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Effect of Different Pediatric Medications on Various Tooth Colored Restorative Materials Used in Pediatric Dentistry: A Comparative Study

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Abstract---Aim: To study and compare the effect of different pediatric medication on tooth-colored restorative materials. Method: One fifty specimens, 50 of each restorative material RMGIC, Compomer and Composite were obtained using circular acrylic mold with a diameter of 5mm and thickness of 2mm and A2 shade for standardization. They were further divided into five subgroups of multivitamin, antiepileptic, anxiolytic, bronchodilator and distilled water as control group. The specimens were immersed in syrup for 2 minutes twice a day for 40 days. The effect of medications on tooth colored restorative material

was analysed by evaluation of colour stability using spectrophotometer and surface microhardness using Vickers hardness tester. Two-way analysis of variance (ANOVA) was used for multiple subgroup comparison. Result: All the materials showed statistically significant change in microhardness and color values after immersion in different syrups from baseline to 40th day period ($p < 0.05$). The maximum and minimum change in surface hardness was observed with RMGIC in antiepileptic (14.58) and multivitamin group (8.05) ($p = 0.000$). Also, significant color change was noticed most with RMGIC in anxiolytic group (15.73) and least with composite (7.06) in antiepileptic group ($p = 0.000$). The (ΔE) value for color change observed for all materials was beyond 3.3 which is clinically unacceptable. Conclusion: Various factors like composition of medicament and material, oral environment, duration medicaments taken can adversely affect the restorative materials. RMGIC should be avoided as aesthetic restoration as it showed least color stability. Composite showed overall better result in terms of surface hardness and color change and can be the choice of material in anterior teeth restoration.

Keywords---pediatric liquid medicaments, microhardness, color stability, aesthetic restorations.

Introduction

Medications are prescribed by paediatricians and physicians for various ailments through various routes of administration like oral, nasal, sublingual, cutaneous, rectal and parenteral routes. Out of which, the oral route is commonly used and the oldest administration mode used. To swallow oral medication in form of capsule or tablets is impractical for children as they are too young. Hence, syrups are mostly recommended for children.¹ As the systemic conditions in children are increasing, the use of paediatric liquid drugs like analgesics, antibiotics, antiepileptics, multivitamins, anxiolytic etc are also on rise. For children with systemic taking liquid medication may be a daily routine. The active chemicals in these medicaments are essential for improving or maintaining health but some inactive substances may cause risks to tooth enamel. Dental erosion is caused by medications with a low pH and regular contact with teeth. Thus, there arises need to study the effect of such medications in oral health.²

Tooth-colored restorative materials come in a variety of forms with its own set of physical qualities and colours. In paediatric dentistry compomers, resin modified glass ionomers and composites, these aesthetically pleasing materials have tremendously changed the concept of today's practice. These tooth-coloured materials are used for restoration of decay areas and most importantly to improve smile and reshape disfigured teeth.² The ability to withstand pressures and chemical insults experienced in the oral environment are the two most desirable properties of a restorative material. The restoration will be available for long periods of time if these challenges are overcome.³

The three most significant characteristics for any restorative material's longevity are colour stability, surface roughness and surface micro hardness. The surface hardness of the restorative material is important. Low surface hardness makes the material vulnerable to scratches and causes restoration failure. Rough surface structure can cause material stains and discoloration, compromising the quality of the repair, and plaque deposition, which can lead to secondary caries.⁴ Also, the surfaces of dental restoration may be altered or stained as the oral cavity is exposed to different solutions daily. There is dearth of literature that states the effect of medication on tooth coloured restorative material. Thus, this study was designed to assess the effect of paediatric medication on various tooth-coloured restorative materials. The null hypothesis tested in this study was that the paediatric medication affects the surface hardness and color stability of tooth-coloured restorative material.

