Efficacy of Resin-Modified Glass Ionomer Varnish in Preventing Occlusal Caries in Permanent Molars: A 12-Month Trial

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Abstract

Preventing occlusal caries in children is a critical component of oral health management, given the susceptibility of newly erupted permanent molars to decay. *Aim and Objectives:* This study aimed to assess the efficacy of resin-modified glass ionomer varnish in preventing occlusal caries in newly erupted first permanent molars over a 12-month clinical trial. *Materials and Methods:* A split-mouth randomized clinical trial was conducted with 59 children aged 6–8 years, analyzing 86 pairs of newly erupted first permanent molars. Varnish™ XT (resin-modified glass ionomer varnish) was applied to one molar (Varnish Group), while the contralateral molar was left untreated (Control Group). Outcomes were evaluated using the International Caries Detection and Assessment System (ICDAS II) at 6 and 12 months. *Results:* The Varnish Group showed significantly better outcomes, with 96.51% of teeth remaining caries-free at 6 months and 90.7% at 12 months. In contrast, the Control Group had only 73.26% and 56.98% caries-free teeth at 6 and 12 months, respectively. Statistical analysis confirmed the efficacy of Varnish™ XT ($p \leq 0.001$). *Conclusion:* Varnish™ XT demonstrated superior effectiveness in preventing occlusal caries compared to untreated teeth.

Keywords: occlusal caries, resin-modified glass ionomer varnish, dental prevention

INTRODUCTION

Dental caries remains a widespread and chronic condition affecting children worldwide, and its prevention remains a critical public health priority [1]. Among dental surfaces, the occlusal surfaces of molars are particularly susceptible to decay, accounting for a significant proportion of caries cases in children and adolescents. Studies indicate that approximately 60–90% of caries in children occur on these surfaces, underscoring the need for targeted preventive measures [2-4].The permanent first molar holds unique significance in the dental arch. It is the first permanent tooth to erupt, typically appearing around the age of six, and plays a vital role in establishing occlusion, mastication, and arch stability [5,6]. Its early eruption into a young oral environment, often before the child has fully developed effective oral hygiene habits, makes it highly vulnerable to caries. Additionally, the molar's anatomical complexity, with its deep pits and fissures, creates an environment conducive to plaque retention and bacterial colonization. These factors collectively contribute to the molar's higher susceptibility to caries compared to other teeth [7,8].

The age group selected for this study, typically encompassing children between six and 12 years, faces specific challenges in maintaining oral health. This period coincides with the eruption of permanent teeth and transitional oral hygiene practices, making children particularly vulnerable to caries development. Inadequate oral hygiene habits, poor diet rich in fermentable carbohydrates, limited fluoride exposure, and socio-economic factors further compound the risk. Moreover, behavioral factors such as noncompliance with regular dental visits and a lack of awareness about preventive measures contribute to the prevalence of caries in this age group [9,10].

Among the strategies for preventing occlusal caries, fissure sealants and fluoride varnishes are widely employed. Traditional resin-based sealants have proven effective but rely heavily on proper isolation and application technique, which may limit their success in challenging clinical conditions such as partially erupted teeth [11-13]. Conventional fluoride varnishes, similarly, are effective only when optimal isolation from saliva is achieved, which may be difficult in certain clinical scenarios. However, their effectiveness in preventing occlusal caries, particularly in high-risk situations, lacks robust clinical evidence over extended periods [14]. These limitations necessitate the development of alternative materials like glass ionomer-based cements (GICs) and resin-modified glass ionomer varnishes (RMGIs), which offer moisture-tolerant properties and a more sustained fluoride release, making them more suitable for newly erupted teeth in challenging clinical conditions (15,16). Despite the potential advantages of these materials, limited research has compared their efficacy to that of traditional approaches, particularly over extended periods. Furthermore, there is a lack of robust clinical evidence assessing their performance in preventing occlusal caries in newly erupted permanent first molars.

Aim and objectives

This study aims to evaluate the effectiveness of a light-curable resin-modified glass ionomer varnish in preventing occlusal caries on newly erupted first permanent molars compared to untreated teeth over a 12-month period. The findings are expected to enhance clinical practices, particularly in pediatric dentistry, by offering evidence-based insights into innovative strategies for preventing occlusal caries and promoting better oral health outcomes.

MATERIAL AND METHODS

The study was conducted in accordance with ethical regulations, having received approval from the Ethics Committee of the Denta Aur Private Medical Center, Târgu-Mureş, Romania with the clinical trial registration number 032/21.03.2023. Clinical procedures took place between May 2023 and July 2024, and informed consent was obtained from the parents of all participants.

Oral Hygiene Training and Compliance Monitoring. All participants received detailed training on oral hygiene, including the Bass brushing technique or the use of electric toothbrushes, depending on individual preferences. Nutritional hygiene advice was also provided to support long-term oral health. Compliance with these recommendations was monitored throughout the study. The instructions were age-appropriate, and parents were actively involved in supporting their children's daily adherence to these practices, ensuring proper oral hygiene and dietary habits.

