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Original Article

Evaluation of glass carbomer sealant and a moisture tolerant resin sealant – A comparative study

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ABSTRACT

Introduction: Fissure sealants have been widely used for more than four decades in preventing dental caries. Advances in technology have led to the development of moisture tolerant sealants. They are available as resin based and glass ionomer based. There is a paucity of studies on the effectiveness of moisture tolerant sealant materials in clinical conditions. AIM: The aim of the present study was to evaluate and compare the retention and caries incidence with use of the two newly introduced moisture tolerant pit and fissure sealants.

Materials and methods: One hundred and eight children formed the study group. The glass carbomer sealant and Embrace WetBond sealant were two moisture tolerant sealants used. The sealant was applied on the occlusal surface of the teeth following the manufacturer's instructions. Children were recalled for assessment of sealant retention and the teeth were examined for dental caries on the occlusal surface using mouth mirror and blunt probe following 1, 3,6,12,18 and 24 months. Sealants were assessed according to a modified version of the CCC sealants evaluation system described by Deery et al. RESULTS: At 18 and 24 months, both GC and EBW showed similar pattern of sealant retention At 24 months, enamel caries was observed in 3 teeth sealed with EBW as compared to only 1 tooth sealed with GC.

Conclusions: There was no significant difference between the retention of glass carbomer sealant and Embrace WetBond sealant, at the end of 2 years. There was no significant difference in the caries incidence between both these sealants.

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1. Introduction

Fissure sealants have been widely used for more than four decades in preventing dental caries. There are two predominant types of sealants: resin based and glass ionomer cement. Placement of a resin sealant is very technique sensitive and is influenced by several factors, such as patient cooperation, operator variability, and contamination of the operating field.[1] A major drawback of sealing fissures with resin is that the clinical procedure is extremely sensitive to moisture, which makes it difficult to etch partially erupted molars.[2] Glass ionomers are less sensitive to moisture than resins and have been indicated as an ideal material for sealing pits and fissures due to their fluoride release and adherence to dental structures.[3] However, used as a pit and fissure sealant, the traditional glass-ionomer cements have shown very poor retention rates as well as leakage even when fully retained.[4,5]

Advances in technology have led to the development of moisture tolerant sealants. They are available as resin based and glass ionomer based. These sealants are easier to handle and are less technique sensitive and are thus easier to use in children where moisture control is difficult. A newly introduced moisture tolerant resin sealant (Embrace Wetbond) incorporates di-, tri- and multifunctional acrylate monomers into an acid integrating network that is activated by moisture and is recommended for use in slightly moist surfaces.

A glass ionomer based material called glass carbomer has also been recently developed. Glass carbomer is a glass based material with an additional carbon chain and contains nano sized powder particles and fluorapatite as secondary filler. The liquid of glass carbomer is polyacrylic acid. Only one study has been published on clinical efficacy of glass carbomer as a sealant comparing it with glass ionomer and conventional resin sealant.[6]

Not many clinical investigations have been carried out using glass carbomers. There is a paucity of studies on the effectiveness of moisture tolerant sealant materials in clinical conditions. Thus this study was undertaken to evaluate and compare the retention and caries incidence with use of the two newly introduced moisture tolerant pit and fissure sealants.

2. Materials and methods

Ethical clearance to conduct the study was obtained from the institutional review board. School children aged between 6 and 9 years, from schools in Bangalore were selected for the study. Prior written consent was obtained from school authorities to examine the children. Two hundred children aged between 6 and 9 years were examined in natural daylight using sterile mouth mirror and blunt dental probes. Inclusion criteria[7]: a. Healthy cooperative children with all four permanent first molars erupted. b. The occlusal surface should be fully visible and free of mucosal tissue. Exclusion criteria: a. Children with hypoplastic permanent first molar or any developmental anomalies. b. Children who were felt not to be sufficiently cooperative to allow sealant placement. c. Children with systemic disorders. One hundred and thirty children fulfilled the inclusion criteria. Consent forms, which explained the need for pit and fissure sealants and the application procedure, were sent to the parents or guardians. Consent was obtained to participate in the study from one hundred and eight children who formed the study group.

