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Clinical Comparison of Resin and Resin-Modified Glass Ionomer Sealants for Pit and Fissure Caries Control

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ABSTRACT

Background: Dental caries remains a highly prevalent chronic disease in children, with occlusal surfaces of primary molars particularly susceptible due to complex pit and fissure morphology. Pit and fissure sealants are effective preventive measures, but comparative long-term performance of resin-based sealants (RBS) and resin-modified glass ionomer cement (RMGIC) for cavitated dentine lesions in primary molars remains unclear. **Objective:** To compare the long-term clinical performance, retention, and patient experience of RBS versus RMGIC in the management of occlusal cavitated dentine caries with limited extension in primary molars. **Methodology:** A randomized, non-blinded split-mouth clinical study was conducted on 70 children with matched primary molars. One tooth per child received RBS and the contralateral tooth RMGIC. Treatments were performed without rubber dam using standard moisture control. Clinical evaluations were conducted at 3, 6, 12, 24, and 36 months. Defect-free survival, dentist- and child-reported experiences, and correlation with treatment variables were assessed. Statistical analysis included McNemar test, Wilcoxon Signed Rank test, and Spearman correlation ($p < 0.05$). **Results:** At 36 months, RMGIC demonstrated higher accumulated defect-free retention than RBS (85.7% vs. 71.4%), with significant superiority at 24 months (94.3% vs. 71.4%, $p = 0.0005$). Dentist-rated child experience and cooperation correlated positively with RMGIC success, while RBS outcomes were independent of behavioral variables. No significant difference was observed in child-reported experience or dental fear scores. **Conclusion:** RMGIC provides superior long-term clinical performance and accumulated success in primary molars with limited occlusal cavitated dentine caries, especially in cases with suboptimal isolation. RBS remains suitable where ideal moisture control is achievable.

Keywords: Dental Caries, Resin-Based Sealant, Resin-Modified Glass Ionomer Cement, Primary Molars, Pit and Fissure Sealant, Pediatric Dentistry.

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INTRODUCTION

Dental caries remains one of the most prevalent chronic diseases worldwide and continues to disproportionately affect children and adolescents, posing a major public health challenge [1]. Untreated dental caries in childhood can negatively influence growth, nutrition, school attendance, and overall quality of life [1, 2]. The occlusal surfaces of molars are particularly vulnerable due

to their complex pit and fissure morphology, which facilitates plaque accumulation and limits the effectiveness of natural cleansing mechanisms and topical fluoride exposure [2, 3]. Pit and fissure sealants are widely accepted as an effective, minimally invasive preventive strategy for occlusal caries management. By creating a physical barrier between the tooth surface and cariogenic biofilm, sealants significantly reduce the risk of caries development in both primary and permanent teeth [4, 5]. Strong evidence from systematic reviews and meta-analyses supports their effectiveness in preventing and arresting non-cavitated and early cavitated occlusal lesions [4, 6]

Sealant materials are classified according to their composition and setting reaction, including resin-based sealants (RSs), glass ionomer sealants (GISs), resin-modified glass ionomer sealants (RMGISs), and polyacid-modified resin sealants [3]. RSs are generally considered the gold standard due to their superior micromechanical retention and long-term sealing ability [6, 7]. However, their performance is highly technique-sensitive and depends on strict moisture control, which can be difficult to achieve in young children and uncooperative patients. Glass ionomer–based sealants, formed through an acid–base reaction between polyacrylic acid and fluor aluminosilicate glass, offer several clinical advantages [3]. Although conventional GISs demonstrate lower retention and wear resistance compared with RSs, they chemically bond to tooth structure, release fluoride, tolerate moisture, and require minimal surface preparation [2, 4, 8]. These properties make them particularly suitable for community-based programs and for children with limited cooperation. However, recent reviews have reported variable retention outcomes between resin-based and glass ionomer sealants, emphasizing the need for further comparative evaluation [7, 9]. Children with special healthcare needs are at increased risk of dental caries due to compromised oral hygiene, dietary habits, and limited access to dental care. In such populations, material selection plays a critical role in clinical success. Arif *et al*., demonstrated that although resin sealants showed superior retention, glass ionomer sealants provided meaningful caries-preventive benefits when ideal clinical conditions could not be ensured [10]. Similarly, Kaur *et al*., highlighted the balance between retention and fluoride release when selecting sealant materials for pediatric patients [11]. Despite the growing emphasis on minimally invasive dentistry, the long-term effectiveness of sealing techniques for managing early dentinal caries remains controversial. Evidence supporting the use of sealants for cavitated dentinal lesions is still evolving [12, 13]. Nevertheless, recent randomized controlled trials suggest that sealing may successfully arrest non-cavitated and minimally cavitated lesions extending into dentine [14]. Therefore, the present study aimed to compare resin-based sealants and resin-modified glass ionomer sealants in the management of occlusal cavitated dentine caries with limited extension in primary molars, focusing on long-term retention, accumulated success, and clinical applicability in pediatric outpatient settings.

