Comparative Evaluation of Colour Changes In Composite Resin Restorative Material, Resin Reinforced Glass Ionomer Restorative Material and Zirconia Reinforced Glass Ionomer Restorative Material Caused by Three Pediatric Liquid Formulations Prescribed in Epileptic Disorders: An in-Vitro Study

Dr. Vatsala Srivastava[1], Dr. Ashwin Jawdekar[2]
[1]Post Graduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai, Maharashtra, India
[2] Professor and Head of Department, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai, Maharashtra, India

Abstract

Background: Anti-epileptic medicines can affect the colour stability of dental restorations. We evaluated colour changes caused by three commonly prescribed anti-epileptic formulations.
Methodology: Fifty-four-disc samples, 18 for each restorative material: composite resin (COMP), resin reinforced glass ionomer (RRGI) and zirconia reinforced glass ionomer (ZRGI) were prepared. Specimens were divided into three groups (6 in each)-1: phenytoin syrup, 2: phenobarbitone syrup, 3: sodium valproate syrup. Samples were kept in 15 ml of syrups for 2 minutes twice daily and incubated in distilled water at 37° C. Colour-changes were observed at baseline, 1- and 3-month interval using a spectrophotometer.
Results: COMP (ΔE 18.3) showed the most colour-change at 1 month in phenytoin syrup group, ZRGI (ΔE 12.3) in phenobarbitone syrup group while least colour-change was seen in RRGI (ΔE 2.58) in phenytoin syrup group. RRGI (ΔE 20.09) showed the most colour-change between 1 and 3months in phenytoin syrup group, ZRGI (ΔE 9.53) in phenobarbitone syrup group while least colour-change was seen in COMP (ΔE 2.32) in sodium valproate syrup group. RRGI (ΔE 20.53) showed the most colour-change between baseline

and 3 months in phenytoin syrup group, COMP (ΔE 17.36) in phenytoin syrup group whereas the least colour-change was seen in ZRGI (ΔE 3.88) in sodium valproate syrup group. The differences were statistically significant.

Conclusion: Colour stability when assessed at the end of 1 month was found to be most in resin reinforced glass ionomer followed by zirconia reinforced glass ionomer and least in composite resin. When assessed between at the end of third month, most colour stability was seen in composite followed by zirconia reinforced glass ionomer and least in resin reinforced glass ionomer. Over all at the end of our study most colour stability was seen in zirconia reinforced glass ionomer followed by composite and least in resin reinforced glass ionomer.

IndexTermsrestorative material, food colourants, aesthetics, colour change, staining, colour stability, Zirconia reinforced glass ionomer cement, glass ionomer cement, composite

DOINumber:10.14704/nq.2022.20.8.NQ44945 **NeuroQuantology 2022; 20(8): 9250-9258**

Introduction

A number of conditions like dental caries, discolouration, trauma and early loss of teeth can lead to aesthetically unacceptable dentitions. With the growing general awareness many parents and children are becoming conscious of their appearance and report to dentists for aesthetic reasons due to discoloured and unpleasing dentition.[1] The presence of poor aesthetics may affect the child's confidence and can affect their normal personality development, if not corrected. An ever-increasing demand for aesthetics has led to innovations and development of newer treatment modalities for these problems.[2]

In pediatric dentistry the commonly used restorative materials for improving aesthetics in carious or traumatized teeth are composite, glass ionomers cements, compomers, and resin modified glass ionomer restorative material.[3] Dental composites are of a dense cross-linked polymeric materials which are strengthened by addition of glass or resin filler particles and/or fibers bounded to the matrix with the help of silane coupling agents.[4] Composite resins aids in providing retention for aesthetic restorations in both primary and permanent dentition. Resin-modified glass ionomers cements which are also known as hybrid ionomers, are used in low stress bearing areas and are recommended in patients with high risk of caries. Zirconia reinforced glass ionomer restorative material is a new class of restorative material that provides strength and durability of amalgam and protective benefits of GIC which totally eliminates the exposure to hazardous materials like mercury and provides sustained release of fluoride.[5]

These materials are available with several types of fillers, and have significantly higher strengths, despite these modifications the materials are also susceptible to discolouration that may be due to intrinsic or extrinsic factors.[2]

The colour sustainability of restorative materials is necessary to assess the success or failure of the treatment. The aesthetics of these materials becomes compromised when it gets exposed to the dynamic environment in the oral cavity due to the presence of microflora, saliva, and frequent intake of coloured food beverages and at times long term medications which becomes a challenging task to dental experts.

