly. Then, the sealants were applied and light cured for 20 s. The sealant application was limited to the borders of the fissure, and a waiting period of 10 s was employed prior to light curing.

Application of Constic

Constic was applied on the occlusal surface of the teeth as per the manufacturer's instructions and light cured for 20 s. After sealing, the teeth were kept in distilled water at 37°C for 24 h.

Thermocycling procedure

All the teeth were subjected to thermocycling between 4°C ± 2°C and 60°C ± 2°C for 1000 cycles [Figure 2]. The dwell time in each bath and the time interval at room temperature between baths were 1 min. After thermocycling, the surfaces of the teeth, apart from the restorations and approximately 1.5 mm beyond the margins, were coated with two layers of nail varnish. The coated teeth were immersed in 1% methylene blue solution for 24 h to allow dye penetration into possible existing gaps between the tooth substance and the restorative material [Figure 3]. Following dye exposure, teeth were washed and rinsed with distilled water. After that, teeth were subjected to the universal testing machine to check the fracture strength.

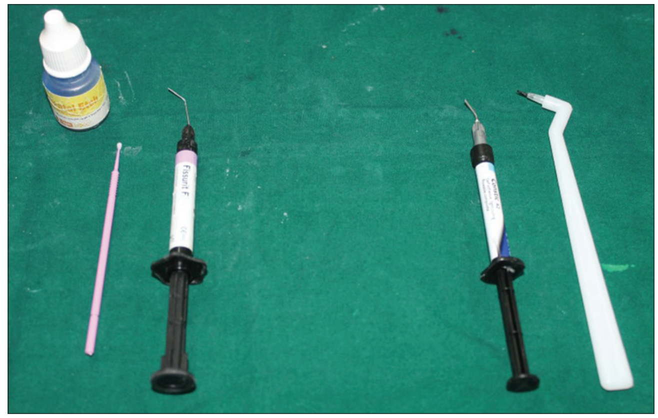

Figure 1: Test materials (Constic and Fissurit F).

Figure 2: Thermocycling of samples.

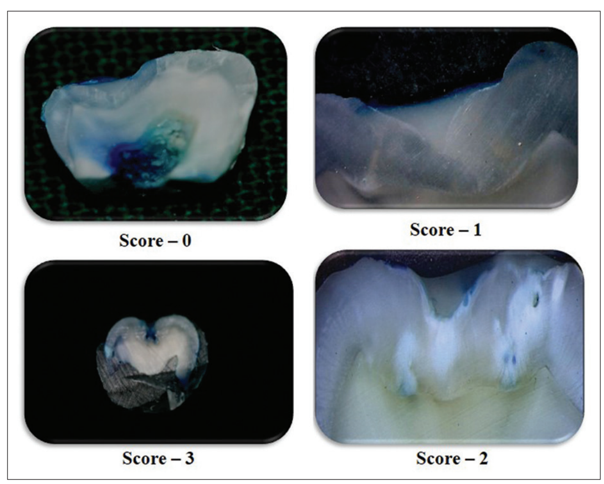

Figure 3: Microleakage scoring.

Procedure of microleakage evaluation

Dye penetration evaluation

Two mesiodistal sections were obtained by grinding off the embedded teeth buccolingually parallel to their axes with a water-cooled diamond disc. The depth of the dye penetration was evaluated under a stereomicroscope using image analysis software (SigmaScan, SPSS; Jandel Scientific, San Rafael, CA, USA) [Figure 4]. Scores were assigned to each individual sample in accordance with the depth of penetration in millimeters. Two examiners measured the depth of dye penetration.[6] In cases of a difference of >1mm, the examiners discussed the gap and a decision was made on a consensual basis. The mean values of the dye penetration for the three sections were recorded separately in millimeters for the occlusal and the cervical interfaces. Data was analyzed using a paired t-test ($\alpha = 0.05$).

The degree of microleakage was blindly scored by two independent examiners, using a grade scale.[7]
0 = No dye penetration
1 = Dye penetration restricted to the outer half of the sealant
2 = Dye penetration restricted to the inner half of the sealant
3 = Dye penetration to the underlying fissure.

Procedure of fracture strength evaluation

After sealant application, specimens were positioned on the testing machine. The specimens were held centrally between the two measuring arms of the vertically positioned digital micrometer. A load pressure was applied on the specimens to simulate the clinical conditions. This pressure was applied on the specimen till the fracture of the sealant occurs. The gauge length used was 25 mm with displacement of −0022.0 mm at the temperature of 25°C and at a speed of 3 mm/min. The compression versus deformation graph was plotted on the star testing system software, which accurately recorded the readings. Images were transferred to a personal computer to be analyzed for bond strength evaluation. The sealant thickness was kept at approximately 100 um.

