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Effect of swimming pool water on staining susceptibility of various restorative materials

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Abstract
The swimming community pays close attention to pH and chlorine levels because these factors dictate whether pool water is safe, pleasant, and enjoyable for swimmers or irritant and has adverse impacts on the person. Exposure to swimming pool water can lead to significant staining of composite resins and glass ionomers, particularly when the water contains high levels of copper salts. The staining can be more pronounced in outdoor pools, where the water is exposed to sunlight, which can further contribute to the degradation of the restorative materials and also after drinking Nescafe and red tea.

Keywords: Swimming pool water, staining, restorative materials

Introduction
Traditional and optimum dental restoration placement is the treatment of choice for the most frequent kind of dental disease, which is chronic and affects the mouth cavity [1]. One of the most common reasons to change a composite resin restoration is because the color does not match properly over time. This is why long-term color stability is an important quality of aesthetic restorative materials [2].
Aesthetic restorations rely on two factors: the material's color permanence and the accuracy of the color match. The restorative material might get stained and discolored after being exposed to the oral environment for an extended period of time, which is a big drawback. Composite resin materials can become discolored for both internal and external reasons [2].
One definition of intrinsic discoloration is discoloration that exists inside the composite material itself. Extrinsic discoloration occurs when a staining substance is either deeply or superficially absorbed after being exposed to it for an extended period of time [3].
Adsorption or absorption of the colorants from external sources is what causes the discoloration of restorative materials on the outside. Some substances, such as chlorohexidine, coffee, tea, and sports drinks, have been found to discolor composite resin restorations [4].

Restorative materials
There are now four main materials utilized for direct cosmetic restorations: composites made of resin and polyacid, glass ionomers and giomers that have been treated with resin [5].
Since their inception in 1970, resin composites have been incredibly popular due to their exceptional aesthetic qualities. However, they become discolored after being exposed to the oral environment for an extended period of time, unlike ceramics. To address this, nanocomposites were introduced as a result of a steady and relatively fast turnover in resin composites aimed at improving their optical, physical, and mechanical properties [6].
The use of nanofill technology has enhanced the qualities of composite, making it comparable to ceramics in terms of shade selection and color stability. As a result, nanofilled composite has been suggested as a good choice for both anterior and posterior restorations. For the Nanocomposite, the primary goal was to merge the hybrid composites' great strength with the micro-fills' outstanding beauty [7]. Nanotechnology was identified as an appropriate technical approach, further developed and adapted to the requirements of a dental filling material.

In an iterative process it was continuously checked against customer needs through all the phases until the final product, Nevertheless, the color characteristics and long-term clinical efficacy have not been determined [7].

About 1972, glassionomer cements (GICs) were introduced as a direct restorative material with two distinct benefits: they adhere to both enamel and dentine and release fluoride. The problem was that they couldn't keep their colors stable enough [8].

As a result, resin-modified glass ionomers, compomers, and polyacid modified resin composites were created to address the drawbacks of traditional glass-ionomers while simultaneously improving their aesthetic qualities [8].

Swimming pools

Chlorine gas or sodium hypochlorite are typical disinfectants used in pool water. The most common way to make pool water safe to swim in and oxidize is to use chlorine. The fact that chlorine can disinfect the water from harmful microbes including bacteria, viruses, and algae as well as oxidize organic waste and swimmer excrement is one of its main benefits. This removes a lot of the organic contaminants that swimmers bring to the pool and stops the spread of illness [9].

Pools are kept clean and safe for swimmers by acting on foreign substances in the water with chlorine. Algae and bacteria flourish in water with insufficient chlorine, leading to water sickness, murky water, and inadequate sanitation. A pH range of 7.2 to 7.8 was suggested as the optimal range [10].

Just as in our kettles, scale forms when the pH of pool water is high due to the combination of calcium and carbonates. The waterline is the most common area to observe this calcification in action, as it collects dirt and dust and gradually turns black over time. The once-sparkly pool water begins to get dark and hazy. When used as a pool filter, calcium carbonate has a knack for plating out on sand and turning it into cement. Because of this, the sand filter can no longer effectively remove debris from the pool. Moreover, the chlorine's ability to react with invader particles is diminished [10].

