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RESEARCH ARTICLE

EFFECT OF CHILDREN'S BEVERAGES ON COLOR STABILITY OF ESTHETIC RESTORATIVE MATERIALS- AN IN-VITRO STUDY

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ABSTRACT

Objectives: To evaluate the effect of exposure to various children's beverages on the colour stability of different aesthetic restorative material commonly used in pediatric dentistry.

Materials and Methods: 30 cylindrical disks of resin modified glass ionomer cement and composite resin were prepared respectively using moulds. 15 samples each group were immersed in one of the two solutions respectively for 7 hours at 37°C temperature and then in artificial saliva for 17 hours at 37°C to simulate to oral environment. Specimens were subjected to spectrophotometric analysis before and after exposure to drinks using CIE-lab system then data was subjected to statistical analysis.

Results: The study revealed both the staining solutions have statistically significant effect on colour stability of Composite resin and RMGIC. On comparing the material composite resin is more resistant to discolouration than RMGIC while orange juice is more aggressive colour stimulant on composite while cola has more ability to discolour RMGIC.

Conclusion: The ability of staining solutions to discolour the restorative materials can affect the clinical choice of the restorative material to be used for the patient and could be related to dietary habits.

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INTRODUCTION

Teeth require restoration for a variety of reasons including dental caries, trauma, abrasion, erosion, and congenital anomalies. Many new restorative materials have been manufactured to meet the demands of a growing global concern for esthetic dental results. Dentists and patients alike have developed a more discerning eye and a preference for proper shade match and more esthetic results. Even though esthetic treatments have been one of the most required dental treatments, coming just after pain related treatments, in-depth knowledge of colour by dentists has not followed. Defining esthetics as "the art of the imperceptible", colour stability can be the difference between success and failure (Adriana Postiglione Bührer Samra, 2008). For direct esthetic restorations, four types of material are widely used: resin composites, polyacid-modified resin composites

(‘compomers’), glass-ionomers and resin-modified glass-ionomers. It has been demonstrated that surface discolorations in composite resins are related to hygiene, eating habits and smoking. The maintenance of the esthetics of a restoration is therefore related to the patients' habits and lifestyle (Fabrício Mariano MUNDIM, 2010). Hence, the aim of this in vitro study was to evaluate the colour stability of resin modified glass ionomer cement and composite in different immersion media.

MATERIALS AND METHODS

30 cylindrical disks of composite resin (A3, 3M SPE Z 350) (Group A) and resin modified glass ionomer cement (A3, 3M ESPE Vitremer) (Group B) were prepared respectively using moulds of 10 mm in diameter and 2.5mm in thickness. Specimens rehydrated by storing in artificial saliva at 37°C for 24 hours in incubator in order to simulate the oral environment. Following rehydration 30 samples of each group A and B were randomly divided into two groups. (n=15) 15

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samples each group were immersed in one of the two solutions (Cola and Orange Juice) respectively for 7 hours at 37°C temperature and then in artificial saliva for 17 hours at 37°C to simulate to oral environment. Specimens were subjected to spectrophotometric analysis before and after exposure to drinks according to colour representation system for colour measurements introduced in 1976 by the Commission Internationale de l'Eclairage (CIE). Colour change was calculated using formula $E^* = [(L^*1 - L^*0)^2 + (a^*1 - a^*0)^2 + (b^*1 - b^*0)^2]^{1/2}$. Data collected was compiled and subjected to statistical analysis using ANOVA, paired t test and Tukey's post hoc analysis.

Table 1. Comparison of the effect of Cola on colour stability of composite resin before and after immersion using paired t test

	N	Mean	Std. Deviation	t value	P value
L pre	15	40.95	1.23		
L post	15	38.06	2.45	4.581	<0.001**
a pre	15	0.36	0.12		
a post	15	0.28	0.15	2.057	0.05*
b pre	15	0.28	0.28		
b post	15	0.48	0.39	1.774	0.098

stability of composite resin there is no significant difference in E^* values observed (Table 3). The effect of Cola on colour stability of resin modified glass ionomer cement showed significant reduction in L^* value and increased a^* and b^* value suggesting that after immersion in cola specimens become darker, reddish and yellowish. While after immersion in orange juice specimens became yellowish (Table 4 and 5). There is significant difference in E^* values of RMGIC in cola and orange juice suggesting that E^* value of cola is more than that of orange juice (Table 6).