Study Design and Participants. The trial followed a split-mouth design, where one molar from a pair of contralateral maxillary or mandibular first permanent molars was randomly assigned to the Vanish™ XT group, and the other served as a control, receiving no treatment. The treated molars formed the Varnish group, while untreated molars formed the Control group.The inclusion criteria were healthy children aged 6–8 years, at high risk of dental caries, with a minimum of one pair of newly erupted, contralateral first permanent molars featuring deep pits and fissures, no dental abnormalities, and no clinical signs of carious lesions. Exclusion criteria included molars with suspicious or uncertain structural integrity, teeth with fillings or sealants, children not classified as high-risk for caries, or those unable to complete the follow-up evaluations.

Caries Detection and Classification. The ICDAS II classification system [17] was used to evaluate and track caries progression. This system includes a numerical scale from 0 to 6, used to classify lesions based on both visual and tactile assessments:

- ICDAS 0: No visible caries; healthy enamel.
- ICDAS 1: First visual changes in enamel, seen only after air drying; no cavitation.
- ICDAS 2: Distinct visual changes in enamel, visible without drying; no cavitation.
- ICDAS 3: Localized enamel breakdown due to caries with or without underlying shadow.
- ICDAS 4: Underlying dark shadow from dentin with or without enamel cavitation.
- ICDAS 5: Distinct cavity with visible dentin.
- ICDAS 6: Extensive cavity with visible dentin.

Two calibrated examiners conducted the caries assessment using visual and tactile methods based on the ICDAS II classification system. A dental probe was used to assess the surfaces for caries, and the teeth were examined after cleaning and drying.

Eighty-seven children were initially screened. Seventeen were excluded due to the presence of carious lesions, fillings, sealants, or because they were not at high risk of caries, and eight declined to participate. Sixty-two children met the inclusion criteria. During the study, three children were excluded due to missed follow-ups, resulting in a final sample of 59 children, comprising 86 pairs of molars (172 teeth) for analysis.

Clinical Procedures. Two calibrated dentists, assisted by trained chairside dental assistants, performed all clinical steps. Both operators completed an ICDAS-II calibration course to standardize the assessment of tooth surfaces and caries detection. Teeth were evaluated using visual and tactile methods based on the ICDAS-II classification system.

Teeth were cleaned using a rotating cup without paste, isolated with cotton rolls and a saliva ejector, and thoroughly dried. Materials were applied according to the manufacturer's instructions. The Vanish™ XT application involved etching the tooth surface with 35% phosphoric acid for 15 seconds, followed by rinsing for 60 seconds and drying for 5 seconds. Equal parts of Vanish™ XT liquid and paste were mixed for 15 seconds and applied in a thin layer (≤0.5 mm) to the occlusal and buccal/lingual surfaces using a brush. The material was then light cured for 20 seconds. After curing, the material was meticulously inspected to ensure proper setting and retention.

Outcome and Follow-Up. The primary outcome was the development of new caries (ICDAS II scores of 1, 2, or 3) on the occlusal surfaces of the molars at 6 and 12 months. Two calibrated examiners conducted caries assessments, with any detected carious lesions being treated and recorded as failures. To ensure consistency, the same baseline treatment was reapplied at each follow-up visit.

Sample Size Determination. The required sample size was calculated as 142 teeth using G-Power software™ (Heinrich Heine University, Düsseldorf, Germany), with 95% power ($\alpha = 0.05$, $\beta = 0.05$).

Statistical Analysis. The data were analyzed using GraphPad Prism™ V6.01 software for Windows. For categorical data, Fisher's exact test was applied in cases of small sample sizes, while the chi-squared test was used for larger datasets. Statistical significance was set at $p \leq 0.05$.

RESULTS

The final sample included 59 children (34 females and 25 males) aged 6–8 years, with a mean age of 7.08 ± 0.67 years. Females represented 57.62% of the participants, while males accounted for 42.37%. Of the 59 children included in the study, 27 had all four first permanent molars (2 pairs) analyzed, while the remaining 32 children had only one pair of molars (2 teeth) included in the analysis.

The Caries Status at Follow-Up:

In the Varnish group: At the 6-month follow-up, out of 86 treated teeth, 83 teeth (96.51%) remained caries-free (ICDAS II code 0), while 3 teeth (3.49%) showed early caries (ICDAS II code 1). At the 12-month follow-up, 78 teeth (90.7%) were caries-free (ICDAS II code 0), and 8 teeth (9.3%) were classified as ICDAS II code 1.

