ORIGINAL RESEARCH

Assessment of Erosive Effect of Various Beverages on Esthetic Restorative Materials Used in Primary Teeth: An *In Vitro* Study

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Abstract

Aim: The purpose of the current study was to evaluate the erosive impact of various beverages on the esthetic restorative materials utilized in primary teeth.

Materials and methods: One hundred and twenty primary molars indicated for serial extraction or over-retention reason with sound buccal surfaces were collected. One millimeter above the cemento-enamel junction, standard Class V cavities were prepared. Following cavity preparation, all teeth were randomly assigned (20 samples per group for each beverage) to one of the three experimental groups based on the type of filling materials: group I: resin-modified glass ionomer cement (GC), group II: nanocomposite resin and group III nanohybrid ormocer-based composite. The samples were kept suspended in various containers containing 250 mL of each orange juice and cola at a temperature of 37°C for three hours per day and rest of day in distilled water. This procedure was repeated for 15 days. Using a 3D optical profilometer, a profilometric reading was recorded for each specimen.

Results: The minimum surface roughness was found in nanohybrid ormocer-based composite (1.816 ± 0.16 and 1.302 ± 0.08) followed by resin-modified glass ionomer cement (3.101 ± 0.12 and 2.946 ± 0.09) and nanocomposite resin (5.242 ± 0.20 and 4.488 ± 0.16) after immersed in the cola and orange juice, respectively. And there was a statistically significant difference found between the different esthetic restorative materials in both media.

Conclusion: On conclusion, the current investigation demonstrates that when exposed to both beverages, the erosive effect was much lesser in nanohybrid ormocer-based composite, followed by resin-modified glass ionomer cement and nanocomposite resin.

Clinical significance: Consuming high-calorie, low pH acidic foods and beverages such as carbonated beverages and fruit juices can lead to erosion, a frequent condition that results in irreparable damage to dental hard tissues and early deterioration of dental restorations.

Keywords: Erosive effect, Esthetic restorative materials, Primary teeth, Profilometer, Surface roughness.

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Introduction

Primary teeth are crucial for a child's early physical, emotional, and social development because they maintain the integrity of the arch space while also enhancing appearance and function. The physical characteristics of tooth-colored filling materials have improved, making a variety of esthetic restorative materials that are more esthetically pleasing available to restore primary teeth today.[1]

The physical effects of a pathologic, persistent, and localized loss of dental hard tissue that is chemically scraped away from the tooth surface by acid and/or chelation without bacterial involvement are referred to as dental erosion in clinical terminology. The acids that cause erosion come from dietary, occupational, or intrinsic sources rather than from the oral flora.[2]

Glass ionomers, resin-modified glass ionomers, compomers, and resin composites are the most often utilized restorative materials in pediatric dentistry. Owing to their esthetic appearance, these materials are popular. The material's physical characteristics determine how well the dental restoration works. Low pH in the oral environment causes the surface integrity of restorative materials to deteriorate. The material's polymer network is destroyed over time by the acidic environment, which also affects the material's chemical and physical properties.[3] A common issue is the discoloration of restorative materials. It might be brought on by internal or external forces. Depending on the filler and matrix bonding type and the matrix's composition, intrinsic variables can cause changes in the material itself. Adsorption or absorption of stains in the mouth cavity is one example of an extrinsic factor. One of the causes of extrinsic discoloration is surface roughness.[4]

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Table 1: Evaluation of mean pre-immersion surface roughness of different esthetic restorative materials with two beverages

Esthetic restorative materials	*Surface roughness (cola)*	*Surface roughness (orange juice)*
Group I: Resin-modified glass ionomer cement	0.214 ± 0.021	0.210 ± 0.018
Group II: Nanocomposite resin	0.188 ± 0.014	0.191 ± 0.012
Group III: Nanohybrid ormocer-based composite	0.202 ± 0.024	0.206 ± 0.022
F-value	2.148	1.194
p-value	0.784	0.826

Dental erosion seems to have become more common as lifestyles have changed over the past 10 years, likely as a result of an increase in the use of soft drinks and fruit juices. It has been acknowledged as a significant factor in both adult and pediatric tooth structural loss.[5] To determine whether a therapy was successful or unsuccessful, the erosive effect of reparative materials is required. Owing to the presence of bacteria, saliva, and often consumed beverages in the oral cavity, the esthetics of these materials are impaired when they are subjected to this dynamic environment, which presents a difficult problem for dental professionals,[6] and only limited evidence available for erosive effect of beverages on the esthetic restorative materials utilized in primary teeth. Hence, this study was carried out to evaluate the erosive impact of different beverages commonly consumed by children on the esthetic restorative materials.