Table 2. Comparison of the effect of Orange juice on colour stability of composite resin before and after immersion using paired t test

		N	Mean	Std. Deviation	t value	P value
Pair 1	L pre	15	40.66	1.68	4.033	<0.001**
	L post	15	37.27	3.25		
Pair 2	a pre	15	0.32	0.14	3.194	0.007*
	a post	15	0.55	0.20		
Pair 3	b pre	15	0.55	0.49	1.994	0.066
	b post	15	1.00	0.56		

Table 3. Comparison of the effect of Cola v/s Orange juice on colour stability of composites resin using unpaired t test

	Group	N	Mean	Std. Deviation	t value	P value
L pre	Cola	15	40.95	1.23	0.545	0.590
	Orange Juice	15	40.66	1.68		
a pre	Cola	15	0.36	0.12	0.830	0.413
	Orange Juice	15	0.32	0.14		
b pre	Cola	15	0.28	0.28	1.841	0.076
	Orange Juice	15	0.55	0.49		
L post	Cola	15	38.06	2.45	0.749	0.460
	Orange Juice	15	37.27	3.25		
a post	Cola	15	0.28	0.15	4.129	<0.001**
	Orange Juice	15	0.55	0.20		
b post	Cola	15	0.48	0.39	2.954	0.006*
	Orange Juice	15	1.00	0.56		
Delta E	Cola	15	3.67	1.09	0.263	0.795
	Orange Juice	15	3.80	1.66		

Table 4. Comparison of the effect of Cola on colour stability of resin modified glass ionomer cement before and after immersion using paired t test

		N	Mean	Std. Deviation	t value	P value
Pair 1	L pre	15	39.56	2.38	3.172	0.007*
	L post	15	37.31	2.18		
Pair 2	a pre	15	0.28	0.12	3.087	0.008*
	a post	15	0.50	0.24		
Pair 3	b pre	15	1.55	0.95	6.843	<0.001**
	b post	15	4.23	1.12		

Table 5. Comparison of the effect of drinks (Orange juice) on colour stability of resin modified glass ionomer cement before and after immersion using paired t test

		N	Mean	Std. Deviation	t value	P value
Pair 1	L pre	15	39.56	2.38	0.575	0.574
	L post	15	37.31	2.18		
Pair 2	a pre	15	0.28	0.12	0.565	0.581
	a post	15	0.50	0.24		
Pair 3	b pre	15	1.55	0.95	10.945	<0.001**
	b post	15	4.23	1.12		

RESULTS

When effect of Cola on colour stability of composite resin showed significant reduction in L^* value and a^* values suggesting that after immersion in cola specimens become darker and greenish, while after immersion in orange juice specimen became darker and reddish (Table 1 and 2). On comparing the effect of Cola and Orange juice on colour

stability of composite resin there is no significant difference in E^* values observed (Table 3). The effect of Cola on colour stability of resin modified glass ionomer cement showed significant reduction in L^* value and increased a^* and b^* value suggesting that after immersion in cola specimens become darker, reddish and yellowish. While after immersion in orange juice specimens became yellowish (Table 4 and 5). There is significant difference in E^* values of RMGIC in cola and orange juice suggesting that E^* value of cola is more than that of orange juice (Table 6). When the values of E^* on composite resin between cola and orange juice were compared, significant difference seen with E^* values of RMGIC in cola and orange juice suggesting that E^* value of cola is more than that of orange juice (Table 7). When E^* values of all the groups were compared using ANOVA test it showed that both the staining solutions has effect on colour stability (E^*) of composite resin and RMGIC (Table 8).

Table 6. Comparison of the effect of drinks (Cola v/s Orange juice) on colour stability of resin modified glass ionomer cement using unpaired t test

	Group	N	Mean	Std. Deviation	t value	P value
L pre	Cola	15	39.56	2.38	0.545	0.590
	Orange Juice	15	36.22	2.14		
a pre	Cola	15	0.28	0.12	0.830	0.413
	Orange Juice	15	0.19	0.11		
b pre	Cola	15	1.55	0.95	1.787	0.085
	Orange Juice	15	0.95	0.089		
L post	Cola	15	37.31	2.18	1.578	0.126
	Orange Juice	15	35.87	2.77		
a post	Cola	15	0.50	0.24	3.768	<0.001**
	Orange Juice	15	0.22	0.14		
b post	Cola	15	4.23	1.12	2.062	0.049*
	Orange Juice	15	3.54	0.61		
Delta E	Cola	15	5.97	1.37	3.769	<0.001**
	Orange Juice	15	4.10	1.34		

Table 7. Comparison of the effect of Cola and Orange juice on colour stability of Composite resin & resin modified glass ionomer cement using ANOVA test

Delta E	N	Mean	Std. Deviation	F value	P value
Cola (Composite)	15	3.67	1.09	8.995	<0.001**
Orange juice (Composite)	15	3.80	1.66		
Cola (RMGIC)	15	5.97	1.37		
Orange juice (RMGIC)	15	4.10	1.34		
Total	60	4.39	1.64		

Table 8. Tukey's post hoc analysis

	Cola (Composite)	Orange juice (Composite)	Cola (RMGIC)	Orange juice (RMGIC)
Cola (Composite)	-	0.993	<0.001**	0.825
Orange juice (Composite)	0.993	-	<0.001**	0.934
Cola (RMGIC)	<0.001**	<0.001**	-	0.003*
Orange juice (RMGIC)	0.825	0.934	0.003*	-

