International Journal of Contemporary Pediatrics
Mridhul MU et al. Int J Contemp Pediatr. 2022 Jan;9(1):69-74
http://www.ijpediatrics.com
pISSN2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20214941

Original Research Article

Effect of pediatric drugs on solubility of restorative materials used in primary teeth

Mridhul M. U., Ambili Ayilliath*, Rena Ephraim, Sharath Chandrashekhar

Department of Pediatric and Preventive Dentistry, Mahe Institute of Dental Sciences, Mahe, Pondicherry, India

Received: 25 October 2021
Revised: 16 November 2021
Accepted: 01 December 2021

***Correspondence:**
Dr. Ambili Ayilliath,
E-mail: dr_ayilliath@yahoo.com

ABSTRACT

Background: Pleasant tasting syrups have a long history of use in pediatric practice to aid compliance with medication. Pharmaceutical firms sweeten liquid drug preparations with sucrose to increase the palatability which causes dental caries and erosion in children. In pediatric population, the commonly used esthetic restorative materials are glass ionomers, compomers or composites. Hence solubility of dental restorative materials are of considerable clinical importance and cannot be overlooked. Aims and objectives of current study were to evaluate the effect of commonly used pediatric drugs on the surface solubility of pediatric restorative materials.
Methods: The study was conducted on 40 disc shaped specimens of GIC and composite immersed in artificial saliva and pediatric drugs, at 37^0C for 7 days to determine the solubility in pediatric drug formulations. The solubility of the specimens was calculated by a given formula by comparing the initial and final masses of the specimens.
Results: In both GIC and Composite groups higher solubility was seen with paracetamol drug formulations. The mean solubility value of GIC was 0.14±0.02 and that of composite was 0.07±0.035, in paracetamol drug formulations.
Conclusions: From the above experimental study it can be concluded that the solubility of restorative materials were comparatively higher in pediatric liquid medications with low pH. Among the drugs paracetamol showed increased erosive effects leading to solubility.

Keywords: Pediatric drugs, Solubility, Restorative materials, Primary teeth

INTRODUCTION

Early childhood caries (ECC) is one of the most prevalent diseases in children worldwide. ECC is driven by a dysbiotic state of oral microorganisms mainly caused by a sugar rich diet. Additionally, poor oral hygiene or insufficient dental plaque removal leads to the rapid progression of ECC.[1] These primary teeth that are affected by caries should be filled with suitable materials to restore the function, and morphology of missing tooth structure till its natural exfoliation period. The demand for esthetic appearances and concerns about conserving the tooth structure in esthetic conscious society in relation to various dental materials is increasing day by day in Pediatric dentistry. This has led to the development of tooth colored restorative materials. Commonly, pediatric population are treated with glass ionomer (GIC), compomers, and composites with the proper indications depending upon the individual requirements of the children.[2] Usually young children are more prone to illnesses like common cold, cough, fever, pneumonia etc as their immune system hasn't been exposed to many infections. These chronically ill young children receive a variety of oral liquid medications like analgesics, antibiotics, antihistaminics, antiepileptics, multivitamins, and antitussives for improvement or maintenance of their health. [2] Pleasant tasted syrups have a long history of use in pediatric practice to aid compliance with medication.

Pharmaceutical firms sweeten liquid drug preparations with sucrose to increase the palatability, compliance and also to act as a preservative. Additionally, these syrups contain agents which aid in improvement of the appearance, bioavailability and stability. These pharmaceutical adjuvants are usually considered to be inert and do not add to or affect the intended action of the therapeutically active ingredients. However, these inert agents pose dangers like dental caries and erosion by decreasing plaque pH because of their increased acidity.[3] In addition to pH, viscosity of the medicated syrups is an important factor to be considered in erosion process. The syrup with high viscosity has more adhesiveness and less flowability. The greater the adherence of the syrup, the longer will be the contact time with the tooth surface and higher the likelihood of erosion and dental caries.[5] The ingestion of liquid oral medications at bedtime is frequently not followed by proper oral hygiene. Bedtime intake of liquid medications is harmful to the teeth because the reduced salivary flow during sleep limits the natural cleansing action of saliva, this leads to the formation of caries and need for restoration of the tooth.[6] The ultimate goal of a restoration is to restore the proper tooth form, function and esthetics while maintaining the physiologic integrity of the teeth in harmony with the oral environment. One of the essential factors in the longevity of the restoration is to adapt to the prepared tooth surface and seal the cavity wall.[7] The effect of long-term consumption of sugar containing liquid medications on the teeth in children is an issue of concern for the dental health. A medication with a low pH that comes in frequent and /or sustained contact with teeth has a greater potential to cause dental erosion and caries. Resistance to surface degradation in the oral environment is essential for longevity of the restorations.8 Because of this solubility of dental restorative materials are of considerable clinical importance and cannot be overlooked. Therefore, in view of the increased use of pediatric drugs by children for prolonged periods in recent years, especially those with chronic diseases, it is essential to determine the effects of these drugs on restorative materials used in pediatric dentistry. So the present article shows the effect of these drugs on the solubility of commonly used pediatric restorative materials like GIC and composite resin.