Procedure for evaluation of shear strength and tensile strength

Forty specimens were randomly assigned into two groups of equal size: Group A – Constic and Group B – Fissurit F. Each group was then further divided into two subgroups ($n = 10$) to check the tensile strength (G_3) and shear bond strength (G_4) of both the groups. Application of the study material was done as mentioned earlier.

Procedure for application of Fissurit F and Constic to evaluate shear bond strength and tensile strength

For Group A, no etchant was required as Constic is a self-etch. The jig was completely filled with the sealant, using a syringe with a disposable 30 × 7 gauge needle to avoid the inclusion of air bubbles.

For Group B specimens, the demarcated enamel sites were etched with 37% phosphoric acid for 15 s, rinsed thoroughly for 20 s, and dried with a mild, oil-free air stream to obtain a uniformly whitish, dull, chalk-like appearance. For both the groups, a plastic jig (4 mm in diameter, 10 mm in height) was placed over the demarcated enamel site and carefully attached with an adhesive system.

Processing of the samples

The material was light cured for 20 s with a visible light-curing unit. Once the bonding procedure was completed, the jig was sectioned longitudinally with a scalpel blade, opened, and carefully removed together with the insulating tape used to demarcate the bonding site. This created a sealant cylinder-shaped specimen (4 mm × 10 mm) adhered to enamel surface. After a 24-h storage in distilled water at 37°C, the specimens were air-dried.

Procedure for evaluation of tensile bond strength and shear bond strength

The shear bond strength and tensile strength for both the groups were recorded under universal testing machine [Figures 5 and 6]. Bond strength was recorded in kgf/cm and then was converted into MPa.

Statistical analysis

Nonparametric tests Kruskal–Wallis and Mann–Whitney tests were applied to the values obtained to compare the relationship between the different groups for microleakage and fracture strength.

Data were subject to statistical analysis using Statistical Package for the Social Sciences (IBM SPSS Statistics for

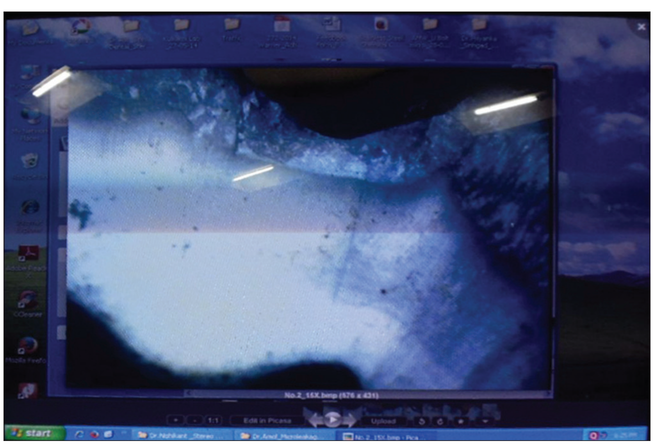

Figure 4: Dye penetration seen in the sample.

Figure 5: Evaluation of tensile bond strength by universal testing machine.

Windows, Version 22.0. Armonk, NY: IBM Corp). Results are expressed as mean and standard deviation of shear and tensile bond strengths (in MPa). Comparison of shear and tensile bond strengths of both groups is done by independent *t*-test. $P < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

Results

For microleakage and fracture strength

A total of 36 sections were examined for microleakage and penetration depth.

Table 1 shows comparison of values obtained for microleakage.

It is seen that 70% of the samples in Group A give a microleakage score of 1, and in Group B, it gives a microleakage score of 2 showing statistical difference between the two groups.

A significant difference was seen in the microleakage between following groups ($P < 0.05$) A versus B. Both sealants used in this study showed some degree of microleakage, but the least microleakage was seen with Constic sealant.

Table 2 shows the value for fracture strength.

Group A shows an average fracture strength of 633.77 and Group B of 457.76.

A significant difference was seen in the fracture strength and microleakage of both the groups:

- A versus B ($P = 0.002$) for microleakage
- A versus B ($P = 0.008$) for fracture strength.

From the results, it can be concluded that the fracture strength of Constic sealant was found to be better than that of Fissurit F sealant. Further, the microleakage is minimum in Constic sealant as compared to the Fissurit F sealant.

For tensile and shear bond strength

Shear bond strength and tensile strength of both Constic and Fissurit F are displayed Table 3.

