ORIGINAL ARTICLE

Effect of Charcoal Toothpastes on the Color Stability of Nano-Filled Composites

Prathiksha Shetty*, Pavitra Sampath B, Prabhu Varsha, Karkala Venkappa Kishan, Soumya T E, Naik Navnith Shiva

Department of Conservative Dentistry and Endodontics, Srinivas Institute of Dental Sciences, Mukka Mangalore, Karnataka, India

*Corresponding author:

Prathiksha Shetty, Post Graduate Student, Department of Conservative Dentistry and Endodontics, Srinivas Institute of Dental Sciences, Mukka Mangalore, Karnataka, India. Email: prathiksha197@gmail.com

Abstract

Objectives: This study aimed to ascertain the impact of charcoal toothpastes on the colour stability of resin composites loaded with nanoparticles.

Methods: Thiry disc-shaped specimens were made utilizing a mould of 8 mm diameter and 2 mm thickness. Fifteen samples each were made for both bulk-fill (Tetric-N-Ceram) as well as nano-filled composite resins (Z250, Filtek Z250 XT), all in A3 shade. Then, three sets of ten discs each were created from the samples and were exposed to brushing with three toothpastes-Healthvit activated charcoal, Colgate total charcoal deep clean, Colgate total (control). A reflectance spectrophotometer was utilized for assessing colour stability. The data were statistically analysed using the Shapiro Wilks test, ANOVA and paired t-test.

Results: Among the toothpastes, Colgate total charcoal deep clean showed greater colour shift in the groups, whereas Healthvit activated charcoal toothpaste showed the least colour change.

Conclusion: The resilience of resin composites' colour was affected by the dentifrice utilised. Tetric N Ceram demonstrated decreased colour stability, both before and after exposure to dentifrices. In comparison to Healthvit activated charcoal toothpaste, Colgate charcoal toothpaste exhibited lowest colour retention capacity.

Keywords: Nano-filled composite, Reflectance spectrophotometer, Colour stability, Charcoal toothpaste

Introduction

An attractive smile is one of the fundamental components of an individual's face that can determine his or her social and psychological well-being and drives the patient to seek dental treatment.[1] People desire white, healthy teeth that reflect their ideal smile; thus, having an excellent-looking smile is highly sought-after.[2] Glass ionomer cement, composite resins, ceramics, zirconia and other attractive materials are currently available in the market to satisfy these needs.

For direct restorations, however, composite resins are the preferred material due to their unique composition, strong compressive strength, good adhesive bonding to the tooth and outstanding initial aesthetics.[3]

The environment in the mouth, notably salivary buffering function, food and drink exposure and some outside variables such as brushing, all have an impact on the colour stability. These conditions can cause staining or discolouration, resulting in the deterioration of the restoration.[4]

To address these issues, improved composites have been developed. Nanocomposites are one such material. The dispersion phase of the nanocomposites consists of milled glass fiber and unique nanoparticles ranging in size from 40 to 50 nm, which are responsible for the enhanced mechanical properties compared to hybrid composites.[5]

In recent times, dentifrices with activated charcoal have become extremely popular. Activated charcoal possesses a large surface area (>1000 m^2/g) and high porosity, which enables it to actively absorb and remove stains, preventing tooth discoloration.[6]

Daily use of a toothbrush can alter a resin composite's surface roughness and smoothness. This is because the abrasives in the dentifrice may roughen the surface of the resin composite, compromising the restoration's aesthetics. Additionally, bristles of the toothbrush have

the potential to damage the tooth surface as well as the composite restoration. Furthermore, charcoal particles could build up in dark crevices and cracks of the gingival sulcus, causing surface or marginal restorative defects. All of the issues mentioned above may negatively impact the aesthetics of tooth-coloured restorations.[7]

According to the null theory of inquiry, the use of charcoal toothpaste has no effect on the colour stability of nano-filled composite materials.

Materials and Methods

Multiple composite resins in A3 shade, including bulk-fill (Tetric-N-Ceram) and Z250 (Filtek Z250 XT) were selected. The details of the composite resins utilized in the study are mentioned in Table 1. The three dentifrices selected were Colgate total, Healthvit charcoal, and Colgate charcoal deep clean (Table 2).