Aims and Objectives

The aim of this in vitro study is to assess the effect of different pediatric medications on different tooth-colored restorative materials (RMGIC, Compomer, Composite)

Objective

- To assess and compare the effect of multivitamin, antiepileptic, anxiolytic & bronchodilator syrups on the surface micro hardness of RMGIC (Equia Forte), Compomer (Dentsply dyract flow) and Composite (3M Z350)
- To assess and compare the effect of multivitamin, antiepileptic, anxiolytic & bronchodilator syrups on the color change of RMGIC (Equia Forte), Compomer (Dentsply dyract flow) and Composite (3M Z350)

Material and Methodology

This study was carried out at the Department of Paediatric and Preventive Dentistry, Karnavati School of Dentistry, Uvarsad, Gandhinagar, Gujarat. Ethical approval of the study was obtained from the Ethical Committee of the institution prior to the start of the study. 50-disc shaped specimens (5 mm in diameter x 2 mm thick) were obtained from each of the materials RMGIC (Equia Forte), Compomer (Dyract flow), and Composite (Filtek Z350) (Table 1) with A2 shade for standardisation using circular acrylic moulds. The material was inserted into the mould frame, which was placed on a glass slab and a matrix strip was placed over it to prevent air trapping and voids. According to the manufacturer's instructions, 150 samples from the three restorative materials were prepared. The specimens were polymerized for 40 seconds using an LED light (LY – C240 Unicorn Denmart, 420-480nm) with a tip 1 mm distant from the specimen. All the specimens were stored in distilled water for 24 hours at 37°C to accomplish the polymerization procedure. The specimens were then polished with super snap rainbow aluminium oxide discs (Shofu, Inc., Kyoto, Japan) and using an electric handpiece at 15,000 rpm for 10 seconds with each disc (coarse, medium, fine, and superfine). For standardisation, a single operator prepared all the samples.

After measuring baseline colour stability and microhardness values, the specimens were divided into five subgroups: Multivitamin, Antiepileptic, Anxiolytic, Bronchodilator (Table 1) and Distilled Water as a control each having 10 samples. The specimens were then submerged in syrup for 2 minutes twice a day for 40 days. They were washed and stored in distilled water after every immersion and both, syrup and water were changed daily. The specimens were dried using paper tissue before testing. At the 1st, 7th, 21st, and 40th days, measurements of colour stability and surface microhardness were taken.

Surface microhardness testing

Using a surface microhardness tester (MV1 – FIE, India), the values of surface microhardness were determined. With a 50 g weight applied for 15 seconds, four indentations were created at different places on each specimen, 1 mm apart from the neighbouring indentation. Vickers Hardness Number was assigned to the average of the three values obtained. Microhardness was measured on the first, seventh, twenty-first, and forty days.

Color stability testing

A portable spectrophotometer was used to measure the colour values of the specimens (NSA 800 3nh- China). The spectrometer was calibrated prior to measurement using the white calibrated standard provided, as per the manufacturer's recommendations. The colour change was computed by comparing baseline values to values measured on the first, seventh, twenty-first, and forty-first days. The CIE L* a* b* colour system measures colour in three dimensions. L* denotes an object's value, which ranges from white (100) to black (0); a* and b* denote chromaticity coordinates along the red-green and yellow-blue axes, respectively. Red (C) is at one end, green (K) is at the other, and grey is in the middle (0). Coordinate b*, on the other hand, measures yellow (C) on one end, blue (K) on the other, and grey in the middle. When evaluating aesthetic restorative materials, the (ΔE) value represents relative colour changes that an observer might notice.

Statistical analysis

The collected data were entered in excel sheets and the data was analysed with IBM SPSS 23.0 for Windows Statistical Software. Statistical Analysis was carried out using Two-way ANOVA was used for multiple subgroup comparison. For All Statistical Analyses, Probability Levels of $P < 0.05$ was considered statistically significant

Results

Surface Microhardness: (Table 2, Graph 1)

The mean VHN values and SD for surface micro hardness for all the groups and subgroups are given in **Table 2**. Two-way analysis of variance revealed that there was a statistically significance difference between all the groups and subgroups at 7,14,21 and 40 days ($P=0.000$). The maximum decrease in surface hardness was

noted for RMGIC in antiepileptic group (14.58). The overall mean difference in the subgroups with the least decrease in surface hardness for multivitamin was in RMGIC group (8.05), for Antiepileptic in Composite group (12.58), for Anxiolytic in Composite (10.37) for Bronchodilator in Composite group (10.44) and was statistically highly significant ($p=0.00$). Composite showed the least decrease in surface hardness in all the groups except multivitamin when compared with control and it was highly significant ($p=0.000$)