Aim and objectives

Aim and objective of current study was to evaluate the effect of commonly used pediatric drugs on the surface solubility of the restorative materials used in primary teeth.

METHODS

The present in vitro experimental study was carried from October 2018 to September 2019in conjunction with the department of pedodontics and preventive dentistry, Mahe institute of dental sciences and hospital, Mahe and further evaluation was carried in Yenepoya research centre, Mangalore, Karnataka India.

Solubility determination

Two different restorative materials namely composite resin (3M) and GIC (Figure 1) were used in this present study. 40 discs shaped specimens were prepared, having dimensions 12 mm×2 mm using teflon moulds (Figure 2). For each specimen, the material was mixed as per manufacturer's instructions and adapted into the teflon mould. During preparation of specimens for composite resin, for each specimen, the material was placed in the teflon mould and covered with Mylar strip followed by light curing for 20s using LED light curing unit (Figure 3). While preparing specimens for GIC, for each specimen, petroleum jelly was applied to all the surfaces of the mould and mould was placed on glass slab covered with Mylar strip. Standard powder to liquid ratio (2.7/1.0 g) was dispensed on mixing pad and was mixed gradually for 15-20s until appropriate consistency was achieved. The mould was slightly overfilled to minimize air entrapment followed by placing a Mylar strip with glass slab over it with slight pressure to remove excess material and obtain a uniformly smooth specimen (Figure 4). All specimens were stored in double deionized distilled water till further use.

Subgrouping of the specimens

A total of 40 specimens were prepared from two restorative materials (20 from each) (Figure 5). Each group was further divided into four subgroups according to the pediatric drug formulations to be tested as group 1: artificial saliva, group 2: moxclav (Ranbaxy) group 3: asthalin (Cipla) and group 4: paracetamol (Citadel) (Figure 6). These 40 discs (composite 20 each and GIC 20 each) were placed in dessicator (Figure 7) containing fresh dried silica gel and then transferred to an oven at 37 degree to remove the excess moisture. After 24 hours the discs were repeatedly weighed until a constant mass was obtained (ml).The discs were then immersed in artificial saliva and pediatric drugs, at 37 degree for 7 days. They were then washed in distilled water, dried at room temperature for 15 min and was weighed again to get the final mass of the material on the disc (m2) (Figure 8). The thickness and diameter of the discs were measured at four points with a digital caliper and the volume (v) was calculated in mm^3.The values of solubility (SL) were obtained using the following equation,[9]

$$SL=\frac{m1-m2}{V},$$

where,

SL=solubility,

m1=constant mass,

m2=final mass of the material on the disc,

V=volume.

Statistical analysis

One way analysis of variance (ANOVA) was used for statistical analysis. Data analysis was done using statistical package for the social sciences (SPSS) software.

Figure 1: Pediatric restorative materials.

Figure 2: Teflon mould.

Figure 3: Composite discs.

Figure 4: GIC discs.

RESULTS

Solubility of GIC

Mean and standard deviations of solubility of GIC were calculated. In GIC highest solubility were seen in paracetamol group (0.14±0.02) followed by artificial saliva (0.05±0.04), Asthalin (0.04±0.03) and Moxclav (0.03±0.02). From one-way ANOVA it is clear that the p value is less than 0.05 which implies that there exists a statistically significant difference between the treatment groups. Since the differences between paracetamol and other treatment groups are greater than 0.074, it can be concluded that solubility of GIC is statistically significantly higher in paracetamol than other groups (Figure 8).

Figure 5: Specimens.

Figure 6: Desiccator.

Figure 7: Weighing machine.

Solubility of composite

Mean and standard deviations of solubility of composite were calculated. In composite highest solubility was seen in paracetamol group (0.07±0.035) followed by Moxclav (0.04±0.040), Asthalin (0.04±0.028) and artifical saliva (0.03±0.022). From one-way ANOVA it is clear that the p value is 0.30, that is greater than 0.05 which implies that there is no significant difference between the groups (Figure 9).