The pit and fissure application was carried out at the Department of Pedodontics and Preventive Dentistry. A single operator carried out the scaling procedure for each child, followed by prophylaxis using slurry of pumice and a rotating brush to ensure removal of debris from the fissures. As both the sealants were moisture tolerant, they were applied using only cotton rolls for isolation. The children were randomly assigned to four groups, (I–IV) consisting of 27 children each, based on the distribution of sealants to eliminate bias of sealant application on any one side only (Fig. 1).

The glass carbomer (GC) sealant (GCP Dental, The Netherlands) material is available as capsules. The sealant

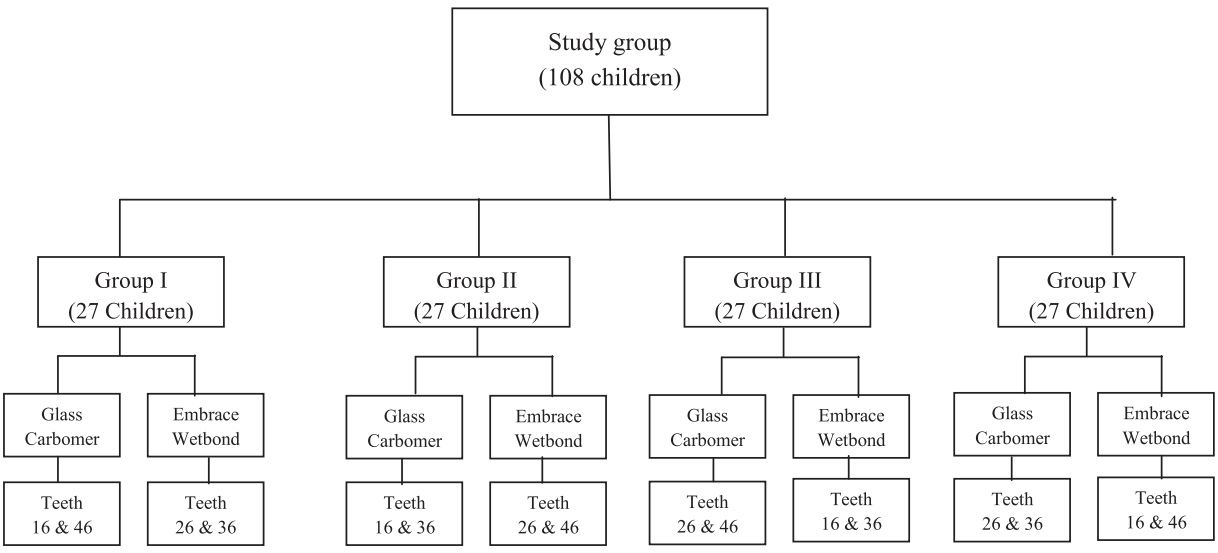

Fig. 1 – Distribution of study group.

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was applied on the occlusal surface of the teeth following the manufacturer's instructions. Prior to mixing, the capsules were inserted into a universal capsule gun and standardized according to manufacturer's instructions. It was mixed for 7 s in a high frequency amalgamator. The pin from the nozzle was removed after mixing and it was inserted into the capsule gun and the lever was pulled twice to prime the material. The material was then directly extruded onto the tooth from the capsule. A layer of GCP Gloss was applied on the surface of the material with a cotton pellet and the glass carbomer material was spread under finger pressure into the pits and fissures. It was cured using a LED curing unit for 60 s (GCP Carboled CL 01).

The Embrace WetBond (EBW) sealant (Pulpdent Corporation, MA, USA) material is available as 3 ml syringes with applicator tips. The occlusal surfaces of the teeth were etched with 38% phosphoric acid (Pulpdent Corporation, MA, USA) for 15 s and rinsed with water. The typical dull, frosted appearance of the etched surface is not desired for this material; rather, the surface should be lightly dried and slightly moist with a glossy appearance. The sealant was applied onto the occlusal surface of the teeth and a probe was used to flow the sealant and prevent air bubbles from getting incorporated. It was then light cured for 20 s. An explorer was used to check for complete coverage of the pits and fissures of all the first permanent molars. The set sealants were checked for high points with an articulating paper and if present were reduced with a finishing bur.

