

Comparative Evaluation of Different Dental Sealants in Preventing Occlusal Caries in Children

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ABSTRACT:

Background: Occlusal caries represents some of the most common complaints in preschool children, also easily occurring in the fissures and pits of molars. Dental sealants have been broadly employed as a preventive countenance nevertheless the efficiency of various sealant materials may vary strongly.

Objective: To assess the efficacy of different types of dental sealant materials on prevention of occlusal caries in children.

Methods: This cross-sectional study was carried out at Hamdard College of Medicine and Dentistry, Karachi, between August 2024 to April 2025. 90 children aged 6-12 were randomized into 3 groups to receive one of 3 types of dental sealants; resin-based sealants, glass ionomer sealants and flowable composite sealants. The occlusal caries and the sealant retention were clinically evaluated at baseline, 3 months, and 6 months.

Results: Resin-based sealants provided the best retention and lowest prevalence of occlusal caries after 6 months. The sealant performance of glass ionomer materials was moderate, flowable composites had lower retention and higher caries development when compared to the other two materials. The differences were all significant ($p < 0.05$).

Conclusion: Resin sealants were the most effective of the sealant materials evaluated in inhibiting occlusal caries because of their relation to superior retention. Glass ionomer and flowable composite sealants were less effective. Both of these results justify the use of resin-based sealants in the clinic of preventive dentistry.

Keywords: Occlusal caries, dental sealants, resin-based sealants, glass ionomer, flowable composite, children, preventive dentistry.

INTRODUCTION:

Dental caries continued to be one of the most common chronic diseases of childhood globally and was a major public health problem. One type of dental caries that had significantly contributed toward the dental caries was occlusal caries especially in pits and fissures of the posterior teeth. These locations were anatomically prone to development of carious lesions because of the intricate anatomy and difficulty in maintaining good oral hygiene [1]. Oral health knowledge has been increased and the use of fluorides have been applied to benefit, yet occlusal caries in children had long remained as one of the major problems in preventive dentistry.

In response to this challenge, marketing of dental sealants as a cornerstone preventive measure had been vigorously promoted. Sealants were physical barriers that would close pits and fissures, thus preventing the adhesion of food particles and bacterial biofilm. Sealants, by establishing a smooth surface that could be cleaned, had dramatically lowered the risk of caries formation [2]. In the past decades, several types of

sealant materials have been introduced and used in clinical practice; such as resin-based sealants, GICs and compomer based sealants. Each material had different physical, chemical, and mechanical properties; these properties contributed to their retention and caries-preventive effectiveness.

Resin-based sealants were the most commonly employed, because of their better retention and much higher long-term efficacy [3]. They needed a dry field for application and had shown to be highly effective in several clinical trials. However, their sensitivity to technique and need for moisture control had made them less useful under some clinical conditions. In comparison, glass ionomer sealants in spite of having a less retention rate, it was beneficial due to a fluoride releasing property, greater adhesion to moist enamel, hence making it applicable to community dental programs and uncooperative children [3]. Compomer, which is a hybrid between composites and GICs, had been introduced as an alternate approach that tried to combine the retention and fluoride release properties.

A variety of sealing materials had been used in many studies but controversy still remained as to which one was the most effective, especially in children. Various study designs, follow-up periods, and assessment of outcomes might have led to heterogeneous conclusions in the literature [4]. In addition, the success of sealants over time had not only relied on the material properties, but also on the intra-patient factors such as oral hygiene, caries risk profile and the skill of the clinician.

In view of the importance of caries preventive strategy for children from their early life stage and the large number of sealant materials available, comparing their clinical effects for occlusal caries prevention had been imperative [5]. The objective of this study was to compare various dental sealants for prevention of occlusal caries in children by assessing their retention, incidence of caries, and overall performance over a period of follow-up. The objective of the study was to facilitate prevention in dental care and thereby improve oral health in the pediatric population [6] by finding the most efficacious and feasible sealant material. Childhood caries was and still one of the most prevalent chronic diseases worldwide constituting a public health problem. Occlusal caries was one of the many types of caries that had contributed significantly especially in the pits and fissures of the posterior teeth. These areas had been extremely caries-susceptible sites because of the morphological complexity and difficulty of retaining a hygiene beneficial to prevent caries [1]. It was revealed that despite increases in awareness of oral health and prescription usage of F, prevalence of occlusal caries in children has remained a significant problem in preventive dentistry.

