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Dental Resin-Based Composites with Nanoparticle-Modified Color Stability

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Abstract

To examine how the colour stability of various nanoparticle-modified resin-based composite (RBC) materials is affected by beverages (coffee, tea, Cola-Cola and mineral water). The 70 beverage specimens were made from RBCs that had been light-cured and divided into four groups based on NPs: one unaltered control (N0); and three ZrO_2 (Zr), TiO_2 (Ti) and SiO_2 (Si) experimental groups. NP concentrations were used to further divide each experimental group into two subgroups: 3 and 7 weight percents. Before and after six months of immersion, the colour change (E) was measured with a spectrophotometer. One-way ANOVA, Bonferroni's post-hoc test and E value conversion to National Bureau of Standards (NBS) units were used to compare and analyse the data. After being immersed in the beverages, the light-cured RBCs that had been modified with ZrO_2, TiO_2 and SiO_2 had smaller colour changes than the unmodified group.

Keywords: Nanoparticle • Reinforcement • Translucent metal • Matrix monomers

Introduction

The lowest E was seen in the Zr groups, followed by the Ti and Si groups; The mean E was lower at a concentration of 3% than it was at a concentration of 7%. NBS results showed that coffee, tea and Coca-Cola caused significant colour changes that were unacceptable (NBS units greater than 3), while water caused only slight colour changes (NBS less than 1). The color stability of RBCs may be enhanced by modifying them with 3% TiO_2 and ZrO_2 at both concentrations. In light of NBS results, RBCs drenched in mineral water and Coca-Cola showed clinically satisfactory variety changes, while those submerged in espresso and tea were clinically unsatisfactory.

Literature Review

For the most part, resin-based composites (RBCs) have been one of the most popular options for restoring anterior and posterior teeth due to their attractive appearance, high success rate and high patient acceptance. However, the primary drawbacks of dental restorations include a lack of mechanical properties, polymerization shrinkage, plaque accumulation and stainability. The staining vulnerability of supportive materials is affected by a few variables. In the matrix of filling materials, oxidation or hydrolysis can cause intrinsic resin matrix degradation. In addition, the discoloration effect is significantly influenced by filler size, distribution and structural properties of resin matrix monomers. It was discovered that the incorporation of inorganic nanoparticles (NPs) reduced the resin matrix's hygroscopic absorption of water, resulting in less discoloration. However, due to the absorption of food and beverage staining products, extrinsic discoloration may also occur [1].

Numerous previous studies have demonstrated that different beverages may stain in varying degrees when light-cured composite restorative material is soaked in them. The concentration of staining agents, the duration of exposure and their composition and properties are the primary contributors to this variation. The incorporation of nano fillers, which enhance the mechanical, physical and optical properties of composite filling, was one of several innovations made to enhance its properties. When they are incorporated into dental restorations, the use of NPs can provide numerous benefits; when compared to bulk-size particles, they offer a unique characterization because of their larger specific surface area. NPs, on the other hand, tend to clump together, which could hinder the chemical interaction between these particles and the organic matrix. A silane-coupling agent was used to treat the inorganic filler to get around this problem. This made the bond strength between the NPs and the resin matrix stronger and made the properties of the nano composite better [2].

Zirconium dioxide (ZrO_2), titanium dioxide (TiO_2) and silicon dioxide (SiO_2) were among the NPs that the researchers used to improve the properties of dental biomaterials thanks to this improvement. Due to its superior properties—such as resistance to corrosion, high micro hardness, adequate antimicrobial properties and low cost TiO_2 is preferred in the dental industry. Additionally, the nano composite's mechanical, physical and optical properties can be enhanced by including TiO_2 in polymeric materials. ZrO_2 is a white translucent metal oxide that has broad application in dentistry because of its biocompatibility, extraordinary strength, high wear opposition and stylish worthiness; it has been utilized for the reinforcement of acrylic resin denture base materials and RBCs in numerous previous studies. In a similar vein, the nano composites incorporating SiO_2 that were tested demonstrated sufficient abrasion resistance and thermal stability. The acrylic resin denture base's wear resistance was increased when SiO_2 nanoparticles were added; additionally, after immersion in various beverage solutions, it demonstrated improved colour stability [3].

Discussion

The success of dental fillings and patient acceptance are greatly influenced by a material's colour stability. NPs consolidating helpful materials introduced superior optical properties when tried in past examinations. The findings demonstrated improved colour appearance and increased light transmittance due to the fact that the NP dimension is less than the wavelength of visible light. When testing dental materials, colour measurement devices have been extensively utilized to accurately assess their colour changes. A spectrophotometer is regarded as an efficient and adaptable instrument for measurement. In most of the cases that were tested, it was found to have higher objective matches and an accuracy that was 33% higher than that of

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human eye observation. A three-layered variety space-based framework was created by the Worldwide Commission on Light (Commission Internationale de l'Eclairage; CIE) was published in 1976 and it has three axes. The lightness is represented by the grayscale L axis, the red-green coordinates by the axis and the blue-yellow coordinates by the b axis. Colour changes (E) are typically calculated by adjusting the CIE system's colour parameters, as this scale encompasses all colours that are visible to the human eye [4-6].

Conclusion

The colour stability of standard dental restorations when immersed in various solutions has been the subject of several studies; however, little is known about how this immersion affects the colour stability of nanoparticle-modified dental restorations. So, the goal of this study was to see how well light-cured composite fillings reinforced with two concentrations of NPs (ZrO_2, TiO_2 and SiO_2) held up to colour after being soaked in four different solutions (coffee, tea, mineral water and Coca-Cola). The null hypothesis stated that incorporation of NP (ZrO_2, TiO_2, or SiO_2) into RBCs at two concentrations (3% and 7% weight percent) would not significantly affect colour stability.

Acknowledgement

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Conflict of Interest

None.

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