Children were recalled for assessment of sealant retention and the teeth were examined for dental caries on the occlusal surface using mouth mirror and blunt probe following 1, 3,6,12,18 and 24 months. Sealants were assessed according to a modified version of the CCC sealants evaluation system described by Deery et al.[8,9]

For each child, assessment scores were recorded using a proforma that included basic demographic information. Data obtained was subjected to statistical analysis using the Z-test for proportion using SPSS software 19 using Windows. Significance for all statistical tests was predetermined at a p-value of <0.05.

3. Results

A significantly higher number of maxillary molars sealed with EWB showed complete sealing of the fissure system at both one and three months following sealant application ($p \leq 0.05$). At 1,3 and 6 months a significantly high number of these teeth sealed with GC showed less than 50% of the fissure system covered with the material ($p \leq 0.05$). Complete loss of sealant was observed at 12 months in 10 teeth sealed with GC, which was significantly different from that of 3 teeth seen with EWB. (Table 1) At the end of 1 year, complete loss of GC sealant was seen in 10 teeth which was significant. Subsequent evaluation at 18 and 24 months showed both materials to have similar pattern of retention.

Retention of sealant on mandibular molars was better with EWB showing complete sealing of fissure system in a significantly higher number of teeth, at 1 and 6 months. At 3 months, 25 mandibular molars sealed with GC showed less than 50%

Table 1 – Comparison of retention between glass carbomer sealant and Embrace WetBond sealant on maxillary first permanent molars.

Retention criteria	Evaluation period																	
	1 month			3 months			6 months			12 months			18 months			24 months		
	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value
A	60	79	0.006[a]	37	52	0.026[a]	28	39	0.099	17	20	0.582	5	2	0.222	0	0	–
B	37	27	0.135	43	41	0.777	44	50	0.395	45	58	0.058	40	48	0.197	35	32	0.639
C	9	0	0.002[a]	18	7	0.019[a]	23	8	0.003[a]	23	14	0.099	26	25	0.86	32	35	0.639
D	0	0	–	5	3	0.471	10	3	0.470	10	3	0.045[a]	15	11	0.368	19	19	1.000

[a] $p < 0.05$ is significant.

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of the fissures covered, which was significantly different ($p \leq 0.05$). A significantly higher number of mandibular molars sealed with EBW showed more than 50% of the fissures covered with the sealant material at 12 months ($p \leq 0.05$). Complete loss of GC sealant from these teeth was significantly higher at 1 and 3 months ($p \leq 0.05$). On further evaluation at 18 and 24 months, both GC and EBW showed similar pattern of sealant retention (Table 2).

With regard to caries incidence there was no difference between the two materials. Maxillary molars that were sealed with EBW showed 3 teeth with white spot lesions, 6 teeth with brown spot lesions and 2 teeth with enamel caries at 24 months (Table 3). More number of mandibular molars in both groups showed white spot lesions at 12 months and at 18 months. But at 24 months, brown spot lesions were observed in more number of molars. At 24 months, enamel caries was observed in 3 teeth sealed with EBW as compared to only 1 tooth sealed with GC (Table 4).