To prevent this situation, the use of dental sealants had been promoted as the main prevention method. The sealants served as a mechanical moat that sealed up the pits and fissures, eliminating the possibility for food and bacteria to gather. By the production of a smooth, cleanable surface, sealants had greatly diminished the caries susceptibility [2]. Whilst over decades, different sealant materials were introduced and were used clinically (e.g., resin-based sealants, glass ionomer cements (GICs), compomer-based sealants). The materials varied substantially in physical, chemical, and mechanical properties that may affect their retention and caries-preventive effect.

Resin sealants had been the most widely-used, with better retention and effectiveness over the long term [3]. They needed a dry application site and they were shown to be very effective through many clinical trials. Nevertheless, they were still highly technique-sensitive and required moisture control to achieve good clinical results in some situations. Glass ionomer sealants, which have received less attention they would have warranted due to lower retention rates, have the advantage of fluoride release and good adhesion to moist enamel and were thus recommended for community-type of dental care and for noncompliant young children [3]. A newer group of materials, the compomers, which supposedly were to bridge the gap between composites and GICs in terms of the balance between retention and fluoride release.

Many experiments had measured how well various sealant materials performed, but there had been a kind of request-vs-reality disjunction, especially in children. Sensitive and specific diagnostic criteria

were undetermined because different research designs, follow-up periods, and assessment methods led to inconsistent results in the literature [4]. Beyond that, durability of the sealant in the long term had not only been material related, but also player dependent, considering oral hygiene behavior, caries activity level or operator skill, for example.

Preliminarily, effectiveness of pit and fissure sealants in preventing occlusal caries has been well recognized. The importance of preventing early caries in children and a wide variety of sealant materials available in clinical had made it necessary to systematically compare the clinical effectiveness. The present study was intended to compare various dental sealants for occlusal caries prevention in children, by assessing their overall and individual retention rates as well as caries incidence over a specified follow-up period. The study aimed to enhance preventative dental care policies and oral health by identifying the best evidence based and practical sealant material for children [6].

MATERIALS AND METHODS:

This was comparative study which was carried out in the Department of Pediatric Dentistry, Hamdard College of Medicine and Dentistry, Karachi, over a period of nine months from August 2024 to April 2025. The angle of the dangle: toothpaste angle of placement for packing open sided interdental brushes obeying Bass technique and wire rack clearance.

Study Design and Ethical Approval:

The study had a prospective, randomized clinical trial design. The approval for this study was taken from the Institutional Review Board (IRB) of Hamdard College of Medicine and Dentistry before the start of study. Informed consent from the parents or guardians was taken for all children after detailed explanation of the aim and methodologies of the research and the potential benefits and possible harm that may affect the patients.

Study Population and Sample Size:

A total of 90 healthy 6–12-year-old children attending the pediatric dental clinic for regular dental treatment were included in the study. The age was chosen due to emergency of first permanent molars, which are extremely prone for occlusal caries. Children presenting with systemic diseases, allergic to dental materials or already with occlusal caries in the first PMs were excluded from the sample (to avoid confounding factors).

The sample size was estimated in 90 subjects according to previous studies and power analysis to identify a significant difference between the groups with 80% power and at 5% level of significance.

Sampling Technique and Group Allocation:

The participants were approached using convenience sampling. Clinical and radiographic examinations of each child's first permanent molars were completed to verify the caries-free status. The teeth were randomly allocated by a computer-generated randomization list into one of three groups:

Group A - Resin sealant (e.g. light cured)

Group B: Glass Ionomer (GI) sealant

Group C: F-releasing sealant

The one-type sealant was randomly applied to first permanent molars of each patient to be equally distributed between groups.

Clinical Procedure:

Prior to sealant application, all participants received professional prophylaxis using a rubber cup and pumice slurry to remove plaque and debris from occlusal surfaces. The teeth were then isolated using cotton rolls and suction to maintain a dry field.

For Group A (resin-based sealant), the occlusal surface was etched with 37% phosphoric acid for 20 seconds, rinsed, and dried until a frosty white appearance was observed. The sealant material was then applied and light-cured according to the manufacturer's instructions.

For Group B (glass ionomer sealant), the occlusal surfaces were conditioned with polyacrylic acid for 10 seconds, rinsed, and gently dried. The glass ionomer cement was mixed and applied directly, then allowed to set chemically without light curing.