Epilepsy is a common neurologic disorder affecting children and majority of epilepsy have onset in childhood.[6] Various syrup and oral suspensions are prescribed in children suffering from epileptic disorders. Various

studies have been conducted to test the colour stability of the restorative materials against syrups prescribed in children, we did not come across any study assessing the colour stability of restorative materials caused by syrups prescribed for epilepsy in patients or their effect on the dental restorations. With the increase in need of superior aesthetics by the parents and children, additional research is required to check the effect of these syrups on commonly used dental restorative materials. Therefore, the aim of this study was to evaluate and compare the colour change caused by commonly prescribed syrup medications for epileptic disorders.

Objectives:

- To compare and evaluate the colour changes caused by three anti-epileptic medications - Phenytoin syrup, Phenobarbitone syrup and Sodium Valproate syrup on three different restorative materials - composite resin, resin reinforced glass ionomer restorative material and zirconia reinforced glass ionomer restorative materials at base line, 1month and 3-month time interval.

2. Study design and setting:

The study was conducted in the XXX after obtaining approval by the Institutional Review Board in in-vitro settings.

This study involves comparison of changes in colour three different restorative materials caused by three pediatric syrup formulations prescribed in epileptic disorders.

2.2 Sample Preparation

A total of 54-disc samples were prepared, with the dimensions 10 mm diameter and 2 mm thickness using Teflon ring. Eighteen discs prepared from each material namely Composite resin restorative material (COMP), Resin reinforced glass ionomer restorative material (RRGI) and Zirconia reinforced glass ionomer restorative material (ZRGI).After the specimen preparation all the specimens were polished and divided into three groups.[3]

In this study we have compared and evaluated colour changes in Composite resin, Resin reinforced glass ionomer restorative material and Zirconia reinforced glass ionomer restorative material at base line, 1 month and 3 months. The prepared samples from each restorative material were stored in a glass beaker containing distilled water in an incubator at 37 degrees Celsius to mimic the oral environment. These samples were immersed in 15ml of each syrup medication twice daily for 2 minutes and then washed and again stored in the incubator. The study was carried out for duration of 3months. All specimens were analysed for change in colour using a spectrophotometer.

Spectrophotometer is scientific standardized colourimetric equipment used for matching and measuring colours which gives information about reflectance curve depicted as a function of wavelengths in entire visible range. This then numerically specifies the perceived colour of an object. CIELAB (Commission Internationale de l'Eclairage) colour coordinates system is a mode which provides information about location of object colour in a 3- dimensional colour space. It quantifies the colour in three coordinate values L*, a*and b*. Here L* represents brightness or lightness (value) and a* and b* serve as numeric correlates both for hue and chroma.[7]

Colour change was calculated from the mean ΔL*, Δa*, and Δb* values for each sample with the following formula.[8]

Equation: $\Delta E^* = [(\Delta L^*)2 + (\Delta a^*) + (\Delta b^*)2$.

2.3 Grouping of the specimens –

Group 1–- phenytoin Syrup (Eptoin Syrup Abbott Healthcare Pvt. Ltd., India),

Group 2 –- phenobarbitone Syrup (Gardenal Syrup Abbott Healthcare Pvt. Ltd., India),

Group 3 – Sodium Valproate Syrup (Valparin Syrup Sanofi India Pvt. Ltd.)

These samples were further divided into subgroups of six samples as per the three restorative materials.