4. Discussion

The major drawback of resin based sealants materials is their moisture sensitivity. To overcome this drawback a moisture tolerant pit and fissure sealants have been recently introduced. Embrace WetBond is a moisture tolerant resin based sealant formulated from a unique dental resin that is self-priming, wet bonding, water miscible, hydrophilic and hydrobalanced. It is recommended for use on slightly moist surfaces.[10] In-vitro studies on Embrace WetBond have shown that the material is less viscous, forms longer resin tags, has less microleakage, superior marginal adaptation and excellent penetration into the fissures as compared to the conventional Bis-GMA based sealants.[11,12]

Glass ionomer sealants have been used as an alternate to resin-based sealants. Retention of glass ionomer to the tooth is based on the adhesive property of the cement. It eliminates the need for acid etching and therefore has a relatively shorter application time. Also, glass ionomers are not as sensitive to moisture as resin sealants and have the added advantage of fluoride release.[13]

Glass carbomer is a kind of glass-ionomer cement that is distinguished by its nano-sized powder particles and its content (fluorapatite). The latter component was added as it has been shown that glass ionomer changed into a fluorapatite-like material over time. The nano-sized particles facilitate a strengthening of the material through an increased particle surface in contact with the glass-carbomer liquid.[14] Clinical studies comparing two moisture tolerant sealants are lacking. Recently, concerns have been raised about the possibility of esterogenic chemicals, especially bisphenol-A (BPA) and bisphenol-A-dimethacrylate (BPA-DMA), leaching out of sealants. Both the sealants placed in this study did not contain BPA or BPA-DMA.

Most of the studies on sealants have used the half-mouth designs in which teeth on one side of the mouth were treated and teeth on the other side were left untreated.[15–17] However, due to ethical reasons, untreated teeth cannot be used as controls. A split mouth design is preferable for comparison of two sealant materials as treatment is not withheld

Table 2 – Comparison of retention between glass carbomer sealant and Embrace WetBond sealant on mandibular first permanent molars.

Retention criteria	Evaluation period																	
	1 month			3 months			6 months			12 months			18 months			24 months		
	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value
A	56	77	0.003[a]	27	34	0.286	8	20	0.014[a]	6	7	0.784	0	1	–	0	0	–
B	36	24	0.068	43	56	0.069	52	58	0.394	42	56	0.042[a]	30	37	0.224	24	28	0.510
C	11	5	0.123	25	13	0.031[a]	27	16	0.058	35	23	0.061	37	30	0.213	37	35	0.758
D	3	0	0.001[a]	8	0	0.004[a]	13	6	0.091	12	9	0.487	19	18	0.879	25	23	0.736

[a] $p < 0.05$ is significant.

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Table 3 – Comparison of caries incidence in maxillary first permanent molars.

Caries score	Evaluation period																	
	1 month			3 months			6 months			12 months			18 months			24 months		
	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value
0	106	106	1.000	103	103	1.000	100	100	1.000	92	92	1.000	78	78	1.000	76	75	0.816
1W	0	0	–	0	0	–	0	0	–	0	2	0.154	4	4	1.000	3	3	1.000
1B	0	0	–	0	0	–	0	0	–	3	1	0.312	3	4	0.684	5	6	0.754
2	0	0	–	0	0	–	0	0	–	0	0	–	1	0	–	2	2	1.000

$p < 0.05$ is significant.

Table 4 – Comparison of caries incidence in mandibular first permanent molars.

Caries score	Evaluation period																	
	1 month			3 months			6 months			12 months			18 months			24 months		
	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value	GC (n)	EWB (n)	p value
0	106	106	1.000	103	103	1.000	100	99	0.999	90	89	0.754	74	72	0.652	72	71	0.839
1W	0	0	–	0	0	–	0	1	–	5	4	0.733	8	9	0.786	4	5	0.732
1B	0	0	–	0	0	–	0	0	–	0	2	0.154	4	4	0.999	9	7	0.599
2	0	0	–	0	0	–	0	0	–	0	0	–	0	1	–	1	3	0.310

$p < 0.05$ is significant.

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from any of the teeth. In the present study, it was ensured that every child received sealants on all four first permanent molars. A split mouth technique was followed by dividing the study sample into four groups, thus ensuring that the same sealant material was not applied on either both of the maxillary first permanent molars or both of the mandibular first permanent molars. This eliminated any bias of placing the same sealant material on two teeth, either on left or right side.

