SHEAR BOND STRENGTH OF SOME SEALANTS UNDER SALIVA CONTAMINATION

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Abstract. The purpose of this *in vitro* study was to compare the shear bond strength of different types of sealant to non-contaminated and saliva-contaminated enamel. The buccal surfaces of 60 sound permanent third molars were individually embedded in self-curing acrylic resin and wet ground with 1,000-grit silicone carbide paper to obtain a flat enamel surface. The specimens were randomly assigned to one of three groups: 1) non-fluoride-releasing resin sealant (Concise™), 2) fluoride-releasing resin sealant (Clinpro™), 3) glass-ionomer sealant (Fuji VII®). Each group was divided into 2 subgroups (n=10): non-contaminated and saliva contaminated with 0.02 ml of fresh human saliva for 20 seconds and then blowed dried prior to sealant placement. All samples were thermocycled 2,000 cycles. The specimens were tested using an Instron running at a crosshead speed of 0.05 mm/min. Stereomicroscope examinations were carried out to evaluate failure sites of the sealants. Data were analyzed with one-way ANOVA and the Turkey test at a siginificance level of $p<0.05$. Comparison of the different types of sealant revealed the shear bond strength of the glass-ionomer sealant was the same for the non-contaminated and saliva-contaminated subgroups. The shear bond strength was lower in both the fluoride and non-fluoride releasing resin-based sealant groups contaminated with saliva than in the fluoride and non-fluoride releasing resin-based sealant groups not contaminated with saliva. Comparison of the different types of sealant also revealed the shear bond strength of the glass-ionomer sealant had a significantly lower shear bond strength than the fluoride and non-fluoride releasing resin-based sealant groups for both the non-contaminated and saliva-contaminated subgroups. The fluoride and non-fluoride releasing resin-based sealant groups were not significantly different from each other. The modes of failure were mostly mixed with the glass-ionomer sealant in both the non-contaminated and saliva-contaminated subgroups of this sealant. The resin-based sealant groups (both fluoride and non-fluoride releasing) had cohesive/mixed failure in the non-contaminated and adhesive/mixed failure in the saliva-contaminated subgroups. In conclusion, saliva-contamiantion did not affect the shear bond strength of glass-ionomer sealant but the glass-ionomer sealant had the lowest shear bond strength.

Keywords: shear bond strength, glass-ionomer, sealant, contamination

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INTRODUCTION

Evidence suggests that nearly 90% of caries in children occur in pits and fissures (Weintraub, 2001). Pits and fissures hinder plaque removal and penetration of fluoride and bactericidal solutions (Carvalho *et al*, 1989; Pearce *et al*, 1999). The use of pit and fissure sealants is widespread, since they are considered an effective preventive method against caries on the occlusal surfaces (Frazier, 1984). Resin-based sealants are the most commonly used sealants in clinical practice (Buonocore, 1971). Saliva contamination during sealing is the main cause of sealants failure (Hebling and Feigal, 2000). Retention of sealants is considerably diminished when proper saliva control and dry field isolation are not achieved, as is commonly experienced with young children, patients with special needs and newly erupted teeth (Duangthip and Lussi, 2003). Glass ionomer cements were introduced about 25 years ago as sealants, especially where resin-based sealants are contraindicated, as in clinical treatment of children with deep pits and fissure in primary molars or permanent first molars that have not fully erupted and whose isolation can be difficult (Komatsu *et al*, 1994; Waggoner and Siegal, 1996). Fluoride contained in glass-ionomer sealants is slowly released into the oral cavity and can help prevent dental caries (Braudau *et al*, 1984; Mount, 1986). Several kinds of fluoride fissure sealants have been developed over the years (Hicks and Flaitz, 1992), despite the lack of scientifically based information addressing the bonding performance of these materials.

The aim of this *in vitro* study was to evaluate the effect of saliva contamination on and compare the shear bond strength of three different pit and fissure sealants.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of Mahidol University. Sixty freshly extracted sound third human molars were obtained and stored in 0.9% normal saline at 4ºC until used. Prior to the study, the teeth were washed in running water to eliminate storage solution residues, the roots were removed and the crown was embedded in self-curing acrylic resin using PVC rings (2.5 cm in diameter and 2 cm in height) with the enamel surfaces facing up. The specimens were hand polished with wet #320, 800 and 1,000 silicon carbide abrasive paper to obtain flat, smooth test surfaces, which were cleaned with an ultrasonic machine (ultrasonic soniator model vibraclean 300, MDT Corporation, USA) for 5 minutes. The 60 specimens were randomly assigned to 2 groups (n=30): A) non-contaminated enamel; and B) saliva-contaminated enamel. Each group was then divided into 3 subgroups (n=10), according to the pit and fissure sealant used: 1) non-fluoride releasing resin sealant (Concise™), 2) fluoride releasing resin sealant (Clinpro™) and 3) glass-ionomer sealant (Fuji VII®). Details of the sealants are given in Table 1. In both the non-contaminated and saliva-contaminated groups, a silicon jig (3 mm in diameter and height) was placed over the demarcated enamel site and carefully attached with adhesive tape. Sealant was inserted into the jig in increments according to the manufacturer's instructions. For saliva contaminated specimens, saliva contamination was done by applying 0.02 ml of fresh human saliva, supplied by one person, to the surface of the tooth with pits and fissures and left undisturbed for 10 seconds, then the specimens was gently air dried for 5 seconds. As the cavity was filled, the specimen was released from the jig, leaving a sealant cylinder (3 mm x 3 mm) adhering to the enamel surface. After 24 hours storage in distilled water at 37ºC, the specimens were thermocycled between 5(±2) and 55(±2)ºC for 1,000

Table 1
Sealants used in the study.

