# The success rates of a glass ionomer cement and a resin-based fissure sealant placed by fifth-year undergraduate dental students

T. Ulusu*, M.E. Odabaş*, T. Tüzüner**, Ö. Baygın**, H. Sillelioğlu*, C. Deveci*, F.G. Gökdoğan*, A. Altuntaş*
*Department of Paediatric Dentistry, University of Gazi, Ankara, Turkey.
**Department of Paediatric Dentistry, University of Karadeniz Technical, Trabzon, Turkey.

Key words: Glass ionomer sealants; resin-based sealants; retention; caries prevention; dental students
Postal address: Dr. M.E. Odabaş, Department of Paediatric Dentistry, University of Gazi, Faculty of Dentistry, 8. Cadde 82.Sokak 06510 Emek Ankara, Turkey.
Email: mesut@gazi.edu.tr

## Abstract

**AIM:** To evaluate retention and caries prevention of a glass-ionomer cement (GIC) and a resin-based fissure sealant placed by fifth-year undergraduate dental students. **METHODS:** The study was conducted according to a split-mouth, randomised clinical trial. Children with at least one pair of caries-free permanent first molars with deep pits and fissures were included in the study. The children were selected from a population that had a high risk for dental caries. Sealant materials were applied by fifth-year undergraduate dental students on 346 fissures of the first permanent molars in 173 children. The ages of the children ranged from 7-15 years (mean 9.4). Two researchers at the clinics supervised all of the procedures. Intra-examiner reproducibility and inter-examiner reproducibility were 0.90 and 0.86, respectively, for the clinical assessment of sealant retention and caries evaluation. **RESULTS:** GIC sealants were completely lost in 31.9% and resin-based sealants in 16.6% ($p<0.05$). The total retention rates of GIC sealants and resin-based sealants were 13.8% and 20.8%, respectively. After 24 months, the caries increment was 3.4% for GIC sealants and 4.8% for resin-based sealants ($p>0.05$). **CONCLUSIONS:** The retention of GIC sealants was markedly inferior to the retention of resin-based sealants; however, GIC when used as a pit and fissure sealant was slightly more effective in preventing occlusal caries.

## Introduction

Dental caries is an infectious disease that can be arrested in its early stages. Approximately 90% of carious lesions are found in the pits and fissures of permanent posterior teeth [NCHS, 2007]. The application of pit and fissure sealants (FS) is widely used for the prevention of dental caries. Pit and FS have their own technology. There are basically two dental materials that are used to seal pits and fissures: resin-based/composites and glass ionomer sealants. The most widely used FS are resin-based composite adhesives. Resin-based sealants change the occlusal morphology by forming a micromechanical-bonded resin layer that functions as a physical barrier between the enamel surface and the oral environment [Simonsen, 2002; Müller-Bolla et al., 2006]. It is generally accepted that resin-based FS are retained longer than GICs [Simonsen, 2002; Locker et al., 2003]. However, it is unclear as to which sealant type better prevents caries.

Fissure sealing with glass ionomer (GIC) cement was introduced by McLean and Wilson [1974]. They reported 84% completely retained sealants after 1 year and 78% after 2 years when using GIC. The main advantages of GIC are its ability to adhere to untreated enamel surfaces and its continuous release of fluoride from the cement [Mejare and Mjor, 1990]. Moreover, when using GIC for fissure sealing, the retention of the material is less dependent on complete moisture control [Poulsen et al., 2001]. However, different studies have shown significantly lower retention rates compared to resin sealants. On the other hand, Torppa-Saarinen and Seppå [1990] investigated the pits and fissures of GIC sealed occlusal surfaces that had been clinically scored as having partial or total loss of sealant under a stereomicroscope or scanning electron microscope and reported that glass ionomer material was still left at the bottom of the fissures in most of the cases. It was assumed that this finding was in part the reason why GIC sealants prevented caries even after they appeared to be lost [Torppa-Saarinen and Seppå, 1990; Arrow and Riordan, 1995; Weerheijm et al., 1996].

The purpose of this study was to compare the retention and the caries-preventive effect of a GIC used as a fissure sealant (Fuji VII, GC Corporation, Japan) and a light-cured, fluoride-releasing resin sealant (Fissurit F, Voco, Germany).

