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Color depth penetration of direct and indirect composite after one month interaction with different colored drinks

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Abstract
Aim: The aim of this study was to evaluate and compare the color depth penetration of direct and indirect composite after one month interaction with three different colored drinks.
Materials and method: Seventy sound extracted molars were collected and stored in saline at room temperature. The teeth were divided into two groups (group I –direct restorative technique and group II indirect restorative technique) and Class I cavity were prepared and restored. Specimens were immersed in cold drink, tea, food color (turmeric solution) and control group (distilled water) for one month, three times a day, and one hour each. Teeth were then soaked in Rhodamine B dye for 24 hours and then sectioned mesio-distally and evaluated under stereomicroscope at 10X magnification. The statistical analysis was done by One Way ANOVA with post hoc test.
Results: The highest colour penetration was observed in indirect composite restorations with turmeric group and lowest colour penetration in direct composite restorations with tea group
Conclusion: Indirect composite restorations showed more color penetration than direct restorations.

Keywords: Color, molars, rhodamine, temperature, turmeric

Introduction
Composites resins are currently considered as universal materials for restorations and have become the potential first choice for direct anterior and posterior restorations with great success and high patient acceptance. The great popularity can be related to their good esthetic appearance results and reduced need of sound tissue removal as compared with former materials [1]. But after a long term use and exposure to a huge variety of food and beverages, the most commonly encountered problem has been color change which is a frequent reason for replacement of restoration.
According to Asmussem E [2] and Dietschi D *et al*. [3] there are three types of composite resin discolorations 1) Extrinsic discoloration: This is caused by the accumulation of plaque and superficial pigments; 2) Intrinsic discoloration: This is caused by the aging of material itself; 3) Alteration of the surface color due to superficial degradation or mild penetration and reaction of the staining agents on the inner side of superficial composite resin layer. Color stability of a restoration throughout its functional lifetime is important for the durability of treatment and of cosmetic importance [4].
The use of composite inlay techniques has already been proved to be an elegant approach to improve the marginal seal and adaptation of esthetic posterior restorations by greatly restricting the volume of composite resin to be simultaneously cured and bonded to tooth [5]. Excessive contact of the tooth structure with acidic food leads to loss of dental hard tissues. Thus it can be assumed that restorative materials, when subjected to low ph environment in the oral cavity, leads to degradation of its surface and marginal integrity [6].
Microleakage may be defined as the clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative material applied to it [7]. Microleakage will result in the discoloration/staining of the restoration, produce tooth sensitivity, aid in the recurrence of caries, and, finally may lead to failure of the restoration [8].
It is already known that the continuous exposure of the restoration margins in the oral

environment reduces the mechanical properties by hydrolytic degradation. It leads to sorption that may result in swelling of the material, weakening of the polymer network, degradation of the filler matrix composite and the embedding of color particles from food may also lead to adverse visual effects with discoloration [18].

Surface staining of a composite is mainly related to the absorption or adsorption of coloring substances [9]. In modern societies diet includes a wide range of colored foods and drinks, which can affect the natural color of composite restorations to different degrees. So far, many studies have extensively reported the harmful effects of coffee, tea, grape juice and cola drinks on dental composites [10-12].

With the advent of newer composites surface degradation to a larger extent has been taken care of however marginal leakage presents a peculiar situation which still continues to haunt the dentists with respect to composite resin. Therefore, a study was purposed, to evaluate and compare the colour depth penetration of direct and indirect composite after one month interaction with three different colored drinks.

Materials and Method

Seventy sound maxillary and mandibular molars, which were extracted for periodontal reasons, free of restorations and caries were selected. Teeth were stored in saline at room temperature until use. They were randomly divided into two groups.

Group I- direct restoration

Group II- indirect restoration

Standardized Class I cavity were prepared with a minimum occlusal depth of 1.5mm and width 2mm. Parallel preparations were made for direct restorative technique and occlusally divergent preparations for inlay technique. For the direct restorations the cavities were prepared with No.245 carbide bur and No.271 carbide bur was used to prepare inlay.

Direct restorative technique

After completion of the preparations, 37% phosphoric acid was applied for 15 seconds. The cavity was thoroughly rinsed with water for 30 seconds and gently air dried. Dentin bonding agent was applied and cured for 20 seconds. Then composite (nanofilled) was placed incrementally and light cured for 40 seconds for each increment.

Indirect restorative technique

After cavity preparation, separating medium was applied, composite resin was packed incrementally and light cured for 40 seconds each. The composite inlay was removed from tooth and curing was carried out for 104 degree Celsius for 6 minutes in curing oven. Then GIC was used for luting the composite inlay.

