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Original Article

Comparison of Color Stability in SDR Flowable Material and Packable Composite Using Easy-Shade Device

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ABSTRACT

Color stability is an important consideration in the selection of composite resins for aesthetic dental restorations. In recent years, SDR flow+ has gained popularity for posterior teeth restorations, although discoloration remains a significant concern. Bulk-fill resin composites, known for their higher cure depth, have also been increasingly used. This study aimed to compare the color stability of SDR flow+ material and conventional bulk-fill composite using an easy-shade device. This randomized controlled trial involved 40 disks each prepared in 8 × 8 mm plastic molds, with the samples divided into two parts. The paired sample t-test showed a P-value < 0.05, indicating a statistically significant difference in color stability between the two materials. While SDR showed greater stability in tea, bulk-fill showed better performance in coffee. Both materials showed significant susceptibility to color changes.

Keywords: Packable composite, Color stability, SDR flow material, Randomized controlled

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Introduction

The primary objective of aesthetic dentistry is to replicate the natural structure of a tooth as accurately

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as possible in shape, color, morphology, and translucency [1]. In recent years, bulk-fill resin composites have become increasingly popular due to their enhanced depth of cure [2, 3]. The improvement is attributed to the incorporation of larger filler particles, a reduction in the amount of pigments, and modifications to the monomer systems used in these composites [4, 5]. Unlike traditional composites, bulk-fill materials could be cured and applied in thicker layers [6].

Smart dentin replacement (SDR) was the first bulk-fill material to receive widespread clinical acceptance, with lower volumetric polymerization shrinkage compared to hybrid composites [7, 8]. Additionally, the shrinkage stresses in SDR are significantly lower than those found in other bulk-fill materials [9]. Color stability, defined as the ability of a dental material to maintain its original color, is a key factor in the performance of aesthetic materials [10, 11]. The oral cavity presents a challenging environment for dental materials [12, 13], with constant exposure to microflora, saliva, and chromogenic foods and beverages, all of which can affect color stability [14, 15]. However, color stability is often overlooked in favor of other mechanical and physical properties when selecting dental materials [16].

Bulk-fill resins are specially formulated to achieve deep curing. The chemical composition of these resins can influence their properties [17]. Although bulk-fill materials are predominantly used for posterior restorations, they must retain essential aesthetic qualities. Both the longevity of composite restorations and the need for replacements can be influenced by factors such as stability of color and surface microhardness. The United States Public Health Service (USPHS) considers color match and anatomical shape, including abrasion resistance, as key indicators of the service life of resin materials and criteria for evaluating the quality of existing restorations. Extrinsic stains from sources like smoking, food, and beverages can negatively affect composite restorations in the oral environment. Thus, it is important to examine how staining processes impact bulk-fill composites. This study aims to evaluate the stability of color and surface microhardness of bulk-fill resin composite materials available in Saudi Arabia after exposure to common beverages [18].

Restorative materials such as packable and flowable composites are commonly used in dental treatments. Flowable composites contain less filler, which reduces viscosity and makes them easier to manipulate, but this can make them more prone to color changes [19]. Previous studies by Fontes *et al.* [20] and Omata *et al.* [21] have demonstrated that the pH levels and staining potential of different beverages can affect the stability of the color of packable composites. However, there is limited information available regarding the stability of color of flowable composites. The perception of color is a psychological phenomenon that can be influenced by the observer's skill and can be described in various ways. Color stability, the most important feature of aesthetic restorative materials, is affected by numerous internal and external factors, which ultimately determine the final appearance of the material [19].

Tooth discolorations can be categorized as either extrinsic or intrinsic based on the stain location. This study focuses on extrinsic discoloration, which is caused by the accumulation of chromogenic substances on the the surface of tooth or within the pellicle layer. The causes of these stains vary depending on an individual's diet, oral hygiene, habits, and lifestyle choices [22]. Composite resin discoloration can occur through three mechanisms: (I) extrinsic discoloration resulting from biofilm buildup on the surface of the restoration; (II) surface or subsurface changes where dye agents lightly penetrate the outer layer of the composite resin; and (III) intrinsic discoloration caused by physicochemical reactions occurring within the composite material itself [23].

