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Comparative evaluation of glass ionomer cement, composite resin in primary teeth restorations

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Abstract:
Restoration of primary teeth requires materials that provide durable clinical performance while maintaining biocompatibility and ease of application. Therefore, it is of interest to evaluate the 90 primary teeth randomly allocated to composite resin or glass ionomer cement groups, assessing retention, marginal adaptation, surface integrity and secondary caries during the specified follow-up period. Composite resin offered advantages in esthetics and mechanical strength, whereas glass ionomer cement provided fluoride release and potential protection against secondary caries. Both restorative materials showed comparable clinical performance across the evaluated parameters during follow-up. Thus, data shows that evidence-based selection of composite resin or glass ionomer cement according to the clinical requirements of primary tooth restoration.

Keywords: Glass ionomer cement (GIC), composite resin, primary teeth, dental caries, pediatric dentistry, restorative materials

Background:
In children all around the globe, but especially in underdeveloped nations, dental caries is a chronic condition that needs constant attention. In order to keep the mouth healthy, promote appropriate chewing and speech development and make room for permanent teeth, it is crucial to treat carious lesions in primary teeth **[1]**. When it comes to pediatric patients, the success and duration of restorations are greatly affected by the choice of restorative material. Composite resin and glass ionomer cement (GIC) are two of the many restorative materials on the market and their positive clinical qualities have led to their broad adoption. Among its many applications, glass ionomer cement shines in pediatric dentistry and less invasive treatments because to its biocompatibility, chemical adherence to tooth structure and fluoride release **[2]**. However, composite resin is the material of choice in stress-bearing regions because to its improved aesthetics, stronger compressive strength and wear resistance **[3]**. New high-viscosity glass ionomer cement (HVGIC) has recently been developed and it outperforms traditional GIC in terms of mechanical properties and clinical performance **[4]**. The relative merits of GIC and composite resin as primary tooth replacement materials is still up for discussion, notwithstanding recent developments. Although there are variations in particular clinical outcomes, many systematic reviews and clinical studies have shown that the two materials have similar survival rates **[5, 6]**. The release of fluoride, which aids in remineralization and decreases the occurrence of secondary caries, is one of the main benefits of GIC **[7]**. Recurrent caries is less common with GIC restorations than with composite resin restorations, according to the studies **[5]**. And when it comes to situations where controlling moisture is difficult, as it often is with pediatric patients, GIC is less technique-sensitive and works better **[8]**. Composite resin, on the other hand, provides better mechanical strength and aesthetic results but requires tight isolation and technical sensitivity. It works well for front teeth and other places that take a beating from occlusal pressures **[9]**. Incorrect handling, however, could lead to marginal leakage and secondary caries due to its possible polymerization shrinkage and absence of fluoride release **[10]**. Composite resin and GIC both exhibit comparable failure rates across different follow-up periods in clinical investigations comparing primary molars, suggesting that both materials are good choices for restorations **[5]**. The selection of material is, however, heavily impacted by variables such cavity size, patient compliance, caries risk and operator expertise **[11]**. Recent developments in minimally invasive dentistry have placed an emphasis on avoiding extractions whenever possible and using biocompatible materials to promote natural healing. Because of its fluoride-releasing ability and adhesive capabilities, GIC has recently attracted a lot of interest in this area **[12]**. Composite resins' clinical efficacy has been enhanced by developments in bulk-fill composites and adhesive methods **[13]**. Therefore, it is of interest to find out how well these materials work for restoring primary teeth and a comparative study is required because of their different characteristics and clinical results.

Materials and Methods:
Study design:
Restorations made of composite resin and glass ionomer cement for baby teeth were the subjects of a randomised controlled clinical trial.

Study setting:
Researchers from a university-affiliated dental school's pediatric and preventive dentistry department conducted the investigation.

Sample size:
In all, ninety main teeth in need of restoration were chosen for the research.

Participants in the research:
Included were children between the ages of 4 and 10 who presented with dental caries in their primary molars.