Table 1: Allotment of samples in their respective groups

	Medication	**Material**		
		Group A	**Group B**	**Group C**
Group 1	phenytoin syrup	COMP (n=6)	RRGI (n=6)	ZRGI (n=6)
Group 2	phenobarbitone syrup	COMP (n=6)	RRGI (n=6)	ZRGI (n=6)
Group 3	sodium valproate syrup	COMP (n=6)	RRGI (n=6)	ZRGI (n=6)

2.4 Procedure of application of material

Group 1) - In this group A- COMP, B- RRGI and C- ZRGI samples was tested with phenytoin syrup at base line, after 1 month and after 3 month time interval respectively.

Group 2) - In this group A- COMP, B- RRGI and C- ZRGI samples was tested with phenobarbitone syrup at base line, after 1month and after 3month time interval respectively.

Group 3) - In this group A- COMP, B- RRGI and C- ZRGI samples was tested with sodium valproate syrup at base line, after 1month and after 3month time interval respectively.

Polished specimen was kept in 15 ml of each syrup medication poured in three glass beakers for 2 mins twice daily and then stored in distilled water kept in a beaker which were placed in incubator at 37 degrees Celsius, and checked at baseline, 1 month & 3month interval.

2.3 Assessment of colour change

All specimens at the baseline underwent colour determination with spectrophotometer. Measurements were then taken at baseline, 1 month & 3month interval, after immersion in the respective medicated syrup.

Colour changes were characterized using the Commission Internationale d'Eclairage L* a* b* colour space (CIE L* a* b*). The colour difference (ΔE) was calculated according to the following equation: $\Delta E^* = [(\Delta L^*)2 + (\Delta a^*)2 + (\Delta b^*)2\ ]$ [8]

2.4 Statistical Analysis

Data were entered into a Microsoft Office Excel (version 2016) in a spreadsheet and checked for errors and discrepancies. Data analysis was done using windows based 'MedCalc Statistical Software'Version19.0.6 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2019). Data for the change in colour intensity (ΔE) was expressed as means with Standard Deviation (SD) and compared using inferential statistical tests of significance.

Results

Data were checked for normality using Shapiro Wilk test for all the comparison since the distribution was normal. Parametric test of significance – one way ANOVA was used.

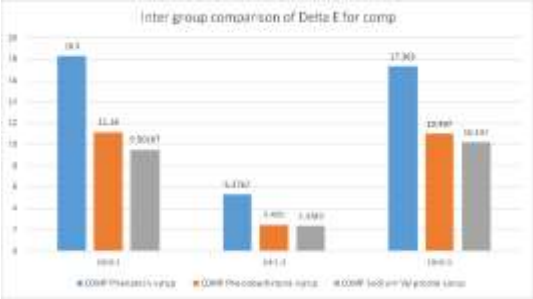

Figure 1- Inter-group comparison for ΔE at base-line, 1 month and 3 months for Composite resin

COMP (**ΔE 18.3**) showed the most colour change at **1 month** in phenytoin syrup group,followed by COMP (**ΔE 17.36**) in phenytoin syrup group seen between **base line - 3month** andleast colour change was seen in COMP (**ΔE 2.32**) **between 1 month-3months**. (Figure 1)

RRGI (**ΔE 20.53**) showed the most colour change between **base line - 3months** in phenytoin syrup group,followed by RRGI (**ΔE 20.09**) in phenytoin syrup group seen **between 1 month- 3months** in phenytoin andleast colour change was seen in RRGI (**ΔE 2.58**) in phenytoin syrup group at **1 month**. (Figure 2)

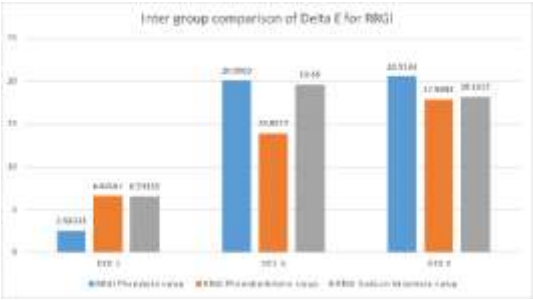

Figure 2 – Inter-group comparison for ΔE at base-line, 1 month and 3 months for Composite resin

ZRGI (**ΔE 12.3**) showed most colour change in phenobarbitone syrup group at **1 month**, followed by ZRGI (**ΔE 9.53**) in phenobarbitone syrup group seen between **1 month- 3months** and least colour change was seen in ZRGI (**ΔE 3.85**) in sodium valproate syrup group between **base line - 3month.** (Figure 3).