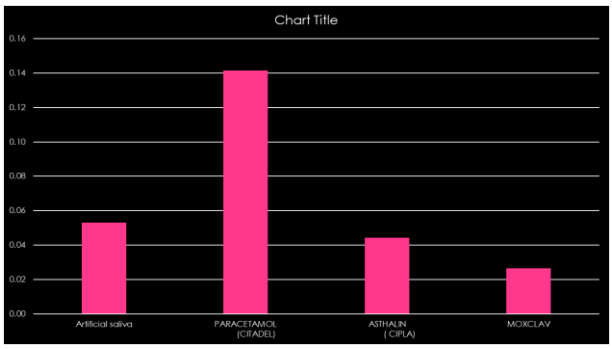

Figure 8: Mean solubility value of Glass Ionomer Cement.

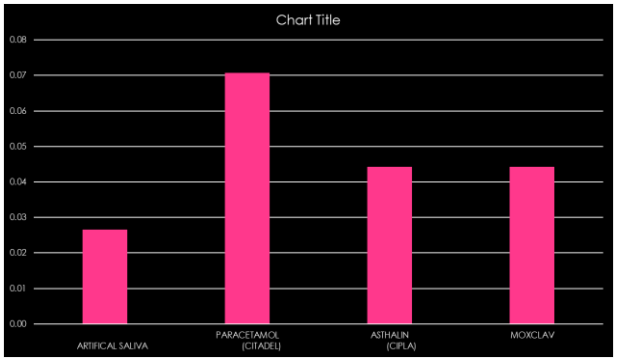

Figure 9: Mean solubility value of Composite.

DISCUSSION

The present study evaluated the effect of three different pediatric drug formulations, i.e. Moxclav, Asthalin, Paracetamol on solubility of composite resin, and conventional GIC as they were the commonly used restorative materials in pediatric dentistry. According to Maguire et al the endogenous pH and titratable acidity of pediatric liquid medications and formulations have high erosive potential due to high titratable acidity. Furthermore, this erosive potential is particularly harmful when used by children suffering from xerostomia or taken on a regular basis and/or at night in the treatment of a chronic condition.[10] Additionally many studies have evaluated the effects of lots of drinks and pediatric medicines with regard to erosion, dental caries, and/or color stability of teeth/dental materials, very little literature has been reported on the effects of pediatric drugs on the solubility of restorative materials.

Solubility of GIC

When comparing the solubility of GIC in the Paracetamol group the mean weight of the samples initially after desiccation was 0.64 and the mean weight of samples after 7 days following immersion in Paracetamol drugs was found to be 0.63. Finally the mean solubility of GIC in Paracetamol group was 0.14±0.02. Among the Asthalin group initial mass of the sample was 0.64 and final mass after 7 days was found to be 0.64. and the mean solubility of GIC in Asthalin group was found to be 0.04±0.03. Among the Moxclav group initial mass of the sample was 0.64 and final mass after 7 days was found to be 0.64. Among the artificial saliva group initial mass of the sample was 0.64 and final mass after 7 days was found to be 0.64. So it was seen that the solubility of GIC in Paracetamol group (0.14±0.02) was the highest which was similar to the result given by Maguire et al where the pH of Paracetamol syrup was around 5.39 and that of Asthalin and Moxclav syrup was lower than the critical pH. Hence low pH, high titratable acidity, frequent ingestion and sugar content in liquid medications may lead to unfavourable effects like erosion, roughened surface, intrinsic/extrinsic staining of tooth surfaces.[10] Apeksha et al also evaluated the effect of different paediatric drug formulations on surface roughness of various restorative materials. In their study among all tested materials, Zirconomer showed least surface changes followed by composite and GIC Such occurrence can be explained by the fact that conventional glass ionomer cement consists of glass particles in a hydrogel matrix. In acidic solutions, H+ ions of the acid diffuse into surface and subsurface layers of the restorative materials and replace metal cations in the matrix. These free cations then diffuse outward and are released from the surface. As the metal cations in the matrix decrease, more ions are extracted from the surrounding glass particles, causing them to dissolve.[11]

Solubility of composite

When comparing the solubility of composite in the Paracetamol group, the mean weight of the samples initially after desiccation was 0.74 and the mean weight of samples after 7 days was found to be 0.73. Finally the mean solubility of Composite in Paracetamol group was 0.07±0.035. Among the Asthalin group initial mass of the sample was 0.74 and final mass after 7 days was found to be 0.72 and the mean solubility of composite in Asthalin group was found to be 0.04±0.028.Among the Moxclav group initial mass of the sample was 0.64 and final mass after 7 days was found to be 0.64. Among the artificial saliva group initial mass of the sample was 0.64 and final mass after 7 days was found to be 0.64.