For Group C (fluoride-releasing sealant), the same procedure as for Group A was followed, with etching and light curing after sealant application.

Occlusal anatomy was carefully restored, and all sealants were checked for retention and marginal adaptation immediately after placement.

Follow-Up and Evaluation:

Participants were recalled at 3-month intervals for clinical evaluation over the study duration. At each visit, occlusal surfaces were examined for sealant retention, marginal integrity, and presence of new carious lesions using the International Caries Detection and Assessment System (ICDAS) criteria. Retention was classified as complete, partial, or lost. The occurrence of occlusal caries was recorded, and any sealant loss was managed as per standard care but was documented for analysis.

Data Collection and Statistical Analysis:

All clinical findings were recorded on structured proformas by a calibrated examiner blinded to group allocation to reduce assessment bias. Data were entered into SPSS version 25 for statistical analysis. Descriptive statistics were calculated for retention rates and caries incidence. The Chi-square test was used to compare categorical variables between groups, while Kaplan-Meier survival analysis assessed the longevity of sealants. A p-value of less than 0.05 was considered statistically significant.

RESULTS:

This study was conducted at Hamdard College of Medicine and Dentistry, Karachi, with a total of 90 children aged 6–12 years enrolled from August 2024 to April 2025. The participants were randomly allocated into three groups, each receiving a different type of dental sealant: Resin-based sealant (Group A), Glass ionomer cement sealant (Group B), and Polyacid-modified resin sealant (Group C). The primary outcome was the incidence of occlusal caries on sealed molars over a 9-month follow-up period.

Table 1: Demographic and Baseline Characteristics of Study Participants:

Characteristics	Group A (n=30)	Group B (n=30)	Group C (n=30)	p-value
Mean Age (years)	8.4 ± 1.5	8.7 ± 1.4	8.6 ± 1.6	0.72
Gender (M/F)	16/14	15/15	17/13	0.85
Baseline DMFT Score	1.2 ± 0.9	1.1 ± 0.8	1.3 ± 0.7	0.68
Oral Hygiene Status (Good/Fair/Poor)	12/14/4	13/13/4	11/15/4	0.91

Table 2: Incidence of Occlusal Caries and Sealant Retention at 9 Months:

Outcome	Group A (Resin-based)	Group B (Glass Ionomer)	Group C (Polyacid-modified resin)	p-value
Incidence of Occlusal Caries (n, %)	2 (6.7%)	7 (23.3%)	5 (16.7%)	0.04*
Complete Sealant Retention (n, %)	25 (83.3%)	18 (60.0%)	20 (66.7%)	0.03*
Partial Sealant Loss (n, %)	4 (13.3%)	10 (33.3%)	7 (23.3%)	0.07
Complete Sealant Loss (n, %)	1 (3.3%)	2 (6.7%)	3 (10.0%)	0.45

The demographic and baseline characteristics of the three groups were comparable, with no statistically significant differences in mean age, gender distribution, baseline DMFT scores, or oral hygiene status (Table 1). This ensured that the groups were homogeneous before the application of different sealants, eliminating confounding factors that could bias the results.

After 9 months of follow-up, the incidence of occlusal caries varied significantly among the groups (Table 2). The resin-based sealant group (Group A) showed the lowest incidence of caries, with only 2 children (6.7%) developing occlusal caries on the sealed molars. In contrast, the glass ionomer group (Group B) had a significantly higher caries incidence at 23.3% (7 children), while the polyacid-modified resin group (Group C) had an intermediate incidence of 16.7% (5 children). The difference between groups was statistically significant ($p = 0.04$), indicating that resin-based sealants were more effective in preventing occlusal caries in this pediatric population.

Sealant retention rates followed a similar trend. Group A demonstrated the highest complete sealant retention rate at 83.3%, significantly higher than Group B (60.0%) and Group C (66.7%) with a p -value of 0.03. Partial loss of sealant material was more frequently observed in Groups B and C, with 33.3% and 23.3% of teeth showing partial loss, respectively, compared to only 13.3% in Group A. However, this difference did not reach statistical significance ($p = 0.07$). Complete sealant loss was rare across all groups, occurring in less than 11% of cases, and differences were not statistically significant ($p = 0.45$). These findings suggest that the resin-based sealants had superior mechanical retention and caries preventive efficacy compared to glass ionomer and polyacid-modified resin sealants in the population studied. The superior retention rate likely contributed to the reduced incidence of occlusal caries, as sealant loss or degradation can expose the occlusal surface to cariogenic challenges.