The matrix composition and the characteristics of inorganic fillers play a significant role in determining the surface smoothness and staining potential of composite resin restorations. Hydrophilic matrices tend to absorb more water, leading to higher susceptibility to staining and dye penetration compared to hydrophobic matrices. Similarly, the type and size of fillers, such as glass and pyrogenic silica, are closely linked to the material's staining behavior [24]. Among the many factors that can impact dental aesthetics, beverages such as tea and coffee, which are consumed worldwide, are notorious for their chromogenic properties. The tannins found in these drinks can cause varying degrees of brown discoloration on teeth [25]. A study by Ertaş et al. explored the staining effects of various drinks on composite resins and mentioned that coffee caused more discoloration than tea, a result consistent with our research [26].

Color stability has become one of the key considerations when picking composite resin materials for aesthetic restorations. It is an important factor included in usually used clinical assessment tools for evaluating the success or failure of composite restorations [27]. In recent years, SDR flow+ has gained popularity as a restorative material for posterior teeth, although discoloration remains a notable

concern. Given the critical nature of the stability of color and the widespread use of SDR flow+ in both anterior and posterior restorations, the objective of this study is to compare the extent of change of color in SDR flow+ material with that of traditional bulk-fill composites.

Study aim

This study aims to compare the stability of color of SDR flow+ material and conventional bulk-fill composite using an easy-shade device.

Hypotheses

There is no significant difference in color stability between SDR® flow+ Bulk Fill Flowable and 3M™ Filtek™ Z250 Universal Restorative, Syringe A2.

Materials and Methods

Study Design

This research was conducted as an in vitro randomized controlled trial designed to evaluate the color stability of two different bulk-fill composite materials.

Sample Size

A total of 40 disks were used, with 20 disks from each of the two materials—SDR® flow+ Bulk Fill Flowable and 3M™ Filtek™ Z250 Universal bulk-fill composite restoration. These disks were created using 8x8 mm plastic molds and were split into two distinct groups. To calculate the required sample size, G Power software (version 3.0.10) was utilized, with parameters set for a type I error rate of 5%, power at 80%, and an effect size of 0.8. The analysis suggested a sample size of 10 disks per group.

Study Reliability

Reliability within the study was ensured by maintaining consistency across all samples. All disks were made with identical dimensions, and the restorations were applied by a single operator. Additionally, all color measurements were recorded using a single device, the Easy Shade, ensuring uniformity throughout the study.

Inclusion Criteria

The study included only intact and sound composite disks that adhered to the required dimensions, ensuring consistency in the sample set.

Exclusion Criteria

Any disks that showed defects or failed to meet the dimensional requirements were excluded from the study to maintain the integrity of the experiment.

Experimental Procedure

Each disk was labeled from 1 to 20 for identification within their respective groups, and all disks were put on A4 sheets for organization. In each group, 10 disks were immersed in Black Tea, and the other 10 disks in Instant American Coffee to assess the impact of these beverages on color stability. The SDR® flow+ Bulk Fill Flowable material was used in the Universal shade, while the 3M™ Filtek™ Z250 Universal material used an A2 shade.

The color of all the composite restorations was evaluated using an Easy Shade device, and the results were systematically recorded in pre-prepared tables. Following this, the disks were put in sterilized water at room temperature inside an incubator for 24 hours, allowing them to be fully set. Once the setting was completed, the disks were separated into two distinct subgroups within each material group. Ten disks from each group were immersed in black coffee (Hintz Instant Café), and another ten in tea (Alrabea Black Tea). The immersion period for both beverages lasted 24 hours.

After the immersion period, the color changes of the disks were assessed using the VITA Easyshade® V device. The gathered data were analyzed statistically using SPSS software (version 22.0, Chicago, IL). A paired sample t-test was performed to compare the pre- and post-experiment values. It should be noted that no blinding procedure was applied in this study.