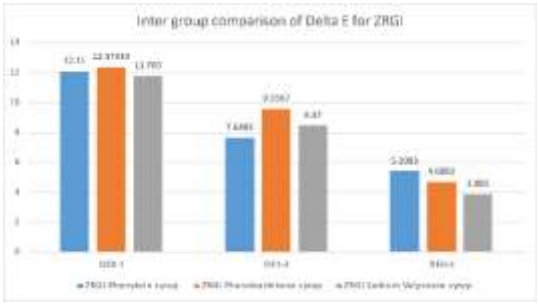

Figure 3- Inter-group comparison for ΔE at base-line, 1 month and 3 months for Zirconia reinforced GIC

Inter-material comparison have been show in figure 4,5,6 between base-line, 1 month and 3 months, respectively.

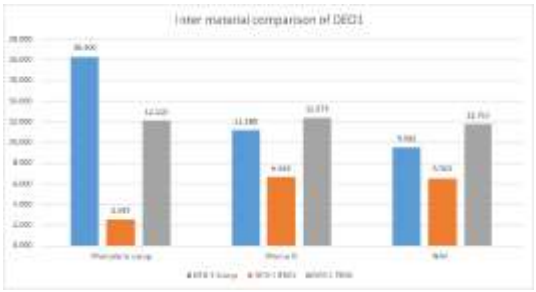

Figure 4 – Inter-material comparison at 1 month

(Pheno B – Phenobarbitone syrup, NAV-Sodium valproate syrup

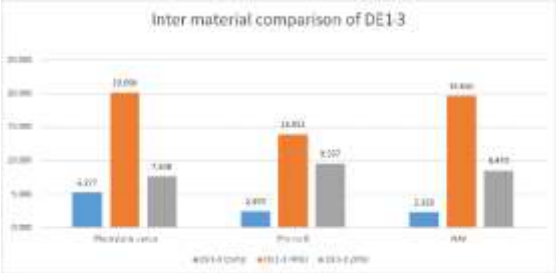

Figure 5 Inter-material comparison between 1 month – 3 months
(Pheno B – Phenobarbitone syrup, NAV-Sodium valproate syrup)

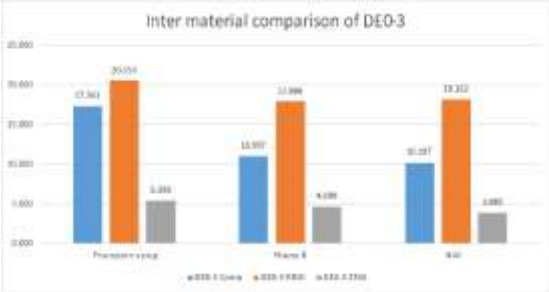

Figure 6 – Inter-material comparison between base line and 3 months
(Pheno B – Phenobarbitone syrup, NAV-Sodium valproate syrup)

4. Discussion

This, being the first study of its kind, was conducted an in-vitro settings since in vitro studies can lay a foundation for further in-vivo studies. In vivo studies have certain practical limitations because of various factors such as different dietary habits in children, different degrees of oral hygiene and different dose requirements and combinations of anti-epileptic drugs. Thus, a randomized controlled trial may not be feasible as a first level investigation.

In our study RRGI (ΔE 20.53) showed the most colour change between base line – 3 months in phenytoin syrup group, followed by COMP (ΔE 17.36) in phenytoin syrup group, least colour change was seen in ZRGI (ΔE 3.88) in sodium valproate syrup group. Zirconia reinforced glass ionomer cement mostly constitutes zirconium oxide, glass powder, tartaric acid, polyacrylic acid, and deionized water as its liquid. The main component of zirconia-reinforced GIC (Zirconomer Improved) is nano-sized zirconia filler particles ranging from 96.5%to 98.5%. These filler particles impart high level of translucency and achieve closer match to natural tooth colour. However, increased susceptibility of ZRGI in terms of colour change may be associated with addition of variable sized inert zirconia particles. [9]