Colour Change: (Table 3, Graph 2)

Mean difference (ΔE) values and standard deviations of color change for all the groups and subgroups is mentioned in **Table 3**. Two-way analysis of variance revealed that the mean color change values of all the groups showed a statistically significant difference after immersion in different syrups from baseline to 40th day ($p<0.05$). The mean color change was observed maximum with RMGIC in anxiolytic (15.73) group followed by composite in multivitamin group (14.08). The overall mean difference was least for Multivitamin in RMGIC group (13.51), for Antiepileptic in Composite group (7.06) for Anxiolytic in Composite group (9.21) and for Bronchodilator in Compomer group (9.17). In intergroup comparison, composite in the antiepileptic medicament showed least color change value (7.06)

Table 1
List of materials used in the study

Material	Composition	Company
RMGIC (Equia Forte)	Powder: 95% strontium fluoro-aluminate-silicate glass, Liquid: 55 Polyacrylic acid, 40% aqueous polyacrylic acid	GC Corporation India
Compomer (Dyract Flow)	Resin matrix: Bis-DMA, TEGDMA and TMPTCA, Filler: Strontium fluoride glass, Polyacrylic acid	Dentsply Sinora USA
Composite (Filtek Z350)	Resin matrix: Bis- GMA, UDMA, TEGDMA AND Bis-EMA, Filler: Silica and Zirconium particles	3M ESPE USA
Multivitamin 200ml (Zincovit)	Purifies water, Sucrose, Humectants, Emulsifier, Vitamins, Minerals, Preservative, L-Lysine, Stabilizer, Acidity regulators, Sequestrant and Antioxidant	Apex laboratory private limited (India)
Antiepileptic 100ml (Levepsy)	Levetiracetam (Sugar free)	Cipla limited (India)
Anxiolytic 100ml (Atarax)	Hydroxyzine hydrochloride, Strawberry flavoring agent	Dr Reddy's laboratories limited (India)
Bronchodilator 100ml (Asthalin)	Salbutamol Sulphate, Carmoisine flavoring agent	Cipla limited (India)

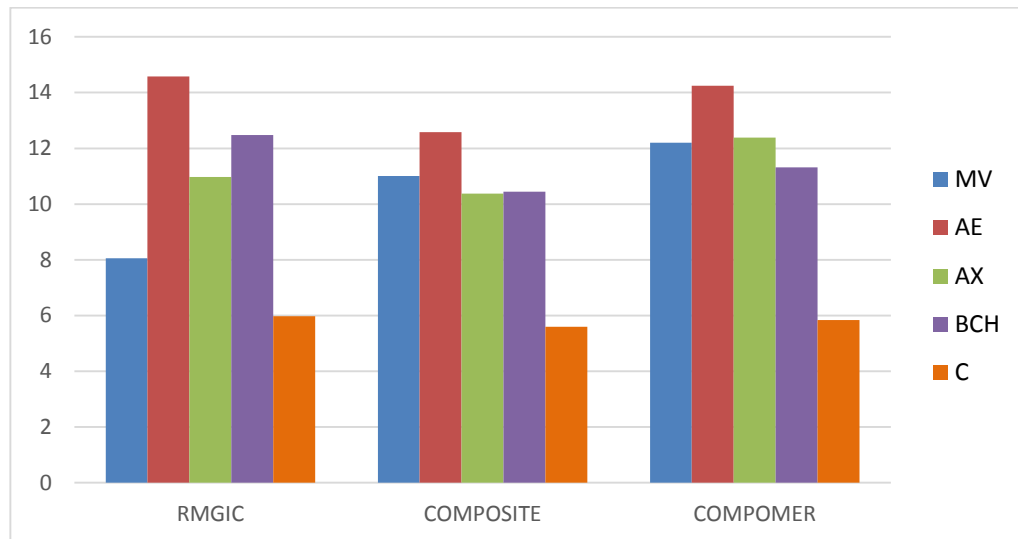
Table 2
Surface micro hardness values (VHN) of different materials on different days with different medications (P value calculated using two-way ANOVA)