Effect of Swimming pools on restorative materials

In 2005, Yap *et al*. found that the strength of various composite materials, including nanofill (Filtek Supreme [FS], 3M-ESPE), ormocer (Admira [AM], Voco), Minifill (Z250 [ZT], 3M-ESPE), compomer (F2000 [FT], 3M-ESPE), and a very viscous glass ionomer cement (Ketac Molar Quick [KM], 3M-ESPE), was affected by the pH of dietary solvents. Their research showed that dietary solvents had no discernible effect on the strength of any of the materials tested, with the exception of AM [11].

The level of surface color staining of six tooth-colored restorative materials was measured by Bagheri *et al*. (2005) after immersion in food-simulating solutions of varying pH values. The materials included a light-cured microfilled RBC (Durafil, Kulzer), a light-cured microglass RBC (Charisma, Kulzer), a polyacid-modified RBC (F2000, 3M/ESPE), a conventional GIC (Fuji IX, GC), and two resin-modified GICs (Fuji II LC, GC; Photac Fil, 3M/ESPE). They discovered that there was no discernible change in color when using distilled water. The surface, material, and stain all interacted strongly with one another [12].

After storing them in artificial saliva (pH 6.8) or subjecting them to a pH-cycling process (demineralizing solution (pH 4.5) for 7.5 hours and remineralizing solution (pH 7.0) for 16 hours), Imparato *et al*. (2007) assessed the color stability of three kinds of fluoride-releasing restorative esthetic materials: a resin-modified glass ionomer cement, a polyacid-modified resin composite, and a conventional glass ionomer cement. Comparing conventional glass ionomer cement to resin-modified and polyacid-modified variants, the former demonstrated superior color stability [13].

It is inevitable that restorations in swimmers' mouths will be exposed to chlorine. To test how well certain esthetic restorative materials hold up in pool water, researchers immersed them in various drinks that swimmers often drink. It was found that these drinks have a strong tendency to discolor tooth-colored restorations [14].

The staining solution's impact on the color change of direct restoratives submerged in pool water varied with the substance. Filtek Z-250 showed the least amount of color change among all the investigated materials, while all of them showed a notable change in DE following immersion in various staining solutions. It may take more than six months of immersion for the pool water to have a noticeable impact on the restoration materials [15].

Hence, additional research is required to assess how various aesthetic restorations fare while submerged in pool water for extended periods of time in terms of color stability. Materials had a determining role in how the staining solution affected the color shift of the aesthetic restorative materials immersed in pool water. Among the pool water-immersed restoration materials that were examined, Nescafe and red tea caused the most discoloration, followed by green tea [15].

The surface microhardness and surface roughness of four "compomers" modified with poly-acid composite resins were measured after one year of wet storage in water and different solutions. The results showed that all experimental samples' Vickers hardness decreased significantly after the first month of wet storage, but surface roughness was unaffected by wet storage for the majority of the modified resins [16].

In their study, Nicholson *et al*. evaluated the effects of a glass-ionomer and a composite resin to those of three polyacid-modified composite resins (compomers) exposed to water and different acidic storage solutions for up to six months. When it came to storing glass-ionomer cement and its constituents, citric acid proved to be the most aggressive option [17].

At pH 1.2, all of the studied materials (enamel, composite Z100, standard glass ionomer cement Fuji IX, and resin-modified glass ionomer cement Fuji II LC) showed greater wear rates compared to less acidic pH levels (3.3 and 7.0), according to Shabanian and Richards, 2002 [18].

The duration of exposure to the PH challenge was crucial. Results from a pH-cycling model using eliminating solution for six hours and fake saliva for 18 hours showed that resin-based restoratives' surface properties were much greater than those of distilled deionized water and artificial saliva, according to Turssi *et al*. 2002 [19].

Demineralization was noted in all specimens and materials after undergoing a pH-cycling model of immersion in a demineralizing solution of pH 4.3 for 6 hours and an immersion remineralizing solution of pH 7.0 for 18 hours. This allowed for a degree of mineral and structural loss, particularly at the cementum/dentin margins, according to Seixas *et al*. 2004 [20].

Since the composite material was not as affected by acids of low pH as the compomer and giomer materials, Mohamed-Tahir *et al*. (2005) concluded that the effects of pH on the microhardness of resin-based restoratives were material dependent [21].

Additionally, Peris *et al*., in press, discovered that pH-challenge can negatively impact the color aesthetic properties of resin-based tested materials. This could be because of variations in the materials used, different pH values of the solutions compared to distilled water, or different durations of exposure to pH variation, with one month or three months being the most appropriate [22].

Conflict of Interest
Not available

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