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A comparative evaluation of compressive strength of different pit and fissure sealants- An in vitro study

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Abstract

Introduction: Sealing Pit and Fissures of occlusal surfaces is one of the most effective dental caries preventive measures, but to do so it needs to have biocompatibility, esthetic appeal and improved mechanical properties like compressive strength, tensile strength and shear bond strength etc.

Aims: To investigate the compressive strength of different Pit and Fissure sealants.

Methods: 10 Standardized restorative material pellets were made from each experimental material namely: CPP-ACP based sealant, GIC based sealant and unfilled resin based sealant which made sample size to be 30. Thermocycline was done to mimic the oral conditions and Compressive strength was evaluated using universal testing machine.

Results: The Compressive strength of GIC based sealant was found to be statistically higher when compared with CPP-ACP and unfilled resin based sealant.

Conclusion: Hence GIC based sealant can be recommended as a stronger and effective pit and fissure sealant in comparison to CPP-ACP based sealant and Unfilled resin based sealant.

Key words: Fissure sealants, S-PRG filler, microleakage, Giomer, Amorphous calcium phosphate, compressive strength

Introduction

Prevention of dental caries is the demand of an era. Because the dental caries is a worldwide dental disease which has sequelae like: pain, tooth abscess, tooth loss, broken teeth, chewing problems and serious infection. To eradicate dental caries many measures have been taken in the past history like: oral hygiene aids where proper brushing and flossing methods has been taught at the dental office during routine check-ups, fluoride application include water fluoridation, fluoride tooth paste, fluoride mouth rinse, dietary fluoride supplements, and professionally applied fluoride compounds such as gels and varnishes has been used, xylitol has been used as a substitutes to sugar, and caries vaccinations has been

delivered. But still the dental caries is a major threat to population. One of the most effective measures of caries prevention is pit and fissure sealant which has been used since ages[1].

With the introduction of acid etching by Buonocore in1955, bonding became a new technology and a further step in its use was the prevention of pit and fissure decay. With the formulation of Bis-GMA resin by Bowen in 1962, resin sealant methods were developed. This resin continues to form the basis of presently available sealants.

According to Simonsen (1978) pit and fissure sealants are defined as ‘’A material that is introduced into the pits and fissures of caries susceptible teeth, thus forming a micromechanically bonded, protective layer cutting the access of caries producing bacteria from their source of nutrients[2]. The properties required of an ideal fissure sealant include biocompatibility, anti-cariogenicity, adequate bond strength, good marginal integrity, resistance to abrasion and wear and compressive strength.

Thus an important factor for sealant success is compressive strength. Compressive strength is an important property in restorative materials, particularly in the process of mastication. This is because most forces of mastication are compressive. Moreover, when comparing materials that are brittle and generally weak in tension, compressive strength is a useful benchmark.[3]

Since ages manufacturers have added filler particle, fluorides, colour etc to improve strength, retention, anti-cariogenic properties of these sealants. Conventional resin based sealants required etching, bonding before the placement of sealants thus became quite time consuming. Thus self-etching sealants got introduced. For prolonged anti-cariogenic activity fluoride containing and CPP-ACP containing pit and fissure sealants has been introduced. Thus this in vitro study has been aimed to investigate the compressive strength of different pit and fissure sealants.

Methodology

For the evaluation of compressive strength, total thirty molds were prepared using Teflon pipe which were cut equally, measuring 2 mm in length and 6 mm in diameter.

A total number of thirty samples were prepared according to three experimental groups (n = 10): Group I (PF seal), Group II (Beautisealant), and Group III (Clinpro). All the specimens were colour coded with different nail colours, as shown in Fig 1. Group I (PF seal) is coloured with pink, Group II (Beautisealant) is coloured with red and Group III (Clinpro) is coloured with green respectively. All the specimens were filled with different groups of pit and fissure sealants and were cured according to manufacturer’s instructions. All the restored samples were then removed from the plastic molds using bp blade and handle, and kept in 3 different sample jar respectively. The samples were then subjected to thermocycling for 500 cycles between the temperature range of 5.5^0c and 55^0c with an interval of 5s in each bath.

After the retrieval of samples from the thermocycling machine, all the samples were stored in saline for 24hr. All specimens were then transferred to the Universal Testing Machine and subjected to load, at a crosshead speed of 1 mm/min at an angle of 90^0 to restoration until visible evidence of failure was observed. For all the study samples the compressive strength was calculated in megapascals using the formula. CS= Load/Area(πr2)

Where CS = compressive strength; load is expressed in Newton (N); π = 3.14; r = half the diameter of mold.

Results

The data was statistically analysed using ONE WAY-ANOVA and the following results were obtained.

