Impact of acidic beverages on esthetic restorations concerning microhardness and color stability: a comparative assessment

Sneha Verma | Abhinay Agarwal | Renuka Jyothi

Abstract Recently, the focus has been placed on esthetic restorations by both clinicians and subjects. With the intake of acidic beverages popular these days, erosive wear of the esthetic restoration results in discoloration, raising a concern and affecting the cost. The objective of the current research was to assess how acidic drinks affected the microhardness and color stability of several esthetic restorative materials. 120 samples were split into three groups of 40 individuals. Each Group I had organically modified ceramics (ORMOCER), Group II had nanoceramics, and Group III had microhybrid composite restorations. The samples were made from the aluminum cylindrical mold of 5mm depth and 10mm diameter, followed by immersion in 25ml acidic beverages (Pepsi) for 10 minutes for 20 days. Microhardness was then assessed using a Vickers diamond indenter for each sample on the 10th and 20th day. At baseline, mean hardness was 58.12±1.74, 60.06±0.36, and 63.22±0.44, respectively, for ormocer, nanoceramics, and microhybrid composite. It was seen that the microhardness was higher for the microhybrid composite. However, the difference was statistically non-significant between the three groups with p=0.864. Microhardness on the 10th day was highest for the microhybrid composite, followed by nanoceramics and ormocer (p= 0.001). However, on the 20th day, the difference was statistically non-significant between the three groups. The study, considering its limitations, concludes that the finest behavior and microhardness are associated with organically modified ceramics after immersion in acidic beverages. Nanoceramics showed the second-best behavior, and microhybrid composite resins were the least among the three.

Keywords: acidic beverages, composite, microhardness, ormocers, vickers microhardness

1. Introduction

In recent times, various clinicians and subjects have considered esthetic restorative materials to restore decayed/broken teeth, both in the anterior and posterior zone. This has globally increased the demand and use of the available aesthetic restorative materials of dentistry. A newer resin composite material, nanohybrid, owing to its esthetic value, is gaining popularity as a restorative material, which is further aided by its excellent esthetics, mechanical, and physical properties (Alaaddin et al 2020). Unique combinations of nanofillers and micro fillers define nanohybrid composites. The nanofillers are very small particles with nanometer-scale dimensions, generally between 1 and 100 nanometers. These nanofillers, such as silica or zirconia nanoparticles, provide the composite material with a number of advantages. The particle size of nanohybrid composite is smaller than the micro-filled composite resins. Nanohybrid can be used for both posterior and anterior regions and has high wear strength, stain resistance, and color stability, making it a suitable esthetic restorative material (Elnoor et al 2021). Modern dentistry relies heavily on aesthetic restorations since they work to repair a patient's teeth in both their functional and beautiful states. Microhardness and color stability are two important elements that affect the long-term success and patient satisfaction of esthetic restorations. Microhardness is the material's capacity to endure dents or scratches, whereas color stability is the capacity of a substance to retain its original color over time. Achieving long-lasting and aesthetically acceptable repairs depends on understanding and maximizing these features.

Recently, to improve concentration, athletic performance, stamina, weight loss, and energy, various energy and sports drinks have been marketed on a large scale. These beverages contain sweeteners, sugar, herbal supplements, vitamins, taurine, and caffeine. However, these sports and energy drinks are marketed under different names and brands, they usually have comparable ingredients and composition with acidic pH (Sato et al 2021). Microhardness is a crucial component of aesthetic restorations because it directly affects how resistant the restoration is to wear and abrasion. Dental materials with greater microhardness values usually have better lifetime and endurance, which lowers the chance of early failure. The low pH of these acidic beverages and food materials leads to the tendency of acidic wearing seen with these materials. For
clinical success, composite restorative materials should have wear obstruction and toughness when placed in the oral environment. They are persistently or discontinuously uncovered to the compounds seen in beverages, foods, and saliva, which could lead to the leaching out of the composite resins’ fillers due to the composite resin matrix softening (Bhatia et al 2016).