Results and Discussion

Figure 1 illustrates the variations in shade observed in SDR disks after immersion in tea and coffee. The results indicate that coffee led to a greater degree of color change in the SDR specimens compared to those soaked in tea.

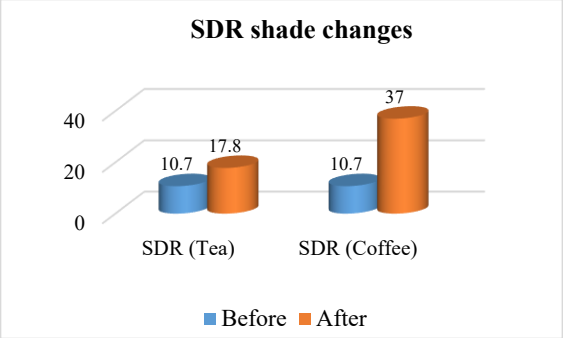

Figure 1. Comparison of shade change for SDR in tea and coffee

Figure 2 displays the color changes in bulk-filled composite disks after being immersed in tea and coffee.

The data reveal that tea caused a more significant color change in the bulk-filled specimens than coffee did.

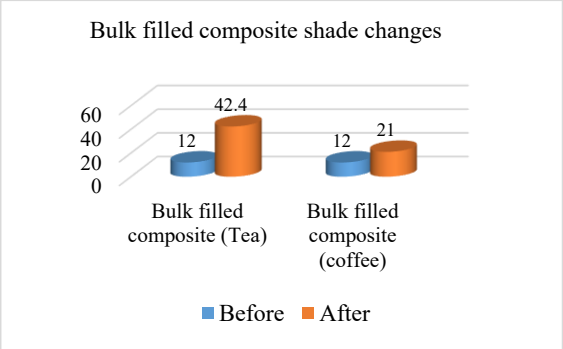

Figure 2. Comparison of shade change for bulk-filled composite in tea and coffee

Table 1. Paired t-test findings

SDR (mean)		P-value	Bulk filled composite (mean)		P-value
Tea (before): 10.7	Tea (after): 17.8	0.000	Tea (before): 12	Tea (after): 42.4	0.003
Coffee (before): 10.7	Coffee (after): 37	0.001	Coffee (before): 12	Coffee (after): 21	0.000

Table 1 presents the comparison of both materials after immersion in tea and coffee, along with their corresponding p-values, calculated using paired t-tests in SPSS version 22. The results demonstrate that the shades of both materials exhibited a statistically significant change, as all comparisons yielded P-values < 0.05.

Table 2. Comparison between two materials' color change when immersed in tea and coffee

Mediums	Tea (after being immersed)	Coffee (after being immersed)
Mean values	SDR: 17.8 Bulk fill: 42.4	SDR: 37 Bulk fill: 21
P-value	0.010	0.018

Table 2 compares the color changes of the two materials when immersed in tea and coffee. The paired sample t-test reveals a p-value less than 0.05, indicating a statistically significant difference in color stability between the two materials. Notably, SDR exhibited greater color stability in tea, while bulk fill showed more stability in coffee.

Our findings indicate that exposure to tea or coffee caused a statistically significant change in the shade of the materials. Specifically, coffee (P-value = 0.001) led to the most substantial color change in SDR, while tea (P-value = 0.003) produced a greater shade shift in the bulk-fill composite. These results align with those reported by Zajkani *et al*. [28], who also observed significant color alterations in specimens submerged in coffee and tea. According to a study by Bahbishi *et al.* [29], Bulk-Fill composite resins displayed less sensitivity to staining from berry juice, tea, and coffee when compared to traditional composites. However, there were no major differences in color changes among the bulk-fill composites themselves.