Table 1: Composite resins used in the study

Composition of Composite Resin						
Resin composite	Type	Shade	Monomer	Filler type	Filler volume (%)	Filler Weight (%)
Filtek Z250 XT	Nano hybrid Universal Restoration	A3	BISGMA UDMA BISEMA PEGDMA TEGDM A	Silica, Zirconia, Non- agglomerated Silica particles, Barium glass	68%	82%
Tetric- N- Ceram	Nano- hybrid bulkfill	A3	BISGMA BISEMA UDMA	Barium, Aluminum silicate, Glass, Ytterbium trifluoride, Mixed oxide prepolymer	55-57%	80-81%

Table 2: Dentifrices used in the study

Composition of Dentifrices	
Colgate total toothpaste	Glycerin, water, hydrated silica, sodium lauryl sulfate, arginine, flavour, zinc oxide, cellulose, gum, C 177891, poloxamer 407, terasodium pyrophosphate, zinc citrate, benzyl alcohol, xanthan gum, cocamidopropyl betaine, sodium saccharine, phosphoric acid, sodium fluoride, sucralose.
Colgate total charcoal deep clean	Glycerin, water, hydrated silica, sodium lauryl sulfate, arginine, flavour, zinc oxide, cellulose, gum, C 177891, poloxamer 407, terasodium pyrophosphate, zinc citrate, benzyl alcohol, xanthan gum, cocamidopropyl betaine, sodium saccharine, phosphoric acid, sodium fluoride, mica, charcoal powder, sucralose.
Healthvit activated charcoal toothpaste	Calcium carbonate, sorbitol, glycerine, precipitated silica, sodium lauryl sulphate, charcoal powder, sodium carboxy methyl cellulose, sodium saccharine, sodium benzoate, flavours, distilled water.

Sample size estimation

The investigation included a sample size of 15 per group and this was estimated based on the data (mean as well as SD) from previous investigation, accounting for α=0.05, β=0.2, and power=80%.[7]

Specimen preparation

Thirty disc-shaped samples were created utilising two distinct nano-hybrid composites.

The specimens were manufactured in two steps using a plastic mould of 2 mm height and 8 mm inner diameter. The initial increment was followed by a forty-second activation of light curing unit [Turbo bee cool]. A mylar strip was applied to composite resin's surface during the placement of the second layer. Following their hardening, a slab of glass was positioned atop the mould. The specimens were polished with silicon carbide paper and submerged in water before they were brushed. After being taken out of the moulds, they were kept immersed in deionized water at 37˚C for an entire day.[8]

Baseline analysis (Sample distribution)

Three groups were formed by randomly allocating the specimens [N= 10].

- Group 1: Control group - Colgate total
- Group 2: Brushed with Colgate total charcoal
- Group 3: Healthvit's activated charcoal was used for brushing

Abrasive challenge

The specimens were brushed using electric toothbrushes each day for seven days. Every day, a tiny amount of prescribed toothpaste for each group was dispensed on the toothbrush head and was maintained in close proximity to the specimens for a duration of 30 seconds. To ensure stability while brushing, the samples were placed on an elevated surface supported by a platform above a table. Each specimen was rinsed with water for eliminating any remaining dentifrice residue after brushing. The specimens were subsequently stored in deionized water at 37˚C until examination was completed.[9]

Color stability (CS) analysis

A reflectance spectrophotometer was used to detect any alterations in surface colour (ΔE) and luminosity (ΔL) in resin composite restorations following brushing with charcoal toothpastes. The baseline color parameters have been documented along with parameters following each tooth cleaning cycle. The device used was calibrated prior to testing each specimen. Each resin composite disc from the specimens was measured at the same location.

The color changes in the specimens were investigated using ΔE and ΔL. Color analysis was performed using CIE L*a*b* coordinates (ΔL, Δa, Δb, and ΔE). The color change (Δ E) was calculated using this formula:

$$\Delta E^* = [(\Delta L^*)2 + (\Delta a^*)2 + (\Delta b^*)2].1/2$$

Colour variations in resin composite restorations were classified into four categories.[10]

- A difference of 0 - perfect match.
- A difference of 0 to 2 - only machine can see the color change, not human eye
- A difference of 2 to 3 - only an expert human eye can see.
- A difference more than three - color change is visible to all.

Statistical analysis

Shapiro-Wilk test was utilized to assess normality of data. Data were gathered and analyzed utilizing SPSS version 22, a statistical tool for the social sciences (IBM, New York, USA). ANOVA with repeated measurements and paired 't' test were utilized for assessing color stability before and after exposure.

Results

Table 3 depicts the mean baseline values (SD of colour change) of the tested composite resins. Each composite resin's colour varied significantly from the initial phase. Tetric-N-Ceram demonstrated greater baseline values than Filtek Z250 XT.

The mean (SD) colour change after brushing with different dentifrices is depicted in Table 3. According to the findings, the maximum color change was seen in Colgate total charcoal deep clean. Maximum colour variations were noted with Colgate total toothpaste, while Healthvit activated charcoal toothpaste showed the least. Brushing with Colgate total charcoal deep clean and Colgate total toothpaste resulted in significant changes (*P*<0.05), while the use of Healthvit activated charcoal toothpaste caused no apparent colour shifts in any of the groups. The Filtek Z250 XT showed the least degree of colour change after seven days of brushing with all the three dentifrices, compared to Tetric-N-Ceram.