The solubility value of composite resin was comparatively less than GIC in this study. Solubility of Composite was seen more in Paracetamol group (0.07±0.035) and least solubility was seen in artificial saliva group (0.03±0.022). This was in accordance with

the study done by Briso et al who evaluated the effect of different acidic solutions on the micro hardness and surface roughness of restorative material and the results showed that the GIC showed the highest surface roughness values (Fuji II LC: 0.1110±0.014 lμm before and 0.139±0.016 lμm after immersion; whereas the lowest values were found for the composite resin sealed with Biscover before (0.047±0.011 lm) and after exposure in distilled water (0.043±0.007 lm), soft drink (0.040±0.005 lm), and hydrochloric acid (0.045±0.005 lm). The probable reason behind this finding can be attributed to small filler particles embedded more homogeneously with resin matrix in the composite resin that makes them less prominent on surface thus imparting higher surface smoothness whereas other factors like type of filler, their size and volume influence the properties as well as quality of polished surface of composite resins.[12]

The greater instability of RMGIC after immersion in acidic solutions when compared with composite resin could be explained by matrix dissolution in the periphery of the glass particles of GIC, which could result from dissolution of the siliceous hydrogel layer. Other factors that could also have contributed to these results are the manipulation and composition of these materials.[13] The glass-ionomer material, such as Fuji II present glass particles in their composition that may be responsible for the lower homogeneity and rougher surface. Furthermore, the components have different hardness and they are manually handled, which can generate porosity due to the inclusion of visually imperceptible air bubbles.[14] Scanning electron microscopy (SEM) studies have shown images of rough surfaces with the presence of voids and protruding glass particles, which clinically add up to a rough and dull surface that could explain the higher surface roughness values of RMGIC. Despite acids causing damage to the surface integrity of glass ionomer cements, this erosive loss of material may be accompanied by an increase in the pH of the acid solution resulting from these material degradation products being able to buffer the external storage media. This buffering effect is likely to be beneficial in protecting teeth from the occurrence and development of dental erosion.[15]

On the other hand, under acidic conditions, the composites were more stable due to the formulation of the material and morphology of the filler particles, which are nanosized and regular, allowing the incorporation of a large inorganic volume. According to Santos et al and others, Composites with small filler particles are more wear-resistant because they are more homogeneous and their particles are less prominent on the surface, resulting in a lower roughness. Whereas the type of filler and size and quantity of the particles influence the properties and quality of polishing of composite resins, the reduction in space between the inorganic nano-clusters is possibly responsible for their superior physical properties.[16-18] Kale et al evaluated the effect of different pediatric drug formulations on color stability of various esthetic restorative materials and results showed that color stability was significantly low with GIC ($p<0.001$) and high with composite for all five groups. (Amoxicillin+clavulanic acid) and metronidazole group showed highest color stainability among all groups. This findings was in contrary to our result.[19]

According to Tuzuner et al the composite exhibits significant discoloration values when exposed to commonly used pediatric drugs. Probable reason behind discoloration of composite resin can be water absorption induced weaker bond between resin matrix and filler particles leading to microcracks or interfacial gaps between matrix filler interface or due to chemical changes in initiator activator system and water absorption of the monomers in composites enabling stain penetration and discoloration.[20] Rueggeberg and Craig 1988 suggested that silanization of filler particles used in resin based composite also plays an important role in discoloration. The fact behind is silane is hydrophilic and leads to high water absorption. Therefore, high staining values of composite resin (Tetric N Ceram) 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, low concentration, and larger size filler particles have more tendency toward discoloration.[21] Further long term studies are required to establish the effects of pediatric drugs on solubility of restorative materials commonly used in primary teeth.