Material	Type	Manufacturers
Concise™ Lot No. 20070709	Resin-based light-cured fissure sealant	3M ESPE, St Paul, MN, USA
Clinpro™ Lot No. 20070416	Resin-based light-cured fluoride-containing fissure sealant	3M ESPE, St Paul, MN, USA
Fuji VII® Lot No. 0407011	Glass-ionomer cement formulated for fissure sealant	GC Corp, Tokyo, Japan

Table 2
Shear bond strength mean (MPa) and standard deviation of the study groups.

	Concise™	Clinpro™	Fuji VII®
Non-contamination	15.79 ± 1.69	12.42 ± 2.95	2.50 ± 0.54[b]
Saliva-contamination	3.87 ± 1.35[a]	5.28 ± 1.78[a]	1.90 ± 0.45[b]

[a]siginificant difference in different situations
[b]siginificant difference in different materials

cycles with a dwell time of 30 seconds. All specimens were then sheared in an Instron Universal testing machine (Instron LTD, Buckinghamshire, England) with a shear force to the specimen using a crosshead speed of 0.5 mm/minute. The surfaces of each group were evaluated with a 40x stereomicroscope to assess the failure of the sealant, which were classified as adhesive, cohesive or mixed. Means (in MPa) and standard deviations were calculated and data were analyzed statistically by one-way ANOVA and Tukey with 95% confidence level.

RESULTS

Shear bond strength means and standard deviations in the non-contaminated and saliva-contaminated groups are shown in Table 2.

Comparison of the three different types of sealant revealed the shear bond strength of the glass-ionomer sealant in both non-contamination and saliva-contamination subgroups showed no significant difference. The shear bond strength in the non-fluoride-releasing resin sealants and fluoride-releasing resin sealants groups was lower in the saliva contaminated subgroup than in the non-contaminated subgroup. However, there were no differences between the fluoride and non-fluoride releasing resin sealants in those in the non-contamination subgroups and there were no differences between the fluoride and non-fluoride releasing resin sealants in the saliva-contaminated subgroups. The glass-ionomer sealant had a significantly lower shear bond strength than the resin sealants. In the resin-based groups, the saliva-contaminated specimens exhibited a mixed or adhesive mode of failure and the non-contaminated specimens exhibited a mixed or cohesive failures. The glass-ionomer sealand exhibited mostly a mixed failure.

DISCUSSION

In this study the mean shear bond strength of the fluoride-containing resin sealant (Clinpro™) was not statistically different from the non-fluoride-containing resin sealant (Concise™), similar to a study by Perdigão *et al* (2005). This may be because the bond strength of the fluoride-containing resin sealant and the non-fluoride-containing resin sealant bonded well because the enamel was treated with 35% phosphoric acid which promoted areas of micromechanical adhesions between the sealant and the enamel surface (Park *et al*, 1993). The resin tag lengths of fluoride-containing resin sealant and non-fluoride resin sealant were probably similar. Rawls (1988) found fluoride-containing resin sealant (FluroShield) had residual tags on the enamel surface approximately 10-20 m long. Silverstone (1974) found the tag lengths of non-fluoride-containing resin sealant were 11.8-18.9 m long. Therefore, the addition of fluoride organic fluoride to the resin-based sealant might not effect the bond strength. The mean shear bond strength of the glass-ionomer (Fuji VII®) was significantly less than that of the resin-based sealants, similar to a study by Papacchini (2005). Resin-based sealants are treated with 35% phosphoric acid (pH=0.6) and the glass-ionomer sealant is treated with 10% polyacrylic acid (pH=1.85), which is less acidic. The enamel etched with 35% phosphoric acid had deeper exposed enamel rods and interrod porosity than the enamel etched with 10% polyacrylic acid; the length of the resin tag with the enamel etched with 35% phosphoric acid was longer than tag of the enamel etched with 10% polyacrylic acid (Glasspoole *et al*, 2002). The bond strength of the saliva-contaminated enamel in the resin-based sealant groups was markedly lower than non-contaminated enamel. Similar findings were previously reported by Barroso *et al* (2005). This is because the microporosities produced by the acid become partially occluded, preventing optimal resin tag formation undermining bonding of the sealant (Silverstone *et al*, 1985).

Regarding the failure modes, in resin-based sealants, a lower bond strength was correlated with mainly adhesive failure, similar to the findings of Truffier-Boutry *et al* (2003) who found predominantly adhesive failure after saliva contamination. Our findings agree with those of Sidhu *et al* (1999), who found the interfacial region was the weak link, irrespective of the mode of failure.

The glass-ionomer sealant exhibited the lowest shear bond strength in both the non-contaminated and saliva-contaminated tests.

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