	Sub groups	Base line mean values	1 day		7 days		21 days		40 days		Over all		P Value
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean difference	SD	
RMGIC	MV	68.50	67.84	0.24	67.28	0.39	63.89	0.52	60.45	1.14	8.05	1.15	0.00*
	AE		66.39	0.09	62.99	0.38	58.95	0.37	53.92	0.54	14.58	0.57	
	AX		66.31	0.24	64.55	0.52	62.85	0.75	57.53	0.78	10.97	0.73	
	BCH		67.12	0.33	65.73	0.30	60.82	0.70	56.02	0.59	12.48	0.81	
	C		68.35	0.23	65.95	0.30	64.81	0.38	62.53	0.20	5.97	0.25	
COMPOSITE	MV	78.32	77.70	0.15	74.53	0.46	70.21	0.38	67.31	0.30	11.01	0.26	0.00*
	AE		75.23	0.30	71.52	0.44	68.07	0.33	65.80	0.21	12.58	0.48	
	AX		75.17	0.23	72.60	0.00	69.49	0.17	67.95	0.33	10.37	0.48	
	BCH		76.18	0.14	72.17	0.00	69.86	0.22	67.88	0.33	10.44	0.40	
	C		78.09	0.20	76.25	0.00	73.27	0.43	72.72	0.74	5.64	0.83	
COMPOMER	MV	73.45	73.21	0.03	67.60	0.00	66.35	0.31	61.25	0.43	12.02	0.44	0.00*
	AE		70.07	0.40	67.34	0.00	63.95	0.39	59.21	0.21	14.24	0.50	
	AX		71.17	0.14	68.40	0.00	65.15	0.33	61.07	0.30	12.38	0.37	
	BCH		71.23	0.28	69.30	0.00	66.71	0.07	62.13	0.22	11.32	0.39	
	C		73.35	0.21	70.28	0.00	69.91	0.19	67.61	0.19	5.84	0.24	
P Value			0.000*		0.000*		0.000*		0.000*		0.000*		

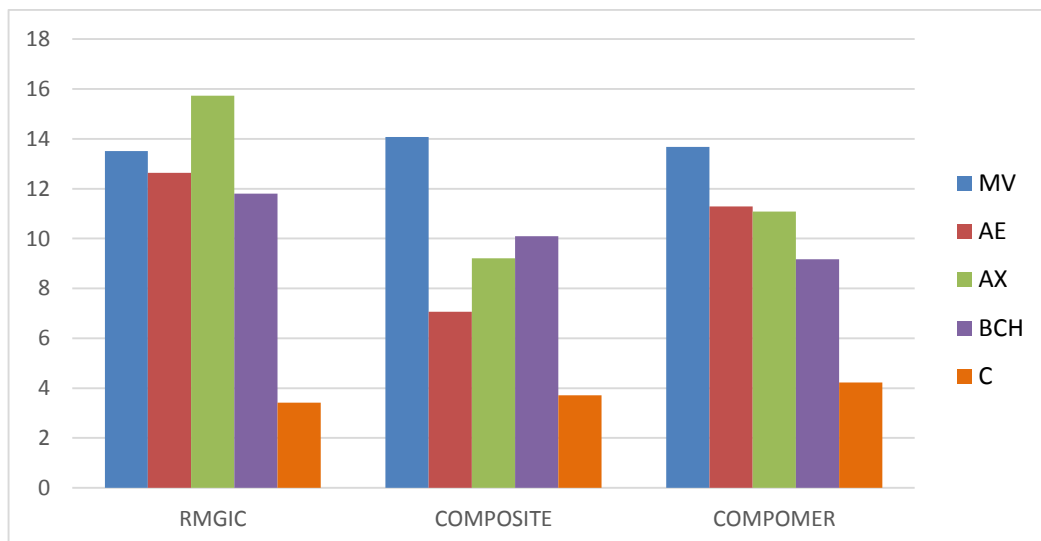
Table 3
Change in color values (ΔE) in different groups on different days with different medications (P value calculated using two-way ANOVA)