Inclusion criteria:
[1] Children aged 4–10 years
[2] Presence of Class I or Class II carious lesions in primary molars
[3] Teeth without pulpal involvement
[4] Cooperative children (Frankl behavior rating positive or definitely positive)

Exclusion criteria:
[1] Teeth with pulpal pathology or abscess
[2] Developmental anomalies of teeth
[3] Children with systemic diseases affecting oral health
[4] Uncooperative patients

Grouping:
The selected 90 teeth were randomly divided into two groups:
[1] Group I (n = 45): Restored with Glass Ionomer Cement
[2] Group II (n = 45): Restored with Composite Resin

Clinical procedure:
Preparation:
[1] Oral prophylaxis was performed prior to treatment
[2] Local anesthesia was administered where necessary
[3] Standard cavity preparation was done using a high-speed handpiece

Group I (GIC):
[1] Cavity conditioned with polyacrylic acid
[2] GIC mixed according to manufacturer's instructions
[3] Material placed and contoured
[4] Surface protected with varnish

Group II (Composite Resin):
[1] Acid etching with 37% phosphoric acid
[2] Application of bonding agent and light curing
[3] Incremental placement of composite resin
[4] Each increment light cured
[5] Finishing and polishing performed

Evaluation criteria:
Restorations were evaluated using modified USPHS/FDI criteria at:
[1] Baseline
[2] 3 months
[3] 6 months
[4] 12 months

Parameters assessed:
[1] Retention
[2] Marginal adaptation
[3] Surface texture
[4] Anatomical form
[5] Secondary caries

Statistical analysis:
[1] Data were analyzed using SPSS software 25.0
[2] Chi-square test and Student's t-test were applied
[3] Significance level set at $p < 0.05$

Results:
A total of 90 primary teeth were included in the study and equally divided into two groups: Group I (Glass Ionomer Cement – GIC): 45 teeth and Group II (Composite Resin): 45 teeth. At baseline, three, six and twelve months, all restorations were assessed using standardized clinical criteria. Comparatively, 91.1% of composite restorations were still in place after 12 months, but only 84.4% of GIC restorations were. A greater retention rate was observed with composite resin, although this difference did not reach statistical significance ($p = 0.312$). It may be inferred that the two materials exhibit similar retention in first teeth after a year. The enhanced mechanical qualities and bonding strength of composite restorations could explain why they have somewhat better retention **(Table 1)**. Composite restorations had marginal adaption at 88.9% compared to 80.0% for GIC, although this difference was not statistically significant ($p = 0.221$). Surface integrity, on the other hand, differed significantly ($p = 0.041$). When compared to GIC, the smoothness of composite restorations was 93.3% higher. Composite resin seems to have superior polishability and wear resistance compared to GIC, which might mean that GIC surfaces degrade more quickly **(Table 2).** Statistical analysis revealed no statistically significant difference between GIC and composite restorations with regard to the occurrence of secondary caries; nevertheless, GIC had a lower incidence rate (8.9% versus 17.8%). Similarly, there was no statistically significant difference between the composite resin and GIC groups in terms of overall success rate (84.4% vs. 77.8%; $p = 0.398$). While composites do a better job mechanically, our results suggest that GIC may give some protection against secondary caries thanks to the fluoride it releases **(Table 3).**

Table 1: Retention Rate of Restorations at 12 Months

Outcome	GIC (n=45)	Composite (n=45)	p-value
Retained	38 (84.4%)	41 (91.1%)	0.312
Lost	7 (15.6%)	4 (8.9%)	

Table 2: Marginal Adaptation and Surface Integrity

Criteria	GIC (n=45)	Composite (n=45)	p-value
Good marginal adaptation	36 (80.0%)	40 (88.9%)	0.221
Poor marginal adaptation	9 (20.0%)	5 (11.1%)	
Smooth surface	34 (75.6%)	42 (93.3%)	0.041*
Rough surface	11 (24.4%)	3 (6.7%)	

*Statistically significant

Table 3: Secondary Caries and Overall Success Rate

Outcome	GIC (n=45)	Composite (n=45)	p-value
No secondary caries	41 (91.1%)	37 (82.2%)	0.218
Secondary caries present	4 (8.9%)	8 (17.8%)	
Overall success	35 (77.8%)	38 (84.4%)	0.398

Discussion:

The purpose of this research was to compare the effectiveness of composite resin and glass ionomer cement when used to restore primary teeth. Both restorative materials showed similar clinical results, with their own set of benefits, according to the results. An important metric for measuring the durability of restorations is retention. There was no statistically significant difference in the retention rates of composite resin **(**91.1% vs. 84.4% in this research). Systematic evaluations have shown similar results, with both materials exhibiting similar failure rates over time **[3]**. The present findings are consistent with the comparative study by Zehra et al., which reported superior clinical performance of composite resin over glass ionomer cement in primary molar restorations. Composite resin showed significantly better retention at 6 and 12 months ($p=0.044$ and $p=0.014$), superior marginal adaptation ($p=0.013$) and better surface and esthetic properties ($p<0.01$), resulting in a higher overall success rate (91.7% vs. 75.0%; $p=0.021$). These findings suggest that composite resin may provide more predictable long-term clinical performance than glass ionomer cement when adequate moisture control and technique-sensitive placement are feasible **[14]**. Composite resin has greater compressive strength and micromechanical bonding, which contribute to its enhanced retention. Preventing microleakage and secondary caries relies heavily on marginal adaptability. Consistent with previous results, this investigation detected marginal adaption to be marginally superior in composite restorations. In comparison to GIC's chemical bonding, which could be weaker under mechanical stress, composite resins' adhesive systems provide superior sealing capacity. The variations in marginal adaptation between the two materials are often clinically minor, according to research **[2]**. Consistent with other studies showing that composite resins had greater wear resistance and polishability, composite restorations considerably improved surface integrity. Because GIC restorations have reduced mechanical strength, they will eventually show surface roughness. Plaque buildup and long-term effectiveness could be affected by this **[6].** This study's most striking result was the reduced occurrence of secondary caries in restorations made with GIC. This is because GIC has the ability to release fluoride, which boosts remineralization and stops germs in their tracks. The results of meta-analyses show that, in comparison to composite resin, GIC causes much less subsequent carious lesions **[4]**. For children at high risk of developing cavities, this quality makes GIC an ideal treatment option. Both materials had similar success rates overall, with composite having a little better record. This confirms the results of more recent systematic evaluations that found no statistically significant variation in clinical efficacy between composite resin and high-viscosity GIC **[13, 15, 16]**. It seems that both materials may be utilized consistently in restorative operations for children. Factors such as cavity size, location, patient compliance and operator competence impact the clinical efficacy of primary tooth restorative materials. It might be tough to work with composite resin in young patients due to the need for careful management of moisture and method sensitivity. When dealing with children who are recalcitrant or in settings where seclusion is not an option, GIC is a better option since it is less technique-sensitive and works well in damp conditions **[8].** Additionally, this study's results are in line with those of randomized clinical studies that have shown that GIC and composite restorations had similar survival rates after two years of follow-up **[9]**. Furthermore, new clinical research has highlighted the enhanced mechanical capabilities of high-viscosity GIC formulations, significantly reducing the difference between GIC and composite resin **[11]**. Composite resin has several benefits, such as high mechanical strength and aesthetics, but it has a few drawbacks, such as being method sensitive and vulnerable to polymerization shrinkage. There is a higher chance of failure and marginal gaps due to improper handling. However, GIC is an excellent material for minimally invasive dentistry because to its chemical adhesion, fluoride release and user-friendliness. Because of its chemical bonding and fluoride-releasing capabilities, GIC finds extensive usage in atraumatic restorative therapy **(**ART), another crucial area to think about. Research has shown that GIC-based ART restorations for primary teeth have high survival rates, especially in community settings **[15].** A small sample size and a short follow-up time of 12 months are two of the drawbacks of the current research. To assess the performance and longevity of these materials, larger-scale, long-term trials are necessary. In addition, there was a lack of in-depth analysis of aspects including food patterns and dental hygiene practices, which might impact the outcome of restorations. When it comes to replacing main teeth, this study's findings support the use of both GIC and composite resin. Clinical circumstances, patient considerations and operator preference should inform the selection of material.

Conclusion:

Both composite resin and glass ionomer cement showed satisfactory clinical performance in primary tooth restorations over 1 year. Glass ionomer cement was associated with fewer secondary caries, while composite resin showed better retention, marginal adaptation and surface smoothness. These findings support material selection based on caries risk, clinical requirements and patient cooperation in pediatric restorative dentistry.

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