## Materials and methods

Participants, including boys and girls ranging from 7-15 years of age (mean age 9.4 years), were selected from a patient population at high risk for dental caries at the University of Gazi Department of Paediatric Dentistry. All first permanent molars were lightly dried with an air syringe, and the occlusal surfaces were examined visually. Clinical evidence of caries (cavitation, discolourisation or other carious defects) or an existing restoration in a first permanent molar indicated exclusion from the study. The children with at least one pair of caries-free first permanent molars with deep pits and fissures were included in the study. Informed consent was obtained from the parents of children. The procedure, likelihood of potential discomfort, risks, and possible benefits were explained in full to the parents of the involved children.

The study was conducted according to a split-mouth design using contra-lateral teeth. The inclusion criteria consisted of clinically non-detectable caries and no FS or restorations present on the fissures. Sealant materials were applied by fifth-year undergraduate dental students on 346 fissures of first molars in 173 children. Two paediatric dentists at the clinics supervised all of the procedures.

**Resin-based.** Prior to the sealant application, each tooth was cleaned using a bristle brush and pumice, rinsed thoroughly with water, and etched with 37% phosphoric acid for 30 s.

The acid was removed by rinsing for 30 s and air-drying thereafter until the surface was dull white. Each tooth was isolated with cotton rolls and a flexible plastic saliva ejector. The resin-based sealant (Fissurit F®, Voco, Germany) was applied to the pits and fissures with a disposable brush and subsequently light polymerised for 30s. The occlusion was checked with articulation paper and modified, if needed, using a finishing bur.

**Glass Ionomer.** Prior to the FS application, each tooth was cleaned with a prophylaxis brush using pumice, rinsed, and dried. The teeth were isolated using cotton rolls. The occlusal surface was conditioned with GC dentine conditioner for 20 s; each tooth was then washed and dried with cotton wool pellets. The GIC (Fuji VII®, GC Corporation, Japan) was mixed according to the manufacturer's instructions and applied to the occlusal surface using a plastic filling instrument. A disposable nylon brush was used to properly spread the GIC onto the pits and fissures. The FS was coated with Vaseline®. Children were instructed not to eat for at least 1 h.

Each tooth was examined at 1, 3, 6, 12, and 24 months after FS application by two examiners. The criteria adopted to evaluate the retention of the FS were as follows [Smales and Wong, 1999]:

- Total retention (TR): total retention of the FS on the occlusal surface,
- Partial retention type 1 (PR1): presence of FS in two-thirds of the pit extension with small fractures and loss of material,
- Partial retention type 2 (PR2): presence of FS in one-third of the pit extension with fractures and loss of material,
- Total loss (TL): complete absence of FS on the occlusal surface of the tooth.

The criteria adopted to evaluate for the presence of caries were as follows [Ketley and Holt, 1993]:

- No visible caries and non-cavitated lesions,
- Presence of micro-cavity (diameter < 1.5 mm across fissure) and large cavities,
- Filled teeth.

The data were statistically analysed using the Wilcoxon matched pair test and Chi-square test. Statistical significance was established at 5%. The inter- and intra-examiner reproducibilities were calculated by the Cohen unweighted kappa statistic.

*Table 1. Retention of fissure sealant materials after clinical application*

| Evaluations | Retention | Fuji VII® | | Fissurit F® | | Total | *p* |
|---|---|---|---|---|---|---|---|
| | | N | % | N | % | | |
| 1 month | TR | 121 | 69.9 | 130 | 75.14 | 346 | 0.0048 |
| | PR1 | 18 | 10.4 | 30 | 17.3 | | |
| | PR2 | 12 | 6.9 | 10 | 5.7 | | |
| | TL | 22 | 12.7 | 3 | 1.7 | | |
| 3 months | TR | 85 | 52.8 | 101 | 62.7 | 322 | 0.0018 |
| | PR1 | 28 | 17.4 | 32 | 19.8 | | |
| | PR2 | 18 | 11.1 | 20 | 12.4 | | |
| | TL | 30 | 1.8 | 8 | 4.9 | | |
| 6 months | TR | 69 | 45.7 | 71 | 47.0 | 300 | 0.0257 |
| | PR1 | 22 | 14.5 | 39 | 25.8 | | |
| | PR2 | 22 | 14.5 | 22 | 14.5 | | |
| | TL | 37 | 24.5 | 18 | 11.9 | | |
| 12 months | TR | 47 | 35.1 | 57 | 38.5 | 288 | 0.0062 |
| | PR1 | 30 | 16.9 | 39 | 26.3 | | |
| | PR2 | 28 | 18.9 | 27 | 18.2 | | |
| | TL | 40 | 27.0 | 20 | 13.5 | | |
| 24 months | TR | 20 | 13.8 | 30 | 20.8 | 276 | 0.0326 |
| | PR1 | 39 | 27.0 | 46 | 31.9 | | |
| | PR2 | 34 | 23.6 | 37 | 25.7 | | |
| | TL | 46 | 31.9 | 24 | 16.6 | | |

TR, total retention; PR1, partial retention 1; PR2, partial retention 2; TL, total loss. *p*= Exact significant level (Wilcoxon pair test). Significant statistically (p<0.05). N, number of teeth.