The setting of both materials applied in this study was under the control of the operator. While the resin sealant polymerized by photo activation, the glass carbomers showed a "command set" on application of heat energy. The amount of heat is directly associated with the quality of the cement setting.[18] The use of heat is supposed to accelerate the matrix-forming reaction of glass carbomer.[19] High-viscosity glass ionomer cement sets faster if heat is applied during the setting procedure, using a high energy light to cure it. This leads to an increase in temperature within the cement, which shortens the setting time and increases the adhesion of glass ionomer to the enamel.[20]

However, as with conventional glass ionomer cements, glass carbomer sealants have to be protected from exposure to moisture during the first setting reaction and from dehydration in the second phase. A silicone based, monomer free, polysiloxane gloss is provided by the manufacturer for surface protection. It also helps in finishing and polishing the sealant once it is placed.[21] It has been assumed that the heat emitted by a curing unit during polymerization of gloss could additionally improve the mechanical properties of glass carbomer.[21]

There is no standardized method for assessing and reporting the adequacy of sealed surfaces and this makes it difficult for comparative analysis and evaluation at recall visits. The most widely used evaluation technique in large scale public health services was given by Cvar and Ryge in 1971.[22] This method utilizes a visual-tactile examination, and the sealant is rated intact, partially lost, or completely lost. In order to measure wear, the anatomic form and marginal integrity of sealants are evaluated over time by comparing casts to calibrated standards. This method is not entirely satisfactory because it is not quantitative and has a potential for subjective error. Most studies[23–26] have formulated their own criteria or have utilized Simonsen criteria for evaluation of sealants. The limitation of Simonsen criteria is that it does not describe partial loss of sealant and does not include scoring of dental caries. The key aspects of a sealed surface that requires evaluation are identification of sealant, differentiation between preventive sealants and restorative sealants, sealant colour, sealant coverage and caries status of the surface.[8] The Colour, Coverage and Caries (CCC) sealant evaluation criterion given by Deery et al in 2001[8] is simple to follow, records dental caries and also indicates the level of surface coverage. It encompasses scoring criteria for sealant retention on the surface of the teeth and for the evaluation of dental caries. Since only sealed occlusal surfaces were required to be evaluated, a modified CCC sealant evaluation criteria was followed in the present study. The examination method for caries was visual-tactile, with emphasis on visual, and a blunt probe was used to confirm presence of the sealant. Caries if present under the sealant could not be probed and posed a problem in the standardization of caries diagnosis.

Reported evidence of sealant needing replacement or repair in contemporary studies averages between 5% and 10% per year.[27] Clinical evidence suggests that sealant loss occurs in two phases. First, an initial loss due to faulty technique, followed by a second loss associated with material wear under occlusal forces. Tooth selection and technique failure at time of sealant placement would be responsible for majority of the sealant loss within six months of placement.[28] Since the probability of sealant failure is highest soon after placement, they should be evaluated clinically for partial or total loss within one year of placement. Sealed tooth surfaces should be assessed at regular intervals to ensure complete retention of the sealant.

During the initial period of evaluation, teeth subjected to resin sealants had significantly higher number of completely covered fissures as compared to glass carbomer for both maxillary and mandibular first permanent molars.

Glass carbomers are glass ionomer based materials which have a higher flexural strength, however, when used as sealants they have similar limitations such as moisture sensitivity.[21] Since no surface preparation was done prior to glass carbomer sealant application; there could have been loss of the material without penetration into the fissures. In an earlier study, specimens of glass carbomer material had not fully hardened even after 40 h.[14] This indicates that glass carbomer material runs a high-risk of being damaged by the patient even before it has hardened completely. It may also explain the higher loss of glass carbomer during the interval phase of evaluation.

With glass carbomer sealant, pushing the bulk of highly viscous material into the molars may have led to an insufficient penetration into the fissures, therefore, leading to a significantly higher total loss of the material.[29] This viscous material also sets rapidly which may have further reduced the ability of the cement to flow readily and to adhere to the surface.