Groups	Sub groups	1 day		7 days		21 days		40 days		Overall		P Value
		Mean Difference	SD	Mean Difference	SD	Mean difference	SD	Mean Difference	SD	Mean difference	SD	
RMGIC	MV	1.59	0.22	2.41	0.52	4.65	0.10	5.86	0.25	13.51	0.27	0.000*
	AE	1.28	0.08	4.16	0.34	3.60	0.22	3.60	0.40	12.64	0.26	
	AX	1.50	0.13	4.04	0.34	4.98	0.36	5.21	0.39	15.73	0.31	
	BCH	1.42	0.18	3.73	0.21	3.09	0.08	3.56	0.22	11.8	0.17	
	C	0.35	0.08	0.55	0.22	1.07	0.16	1.45	0.24	3.42	0.18	
COMPOSITE	MV	2.19	0.20	4.37	0.34	3.12	0.21	4.40	0.36	14.08	0.28	0.000*
	AE	1.03	0.05	2.26	0.52	2.07	0.14	1.70	0.24	7.06	0.24	
	AX	1.34	0.14	2.32	0.21	2.04	0.31	3.51	0.34	9.21	0.25	
	BCH	1.53	0.18	2.25	0.21	3.66	0.36	2.65	0.32	10.09	0.27	
	C	0.36	0.09	0.63	0.16	1.20	0.09	1.52	0.35	3.71	0.17	
COMPOMER	MV	1.26	0.17	2.72	0.23	4.78	0.24	4.92	0.10	13.68	0.19	0.000*
	AE	1.38	0.15	3.53	0.18	3.72	0.30	2.66	0.16	11.29	0.20	
	AX	1.34	0.14	3.58	0.08	4.48	0.35	1.69	0.20	11.09	0.19	
	BCH	1.43	0.16	2.59	0.32	3.57	0.29	1.58	0.16	9.17	0.23	
	C	0.39	0.18	0.69	0.21	1.71	0.22	1.44	0.31	4.23	0.42	
P Value		0.000*		0.000*		0.000*		0.000*		0.000*		

Graph 1: Overall mean difference values of surface micro hardness (VHN) in different groups (P value calculated using two-way ANOVA)



Graph 2: Overall mean difference values (ΔE) in color change in different groups (P value calculated using two-way ANOVA)



Discussion

Caries is one of the most frequent chronic diseases in the world. This occurs as a result of a long-term complex interaction between acid-producing bacteria and fermentable carbohydrates, with host factors such as teeth, saliva, and diet playing a vital role. A tooth may require repair or restoration for a variety of causes other than dental caries.¹ Liquid medicaments with reduced pH and greater titratable acidity may cause difficulties such as surface erosion, intrinsic

or extrinsic color change and effect on dental restorations. Furthermore, extended contact with liquid medicaments on deciduous teeth can cause enamel softening, uneven surfaces, and restorative surface deterioration.⁵ American Academy of Pediatric Dentistry's (AAPD's), Caries Risk Assessment tool (CAT) stipulates that child with chronic illnesses and those who use medications for an extended period of time have a higher risk of dental disease.⁶Hence, in our study liquid medicaments syrups were used to assess the properties of aesthetic restorations.

In this study the restorative materials used were RMGIC (Equia Forte), Compomer (Dyract Flow) and Composite (Filtek Z350) as they are the most commonly used restorative material, mentioned in various studies by Tamer Tüzüner², S. yildium⁷, Elif Aydogan Ayaz⁸. Shade A2 was selected for the materials used in this study to minimize the influence of color differences and for standardization purpose. In this study, the size of the specimens prepared were 5mm in diameter and 2mm in thickness. The finishing was done with matrix strips and polishing was done using aluminium oxide abrasive discs. According to Hachiya Y et al.⁹ For reducing staining potential, the length of time between finishing and polishing is an important factor. Hence the samples were immersed in distilled water for 24 hours prior to polishing to complete the polymerization process. This study is in agreement with Bagheri et al¹⁰ who have used both matrix finish and polished specimen and have stated that it exhibited high susceptibility to staining.

Because of its non-acidic pH, distilled water was chosen in this study as the control medium and also as the storage medium because of its ability to replicate a wet oral cavity. It is in accordance with studies performed by Ertas et al ¹¹ and Fontes et al¹². Water uptake has been shown in these studies to modify and degrade the properties of resin-based restorations as material degradation occurs due to the hydrolysis of silane interface and loss of chemical interactions between filler particles. Various authors have studied different immersion time for different days to study the effect of medication on materials. According to the study by Dan Zhou et al¹³ in the oral cavity, the contact of the enamel with acidic substances is usually only transient before clearance by saliva.