The presence of inert zirconia filler particles and the difference between refractive index of filler particles and reacted glass particles may also contribute to colour changes as stated by Kale et al. (2019)[4]

In a study reported by Tüzüner et al.(2017)[10] the composite resin exhibited significant discolouration values when exposed to commonly used pediatric drugs. Probable reason behind discolouration of composite resin can be water absorption induced due to weaker bond between resin matrix and filler particles leading to microcracks between matrix-filler interface or due to changes in chemical composition of the initiator-activator system and water absorption of the monomers in composites enabling stain penetration and discolouration.[10]

Silanization of filler particles used in resin-based composite also plays an important role in discolouration. Rueggeberg and Craig (1988) [11] stated the fact that silane is hydrophilic and leads to high water absorption. Therefore, high staining values of composite resin may attribute to high proportion of silane present in the structure of the material. As a result, it can be stated that composite resins with high amount of resin matrix and larger size filler particles

have more tendency toward discolouration.[12] RRGI (ΔE 20.09) showed the most colour change between 1 month-3months in phenytoin syrup group, followed by ZRGI (ΔE 9.53) in phenobarbitone syrup group, least colour change was seen in COMP (ΔE 2.32) in sodium valproate syrup group. Therefore, the micro-cracks or the interfacial gaps at the interface between filler and matrix allow stain penetration and discolouration.

In the study by Knobloch et al. (2000) [13]; authors have stated that all resin reinforced glass ionomer restorative material cements show high water surface assimilation due to their hydrophilic nature, the amount of water adsorption is dependent on the resin content of the resin composite and the quality of the bond between the resin and the filler. Extra water sorption decreases the life of resin composites by expanding and plasticizing the resin component, hydrolysing the silane and causing microcrack formation.

Caries affects both the deciduous and the permanent dentition, and may involve the coronal and radicular parts of the tooth. The interplay between host- and environment related factors govern the development and progress of dental caries. There are many factors which increase the susceptibility of an individual to dental caries or its sequelae. These include microbiological factors, behavioural and lifestyle-related factors like poor oral hygiene. [14]

Esthetic appearance of teeth is considered as a prime factor for social acceptance in addition to restoring functions like mastication and speech, in cases of carious tooth, trauma to the teeth or hypocalcified teeth. Restorations can help prevent development of parafunctional habits, aid in the growth of jaws and alignment of teeth and prevent psychological problems. [15]

The requirement for a natural appearance has led to development of materials that simulate natural teeth.[16] Commonly used restorative materials in primary and permanent dentition are conventional glass ionomers, composite resins, and resin-modified glass ionomers. Aesthetics of these materials can be compromised when exposed to the dynamic environment in the oral cavity with the presence of microflora, saliva, and intake of foods and beverages; thus making it challenging task for dental experts.[17]

Extrinsic dental discolouration usually results from excessive consumption of coloured beverages, fruit juices, energy drinks, candies or prolonged use of syrup medications in case of children with special health care needs. Most of these beverages and medicated syrups have a low pH rendering them acidic in nature. This results in staining and corrosion of the restorations. Epilepsy is neurologic disorder which commonly affects children and majority of epileptic disorders get diagnosed in childhood. [14]

Oral suspensions which are prescribed in children with such disorders are to be taken for longer duration. Many Studies have been conducted where colour stability has been checked for these restorative materials against syrups formulations like of antibiotics, anti-inflammatory and analgesics. In our review of literature, we did not come across studies checking the colour stability of restorative materials against syrup medication prescribed for epileptic children. Therefore, we must, know the colour stability of different aesthetic restorations to various syrup formulations commonly prescribed for epileptic disorders.

There are certain limitations of this study due to the in-vitro methodology. The oral cavity is dynamic in nature and is difficult to replicate, factors such dietary habits, the impact of brushing, different consistency of saliva, presence of chromogenic - non-chromogenic bacteria and presence of high or low susceptibility to caries and different dozes and duration of medication prescribed to children with epileptic disorders have its impact on the staining.