CONCLUSION

Based on the results of the present study, it can be concluded that, these commonly used pediatric restorative material showed higher solubility and when exposed to three different frequently used pediatric liquid medications. Therefore the information regarding the erosive effect of these commonly used pediatric liquid medications should be given to the pediatricians, pediatric dentists and parents too, for alerting them to the risk of these drugs on solubility of the restorations. Hence the importance of maintaining oral hygiene measures and regular dental visits has to be stressed in children who are under such pediatric drug medications so as to maintain a healthy oral environment. In addition, further studies need to be carried out with in vivo study designs including commonly used liquid medications and restorative materials in children.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Anil S, Anand PS. Early childhood caries: prevalence, risk factors, and prevention. Front Pediatr. 2017;5:157.
2. Tuzuner 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. Bio Med Res Int. 2017:7(2):123-7.
3. Kiran KJ, Vinay C,Uloopi KS, Sekhar RC, Madhuri V, Alla RK. Erosive potential of medicated syrups on primary teeth: An in vitro comparative study. British J Med Med Res. 2015;5(4):525.
4. Kulkarni P, Anand A, Bansal A, Jain A, Tiwari U, Agrawal S. Erosive effects of pediatric medicinal syrups on primary enamel. Indian J Dent. 2016;7: 131-3.
5. Scatena C, Galafassi D, Gomes-Silva JM, Borsatto MC, Serra MC. In vitro erosive effect of pediatric medicines on deciduous tooth enamel. Brazilian Dent J. 2014;25(1):22-7.
6. Govil S, Gupta V, Bhatt A. Comparative evaluation of micro-leakage of different tooth colored restorative materials. An in-vitro study. IJCPHR. 2016;1(1):10-4.
7. Evancusky JW, Meiers JC. Microleakage of Compoglass-F and Dyract-AP compomers in Class V preparations after salivary contamination. Pediatr Dent. 2000;22(1):39-42.
8. Passos IA, Sampaio FC, Martínez CR, de Morais Freitas CH. Concentracion de sacarosa y pH en medicamentos liquidos pediatricos para uso a largo plazo por via oral. Revista Panamericana de Salud Publica. 2010;27(2):132-8.
9. Moreira-da-Silva E, Almeida GS, Poskus LT, José G, Guimarães A. Relationship between the degree of conversion, solubility and salivary sorption of a hybrid and a nano filled resin composite . J Appl Oral Sci. 2008;16(2):161-6.
10. Maguire A, Rugg-Gunn AJ, Butler TJ. Dental health of children taking antimicrobial and non-antimicrobial liquid oral medication long-term. Caries Res. 1996;30(1):16-21.
11. Nalwade AV, Kale YJ, Dadpe MV, Dahake PT, Kendre SB. Effect of paediatric liquid medications on surface roughness of dental restorative materials. J Adv Med Dent Scie Res. 2019;7(2):123-7.
12. Briso ALF, Caruzo LP, Catelan APA, PH dos Santos PH dos. In vitro evaluation of surface roughness and microhardness of restorative materials submitted to erosive challenges. Oper Dent. 2011;36(4):397-402.
13. Abu-Bakr N, Han L, Okamoto A, Iwaku M. Changes in the mechanical properties and surface texture of compomer immersed in various media. J Prosthet Dent. 2000;84(4):444-52.
14. Sales-Peres SHC, Magalha ˜es AC, Machado MAM, Buzalaf MAR. Evaluation of the erosive potential of soft drinks. Eur J Dentist. 2007;1(1)10-3.
15. Turssi CP, Hara AT, Serra MC, Rodrigues AL. Effect of storage media upon the surface micromorphology of resin-based restorative materials. J Oral Rehab. 2009;29(9) 864-71.
16. Yu H, Wegehaupt FJ, Weigand A, Roos M, Attin T, Buchalla W. Erosion and abrasion of tooth-colored restorative materials and human enamel. J Dentist. 2009;37(12) 913-22.
17. Yap AUJ, Lye KW, Sau CW. Surface characteristics of tooth-colored restoratives polished utilizing different polishing systems. Operat Dentist. 2017; 22(6):260-5.
18. Santos N, Khan AM, Matsumae I, Satou J, Shintani H. In vitro color change of composite-based resins. Dent Mater. 1989;5:384-7.
19. 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. J Indian Soc Pedod Prev Dent. 2019;37:151-6.
20. Tuzuner T, Turgut S, Baygin O, Yilmaz N, Tuna E, Ozen B. Effects of different paediatric drugs on the colour stability of various restorative materials applicable in paediatric dentistry. Biomed Res Int. 2017:96:84-93.
21. Rueggeberg FA, Craig RG. Correlation of parameters used to estimate monomer conversion in a light-cured composite. J Dent Res. 1988;67:932-7.

Cite this article as: Mridhul MU, Ayilliath A, Ephraim R, Chandrashekhar S. Effect of pediatric drugs on solubility of restorative materials used in primary teeth. Int J Contemp Pediatr 2022;9:69-74.