MATERIALS AND METHODS

Study Design and Seting

This randomized, non-blinded split-mouth clinical study was conducted at Department of Pedodontics, Rajshahi, Bangladesh. The study followed a minimally invasive dentistry approach and adhered to relevant clinical research guidelines.

Study Population

Seventy children presenting with occlusal cavitated dentine caries in primary molars were consecutively recruited. Sixty-six children completed the full 36-month follow-up period. Each participating child contributed two primary molars that fulfilled the eligibility criteria.

Eligibility Criteria

Included teeth were primary molars with occlusal cavitated dentine caries limited to no more than one-third of the occlusal surface in any dimension (ICDAS 3–4), expected to remain in situ for at least three years. Exclusion criteria comprised extensive cavitation (ICDAS 5–6), hypomineralization affecting the treatment area, previous restorations, interfering approximal caries, expected exfoliation within three years, and children unable to cooperate during dental treatment.

Randomization and Allocation

A split-mouth design was used. For each child, one molar was randomly allocated to resin-based sealant (RBS) treatment and the contralateral molar to resin-modified glass ionomer cement (RMGIC) restoration. Additional randomization determined the treatment order

and the tooth treated first to minimize bias related to cooperation or operator handling.

Clinical Procedures

RBS was placed without caries removal. The cavity and surrounding enamel were etched with 38% phosphoric acid for 20 seconds, rinsed, air-dried, and sealed using a light-cured resin sealant, polymerized for 20 seconds with an LED curing unit (1000 mW/cm²). RMGIC restorations were performed under topical and/or local anesthesia following complete caries removal using rotary instruments. The material was light cured for 40 seconds and polished if required. All treatments were performed without rubber dam using cotton rolls, DryTips®, and saliva ejectors for moisture control.

Outcome Assessment and Follow-up

Clinical evaluations were performed at 3, 6, 12, 24, and 36 months. Restorations and sealants were classified as "defect-free" or "defect," with defects defined as material loss, fractures, secondary caries, or extraction related to occlusal caries or treatment. Defective cases were repaired and excluded from further analysis.

Patient Experience and Statistical Analysis

Children's treatment experience was recorded using a 7-point facial scale, while dentists assessed cooperation and overall experience using a four-grade scale. A priori power analysis indicated 95% power at a 5% significance level with 66 teeth per group. Data were analyzed using SPSS software (version 25). Retention and caries outcomes were compared between groups using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Characteristics of the 70 Participating Children

Variable	Boys (n = 38)	Girls (n = 32)	Total (n = 70)
Age (years)	4.62 ± 1.12 [2.9–8.5]	5.01 ± 1.43 [2.9–8.1]	4.80 ± 1.28 [2.9–8.5]
d	3.21 ± 2.01 [2–9]	3.25 ± 1.60 [2–7]	3.23 ± 1.83 [2–9]
e	0.24 ± 0.85 [0–4]	0.09 ± 0.30 [0–1]	0.17 ± 0.67 [0–4]
f	0.32 ± 0.90 [0–4]	0.74 ± 1.50 [0–6]	0.51 ± 1.22 [0–6]
deft	3.77 ± 2.38 [2–11]	4.08 ± 2.42 [2–12]	3.91 ± 2.56 [2–12]

d = dentine caries in primary teeth;
e = primary teeth extracted due to caries;
f = filled primary teeth

Table 1 shows the baseline characteristics of the 70 participating children (38 boys and 32 girls). The mean age was 4.80 ± 1.28 years, with a comparable age distribution between boys and girls. The mean number of decayed primary teeth (d) was similar in both sexes (overall 3.23 ± 1.83). Extracted (e) and filled (f) primary teeth were low in both groups, indicating limited restorative care. The overall mean deft score was 3.91 ± 2.56, with slightly higher values observed among girls than boys.