Materials and Methods

Specimen Preparation

This study was conducted in the College of Dentistry, Prince Sattam Bin Abdulaziz University, Alkharj, Kingdom of Saudi Arabia. The study was conducted during the year of 2022 and institutional approval was obtained. One hundred and twenty primary molars indicated for serial extraction or over-retention reason with sound buccal surfaces were collected. Teeth without caries, cracks, or hypocalcification were chosen for the study. Hypoplastic and carious teeth were excluded from the study. The teeth were properly washed with running water and maintained in distilled water at room temperature until they were used for the microleakage measurement. A standard Class V cavity was created 1 mm above the cement–enamel junction. Using a periodontal probe, the cavity preparation was standardized. The cavity was 2-mm deep, 2 mm occluso-cervically, and 3 mm mesio-distally.

All teeth (20 samples per group for each beverage) were randomly assigned to one of three experimental groups after cavity preparation according to material used.

Group I: Resin-modified Glass Ionomer Cement

The RMGIC capsules glass ionomer cement ((GC) Fuji II LC Capsules-GC Corporation, Tokyo, Japan) were stimulated and mixed in an amalgamator (Gnatus Amalga mix 2) for 10 seconds in accordance with the manufacturer's instructions. The various components were inserted one at a time into the created cavity using the GC applier. Curing the resources against the mylar strip procured the smoothest surfaces. The material was exposed to light for 20 seconds to cure it.

Group II: Nanocomposite Resin

The teeth in this group had their cavities filled with 37% phosphoric acid gel for 60 seconds after being thoroughly cleansed with water and dried with compressed air. Following etching and cleaning, the cavity was dried for 15 seconds using compressed air, and then a bonding agent (dentin primer) was applied for 60 seconds. The chamber with the bonding agent was then exposed to light for 20 seconds. The tooth was mounted with a retainer and a translucent matrix band. The cavity was filled with nanocomposite resin (Z350, 3M ESPE FiltekTM Universal Restorative, USA), which was then applied and gradually dried.

Group III: Nanohybrid Ormocer-based Composite

The nanohybrid ormocer-based composite (Admira Fusion, Voco, Cuxhaven, Germany) ingredients were polymerized for 20 seconds using a curing unit (Celalux II, Voco, Cuxhaven, Germany) in accordance with the manufacturer's instructions on the created cavity.

The baseline evaluation was done for each group specimens prior to immersion in the beverage media. The pH of the beverages was checked with pH indicator.

Immersion of Specimens in Different Beverages to Assess Surface Roughness (Erosive Effect)

At a temperature of 37°C, the specimens (20 in each group) were suspended in various containers that contained 250 mL each of orange juice and cola. Specimens were submerged in the appropriate beverage for three hours each day, with distilled water being used for the remaining time. Around 15 days were spent repeating this process.

Evaluation of Erosive Effect of Beverages on Esthetic Restorative Materials

A 3D optical profilometer was used to provide a profilometric readout for each specimen. Before each measurement, excess of water was blotted with absorbent tissue without touching the specimen surface. Each specimen's average surface roughness (Ra) values were calculated. With a 0.8-mm cutoff and 0.25 mm/s speed, a profilometer was used to record the Ra value (m) reading. An average was determined after three measurements were taken.

Statistical Analysis

The statistical evaluation was conducted using SPSS software, version 20.0. The erosive effect of various esthetic restoratives in two distinct beverages was compared using a one-way analysis of variance test, and the data obtained were normally distributed. A *p*-value of 0.05 or less was regarded as statistically significant.

Results

Table 1 shows the mean pre-immersion surface roughness of different esthetic restorative materials with two beverages. In both beverage groups the surface roughness was slightly more in resin-modified glass ionomer cement group (cola was 0.214 ± 0.021 and orange juice was 0.210 ± 0.018), followed by nanohybrid ormocer-based composite group (cola was 0.202 ± 0.024 and orange

Table 2: Evaluation of mean post-immersion surface roughness of different esthetic restorative materials with cola beverage

Esthetic restorative materials	*n*	*Surface roughness*	*F-value*	*p-value*
Group I: Resin-modified glass ionomer cement	20	3.101 ± 0.12	6.844	0.001
Group II: Nanocomposite resin	20	5.242 ± 0.20		
Group III: Nanohybrid ormocer-based composite	20	1.816 ± 0.16		

Table 3: Evaluation of mean post-immersion surface roughness of different esthetic restorative materials with orange juice

Esthetic restorative materials	*n*	*Surface roughness*	*F-value*	*p-value*
Group I: Resin-modified glass ionomer cement	20	2.946 ± 0.09	4.132	0.001
Group II: Nanocomposite resin	20	4.488 ± 0.16		
Group III: Nanohybrid ormocer-based composite	20	1.302 ± 0.08		

juice was 0.206 ± 0.022) and nanocomposite resin group (cola was 0.188 ± 0.014 and orange juice was 0.191 ± 0.012). And there was no significant difference found between the different esthetic restorative materials.