Table 3: Comparison of colour of 3M and Ivoclar composites at baseline and after treatment with various toothpastes

Composition of Composite Resin						
Composite	Toothpaste	n	Mean ΔE t0 (SD)	Mean ΔE t1 (SD)	t	*P* value
3M	Colgate total	5	30.18 (1.01) [a]	31.34 (0.65) [ab]	2.941	.042*
	Colgate charcoal	5	31.66 (1.72) [a]	33.02 (1.62) [a]	2.049	.110
	Health Vit	5	32.00 (1.09) [a]	32.34 (0.88) [a]	1.298	.264
F value			2.722	2.820		
Sig			.106	.099		
Ivoclar	Colgate total	5	36.88 (0.81)[a]	36.92 (0.47)[b]	0.121	.909
	Colgate charcoal	5	35.88 (0.87)[a]	37.24 (2.63)[b]	1.553	.195
	Health Vit	5	36.46 (2.26)[a]	36.50 (2.50)[b]	0.237	.825
F value			.582	.155		
Sig			.574	.858		

Discussion

People now place great importance on their appearance, especially their smile. Additionally, a person's smile and tooth colour significantly impact their self-confidence. To brighten their smiles and remove stains, many people utilize abrasive toothpastes at home. However, using different toothpastes on a cosmetic restoration could have the advantage of a whitening agent.[2]

Activated charcoal material has the capacity to absorb chromophores, pigments, as well as stains from resin composites and possesses mechanical or abrasive properties.[6] This study used nano filled composites which are routinely used for restoring anterior teeth.

To imitate clinical settings and ensure consistent brushing of all the study's specimens, an electric toothbrush was used. A single operator performed the brushing exercise to reduce calibration errors. To prevent any protective layer from forming during the storage simulating saliva exposure, the samples were submerged in deionized water.[2]

A resin composite's colour stability is influenced by the colouring agent, depth of polymerization and resin matrix dimension with the filler particles. Furthermore, it has been highlighted that the chemical differences between resin components, such as oligomer purity, monomer amount, activator initiator and inhibitor type, ion oxidation, and reactive carbon-carbon double bond, can affect colour stability.[7]

Techniques such as visual and instrumental methods aid in assessing discoloration; however, colour evaluation by visual comparison may be unreliable due to dissonance between observers' colour perception and interpretation.[11] Digital image analysis, spectrophotometry and colorimetric analysis are some of the instrumental techniques for measuring colour. Spectrophotometry is considered to be one of the most accurate techniques in dental material studies because it can measure characteristics like metamerism and reflectance that a colorimeter is not equipped to assess.[12]

L*a*b* coordinates are used for absolute measurements, and δ E indicates the color outcome. In theory, no colour difference will be noticeable when a material is exposed within the testing environment, if it is completely colour-stable.[13] δ E levels smaller than 1.5 are not detectable by human eye, but they can be measured using a spectrophotometer. In the current investigation, δ E values greater than three were considered clinically noticeable.[14]

In this study, the change in colour was more noticeable in nanohybrid composite resin specimens brushed with charcoal toothpaste. This could be due to the possibility that certain monomers, like TEGDMA are water soluble, which leads to greater discolouration owing to toothpaste component absorption. Tetric-n-ceram showed greater colour change than Z250 probably because Z250 XT has higher filler volume percentage.[7]

Similarly, discs brushed with Colgate charcoal toothpaste exhibited greater colour change than disks smeared with toothpaste containing activated charcoal from Healthvit. Mica is one of the ingredients in Colgate toothpaste, which might explain this. According to a study by Karaman E, PMMA denture teeth material treated with silane containing mica infill caused significant changes in the material's natural colour.[10]

In summary, the current study findings revealed a varying influence of dentifrice. Furthermore, toothbrush abrasion reduced the colour stability of nanohybrid composites.

The shortcomings of the current study were that samples were brushed for only seven days and the study was carried out in an in vitro environment.

Conclusion

Within the study's limitations,

- Tetric-N Ceram demonstrated reduced colour stability, both prior to and during dentifrice exposure.

- When contrasted with Healthvit activated charcoal toothpaste, it was concluded that Colgate charcoal toothpaste had worse colour stability.

Clinical significance

Colour stability of a tooth-coloured restoration is important as it may affect the aesthetics of the person's teeth and their overall appearance. As people are more inclined towards their appearance, it is very important for the composite material to have long lasting colour stability.

Scope of the study

Further variations in the colour stability of the samples could be observed by brushing for an extended period of time.

Funding

Conflicts of interest

Nil

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