Review Article

Factors that Influence the Color Stability of Composite Restorations

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Abstract

The aim of this study is to understand the factors that influence the color stability of composite restorations. we live in a world of esthetic dentistry where esthetic tooth-colored restorations are the trend today. Composite restoration which satisfies this need of esthetic tooth-colored restorations has evolved tremendously. Although the material holds good promise in the field of esthetic dentistry, it also possesses certain disadvantages such as discoloration in the long run. This article reviews the various factors that affect the color stability of composite restorations. since patients seek better esthetic restorations, the proper color matching is important not only in the first period of service but also over a long period. Thus, awareness of the various factors that influence the color stability of composite restorations is beneficial.

Keywords: *Color stability, composite, restorations*

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Introduction

Composite restorations are widely used as an esthetic restorative material in anterior and posterior teeth. Composite resin should retain the color and polish over a long period to serve as a long-term esthetic restorative material. Discoloration of these composite restorations may occur due to various factors, intrinsic, or extrinsic. Although the quality of composite resin restorations has improved with the advent of new technology in material science in recent years, discoloration of the composite resin materials remains to be the major long-term clinical problem.

Color stability is the ability of any dental material to be able to retain its original color. The oral cavity has a dynamic environment. With the continuous presence of microflora, saliva, and frequent intake of colored food (chromatogens), the color stability of an esthetic material may become compromised. However, the property of color stability of esthetic dental materials is often ignored over other physical and mechanical properties while making a choice. Further, the wide array of materials available at the disposal of the clinician compounds the challenge of making a wise choice. This review gives us detailed information on the various factors that influence the color stability of composite restorations.

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Factors Affecting Color Stability of Composite Restorations

Different factors can be responsible for affecting the color stability in composite restorations.

The color stability of a resin composite is related to the resin matrix, dimensions of filler particles, depth of polymerization, and coloring agents.[1-3]

Discoloration of tooth-colored, resin-based materials may be caused by intrinsic or extrinsic factors. Intrinsic factors involve physicochemical discoloration reactions in the composite matrix, in surface and deeper layers of the material, triggered by ultraviolet (UV) irradiation, thermal energy, or humidity. Chemical discoloration has been attributed to change or oxidation in the amine accelerator, oxidation in the structure of the polymer matrix, and oxidation of the unreacted pendant methacrylate groups.

Extrinsic factors happen due to accumulation of plaque and stains, intensity and duration of polymerization, exposure to environmental factors, including ambient and UV irradiation, heat, water, and food colorants.[4] Moreover, one or more of these factors

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may be responsible for visibly detectable or esthetically unacceptable color changes of dental materials.[5]

Intrinsic Factors: Composition of Composite Resins

Matrix

Studies have shown that resin materials using urethane dimethacrylate showed more color stability than resin materials using dimethacrylate as matrix. The urethane dimethacrylate matrix results in lower viscosity and lower water sorption.[6] It has been found that composite-based resins can absorb water at a higher rate because of high diffusion coefficient in comparison to methyl methacrylate-based resins and thus stain more.[7] The bis-acryl resins showed lesser color stability as compared to the polymethyl methacrylate (PMMA) since bis-acryl polymers are more polar than PMMA polymers and therefore have a greater affinity toward water and other polar liquids.[2]

Fillers

Ormocer with its rigid organic matrix containing three-dimensionally linked inorganic–organic copolymers (ormocers) and additive aliphatic and aromatic dimethacrylates have high wear resistance as compared to microfilled or microhybrid composite and can resist discoloration. Excessive water sorption may decrease the life of a resin composite by expanding and plasticizing the resin component, hydrolyzing the silane, and causing microcrack formation. As a result, the micro cracks or interfacial gaps at the interface between the filler and matrix allow stain penetration and discoloration.[6] It has been shown that hydrophilic materials have a higher degree of water sorption and relatively higher discoloration value with staining solutions than hydrophobic materials.[6]