In a study using the same moisture tolerant resin sealant, higher complete retention of nearly 65% was observed at 3 months.[30] But the complete loss of sealants reported in their study was 18% which was much higher than that observed in our study (4.5%). Almost 30% of teeth with EBW resin sealants had the sealant covering all the fissures, in our study at 3 months. The flow of lesser viscous material into the fissures of maxillary molars following etching may have been better and hence the resin sealant showed significantly lesser complete loss. When resins are attached to enamel by acid-etching technique, they provide stronger mechanical bonds than the molecular bonds of glass ionomer materials.[31]

However, even with its higher viscosity, glass carbomer showed comparable retention with resin sealants with regard to its presence on more than 50% of the fissure system at 3 months. At 6 months, glass carbomer had 12.1% of teeth which had sealant covering all the fissure systems. There was no sealant present on 11.57% of the teeth. This was lower than 64% in another study and this was because in their study they even considered partially retained sealant in their evaluation.[6]

One main reason for the loss of the glass ionomer based sealants such as glass carbomer could be inadequate adhesion

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of the cement to the enamel surface. The topography of the occlusal surfaces may be an obstacle for good adhesion. Surface irregularities may result in entrapment of air voids, hence reducing the strength of the adhesive joint.

Higher complete retention rates of 50–91% have been reported in earlier studies on Embrace WetBond sealant.[23,30] In our study, only 14.21% of teeth had resin sealants covering the fissures. Acid etching for resin based sealants may be less effective in newly erupted teeth with immature enamel containing higher levels of protein. Published data on complete retention of resin based fissure sealants confirms lower retention rates in younger children.[32–35]

At 12 months, none of the molars sealed in both groups showed complete coverage of all fissures. However, 34 to 35 percent of both sealants were present on more than 50% of the fissure system. Chen et al had reported retention of 41.5% at 1 year with glass carbomer. However, they had used different criteria in which partial and total retention was considered as one.[6] Complete loss of resin sealant was higher in our study (24.42%) as compared to earlier reports.[23,30]

Residual water retained on the enamel surface may create a liquid meniscus at the bottom of narrow fissures, due to surface tension, inhibiting further sealant penetration. This may be the reason for low complete retention of Embrace Wetbond sealant.[36]

Despite the relative low retention of glass carbomer sealant material, caries was very low in these teeth. This can be because even where the material appears clinically to have been totally lost, there may remain small particles of material attached to the enamel of the occlusal fissures.[37] Another reason for caries prevention could be due to release of fluoride by the material into the surrounding enamel. At 12 months, in our study, the occurrence of caries with both sealants was low in both arches. The occurrence of caries following 12 months of glass carbomer sealant placement was reported to be 2.6% by Chen et al,[38] which is higher than 1.74% observed in our study.

The establishment of a fluoride reservoir might also contribute to caries prevention. This would make the effectiveness of glass carbomers as sealants less dependent on the long-term retention of the material. Glass ionomers sealants are to be regarded as slow-release fluoride reservoirs and should be called 'fluoride depot cements'.[39] The addition of fluorapatite to the contents of glass carbomer sealant might have enhanced the structure of enamel and made the teeth more resistant to caries.

In our study, 2.91% of teeth sealed with Embrace WetBond developed enamel caries, which is comparable 2.6% reported in an earlier study.[23] Embrace WetBond sealant has been shown to have long lasting anti bacterial activity when in solution, especially against *S. mutans*. This could have contributed to the low caries incidence.[40]

However, the occurrence of dental caries, if any, beneath the sealants could not be detected due to the A limitation of this study is that routine clinical examination was insufficient to diagnose opacity of the two materials. Teeth sealed very early after eruption require frequent reapplication of the fissure sealant, than teeth sealed later.[41] Therefore, the retention rates could have been enhanced by sealant reapplication at periodic intervals. Studies on glass carbomer sealants with longer periods of evaluation are necessary.

5. Conclusions

1. There was no significant difference between the retention of glass carbomer sealant and Embrace WetBond sealant, at the end of 2 years.
2. There was no significant difference in the caries incidence between both these sealants.

Conflicts of interest

All authors have none to declare.

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