The term flowable consistency describes how fluid or viscous the composite material is. The viscosity of flowable composites is lower than that of conventional composite materials, enabling them to flow more freely into cavities, conform to the tooth structure, and access hard-to-reach places. They are especially well suited for the repair of cavities with intricate anatomical structures or hard-to-reach places when using conventional composite materials because of this property. Lately, high and flowable consistency bulk-fill resin-based composite restorative materials have gained popularity owing to their simple strategy of application, which was different from the regular composite resins (Tseng et al 2021). Also, they can be embedded in a single layer of 4mm, unlike regular composite resins. Vickers microhardness is a measurement of the tiny scale hardness or resistance to the indentation of a substance. The Vickers hardness test, which includes employing a diamond indenter with a square-based pyramid form to apply a regulated force to a material’s surface, is used to ascertain it. To determine the hardness of materials, particularly dental restorative materials, the Vickers hardness test is often used in a variety of sectors, including dentistry. To incorporate further advancements in the composite resin materials, high-level composite fillers are incorporated by lesser filler components allowing more transmission of light and increasing the molecular size, which further improves the light-receptive photograph initiator system with the expanded size of the molecule (Unsal and Karaman, 2022; Veena Kumari et al 2019). The objective of the present research was to assess how acidic drinks affected the microhardness and color stability of different cosmetic repair materials.

The mechanical characteristics of various cosmetic restoration materials and found to be equivalent to those of CAD/CAM ceramic, but the impact of brushing your teeth on pressable ceramic has not been fully analyzed. Examining how simulated artificial toothbrushing affected the microhardness, color stability, and surface roughness of several ceramic materials was the goal of the present work (Mahrous et al 2023). Barve et al (2021) intended to determine the influence of popular drinks on the microhardness and color durability of microhybrid (MH) and nano filled (NF) resin composites. Due to their strength and aesthetic qualities, composite resins are among the most often used materials in dental restorative procedures. Bulk fill resins are becoming more and more common; however, since they are placed in a single 4-5 mm step, there is fear that some of their components may leak. The resins Opus Bulk Fill (OBF), Tetric N-Ceram Bulk Fill (TNC), and Filtek Bulk Fill (FBF), and are three that are used for restoration, were examined in this in vitro investigation to determine their microhardness, solubility, sorption, and color durability (Espíndola-Castro, 2020). Cangul et al (2022), two unique resources together with modeling resins. Molded in plastic, the composites were put. The surfaces of a pair of composite groupings were then treated with modeling resins. All of the groups’ microhardness and color were assessed. To conduct the statistical analysis for the present research, Kruskal Wallis and One-Way ANOVA tests were utilized.

Alshali and Alqahtani (2022) determined how various bleaching agents affect the CAD/CAM ceramics with microhardness and color, including IPS CAD (lithium disilicate), VITA ENAMIC (polymer-infiltrated ceramic), and Celtra Duo CAD. Measurements of Spectrophotometric color were used to measure Vickers microhardness made at basis and upon bleaching. Head and Neck Cancer (HNC) treatment radiotherapy (RT) is linked to the routine of tobacco and has side effects that might affect the dental cavity, including a rise in the incidence of caries. Conti et al (2022) examined how high fluoride toothpastes affected the color, microhardness, and restoring ability of irradiation teeth. Muralidasan et al (2023) compared and assessed how home bleaching affected the flexural strength and microhardness of microhybrid and nanohybrid composite resins. Utilizing a specially created silicon rubber mold, the research material was created. 40 disc-shaped specimens were produced and separated into 4 groups for microhardness testing. The purpose of this in vitro research Bharathwaj et al 2023; Azmy et al 2022) assessed the impact of five different single-serve sachet powder drinks that have recently become popular among teenagers on the coloration of Nanohybrid composite resin.

2. Materials and Methods

The current in-vitro research aimed to estimate the impact of acidic drinks on the microhardness and color stability of various materials for aesthetic restoration. The study population was comprised of samples from the Department of Prosthodontics of the Institute. The study included 120 samples which were divided into 40 samples each. Group I had organically modified ceramics (ORMOCER), Group II had nanoceramics, and Group III had microhybrid composite restorations.

The 40 samples were made from each restorative material with the help of hollow and round aluminum forms having an inner breadth of 10mm and depth of 5mm. On the inner surface of the shape, Vaseline was applied as a lubricant to allow simple sample recuperation. Polyester matrix mylar strips were used to cover the base and top surface of the restorative material. The level was maintained with a glass slide which was inflexible to attain a bubble-free and uniformly polymerized surface of the restorative material following the curing of the material. Glass slide was pressed with the pressure of the finger to remove the extra material followed by polymerization of each side for 40 seconds. The curing unit with it only employed one light polymerization mode. At a 1.5mm distance, the light was positioned opposite the exterior of the sample. Fine
polishing disks were then used to clean the surface of every sample to simulate the clinical situation. All the samples from all three groups were immersed for 10 minutes in 25ml of an acidic beverage (Pepsi) each day for 20 days.