Table 2: Comparison of Resin-Based Sealant (RBS) and Resin-Modified Glass Ionomer Cement (RMGIC) for Treatment of Occlusal Cavitated Dentine Caries with Limited Extension in Primary Molars During 36-Month Follow-up (n = 70)

Follow-up Interval	RBS – Defect-free % (n)	RMGIC – Defect-free % (n)	McNemar Test (Binomial Distribution) p-value
3 months	94.3 (66)	100.0 (70)	0.25
6 months	92.9 (65)	98.6 (69)	0.125
12 months	88.6 (62)	97.1 (68)	0.070
24 months	71.4 (50)	94.3 (66)	0.0005*
36 months	71.4 (50)	85.7 (60)	0.093

Over a 36-month follow-up of 70 primary molars with limited occlusal cavitated dentine caries, resin-modified glass ionomer cement (RMGIC) consistently showed higher defect-free retention rates than resin-based sealant (RBS) at all intervals. At 3, 6, and 12 months, differences were not statistically significant. However, at 24 months, RMGIC demonstrated significantly better performance than RBS (94.3% vs. 71.4%, p = 0.0005). By 36 months, RMGIC continued to outperform RBS (85.7% vs. 71.4%), although the difference was not statistically significant (p = 0.093).

Table 3: Comparison of Resin-Based Sealant (RBS) and Resin-Modified Glass Ionomer Cement (RMGIC) for Treatment of Occlusal Cavitated Dentine Caries with Limited Extension in Primary Molars During the 36-Month Follow-up (n = 70)

Outcome Measure	RBS (Mean ± SD)	RMGIC (Mean ± SD)	p-value
Dentist rating of total experience	1.22 ± 0.56	1.40 ± 0.77	0.076
Dentist rating of child experience	1.29 ± 0.53	1.56 ± 0.83	0.005*
Dentist rating of child cooperation	1.32 ± 0.60	1.37 ± 0.73	0.512
Child experience (Face-scale)	1.49 ± 1.08	1.82 ± 1.68	0.209

WSR = Wilcoxon Signed Rank test

During the 36-month follow-up of 70 primary molars with limited occlusal cavitated dentine caries, dentist- and child-reported outcomes were compared between resin-based sealant (RBS) and resin-modified glass ionomer cement (RMGIC). Overall, dentists rated the total treatment experience slightly higher for RMGIC than RBS, though this difference was not statistically significant (1.40 ± 0.77 vs. 1.22 ± 0.56, p = 0.076). Dentist-rated child experience was significantly better with RMGIC (1.56 ± 0.83) compared to RBS (1.29 ± 0.53, p = 0.005). Child cooperation and child-reported experience (Face-scale) showed no significant differences between the two materials.

Table 4: Spearman Rank Correlation (r_s) Between Evaluated Variables and Accumulated Success Rate After 36 Months for Resin-Based Sealant (RBS) and Resin-Modified Glass Ionomer Cement (RMGIC) (n = 70)

Variables (Rank levels)	RBS accumulated success rate after 36 months [r_s (p-value)]	RMGIC accumulated success rate after 36 months [r_s (p-value)]
D-exp (1–4)	0.092 (0.468)	0.381 (0.001) *
D-C-exp (1–4)	0.041 (0.743)	0.262 (0.031) *
D-coop (1–4)	0.029 (0.821)	0.358 (0.003) *
C-Face-exp (1–7)	−0.097 (0.441)	0.244 (0.051)
CFSS-DS-pv (15–75)	0.098 (0.444)	0.109 (0.389)

RBS = Resin-Based Sealant; RMGIC = Resin-Modified Glass Ionomer Cement;
D-exp = Dentist rating of total treatment experience;
D-C-exp = Dentist rating of child experience during treatment;
D-coop = Dentist-rated cooperation;
C-Face-exp = Child-rated experience (Face-scale);
CFSS-DS-pv = Children's Fear Survey Schedule–Dental Subscale, parental version