In the Control group: At 6 months, out of 86 untreated teeth, 63 teeth (73.26%) were caries-free (ICDAS II code 0), while 19 teeth (22.09%) scored ICDAS II code 1, and 4 teeth (4.65%) scored ICDAS II code 2. At 12 months, 49 teeth (56.98%) were caries-free (ICDAS II code 0), 14 teeth (16.28%) scored ICDAS II code 1, 13 teeth (15.12%) scored ICDAS II code 2, and 10 teeth (11.63%) developed more advanced caries (ICDAS II code 3).

Statistical analysis revealed significant differences between the Varnish and Control groups regarding caries progression. These differences were evident at both the 6-month and 12-month follow-ups. All these data are summarized in the following table (Table 1).

Table 1. Caries Status of Treated and Untreated Teeth at 6- and 12-Month Follow-Up

Group	Follow-Up	ICDAS code 0	ICDAS code 1	ICDAS code 2	ICDAS code 3	Total Teeth	*p*-value
Varnish Group	6 months	83 (96.51%)	3 (3.49%)	0	0	86	< 0.001
	12 months	78 (90.7%)	8 (9.3%)	0	0	86	< 0.001
Control Group	6 months	63 (73.26%)	19 (22.09%)	4 (4.65%)	0	86	-
	12 months	49 (56.98%)	14 (16.28%)	13 (15.12%)	10 (11.63%)	86	-

DISCUSSIONS

The results of this study indicate that the use of a light-curable resin-modified glass ionomer varnish (Vanish™ XT) can significantly reduce the development of occlusal caries in newly erupted first permanent molars, as compared to untreated teeth. At both the 6- and 12-month follow-ups, molars treated with the Vanish™ XT varnish demonstrated a significantly higher percentage of caries-free teeth (ICDAS code 0) compared to the control group, which did not receive any treatment.

At 6 months, 96.51% of teeth in the Varnish group remained caries-free, a result that is consistent with other studies evaluating fluoride varnishes and resin-modified glass ionomer products. In contrast, only 73.26% of teeth in the Control group were caries-free at the same interval, and this difference was statistically significant. These findings align with previous research that has highlighted the effectiveness of fluoride varnishes and glass ionomer-based materials in preventing dental caries, particularly in children with deep fissures and high caries risk [18,19].

The efficacy of resin-modified glass ionomer varnishes like Vanish™ XT is attributed to their moisture-tolerant properties and sustained fluoride release, which allow for better adaptation to the oral environment, especially in partially erupted or difficult-to-isolate teeth [15,20,21]. Previous studies have shown that these materials provide long-lasting protection by releasing fluoride gradually, which is essential in high-risk groups, where traditional fluoride varnishes may not offer optimal protection due to issues with isolation [20,22].

Over the 12-month period, the results remained favourable for the Vanish™ XT group, with 90.7% of teeth remaining caries-free at the 12-month follow-up. This extended period of protection further supports the long-term benefits of using resin-modified glass ionomer varnishes in preventing occlusal caries. The Control group, on the other hand, exhibited significant progression of caries, with only 56.98% of untreated teeth remaining caries-free after 12 months, and a notable increase in the proportion of teeth classified as ICDAS code 2 and ICDAS code 3.

While this study provides promising results, it is important to acknowledge that the success of any preventive treatment depends on a combination of factors, including patient compliance, oral hygiene practices, and the technique used during application. In this study, the clinical procedure was standardized, with two calibrated examiners ensuring consistent caries detection and treatment, which reduces the potential for bias. However, further studies involving larger and more diverse populations, longer follow-up periods, and comparisons with other preventive measures (e.g., resin-based sealants) are necessary to further substantiate the findings.

Several studies have also examined the use of fluoride varnishes and sealants for occlusal caries prevention. For example, studies have demonstrated that fluoride varnishes can reduce the incidence of caries in high-risk children, but the level of efficacy may vary depending on the product and the clinical conditions under which it is applied [23]. Additionally, recent investigations into the use of alternative materials such as bioactive glass and fluoride-releasing cements suggest promising outcomes in caries prevention, particularly in pediatric dentistry [16,24].

While the findings of this study demonstrate the effectiveness of Vanish™ XT in preventing occlusal caries, some limitations should be considered. An important limitation of this study is the relatively small sample size, which may affect the generalizability of the results, alongside the short follow-up period (12 months) that does not allow for long-term assessment of the material's effectiveness, as well as the exclusive focus on a single product (Vanish™ XT) without direct comparisons to other available preventive materials. Further studies with larger, more diverse populations, extended follow-up periods, and direct

comparisons to other preventive materials are needed to confirm and expand upon these findings.

CONCLUSIONS

This study demonstrates that light-curable resin-modified glass ionomer varnish (Vanish™ XT) is highly effective in preventing occlusal caries on newly erupted first permanent molars. The varnish provides significant protection over 6- and 12-month periods, particularly in high-risk children, thanks to its ease of application, moisture tolerance, and sustained fluoride release. These characteristics make Vanish™ XT a promising addition to pediatric preventive care.

Conflicts of Interest

The authors declare no conflict of interest.

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