Photoinitiators

It is known that the efficiency of polymerization may influence discoloration since the higher degree of conversion, the smaller the amount of residual monomers available to form colored degraded products.[8] Observing light sources as an isolated factor, it was noted that this might cause color alteration to the studied composite resin. Studies show that the light-emitting diode (LED) unit showed the lowest color alteration when compared to quartz-tungsten-halogen (QTH) units and Jet Lite.[9] It is believed that the advantage of LED over conventional halogen lamp was because we used a high-power density LED unit (790 mW/cm^2), which according to Bala *et al*. promotes a higher degree of monomer conversion and hence better results.[10] As Jet Lite is a high-power halogen light device (greater power than Ultralume 5 and XL 3000), during the accelerated curing, it can promote the formation of polymer chains with lower molecular weight and residual monomers and consequently, partial polymerization of the material, with part of the photoinitiator remaining idle.[9] However, there was no significant difference between light sources on promoting changes of color stability of the composite resin.[9]

Extrinsic Factors

Type of food colorant

Various types of colorants (food and other coloring agents) that have a potential to cause color changes of dental materials such as tea and coffee (with or without sugar and milk), beverages, grape juice, wine, cherry juice, soya sauce, nicotine, and disinfecting agents used in mouth rinses have been studied over the years.[6,11,12]

Chlorhexidine is widely used as a broad-spectrum topical antibacterial agent to control oral diseases. It is known to cause discoloration of the oral tissues and the restorations, especially in combination with dietary factors. It has been proposed that dietary factors containing tannin have a high chromatogenic potential particularly when used with chlorhexidine. Denatured proteins and iron from the diet contains thiol groups that provide sulfur and eventually forms iron sulfide which is responsible for the stain.[7]

Consumption of certain beverages such as coffee and tea may affect the esthetic and physical properties of composite resins, thereby undermining the quality of the restoration. The consumption of aerated drinks is high in young adults and children. These aerated drinks being acidic may be detrimental to the properties of restorative resins. The effect of beverages on the properties of composite resins may also be directly related to the amount and frequency of its intake.[13,14]

It has been shown that low pH media such as cola (pH 2.7) affect the surface integrity of materials include resins by softening of matrix and causing a loss of structural ions such as calcium, aluminum, and silicone from the glass phase.[3] Previous studies have shown that the addition of sugar and milk powder in tea and coffee results in an increased color change, the differences that were found to be significant.[14] Coffee has been found to be a stronger chromatogen than tea or cola.[15,16]

Surface finish

Rough surfaces of restorative materials tend to accumulate more plaque and absorb more water and food colorants. Smoothly finished restorations on the other hand show better color stability. Surface roughness of resins is due to irregularly arranged inorganic filler particles and

hence get easily stained by mechanical adsorption.[6] It has been proposed that the light-polymerized provisional restorative materials have higher roughness because of larger filler particles and pits resulting in more colorant particle deposition.[15] Heat-cured materials show fewer voids than the light-cured materials, heat-cured materials have higher polymerization rates and thus are found to be more color stable.[17]

Effect of bleaching on composite restorations

The effect of staining solutions on color change of composite resins is material dependent and has been primarily attributed to basic composite formulation, type of filler particles and particle size.[18,19] The results of previous studies indicate that the color change induced by the bleaching agent might be dependent on the monomer structure and volume of the resin matrix as well as the filler systems of composite materials.[20]

Conclusion

Color stability is the ability of materials to retain their original color. Daily intake of food with staining ability such as tea, coffee, and cola can compromise esthetics of restorative materials. Understanding the property of color stability and the comparative analysis of various restorative materials will help a clinician to choose the materials as per the diet habits of the patients and ensure predictability of success. It will also enable the clinician to educate and counsel the patient about the effects of specific chromatogenic ingredients in the diet such as tea, coffee, and wine on the color stability of the restorative material used.

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Conflicts of interest

There are no conflicts of interest.

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