Evaluation of mean post-immersion surface roughness of different esthetic restorative materials with cola beverage was depicted in Table 2. The minimum surface roughness was found in nanohybrid ormocer-based composite (1.816 ± 0.16) followed by resin-modified glass ionomer cement (3.101 ± 0.12) and nanocomposite resin (5.242 ± 0.20) after immersed in the cola beverage. And there was a statistically significant difference found between the different esthetic restorative materials.

The post-immersion surface roughness of different esthetic restorative materials with orange juice was showed in Table 3. The minimum surface roughness was found in nanohybrid ormocer-based composite (1.302 ± 0.08) followed by resin-modified glass ionomer cement (2.946 ± 0.09) and nanocomposite resin (4.488 ± 0.16) after immersed in the orange juice. And there was a statistically significant difference found between the different esthetic restorative materials.

The inference of the study indicates that the erosive effect was significantly less in nanohybrid ormocer-based composite followed by resin-modified glass ionomer cement and nanocomposite resin after immersed in both the beverages.

Discussion

Dentistry has recently benefitted from a notable scientific advancement in the development of esthetic restorative materials. For primary teeth, the optimum restorative material should be simple to use and possess adhesive qualities to reduce the need for considerable preparation.[7]

When choosing the beverage, it is important to keep in mind that enamel erosion is influenced by the pH, buffer capacity, temperature, length of acid exposure, and calcium, fluorine, and phosphate concentrations in the environment. When the pH falls below 5.5, which is referred to as the critical pH, damage to the enamel may result.[8]

Coca-Cola is one of the most well-liked soft drinks, and consumption is really sensible everywhere. However, the erosive potential of acidic foods and drinks depends on low value of pH, type and dissociation constant of the acid, content of mineral components as well as physical properties.[9] Orange juice is valuable contribution to a healthy nutrition as it is rich with vitamin C to prevent common cold in winter. Children are drawn to soft drinks because they are popular, pleasant, and supposed to relieve dyspepsia.[10]

Evidently, pH is not the sole element impacting the erosion of enamel; other factors such as buffering ability and titratable acidity may also have an impact. Chelation is yet another pH-independent characteristic that aids in erosion. At neutral or even alkaline pH, the removal of metallic ions like Ca+ from a biological calcium–phosphorus system may take place.[11]

Erosion is a frequent lesion in the esthetic zone, hence in this investigation, class V cavity was chosen to be prepared. Owing to cavities' shallowness and narrowness, restoration materials were placed entirely inside them. As they are the most popular beverages and have differing pHs, cola and orange juice were chosen.[12] According to Hanaa Mahmoud Shalan et al.,[13] in order to mimic actual circumstances, specimens were submerged in beverages for three hours each day and preserved in distilled water for the remainder of the time. Turssi et al.'s[14] research established a correlation between the micromorphology of resin-based products maintained in distilled water and artificial saliva.

Orange juice caused minimum surface roughness on nanohybrid ormocer-based composite followed by resin-modified glass ionomer cement and nanocomposite resin compared to cola. According to Grobler et al.,[15] orange juice and cola have an equivalent amount of erosive potential. According to West et al.,[16] under both in situ and *in vitro* conditions, orange juice exhibited a higher propensity for erosive degradation than water.

In this study post immersion in cola, the surface roughness on nanohybrid ormocer-based composite was comparatively less compared with resin-modified glass ionomer cement and nanocomposite resin. With pH values of 2.74 for cola and 3.72 for orange juice, respectively, the immersion fluids utilized in this investigation are extremely acidic and may erode the restorative materials. Both of the studied materials show the largest rise in Ra values when exposed to media. The difference in Ra values of the two tested materials in this study was in accordance with the studies conducted by Han et al.,[17] El-Korashy and Mobarak,[18] Abu-Bakr et al.,[19] and Wongkhantee et al.[20]

As this study was conducted *in vitro*, it has several limitations, including the possibility that the surface roughness values were inflated due to the absence of saliva and the inability to imitate the oral environment. So, this study recommend further studies to be carried out to analyze the surface imperfections, water sorption, and dissolution of these restorative materials using temperature and pH as variables.

Conclusion

On conclusion, this investigation demonstrates that when exposed to both beverages, the erosive effect was much lesser in nanohybrid

ormocer-based composite, followed by resin-modified glass ionomer cement and nanocomposite resin.

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