*Table 2. Caries and filled teeth evaluations after 1, 3, 6, 12 and 24 months of fissure sealant application.*

| | Clinical evaluation (carious + filled) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Materials** | **1 month** | | **3 months** | | **6 months** | | **12 months** | | **24 months** | |
| | N | % | N | % | N | % | N | % | N | % |
| **Fuji VII** | 0 | 0 | 0 | 0 | 1 | 0.6 | 3 | 2.0 | 5 | 3.4 |
| **Fissurit F** | 0 | 0 | 0 | 0 | 1 | 0.6 | 5 | 3.3 | 7 | 4.8 |
| **p value** | 1.0000 | | 1.0000 | | 1.0000 | | 0.4677 | | 0.5257 | |

Chi-square test ($p<0.05$); N, number of teeth.

## Results

Intna- and inter-examiner reproducibilities were 0.90 and 0.86, respectively, for the clinical assessment of FS retention and caries evaluation.

The results of the retention rates of FS for all periods are presented in Table 1. Retention of the Fuji VII® FS was significantly lower than the retention of the Fissurit F® FS at all follow-up examinations ($p<0.05$). The differences in caries development between the FS materials at all periods were not significant. ($p>0.05$). Amongst the FS materials, the caries incidence for the Fissurit F® group was insignificantly higher than that of the Fuji VII® group at 12 and 24 months (Table 2).

## Discussion

Although the pits and fissures of molars make up only 13% of the total tooth surface, they account for 88% of total caries in young permanent teeth [Brown and Selwitz, 1995]. The occlusal surface of molars is responsible for approximately 67-90% of caries in children from 5-17 years of age [Kaste et al., 1996; Brown et al., 1999]. One of the widely used methods for protecting occlusal surfaces is the application of pit and fissure sealants; FS effectiveness is directly related to its retention and is dependent on application procedures [Simonsen, 1991; Ripa, 1993]. However, FS retention is easily compressed by saliva contamination, which consequently reduces the caries-preventive effect [Bishara et al., 2002]. Due to the hydrophilic properties, GIC is not as moisture-sensitive as hydrophobic resin [Smith, 1998]. However, it should be noted that the most important aspect of FS placement is the isolation of the tooth from saliva.

The low retention rates found in this study are in agreement with previous studies on GIC fissure sealants [Forss and Halme, 1998; Poulsen et al., 2001; Skrinjaric et al., 2008]. In this study, the total retention rates for Fuji VII® was 13.8% for a two-year period. However, Arrow and Riordon [1995] reported significantly greater retention rates for GIC sealants when compared with resin FS, although most of the studies reported significantly lower retention rates for GIC sealants.

Our results are also in agreement with previous studies that found a higher or similar caries-preventive effect of GIC sealants [Forss et al., 1994; Arrow and Riordan, 1995; Williams et al., 1996; Forss and Halme, 1998]. It has been shown that GIC sealants have a caries-preventive effect even after the FS has been lost [Williams and Winter, 1981]. Williams et al. [1996] reported no significant difference in caries increment between resin-based FS and GIC sealants in a 4-year period. Although GIC sealants were nearly all lost, 61% of the resin-based sealants were retained.

GIC sealants, which do not require etching of the tooth surface, are generally easier to place than resin-based sealants. On the other hand, it has been suggested that GIC, which is used as the fissure sealant in Atraumatic Restorative Treatment (ART), has higher retention rates because of the 'press-finger' technique that condenses the material into the pits and fissures [Frencken et al., 1998; Holmgren et al., 2000]. Beiruti et al. [2006] reported that the caries-preventive effect of high viscosity GIC sealants, placed according to the ART procedure, was higher than that of resin-based sealants after 3 to 5 years.