The samples were removed from the acidic beverage and were dried with dry tissue paper, and the readings for surface hardness were recorded at the baseline. Microhardness for each sample was recorded with the Vickers diamond intender placed in the acidic beverage. A 15-second force was placed on the uncovered sample surface to record the surface hardness utilizing the conventional surface of (Wu et al 2022). Three readings were recorded consecutively at baseline, and the mean values were taken as VHN1 (Vickers hardness number). Towards the end of inundation or trial duration, on the 20th day, microhardness was recorded as the mean of three readings and recorded as VHN2 in a similar manner used at the baseline.

The collected data were statistically evaluated using one-way ANOVA (analysis of variance) and SPSS software, version 22.0, Chicago, IL, USA, for the flexure strength between the three groups, and the level of significance was kept at a p-value of <0.05.

3. Results

The present in-vitro study aimed to calculate the impact of acidic drinks on the microhardness and color stability of a variety of cosmetic restoration materials. The study included 120 samples which were divided into 40 samples each. Group I had organically modified ceramics (ORMOCER), Group II had nanoceramics, and Group III had microhybrid composite restorations. On assessing the mean surface hardness of the three study groups at baseline, before placing them in the acidic beverage, it was seen that the mean hardness was 58.12±1.74, 60.06±0.36, and 63.22±0.44 respectively, for ormocer, nanoceramics, and microhybrid composite (Figure 1). It was seen that the microhardness was higher for the microhybrid composite. However, the difference was statistically non-significant between the three groups with p=0.864, as shown in Table 1.

On assessing the microhardness at 10th days after immersion in the acidic beverage, it was seen that the microhardness was 49.82±0.81, 51.16±0.67, and 56.33±0.04 for ormocer, nanoceramics, and microhybrid composite respectively (Figure 2). The microhardness on the 10th day was highest for the microhybrid composite, followed by nanoceramics and ormocer. The variation in the three groups was significant using statistics, and the p-value was 0.001, as depicted in Table 2.

![Figure 1 Baseline microhardness of three materials for aesthetic restoration.](image)

Table 1 Microhardness of three esthetic restorative materials at baseline.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Material used</th>
<th>Mean± S. D</th>
<th>f-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ORMOCER</td>
<td>58.12±1.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Nanoceramics</td>
<td>60.06±0.36</td>
<td>26.363</td>
<td>0.864</td>
</tr>
<tr>
<td>3.</td>
<td>Microhybrid composite</td>
<td>63.22±0.44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On assessing the microhardness at 10th days after immersion in the acidic beverage, it was seen that the microhardness was 49.82±0.81, 51.16±0.67, and 56.33±0.04 for ormocer, nanoceramics, and microhybrid composite respectively (Figure 2). The microhardness on the 10th day was highest for the microhybrid composite, followed by nanoceramics and ormocer. The variation in the three groups was significant using statistics, and the p-value was 0.001, as depicted in Table 2.

Table 2 Microhardness of three esthetic restorative materials on 10th day.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Material used</th>
<th>Mean± S. D</th>
<th>f-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ORMOCER</td>
<td>49.82±0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Nanoceramics</td>
<td>51.16±0.67</td>
<td>24.724</td>
<td>0.001</td>
</tr>
<tr>
<td>3.</td>
<td>Microhybrid composite</td>
<td>56.33±0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
After 20-day immersion of the study samples in the acidic beverage, it was seen that surface microhardness with the Vickers hardness intender was higher for Microhybrid composite and was 53.16±0.21 followed by Group II (nanoceramics), where it was 50.34±0.26, and the least surface microhardness was seen for Group I, ORMOCER where microhardness was 48.12±0.44. However, as indicated in Table 3 and Figure 3, the alteration among the three research groups was statistically insignificant (p = 0.6).

On the multiple comparisons of the three groups using Turkey’s post hoc test, a statistically important difference was seen in the microhardness of Group I and Group III, Group II and Group III, and Group III and Group II with p=0.001. However, a statistically non-significant variance was seen in Group I and Group II with p= 0.07 and Group II to Group I with p=0.07, as depicted in Table 4.

### Table 3 Microhardness of three esthetic restorative materials on 20th day.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Material used</th>
<th>Mean ± S. D</th>
<th>f-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ORMOCER</td>
<td>48.12±0.44</td>
<td>26.644</td>
<td>0.06</td>
</tr>
<tr>
<td>2.</td>
<td>Nanoceramics</td>
<td>50.34±0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Microhybrid composite</td>
<td>53.16±0.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4 Comparison of mean surface hardness in different study groups.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Groups</th>
<th>Comparison</th>
<th>Mean difference</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Group I</td>
<td>Group II</td>
<td>-1.36</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group III</td>
<td>-6.53</td>
<td>0.001</td>
</tr>
<tr>
<td>2.</td>
<td>Group II</td>
<td>Group I</td>
<td>1.36</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group III</td>
<td>-5.11</td>
<td>0.001</td>
</tr>
<tr>
<td>3.</td>
<td>Group III</td>
<td>Group I</td>
<td>6.53</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group II</td>
<td>5.11</td>
<td>0.001</td>
</tr>
</tbody>
</table>
The average microhardness values for restorative materials on staining solutions are shown in Figure 4. The soldex group recorded the lowest value, and the results are contrasted with those of other materials.