DISCUSSION

As tooth-colored restorative dental materials are continuously exposed to saliva, beverages and food stains in the oral environment, it is important to determine their susceptibility to color change. To ensure restorations imperceptibility both intrinsic color stability and staining resistance over a long period in the oral environment are necessary. Consumption of certain beverages such as coffee, soft drinks, alcoholic beverages, and even water may affect the aesthetic and physical properties (micro hardness, surface roughness, and translucency) of the composites due to the degradation of the resin matrix thereby undermining the quality of restoration (Council on dental materials and devices, 1975), however in the pediatric population as fruit juices and soft drinks are consumed often, hence in the present study cola and orange juice were chosen. The cola solution and orange juice has lower pH and has coloring ability. Their effect of acidity on surface texture is well known but their effect on color stability is yet to be determined. Immediately after consumption of any kind of acidic beverages, the pH drops but it comes to normal when saliva comes into action. Hence in this study specimens were immersed in media for 7 hours and followed by 17 hours in artificial saliva. The 7 hours continuous immersion in media is equal to 1 year of consumption of beverages. Dentists have been demanding improved and more easily achievable aesthetics in anterior restorations than those offered by earlier traditional composites, without sacrificing the strength of the material. The staining capacity of the cola and orange juice on the composite can be justified due to staining susceptibility of composite resins that might be attributed to their degree of

water sorption and the hydrophilicity of the matrix resin. Composite resins that can absorb water are also able to absorb other fluids with pigments, which results in discoloration. Denis Roberto FalcãoSpina *et al* showed that more color degradation occurred in the nanohybrid material than in the microfilled and microhybrid materials. Degradation of residual amines and oxidation of residual unreacted carbon-carbon double bonds culminate in the formation of yellowing compounds in all resin-based materials. However, composites with a smaller filler size do not necessarily show low levels of discoloration, as demonstrated in the present study. Staining of composite resins is dependent on monomer structure, as well as surface irregularities (Denis Roberto FalcãoSpina, 2015). In the resin-modified glass-ionomer cement, a command setting behaviour is introduced by means of a polymerizable component, commonly hydroxyethyl methacrylate (HEMA). However, these materials take up more water than conventional ionomers due to 2-hydroxyethylmethacrylate (HEMA) that is present in the liquid of the RMGIC is hydrophilic in nature, and materials with a higher HEMA content have consequently higher water sorption (Michael, 1991). The pH of the staining agents in the present study ranges from 2.7 for cola to 3.3 for orange juice, a possibility is that the acidic pH may have had an effect on the structure of the materials. Neamat *et al.* have shown that fillers tend to fall out from resin materials and the matrix component decomposes when exposed to low pH environments. Many soft drinks are acidic and the pH is 3.0 or lower. This means that drinking acidic drinks over a long period and with continuous sipping can erode the tooth enamel and the resin material as well (Claudio Poggio, 2016). S. Wongkhantee *et al* studied the

effect of acidic media on surface hardness of composite resin and RMGIC. They found that Cola soft drink significantly reduced surface microfilled composite, and resin modified glass ionomer, while Orange juice and sports drink significantly reduced surface hardness of enamel. The solutions used in our study cola and orange juice being acidity in nature caused surface degradation of specimens thus, enhancing the ability of staining agent for penetration and reaction into surface (Wongkhantee, 2006). Although, cola had the lowest pH and it might damage the surface integrity of the materials, it did not produce as much discoloration as orange juice which may be because of lack of a yellow colorant in cola. Cola gains its color through the addition of caramel color. Caramel exhibits colors ranging from palest yellow to deepest brown and is made by heating sugar or glucose in the presence of alkali or mineral acid. The high color staining ability of orange juice is probably due to high acidic pH with yellow colorant (Kuehni, 1979). According to individual ability of human eye to appreciate differences in colors, three different intervals were used to distinguish changes in color values: $E^* < 1$ - imperceptible by the human eye; $1.0 < E^* < 3.3$ - considerate appreciate only for skilled person, both clinically acceptable and, $E^* > 3.3$ - easily observed, these color changes values are not clinically acceptable (Silvia, 2009). In our study all the four groups showed significant effect of immersion medias (cola and orange juice) on color stability of composite resin and RMGIC ($P < 0.001$). However, the effect of cola ($E^* = 5.97$) on color stability of RMGIC was found to be highest of all the other groups. The color change observed in RMGIC because of immersion into cola and orange juice could be appreciated by naked eye while the color change which happened for the other groups is appreciate by skilled person but the color change could be accepted clinically. The study proved that composite is more resistant to discoloration as compare to RMGIC.

Conclusion

This study hence concludes that frequently consumed beverages have an effect on discoloration of the composites resins and resin modified glass ionomer cement. However, the present study is limited by including only two different materials and two beverages. Furthermore, no long-term measurements were performed. Therefore, further researches are needed to investigate other possible factors affecting the discoloration of restorative materials.

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