An unexpected finding of this study was the total retention rate of resin-based sealant (20.8%), as previous studies showed higher total retention rates [Mejare and Mjör, 1990; Forss et al., 1994; Beiruti et al., 2006]. This is probably for two reasons. Firstly, although the mean age of the children was 9.4 years, placing resin sealants on fully erupted teeth would result in good retention, and as newly erupted first molars were included. Any incomplete eruption of these teeth may have led to salivary contamination during FS application, thereby decreasing mechanical bonding and substantialy compromising FS retention [Barja-Fidalgo et al., 2009].

Secondly, the sealing procedure for resin-based materials is more technique sensitive than for polyacid-based materials, mainly because of hydrophobic nature of resin-based materials [Beiruti et al., 2006]. In the present study, FS application was performed by inexperienced fifth-year undergraduate dental students. Although two experienced paediatric dentists in the clinics supervised all of the procedures, dental students might not have been able to effectively apply resin-based sealants, a procedure which is considered more technique sensitive than that for GIC sealants.

Complete isolation of the tooth from contamination by saliva is the most important aspect of FS placement. In this study, teeth were isolated using cotton rolls. However, isolation by rubber dam or cotton rolls is equally effective and results in similar retention rates [Locker et al., 2003]. Straffon et al. [1985] investigated the effect of isolation on the efficacy of resin-based sealants for 36 months; 61% of the total number of teeth with retreated FS were mandibular teeth. In that study, one group of teeth was isolated with a rubber dam and the other with cotton rolls. No tooth that had a FS placed became carious in either group. The most caries-susceptible period of a first molar tooth is during the 1-1.5 year-long eruption phase [Carvalho et al., 1989]. In this period, the enamel has not fully matured, and it is usually difficult for a child to clean the erupting tooth surfaces [Taifour et al., 2003]. This challenge can be overcome by applying GIC sealants because of its hydrophilic properties.

In addition, acid-etching for resin based sealants may be less effective in newly erupted teeth with immature enamel containing higher levels of protein. The dental literature confirms that resin-based FS present lower retention rates in younger children [Songpaisan et al., 1995; Forss and Halme, 1998; Pardi et al., 2003; Poulsen et al., 2006]. In the light of a recent review [Splieth et al.,2010], it has been suggested that as the occlusal surfaces of erupting teeth often show the initial stages of caries, it is more correct to see FS as a therapeutic treatment than as a purely preventive treatment. The therapeutic indications for FS include active lesions in pits and fissures, possibly even up to deep enamel caries or initial dentine lesions. The standard recommendation for deeper lesions is still operative procedures.

## Conclusion

The retention rates for resin-based sealants were significantly higher than that of GIC sealants; however, GIC was slightly more effective in preventing occlusal caries. Further investigations on new materials and techniques should be performed to determine more effective procedures in the prevention of caries in the pits and fissures of teeth.

## References


Arrow P, Riordan PJ. Retention and caries preventive effects of a GIC and a resin-based fissure sealant. Community Dent Oral Epidemiol 1995; 23: 282-285.

Barja-Fidalgo F, Maroun S ,de Oliveira BH. Effectiveness of a GIC used as a pit and fissure sealant in recently erupted permanent first molars. J Dent Child (Chic) 2009; 76: 34-40.

Beiruti N, Frencken JE, van't Hof MA, Taifour D ,van Palenstein Helderman WH. Caries-preventive effect of a one-time application of composite resin and glass ionomer sealants after 5 years. Caries Res 2006; 40: 52-59.

Bishara SE, Oonsombat C, Ajlouni R ,Denehy G. The effect of saliva contamination on shear bond strength of orthodontic brackets when using a self-etch primer. Angle Orthod 2002; 72: 554-557.

Brown LJ, Selwitz RH. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of dental sealants. J Public Health Dent 1995; 55: 274-291.

Brown LJ, Wall TP ,Lazar V. Trends in untreated caries in permanent teeth of children 6 to 18 years old. J Am Dent Assoc 1999; 130: 1637-1644 contd.

Carvalho JC, Ekstrand KR ,Thylstrup A. Dental plaque and caries on occlusal surfaces of first permanent molars in relation to stage of eruption. J Dent Res 1989; 68: 773-779.

Forss H, Halme E. Retention of a glass ionomer cement and a resin-based fissure sealant and effect on carious outcome after 7 years. Community Dent Oral Epidemiol 1998; 26: 21-25.

Forss H, Saarni UM ,Seppa L. Comparison of glass-ionomer and resin-based fissure sealants: a 2-year clinical trial. Community Dent Oral Epidemiol 1994; 22: 21-24.