It was noted that Group III (Clinpro) had the lowest mean value of 65.49, followed by Group I (PF Seal) with a mean value of 66.92, while Group II (Beautisealant) had the highest mean value of compressive strength, i.e, 86.52 as shown in Table 1. A statistically significant difference existed between the three groups with p=0.000 as shown in Table 2. The intercomparison of compressive strength of various groups also showed the statistically significant results, Table 3.

Discussion

The result from the present study revealed that the mean compressive strength was observed to be highest in (Group II) Beautisealant. In a research by **Jong soo kim** in **2012**[4] in which comparison of compressive strength and surface microhardness between flowable composite resin and giomer was done, the results of which revealed that the compressive strength of giomer is higher than that of flowable composite resin. Jong soo Kim concluded that Giomer would be the good alternative to composite resin.

There could be many possible reasons that the compressive strength of BeautiSealant is better than the conventional pit and fissure sealant and one of the reason could be the Beautisealant primer is Bisphenol A- and HEMA-free with dual adhesive monomers that thoroughly penetrate and prepare pits and fissures for bonding to the sealant. Unlike traditional sealants which require phosphoric acid etching, demineralising and dehydrating healthy teeth, SHOFU's self-etching primer is significantly less acidic helping to preserve healthy tooth structure. BeautiSealant achieves better compressive strength, which is better than fissure sealing with phosphoric etching.

Secondly, Giomers contain a multifunctional glass core that undergoes an acid base reaction during manufacturing and is subsequently protected by a surface modified layer. This trilaminar structure forms a type of stable glass ionomer which allows ion release and recharge to take place, while protecting the glass core from the damaging effects of moisture, greatly improving long-term durability and hence preserving the compressive strength of the sealant.

Thirdly **Ruengrungsom C et al.**[5] reported that Na is present in the S-PRG filler composition and is released with Al. The release of Al is associated with enhanced F release, leading to increases in the formation of aluminofluoro complexes, thus resulting in increase in the compressive strength.

In the present study compressive strength was found to be least in Group III (Clinpro). The reason for least compressive strength of this sealant could be due to its unfilled property. In a study done by **Kaga M** in **2011**[6], it was found that sealants without filler provided greater penetration into enamel, especially into fissures than sealants incorporating microfiller. On the other hand **Reddy VR et al** in **2015**[7] have not found significant differences in retention between sealants with and without filler and have reported that both penetrate into fissures equally well. However unfilled pit and fissure sealants being lesser in viscosity, result in decrease in compressive strength of the sealant.

Conclusion

In conclusion, we found that the resin-based Beautisealant containing S-PRG has been proved superior in terms of compressive strength when compared compared to the conventional sealants. Since it eliminates the need for phosphoric acid etch and rinse steps entirely, while still maintaining equal or better compressive strengths, thus creating a faster, easier, and gentler sealant system that can be efficiently used in the pediatric dentistry.

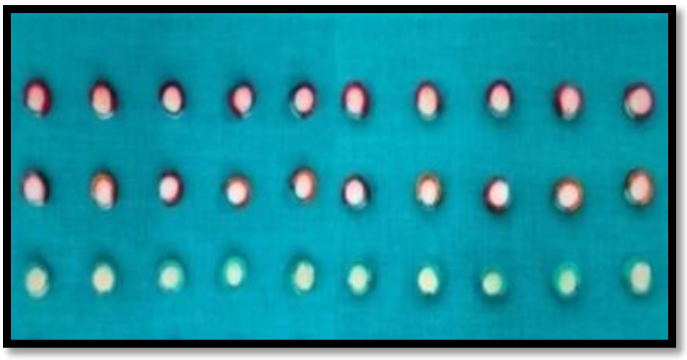

Figure 1: Colour coding of all moulds

Group	N	Mean	Std. Deviation	Std. Error Mean
PF seal (PINK) GR-I	10	66.920	8.1652	2.5821
Beauti Sealant (RED) GR-II	10	86.520	13.9205	4.4020
Clinpro (GREEN)GR-III	10	65.490	11.0473	3.4935

Table 1: Mean values of microleakage in different groups.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2761.553	2	1380.776	10.830	0.000*
Within Groups	3442.441	27	127.498		

*p value < 0.05 Significant

Table 2: Comparison of means of microleakage among different groups.

Group	Group	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PF seal (PINK) GR-I	Beauti Sealant (RED) GR-II	-19.6000	5.0497	.002*	-32.489	-6.711
	Clinpro (PURPLE) GR-III	1.4300	5.0497	1.000**	-11.459	14.319
Beauti Sealant (RED) GR-II	Clinpro (PURPLE) GR-III	21.0300	5.0497	.001*	8.141	33.919

Table 3: Intercomparison of compressive strength of various groups

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