Figure 6: Evaluation of shear bond strength by universal testing machine.

Overall, the data analysis showed a statistically significant difference ($P < 0.05$).

A significant difference was seen in the shear bond strength and tensile strength of both the groups ($P < 0.01$).

Shear bond strength of Fissurit F was 6.12 ± 2.84 Mpa and of Constic was 2.06 ± 0.63 Mpa.

Tensile bond strength of Fissurit F was 14.30 ± 4.49 Mpa and of Constic was 6.33 ± 1.47 Mpa.

From the results, it can be concluded that the shear bond strength and tensile strength of Fissurit F sealant was found to be better than that of Constic sealant.

Discussion

In spite of the overall reductions in caries prevalence, fissure caries continues to remain a significant clinical problem. One of the best methods of preventing the occlusal caries is identifying caries-susceptible sites and sealing them off with sealants before a significant start of the disease process.[8] Changing and simplifying the steps in bonding from multi-bottle to one bottle system to self-etch system have now progressed to the evolution of composites with ability of self-etch self-adhesion. However, these composite simplify the procedure, but clinically, they have a limited range of indications. This study tries to evaluate whether the newly introduced flowable composite offers any advantage in comparison to the conventional sealant.[9] Hence, to check this, an *in vitro* study to compare the microleakage, fracture resistance, and bond strength of Constic with a conventional pit and fissure sealant Fissurit F was designed to evaluate and

Table 1: Comparison of values obtained for microleakage

Groups	Number of samples	Microleakage				Significance
		0	1	2	3	
Group A	18	1	11	4	2	0.002
Group B	18	0	3	11	4	

Table 2: The value for fracture strength

Groups	Number of samples	Fracture strength	Significance
Group A	18	633.77	0.008
Group B	18	457.76	

Table 3: Comparison of shear and tensile bond strengths of Group A and B

	Groups	*n*	Mean (MPa)±SD	*P* value of *t*-test
Shear	Constic	10	2.066000±0.6351938	0.000**
	Fissurit F	10	6.126000±2.8437385	
Tensile	Constic	10	6.3300±1.47372	0.000**
	Fissurit F	10	14.3040±4.49399	

**Statistically highly significant difference ($P<0.01$). SD: Standard deviation compare whether any variations in properties is seen with sealants of different chemical and physical characteristics.

Adequate sealing of the interface between the sealant and tooth surface is essential for optimal clinical performance as insufficient sealing can result in marginal discoloration, caries, and thus the failure of prevention goal. For that reason, microleakage tests are the cheapest and fastest method to evaluate the sealing ability of sealants.[10] In the present study, it was found that the fracture resistance and microleakage of Constic were superior to the sealant which was in contrast to the study where two fissure sealants and two flowable sealants were compared and they found nonsignificant difference between the two.[11]

Any force on the restoration produces compression, tension, or shear along the tooth/restoration interface leading to complex stress distributions; a combination of compressive, tensile, and shear stresses. The quality and efficacy of bonding of these adhesive materials are reflected in their mode of failure – either cohesive, adhesive, or mixed.[12]

Meticulous application procedures have resulted in high retention rates and high *in vitro* bond strengths.[13] A report was published by the American Dental Association Council on Scientific Affairs on self-etching bonding agents that a self-etching bonding agents provide a comparable retention to bonding agents that involve a separate acid etching step.[14]

Our study shows that the fracture strength of Fissurit F flowable composite with acid-etching and adhesive system is 457 N and for Constic flowable composite without etching and adhesive system is 633 N while the shear bond strength and tensile strength of Fissurit F and Constic are 6.126 Mpa and 2.066 Mpa; 14.30 Mpa and 6.33 Mpa, respectively.

An analysis of variance revealed that there were significant differences among the different groups at a 95% confidence level ($P < 0.0005$). Significant differences were noted between the self-etch and self-adhesive sealant group (Constic Pit and Fissure Sealant) and the other material, i.e., Fissurit F (Student's *t*-test values are >0.001, i.e., $P < 0.002$ and <0.008). Hence, the significant differences were found between the Constic and Fissurit F groups.

Conclusion

The current study showed higher tolerance of the Constic pit and fissure sealant to microleakage and better bond strength compared to Fissurit F. However, in clinical practice, microleakage influences the efficacy of the sealant more than the bond strength does, since lesser the microleakage, better the sealing ability, and better the cariostatic action of the pit and fissure sealant. Hence, taking this into consideration, Constic can be considered as an alternative to conventional sealant.

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Conflicts of interest

There are no conflicts of interest.

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