Spearman rank correlation analysis evaluated the relationship between various dentist- and child-reported variables and the accumulated success rate of resin-based sealant (RBS) and resin-modified glass ionomer cement (RMGIC) after 36 months (n = 70). For RBS, none of the variables showed a significant correlation with success (all p > 0.05). In contrast, for RMGIC, dentist-rated total treatment experience (D-exp, r_s = 0.381, p = 0.001), dentist-rated child experience (D-C-exp, r_s = 0.262, p = 0.031), and dentist-rated child cooperation (D-coop, r_s = 0.358, p =

0.003) were positively and significantly correlated with success. Child-rated experience (C-Face-exp) and parental report of dental fear (CFSS-DS-pv) did not show significant correlations for either material. These results indicate that dentist-perceived cooperation and treatment experience are associated with higher long-term success for RMGIC but not for RBS.

DISCUSSION

The present study evaluated the long-term clinical performance of resin-based sealant (RBS) and resin-modified glass ionomer cement (RMGIC) in managing occlusal cavitated dentine caries with limited extension in primary molars over a 36-month follow-up period. While both materials demonstrated satisfactory short-term outcomes, RMGIC showed superior durability and accumulated success over time. During the early follow-up periods (3, 6, and 12 months), both materials exhibited high defect-free survival rates, with no statistically significant difference between them. This finding is consistent with previous clinical trials reporting comparable short-term retention and caries-preventive effects of resin-based and glass ionomer sealants under controlled clinical conditions [1-3]. The favorable initial performance of RBS may be attributed to its strong micromechanical retention and resistance to occlusal wear [4, 5]. At the 24-month evaluation, a statistically significant difference was observed, with RMGIC demonstrating a higher defect-free rate than RBS. This outcome aligns with studies reporting gradual loss of resin sealants over time, particularly in pediatric populations where moisture control and occlusal stress remain challenging [6, 7]. In contrast, the chemical adhesion, fluoride release, and moisture tolerance of RMGIC may contribute to its superior long-term stability [8-10]. Although the difference at 36 months was not statistically significant, RMGIC maintained a higher accumulated success rate. This trend is supported by long-term observational studies indicating that glass ionomer–based sealants retain caries-preventive effects even after partial material loss due to continuous fluoride release and remineralization of adjacent tooth structure [11-14].

Dentist- and child-reported outcomes revealed differences in treatment experience. Dentist ratings indicated significantly better child experience during RBS placement, possibly due to shorter working time and smoother handling characteristics [15, 16]. However, no significant difference was observed in dentist-rated cooperation or child-reported face-scale experience, suggesting that both materials are generally acceptable to pediatric patients. Correlation analysis provided further insight into factors influencing clinical success. For RBS, no significant association was found between accumulated success and dentist experience, child cooperation, or dental fear, indicating that RBS outcomes are primarily material- and technique-dependent [17]. In contrast, RMGIC success was positively correlated with dentist-rated treatment experience, child experience, and cooperation, highlighting the influence of behavioral and operator-related factors on material performance [18, 19]. Children's dental fear scores (CFSS-DS) did not significantly correlate with accumulated success for either material. This suggests that while dental anxiety may affect treatment behavior, it does not directly impact long-term sealant survival once the procedure is completed successfully, consistent with previous pediatric studies [20]. Overall, the findings support the use of RMGIC as a reliable material for managing occlusal cavitated dentine caries with limited extension in primary molars, particularly in situations where moisture control is suboptimal. Resin-based sealants remain a suitable option in well-controlled clinical environments where ideal isolation can be ensured.

CONCLUSION

Resin-modified glass ionomer cement (RMGIC) demonstrated superior long-term clinical performance and higher accumulated success rates compared to resin-based sealant (RBS) in managing occlusal cavitated dentine caries with limited extension in primary molars. RMGIC's chemical adhesion, fluoride release, and moisture tolerance likely contribute to its durability, making it particularly suitable for pediatric patients with limited cooperation or suboptimal clinical conditions. Although RBS performed well under ideal isolation, its long-term retention was lower, and success appeared largely material- and technique-dependent. Dentist-rated child cooperation and treatment experience were positively associated with RMGIC outcomes, highlighting the importance of operator-patient interaction. Overall, RMGIC represents a reliable and effective sealant option in routine pediatric dental practice, while RBS remains

appropriate when strict moisture control and optimal application conditions can be ensured.

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