The glass ionomer sealants, while showing lower retention and higher caries rates, still performed moderately, likely due to their fluoride release property, which can provide some cariostatic effect even after partial sealant loss. The polyacid-modified resin sealants showed intermediate results in both retention and caries prevention, aligning with their combined properties of resin-based materials and glass ionomer cements.

Overall, the study demonstrated that dental sealants significantly reduced the incidence of occlusal caries in children, with resin-based sealants offering the most effective protection over a 9-month period. These results support the continued use and preference for resin-based sealants in pediatric dental care for caries prevention on occlusal surfaces.

DISCUSSION:

The present study aimed to comparatively evaluate the effectiveness of different dental sealants in the prevention of occlusal caries in children. The findings revealed significant differences in the performance of the evaluated sealants over the follow-up period, suggesting that the type of sealant material played a critical role in determining caries prevention outcomes [7].

Among the evaluated materials, resin-based sealants demonstrated the highest retention rate and the most effective caries prevention. This finding was consistent with earlier studies, which reported superior mechanical properties and better marginal adaptation of resin-based sealants compared to glass ionomer-based alternatives. The superior viscosity and ability of resin sealants to penetrate deeper into pits and fissures may have contributed to their enhanced performance [8]. Furthermore, the need for proper isolation during placement, while considered a limitation, likely contributed to their long-term success when ideal clinical conditions were maintained.

In contrast, glass ionomer sealants exhibited a lower retention rate but still provided a degree of caries prevention. Their ability to release fluoride over time may have contributed to their cariostatic effect, even in cases where partial loss of material occurred [9]. The findings supported the use of glass ionomer sealants in situations where moisture control was difficult, such as with uncooperative pediatric patients

or in community-based settings. However, their long-term effectiveness appeared to be limited compared to resin-based sealants, as shown by a higher incidence of new carious lesions in this group over time [10]. Compomer-based sealants demonstrated intermediate performance between resin and glass ionomer sealants. While they exhibited improved fluoride release compared to resins and better retention compared to glass ionomers, their clinical effectiveness did not match that of resin sealants [11]. These results were in line with previous studies suggesting that although compomers may offer certain advantages, they should not be considered a replacement for resin-based sealants when ideal application conditions can be achieved.

It was also observed that proper technique, including surface preparation, isolation, and curing, significantly influenced the success of all sealant types [12]. Operator skill and patient cooperation played a critical role in determining the outcome. Some sealant failures could be attributed to improper placement or early exposure to moisture, especially in the case of hydrophobic materials like resin sealants.

The study's findings emphasized the importance of regular follow-up and reapplication when necessary. Even the most effective sealants demonstrated partial or complete loss in some cases over the follow-up period [13]. Therefore, periodic examination and maintenance were essential components of a successful caries prevention strategy.

One limitation of the present study was the relatively short follow-up period. Although early results were indicative of performance trends, longer-term data would be beneficial in confirming the longevity of each sealant type. Additionally, the study was conducted under controlled clinical conditions, which may not fully replicate real-world scenarios, especially in public health or school-based settings [14]. Resin-based sealants were found to be the most effective in preventing occlusal caries in children, particularly when optimal clinical conditions were maintained. Glass ionomer sealants provided a reasonable alternative in moisture-compromised situations due to their fluoride release, while compomer sealants offered a balance between the two. The study highlighted the necessity of individualized material selection based on clinical circumstances, patient needs, and the ability to achieve appropriate isolation during application [15].

CONCLUSION:

This study demonstrated that all evaluated dental sealants were effective in reducing the incidence of occlusal caries in children, although their performance varied over time. The resin-based sealants showed superior retention and caries-preventive outcomes compared to glass ionomer-based sealants. However, glass ionomer sealants still provided a reasonable level of protection, particularly in settings where moisture control was challenging. The findings highlighted the importance of early application of sealants in caries-prone children and underscored the need for regular follow-up to ensure their longevity and effectiveness. Overall, the comparative evaluation emphasized that the choice of sealant material should be based on individual clinical conditions, patient cooperation, and the ability to maintain a dry working field. The results contributed valuable insights to pediatric preventive dentistry and supported the continued use of sealants as a key caries prevention strategy.

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