In the present study the specimens were immersed daily for 2 min twice a day to stimulate transient contact of restorations with medicaments. The specimens were stored in distilled water after every immersion cycle, to replicate the clinical situation and the water was changed daily to prevent carry over- staining. It was contradictory by Curtin¹⁴ who have placed the specimen in continuous contact with the staining solutions. In this study the specimen were immersed for two times a day for 40 days as most of the medications used in this research are indicated to be taken twice a day for prolonged period of time.

The Vickers microhardness test was chosen for this study because it is a reasonably simple, widely used, and reliable method of getting outcomes as stated by Criag R¹⁵ and O'Brien WJ¹⁶. The decrease in surface microhardness was observed among all the materials immersed in distilled water. According to D I Hamadamin et al ⁵ the decrease in surface hardness of the restorative materials after stored in distilled water was because within the resin matrix, water functions as a plasticizing molecule, softening the polymer resin part by expanding the network and lowering frictional forces between polymeric chains.

But it was contradicted by Badra et al¹⁷ who observed that immersion in distilled water showed an increase in the hardness of resin-composite restorative. This may be due to elution of unreacted components from the resin-composites and post-irradiation and post setting polymerization.

It was observed that the surface hardness decreases over the period of time after immersion in syrups from baseline up to 40 days for all three materials used and the difference was highly significant ($p < 0.05$). Our result is in accordance with Gurdogan Guler EB et al¹⁸ who also demonstrated lower microhardness values from baseline till all the measurement days ($p < 0.05$). In the present study, microhardness was better after 7 days in all the restorative material as compared to 40 days. Which is similar to result by Badra et al¹⁷ who stated that after 7 days of immersion in a beverage, the restorative material was more stable in terms of microhardness than after 30 days. In the current study, the reduction in surface hardness was observed more with compomer and RMGIC when exposed to different liquid medicaments. It might be due to the change in the filler particle size. A variety of responses in the resin-based material might be due to the differences in structure between the materials such as the size and amount of filler, the type of matrix and volume of resin material as stated by Celik¹⁹ et al.

We observed that overall reduction in surface hardness with RMGIC, composite and compomer was seen most in antiepileptic group. Multivitamin showed best result with RMGIC whereas antiepileptic, anxiolytic and bronchodilator showed best result with Composite group. This study observations expresses that contact of restorations with medicaments can decrease the surface hardness and this can be summative effect of acid present and PH of medicaments, its adhesion to tooth enamel along with other factors like buffering capacity, mineral content and salivary flow rate of individual. Hara and Zero et al²⁰ reported that PH can be consider as a predictor for dental erosion. According to Gurdogan Guler EB et al¹⁸ the properties of restorative materials are affected by the chronic use of multivitamin syrups and effervescent tablets. Our results are in accordance with Zhou D et al¹³, Dhwani L et al²¹, and it can be stated that irrespective of type of medicaments used, liquid absorption causes surface degradation of material and compromising its surface hardness.

In this study, a spectrophotometer was used for color stability as it is accurate and readily available. Studies by Ruyter IE²² and Abu-Bakr N²³ have determined that a colour change (ΔE) of 3.3 or less is clinically appropriate. However, in this study, the majority of colour change values were greater than 3.3, indicating that they were not clinically acceptable. The colour change was less with distilled water compared to other groups in this study and the difference was statistically significant. The changes in the control group may be attributed to the materials hygroscopic water absorption. This finding is consistent with the findings of Eslami et al²⁴ who stated that the staining effect of distilled water was the least among the tested groups. When immersed in various liquid medications over 40-day period, the colour change was observed in all the materials, with the most in the RMGIC group and the least in the composite group except for multivitamin and the difference was highly significant ($p < 0.05$). The degree of water sorption of the matrix resin may contribute to the staining susceptibility of resin-based materials. According to Iazzetti et al²⁵ fluoride-releasing materials are more