![Figure 4 Average values of microhardness for restoration materials on staining solutions.](image)

4. Discussion

The present in-vitro study included 120 samples which were divided into 40 samples each. Group I had organically modified ceramics (ORMOCER), Group II had nanoceramics, and Group III had microhybrid composite restorations. On assessing the mean surface hardness of the three study groups at baseline, before placing them in the acidic beverage, it was seen that the mean hardness was 58.12±1.74, 60.06±0.36, and 63.22±0.44 respectively, for ormocer, nanoceramics, and microhybrid composite. It was seen that the microhardness was higher for the microhybrid composite. However, the difference was statistically non-significant between the three groups with p=0.864. These outcomes were in line with the previous findings of Poggio et al (2018) and Wang et al (2023), where no discernible difference was seen in the microhardness of the assessed esthetic restorative resources using the Vickers intender.

Concerning the assessment of the microhardness at 10th days after immersion in the acidic beverage, it was seen that the microhardness was 49.82±0.81, 51.16±0.67, and 56.33±0.04 for ormocer, nanoceramics, and microhybrid composite respectively. The microhardness on the 10th day was highest for the microhybrid composite, followed by nanoceramics and ormocer. The statistical difference between the three groups was substantial, and the p-value was 0.001. These results were in agreement with the studies of Hamdy et al (2023) and Abdallah et al (2021), where authors in their findings reported that pH largely affects the solubility and hardness of different esthetic restorative materials with different filler sizes.

The study results showed that after 20-day immersion of the study samples in the acidic beverage, it was seen that surface microhardness with the Vickers hardness intender was higher for Microhybrid composite and was 53.16±0.21 followed by Group II (nanoceramics), where it was 50.34±0.26, and the least surface microhardness was seen for Group I, ORMOCER where microhardness was 48.12±0.44. However, the difference between the three study groups was statistically non-significant, with p=0.6. These results can be explained by the studies by Nica et al (2022) and Wheeler et al (2019) after immersing samples in Coca-Cola for glass ionomer and compomers and other acidic agents, and no statistically significant difference was seen on microhardness of any restorative material following immersion in the acidic beverages.

For multiple comparisons of the three groups using Turkey’s post hoc test, Group I and Group III, Group II and Group III, and Group III and Group II had microhardness differences that were significantly different from each other (p=0.001). However, a statistically non-significant difference was seen in Group I and Group II with p=0.07 and Group II to Group I with p = 0.07. These outcomes were in line with the studies of Ahmed et al (2022), where similar results were reported by the authors in their respective studies.

5. Conclusions

The usage of Facebook news has been shown to have a complicated and multidimensional impact on political beliefs and engagement. While Facebook gives users a place to obtain a variety of news items and participate in political debates, its effect on people’s political opinions and actions is impacted by a number of different elements. Examining the factors that most clearly separate Facebook users from nonusers revealed some information on a potential second-level digital divide. Given that these people tend to be early adopters of new technology, it may not come as a huge surprise that Facebook users are often richer, younger, and more knowledgeable. This research has a number of shortcomings that should be noted.
First, more Facebook features could possibly contribute to the OSROR model. In future research, increased network heterogeneity, for instance, might add another variable to the first O and provide a wider variety of information and debate. Second, this study’s focus is just on Facebook use. Although it is one of the most widely used social networking sites in HK, users also communicate via WeChat and WhatsApp. Despite these drawbacks, this research adds significantly by employing the OSROR model to explain the processes behind various Facebook usages for political involvement and protest. Future studies should take into account and review the system’s key characteristics, then evaluate its benefits and consequences using algorithms instead of seeing one platform having significant influence as Facebook or similar online social connections, which might potentially influence decisions regarding utilization with generic measures.

**Ethical considerations**

Not applicable.

**Declaration of interest**

The authors declare no conflicts of interest.

**Funding**

This research did not receive any financial support.

**References**


Veena Kumari R, Pradeep PR, Aswathi S, Evaluation of surface roughness of composite resins with three different polishing systems and the erosive potential