Despite the above limitations, no study has so far reported colour changes in Composite resin, Resin reinforced glass ionomer restorative material and Zirconia reinforced glass ionomer restorative material caused by three pediatric liquid formulations prescribed in epileptic disorders. Therefore, it lays a foundation for further research.

5. Conclusion

Colour stability when assessed at the end of 1 month was found to be most in Resin reinforced glass ionomer followed by ZRGI and least in composite. When assessed between at the end of third month, most colour stability was seen in composite followed by ZRGI and least in RRGI. Over all at the end of our study most colour stability was seen in ZRGI followed by composite and least in RRGI.

6. Recommendations

Further in-vivo, multi-centric studies with a larger sample and longer follow-up period with multiple observations to test the colour stability of the different restorative materials for both primary and permanent dentition is recommended.

7. Conflict of interest

The authors declare that there are no conflicts of interest.

8. Funding

No external source of funding.

Reference

- Tarang C, Gunjan Y, Mani TA, Kavita D, Arora D. Recent trends of esthetics in pediatric dentistry. Int J Oral Health Med Res. 2017;4:70-5.
- Kapur A, Chawla HS, Goyal A, Gaube K. An esthetic point of view in very young children. The Journal of clinical pediatric dentistry. 2005 Jan 1;30(2):99-103.
- Kale YJ, Nalwade AV, Dahake PT, Dadpe MV, Kendre SB. Effect of different pediatric drug formulations on color stability of composite, zirconia-reinforced glass ionomer cement, and glass ionomer cement. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2019 Apr 1;37(2):151.
- Philips' Science of Dental Materials - 12th edition, page no. 277-298
- Zirconomer Improved Zirconia Reinforced Restorative. Available from: http://www.shofu.com.sg/downloads/pdf/ZirconomerImproved Brochure.pdf.
- Guerrini R. Epilepsy in children. The Lancet. 2006 Feb 11;367(9509):499-524.
- Wyszecki G, Stiles WS. Color science: concepts and methods, quantitative data and formulas.
- Ganz E, Pauli HK. Whiteness and tint formulas of the Commission Internationale de l'Eclairage: approximations in the L* a* b* color space. Applied optics. 1995 Jun 1;34(16):2998-9.
- Padiyar N. Colour stability: An important physical property of esthetic restorative materials. International Journal of Clinical Dental Science. 2010;1(1).

- Tüzüner T, Turgut S, Baygin O, Yilmaz N, Tuna EB, Ozen B. Effects of different pediatric drugs on the color stability of various restorative materials applicable in pediatric dentistry. BioMed research international. 2017 Jan 10;2017.
- Rueggeberg F, Craig RG. Correlation of parameters used to estimate monomer conversion in a light-cured composite. Journal of dental research. 1988 Jun;67(6):932- 7.
- Oysaed H, Ruyter IE. Water sorption and filler characteristics of composites for use in posterior teeth. Journal of dental research. 1986 Nov;65(11):1315-8
- Knobloch LA, Kerby RE, McMillen K, Clell and N. Solubility and sorption of resinbased luting cements. Operative Dentistry. 2000 Sep 1;25(5):434-40.
- Abusunilli H, Avula JS, Kakarla P, Bandi S, Mallela GM, Vallabhaneni K. Colour stability of aesthetic restorative materials used in pediatric dentistry: Anin vitro study. Journal of Indian Society of Pedodontics and Preventive Dentistry 2016;34:233-7
- Mount GJ, Hume WR, Ngo HC, Wolff MS, editors. Preservation and restoration of tooth structure. John Wiley & Sons; 2016 Jun 13.
- Hervás García A, Lozano M, Cabanes Vila J, Barjau Escribano A, Fos Galve P. Composite resins: a review of the materials and clinical indications.
- Miglani S. Burden of dental caries in India: current scenario and future strategies. International journal of clinical pediatric dentistry. 2020 Mar;13(2):155.

List of abbreviations	
COMP	Composite resin
RRGI	Resin reinforced glass ionomer restorative material
ZRGI	Zirconia reinforced glass ionomer restorative material
Pheno B	Phenobarbitone syrup
NAV	Sodium Valproate syrup