Selection of beverages

The selection criteria of experimental beverages were common uptake and availability of beverages among Indian population. The selection criteria also included the different pH values of the beverages from slight acidic to neutral pH values. The pH was measured using digital pH meter. The measured values were Tea (4.9), Cold drink (2.8), Food colour (7.2), and Distilled water (7). (Figure 1)

Then the samples were subdivided into eight groups. Direct composite with tea, cold drink (cola flavor), food colour (turmeric solution) and indirect composite with tea, cold drink (cola flavor), food colour (turmeric solution) and for control group direct composite with distilled water and Indirect composite with distilled water.

Preparation of solution

For preparation of turmeric solution 0.5 gram of turmeric was dissolved in 150 ml of distilled water. Tea was prepared by adding 15 gram of tea leaves in 150 ml of distilled water. In case of cold drink 150 ml of cold drink (cola flavor) was directly used.

Samples were stored for one month in three different beverages of tea, cold drink (cola favour), food color (turmeric solution) and water (control group). The specimens were stored three times a day, one hour each, for one month. After one month samples were coated with nail varnish and apex was sealed with sticky wax. The specimens were then soaked in Rhodamine B dye for 24 hours. Then the teeth were sectioned mesiodistally and the color penetration was checked under stereomicroscope 10 x magnifications. (Figure 2)

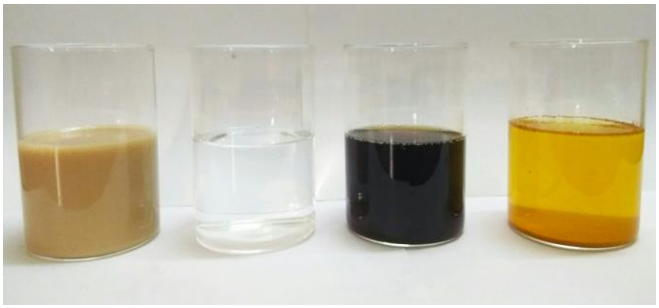


Fig 1: Experimental drinks tea, distilled water, cold drink, turmeric solution

Fig 2: Stereomicroscope

Scoring Criteria

Score 0 - No Dye penetration

Score 1-Dye penetration along occlusal wall but less than ½ way to axial wall

Score 2-Dye penetration along occlusal wall but more than ½ way to axial wall

Score 3-Dye penetration along occlusal wall, up to and along axial wall

The statistical data analysis was done by One Way ANOVA with post hoc test.

Results

The color penetration between the restoration and the tooth was checked by dye penetration. Of 10 samples in each group

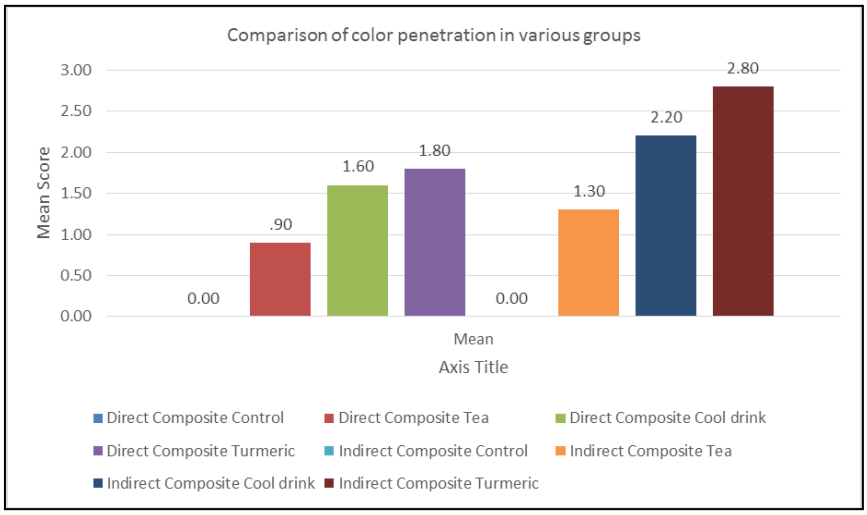
of direct restoration tea, cold drink and turmeric group the mean score was 0.90,1.60 and 1.80 respectively and among indirect restorations of 10 samples in each group of tea, cold drink and turmeric solution the mean score was 1.30,2.20,2.80 respectively. The difference among F value of direct restoration and indirect restoration was 26.798 and 73.11.

The results suggests that highest colour penetration was in Indirect composite turmeric group and lowest colour penetration in Direct composite tea Group. There was statistically significant differerence present in the colour penetration in various groups (p<0.001) (Table 1, 2 and 3)

Table 1: Comparison of various colored drinks.