Frencken JE, Makoni F ,Sithole WD. ART restorations and glass ionomer sealants in Zimbabwe: survival after 3 years. Community Dent Oral Epidemiol 1998; 26: 372-381.

Holmgren CJ, Lo EC, Hu D ,Wan H. ART restorations and sealants placed in Chinese school children-results after three years. Community Dent Oral Epidemiol 2000; 28: 314-320.

Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle JA, Winn DM ,Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991. J Dent Res 1996; 75 Spec No: 631-641.

Ketley CE, Holt RD. Visual and radiographic diagnosis of occlusal caries in first permanent molars and in second primary molars. Br Dent J 1993; 174: 364-370.

Locker D, Jokovic A ,Kay EJ. Prevention. Part 8: The use of pit and fissure sealants in preventing caries in the permanent dentition of children. Br Dent J 2003; 195: 375-378.

McLean JW, Wilson AD. Fissure sealing and filling with an adhesive glass-ionomer cement. Br Dent J 1974; 136: 269-276.

Mejare I, Mjor IA. Glass ionomer and resin-based fissure sealants: a clinical study. Scand J Dent Res 1990; 98: 345-350.

Muller-Bolla M, Lupi-Pegurier L, Tardieu C, Velly AM ,Antomarchi C. Retention of resin-based pit and fissure sealants: A systematic review. Community Dent Oral Epidemiol 2006; 34: 321-336.

NCHS. National Center for Health Statistics. Centers for Disease Control and Prevention. Available at: www.cdc/nchs/nhanes.htm. Accessed October 2. 2007.

Pardi V, Pereira AC, Mialhe FL, Meneghim Mde C ,Ambrosano GM. A 5-year evaluation of two glass-ionomer cements used as fissure sealants. Community Dent Oral Epidemiol 2003; 31: 386-391.

Poulsen S, Beiruti N ,Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass-ionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001; 29: 298-301.

Poulsen S, Laurberg L, Vaeth M, Jensen U ,Haubek D. A field trial of resin-based and glass-ionomer fissure sealants: clinical and radiographic assessment of caries. Community Dent Oral Epidemiol 2006; 34: 36-40.

Ripa LW. Sealants revisted: an update of the effectiveness of pit-and-fissure sealants. Caries Res 1993; 27 Suppl 1: 77-82.

Simonsen RJ. Retention and effectiveness of dental sealant after 15 years. J Am Dent Assoc 1991; 122: 34-42.

Simonsen RJ. Pit and fissure sealant: review of the literature. Pediatr Dent 2002; 24: 393-414.

Skrinjaric K, Vranic DN, Glavina D ,Skrinjaric I. Heat-treated glass ionomer cement fissure sealants: retention after 1 year follow-up. Int J Paediatr Dent 2008; 18: 368-373.

Smales RJ, Wong KC. 2-year clinical performance of a resin-modified glass ionomer sealant. Am J Dent 1999; 12: 59-61.

Smith DC. Development of glass-ionomer cement systems. Biomaterials 1998; 19: 467-478.

Songpaisan Y, Bratthall D, Phantumvanit P ,Somridhivej Y. Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community Dent Oral Epidemiol 1995; 23: 25-29.

Splieth CH, Ekstrand KR, Alkilzy M et al. Sealants in dentistry: outcomes of the ORCA Saturday Afternoon Symposium 2007. Caries Res 2010; 44: 3-13.

Straffon LH, Dennison JB ,More FG. Three-year evaluation of sealant: effect of isolation on efficacy. J Am Dent Assoc 1985; 110: 714-717.

Taifour D, Frencken JE, van't Hof MA, Beiruti N ,Truin GJ. Effects of glass ionomer sealants in newly erupted first molars after 5 years: a pilot study. Community Dent Oral Epidemiol 2003; 31: 314-319.

Torppa-Saarinen E ,Seppa L. Short-term retention of glass-ionomer fissure sealants. Proc Finn Dent Soc 1990; 86: 83-88.

Weerheijm KL, Kreulen CM ,Gruythuysen RJ. Comparison of retentive qualities of two glass-ionomer cements used as fissure sealants. ASDC J Dent Child 1996; 63: 265-267.

Williams B, Winter GB. Fissure sealants. Further results at 4 years. Br Dent J 1981; 150: 183-187.

Williams B, Laxton L, Holt RD ,Winter GB. Fissure sealants: a 4-year clinical trial comparing an experimental glass polyalkenoate cement with a bis glycidyl methacrylate resin used as fissure sealants. Br Dent J 1996; 180: 104-108.