susceptible to staining. RMGIC's colour change in this study may be due to its fluoride releasing property, less filler particles and as it contains HEMA resin matrix which is hydrophilic in nature thus it is more susceptible to staining. It is in agreement by Tunc ES et al²⁶ that material with less filler particle and rough surface are more prone to discoloration. Composite resin showed less color change as compared to RMGIC and compomer as it is hydrophobic and comprises of Bis-GMA, TEGDMA and UDMA which are less susceptible to staining. It is in agreement with Bagheri et al¹⁰ who stated that resin matrix with Bis-GMA, TEGDMA and UDMA showed lower staining susceptibility. This study is in accordance with Shintani H et al²⁷ who reported that hydrophilic materials have a higher degree of water sorption and a relatively higher discoloration value with staining solutions than hydrophobic materials. Water absorption can weaken the binding between the resin matrix and the filler particles, resulting in microcracks or interfacial gaps, or chemical changes in the initiator activator system and water absorption of the monomers in composites, allowing stain penetration and discoloration. On the contrary with Tüzüner et al² as compared to GIC and Compomer, composite showed significant change in color when exposed to commonly used pediatric drugs.

In the present study color stability of compomer was found to be between RMGIC and Composite among all the liquid medication used, it may be due to the hydrophilic nature, resin matrix as well as fluoride release. Our result mentioned that when compared intergroup, the greatest changes in color were observed for RMGIC following immersion in anxiolytic group and least for composite in antiepileptic group. This finding can be explained by differences in the PH, colorant particles, sugar content and viscosity of the syrups studied. The coloring agents present in these liquid medications may be absorbed and adsorbed in varying amount by the resin matrix affecting the color stability of these materials. According to Kahaliv W et al²⁸ as the liquid medications have a high viscosity they tend to stick to the surface of the tooth for extended periods of time and have a poor salivary clearance rate, causing enamel erosion and other complications.

Bagheri et al¹⁰ have suggested that actual staining in the oral cavity, unlike in vitro circumstances, would be influenced by the intermittent nature of stain exposure, dilution of staining media by saliva and other fluids, and polishing of restorations through toothbrushing. Study by Bezgin et al.²⁹ have reported that regular brushing influenced significantly the color stability of aesthetic restorative materials and decreased the amount of color change over time. According to Brooksbank A³⁰ the surface sealants were used to saturate the material surface, as well as to correct any defects, voids, and/ or irregularities, increasing wear- and stain-resistance, and thus enhancing the aesthetic qualities. The results of this study explains that the discoloration of restorative material is due to different factors including the size of particle, fillers present, hydrophilic property of the restorative material as well as PH, sugar content, coloring agents, contact time and viscosity of the liquid medicaments. Thus, this study is in agreement with S Yildium et al⁷ and Gurdogan G et al¹⁸ who stated that liquid medications can affect the color stability of restorative materials by variable amount. As a result, the null hypothesis that the paediatric liquid medication has an effect on the tooth-colored restorative material was accepted in our research.

By altering the ingredients of drugs, negative consequences such as change in color and surface hardness in teeth and restorative materials can be avoided. Pharmaceutical companies should mention the type and amount of sweetener used, as well as the potential for tooth decay. In fact, no-cariogenic-substance drugs should be introduced to the market, with a "Teeth Friendly" symbol on the product. Parents are aware about the tooth decay caused by sugar but are unaware about the sugar containing foods and beverages, including prolonged liquid medicaments. The Pedodontist plays an important role in educating people about the adverse effect of prolonged liquid medications. The availability of unsugard liduid medication for children will inspire dentists and medical professionals to prescribe them. More research is needed to determine the direct effect of sugar containing medicaments on the enamel surface, which is essential prior to any procedures for preventing tooth erosion caused by PLMs.³¹ The qualities of restorations in the oral cavity can be influenced by temperature fluctuations, pH levels, salivary enzymes, and the ionic content of meals or liquids which were not studied in our research.

Conclusion

- The hardness and colour change of restorative material are affected by the composition of the material and the medicament and the oral environment of an individual.
- In most of the subgroups, composite showed better surface hardness and color stability values over 40-day period.

All the material showed (ΔE) value > 3.3. Thus, compromising esthetics with RMGIC being most affected.

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