Material	Group	N	Minimum	Maximum	Mean	Std. Deviation	F value	P value
Direct Composite	Control	10	0	0	0.00	0.000	26.798	<0.001**
	Tea	10	0	2	.90	.568		
	Cold drink	10	1	2	1.60	.516		
	Turmeric	10	1	3	1.80	.632		
Indirect Composite	Control	10	0	0	0.00	0.000	73.11	<0.001**
	Tea	10	1	2	1.30	.483		
	Cold drink	10	1	3	2.20	.632		
	Turmeric	10	2	3	2.80	.422		

**-Highly significant (p<0.001)



Comparison of various colored drinks on direct and indirect composites

Table 2: Post Hoc Tukey test for Direct composite material

Comparison between		Mean Difference	P value
Control	Tea	-.900*	0.001*
Control	Cool drink	-1.600*	<0.001**
Control	Turmeric	-1.800*	<0.001**
Tea	Cool drink	-.700*	0.017*
Tea	Turmeric	-.900*	0.001*
Cold drink	Turmeric	-.200	0.805 NS

**-Highly significant (p<0.001), *-Significant (p<0.05), NS- Not significant (p>0.05)

Table 3: Post Hoc Tukey test for indirect composite material

Comparison between		Mean Difference	P value
Control	Tea	-1.300*	<0.001**
Control	Cool drink	-2.200*	<0.001**
Control	Turmeric	-2.800*	<0.001**
Tea	Cool drink	-.900*	<0.001**
Tea	Turmeric	-1.500*	<0.001**
Cold drink	Turmeric	-.600*	0.025 *

**-Highly significant (p<0.001), *-Significant (p<0.05)

Discussion

Close marginal adaptation is essential for the quality of composite restorations and esthetics.

According to Zarrati *et al*. marginal adaptation of direct composite is better than indirect composite inlay. The marginal gap of direct composite was significantly lower than that of indirect composite because in direct composite restorations, the distance between the restoration and the dental wall would be minimum, which is filled with bonding agent [16]

Chittem J *et al*. [17] Debora SG *et al*. [18] Malhotra *et al*. [19] have conducted studies on the effects of different food stains on composite restorative materials and found that discoloration by colored food agents and various beverages are among the major causes for composite resins discoloration.

Discoloration of composite resins is multifactorial in nature and it includes acidity, degree of resin polymerization as well as food colorant absorption/penetration. Differences in the sizes of particles and differential solubility of stains could also be the contributing factors [17]. Staining susceptibility of composite resins could be attributed to their degree of water sorption and hydrophilicity of resin matrix. If the resin matrix is capable of absorbing water, it is also capable of absorbing any other fluid, which ultimately leads to discoloration. Extreme water sorption causes the expansion and plasticizing of the resin, hydrolysis of silane, which in turn creates microcracks and as a result, micro cracks or interfacial gaps at the junction between the filler and matrix, allows stain penetration and discoloration [18].

Different beverages and food stuffs also have potential for pH variations. It has been reported that contemporary fluid consumption patterns have replaced the consumption of water with carbonated soft drinks and fruit juices. The pH is also an

unfavorable factor for hydrophilic resins as it affects the degradation of resins through catalysis [13]. According to previous studies in both *in vivo* and in vitro, low pH of the commonly up taken beverages had shown to have an adverse effect on degradation of the resin composites [14-15, 20] The carbonated soft drinks are acidic due to the presence of both phosphoric acid and carbonic acid, which leads to increased enamel decalcification, erosion and microleakage around the restoration [22-23].

The staining of composites by coffee/tea has been widely studied and reported [19, 21]. They are important nonalcoholic beverages that act as the main drink in various social gatherings/rituals as its caffeine content provides a stimulant effect [19] and the discoloration in tea was mainly due to surface adsorption of polar colorants at the surface [21].

Turmeric/Indian saffron has been used as flavoring and/or coloring agent in a variety of dishes/curries also regarded as pH indicator in ayurveda. It is said that major constituents of turmeric (Curcuma) are curcuminoids, the yellow coloring principles that is responsible for the yellow color of turmeric. Smaller molecular size of curcumin coupled with the water absorption characteristics of the tested materials has created a stronger staining effect [21]

The results of the current study give an insight how different beverages which may affect the color stability of direct and indirect composite restorations through microleakage. Thus the clinician should explore the means to reduce marginal leakage and different materials with nanotechnology of better marginal adaptation.

Conclusion

Based on the study the following conclusions may be drawn:

1. Color depth penetration was not related to ph of the coloring agent.
2. Molecular size of the coloring agent may have played an important role in color depth penetration.

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