Bulk-fill composites generally exhibited lower microhardness values when immersed in various solutions [29]. Additionally, Paolone *et al.* [30] found that bulk-fill materials displayed inconsistent color stability, a factor likely influenced by the diversity of materials and staining methods used across studies. Similar to our observations, Arruda *et al*. [31] reported that all resins tested were susceptible to extrinsic staining from coffee, with Filtek Bulk Fill showing the least shade alteration.

When used to restore proximal cavities with vestibular inclusion, bulk-fill resins' color changes can lead to noticeable aesthetic issues, in addition to raising concerns regarding the degree of polymerization. While the bulk-fill technique offers a significant advancement in posterior restorations due to its ease and speed of insertion, as a relatively new material, it lacks sufficient long-term clinical data to confirm its performance across various clinical conditions [16].

A study by Shamszadeh *et al.* [32] revealed that bulk-fill composite resin demonstrated a higher susceptibility to color change after immersion in coffee. The research highlighted that as the specimen thickness increased, so did the degree of color shift. Thicker samples were found to be more prone to discoloration, likely due to the shallower curing depth of the bulk-fill materials when applied. These findings align with the results we anticipated in our study.

Erdemir *et al.* [33] found that bulk-fill composites exhibited varying degrees of resistance to staining from liquids. The extent of discoloration was influenced by factors such as the type of pigment present in the staining solutions, the duration of exposure, and the composition of the resin composite. Future research should examine how the new monomers used in bulk-fill composites interact with colorants and assess their long-term color stability following extended exposure.

Alandia-Roman *et al.* [34] investigated 19 different bulk-fill composites and a variety of artificial staining liquids, including coffee, tea, red wine, and coke. Their results showed that the color change in bulk-fill materials was more pronounced compared to traditional resin-based composites.

SDR, a relatively new restorative material, is claimed to have a lower viscosity and reduced polymerization shrinkage due to the presence of unique monomers. However, when compared to traditional resin-based composites like Clearfil AP-X, flowable composites such as Clearfil Majesty Flow exhibit lower viscosity but greater shrinkage (manufacturer's unpublished data) [30].

The results from our study demonstrated significant differences in the color changes of the tested composite resins (P-value = 0.0001). Among the bulk-fill materials, Aura and Opus showed the largest color changes.

Ardu *et al.* [18] reported that the mean E00 values varied significantly, ranging from 0.5 for Saremco Microhybrid in saliva to 51.1 for Filtek Supreme in red wine, with the study conducted against a white background [18]. After being exposed to staining solutions for four weeks, all the materials exhibited noticeable color changes. Additionally, significant differences were found between the composite resins tested and the staining treatments applied. A lower filler content (37–53%) in flowable composites leads to reduced viscosity, which has been a point of interest in various studies. For instance, Yu and Lee [35] compared the optical properties of a packable composite to a flowable composite produced by the same manufacturer and found marked differences in color, translucency, and fluorescence between the two types of composites.

Dos Santos *et al.* [36] suggested that a higher proportion of resin matrix and reduced filler content in flowable composites might result in a greater ability to retain various colors from intra-oral fluids. Flowable composites are a more recent addition to the conventional composite family, and due to their novelty, their properties are still not as well understood, which is why Afzali *et al.* [37] chose to study them. Their research showed that an acidic salivary pH of 6.5 can lead to significant color changes in the material. A low pH might damage the surface integrity of the material and weaken its matrix, which in turn facilitates the absorption of food dyes and causes discoloration. The susceptibility to staining in restorative materials is often linked to the type of filler and the resin matrix composition. Afzali *et al.* [37] used the CIE Lab system to evaluate color differences in their study, as it is highly sensitive and reproducible, making it ideal for detecting even subtle color variations.

Conclusion

In summary, the color stability of SDR and bulk fill composites varies depending on the immersion medium, with SDR showing greater stability when exposed to tea and bulk fill performing better in coffee. However, both materials are prone to significant shade alterations when subjected to these liquids. Based on these results, both SDR and bulk-fill composites can be considered suitable options for aesthetic restorations, without a need for preferential judgment between the two.

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