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*Original Article*

# Effect of paediatric liquid medications on surface roughness of dental restorative materials

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***ABSTRACT*:**
**Background-** Various liquid drug formulations are prescribed to children, frequent usage of which can result in loss of enamel structure. **Aim**- To evaluate effect of different paediatric drug formulations on surface roughness of various restorative materials. **Method-** Total 120 specimens of three restorative materials (40 each), Zirconomer Improved, composite resin and Glass ionomer cement were prepared respectively. Specimens were divided in five groups (n= 8) and immersed in five different paediatric drug formulations (Amoxicillin+Clavulanic acid, metronidazole, cephalexin, ibuprofen, ibuprofen+paracetamol), agitated for two min and procedure was repeated eight hourly for one week. Surface roughness of each sample was evaluated using profilometer. Statistical analysis of the result obtained was analysed using One-way ANOVA & Tukey's HSD. **Result**- Result obtained showed $R_a$ value (Roughness average) elevation was significantly low with Zirconomer Improved as compared to composite material and Glass ionomer cement. **Conclusion**- Among all tested materials, Zirconomer Improved showed least surface changes as compared to composite and Glass ionomer cement.
**Key words**- dental restorations, paediatric liquid medication, profilometer, surface roughness.

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## INTRODUCTION:

Dental erosion is seen frequently in primary as well as permanent dentition.[1] The factors responsible for erosion can be extrinsic or intrinsic. Extrinsic factors include frequent consumption of acidic food or beverages and some medicinal formulations, whereas intrinsic factors are related to gastro intestinal disorders.[2] In paediatric patients, drug formulations are given in liquid form to facilitate its intake. However, some of the agents used in paediatric liquid medications can cause damage to dental tissues because of their low pH. [3] Some formulations contain acidic ingredients as preservative to maintain their chemical stability and control tonicity.[4] Frequent consumption of such drug formulations lead to loss of the surface enamel due to low endogenous pH, high titratable acidity and minimal quantities of minerals such as calcium or phosphate. [3] Apart from previously stated reasons, other factors responsible for change in the surface morphology of enamel may include high frequency of medication, bedtime consumption, high viscosity and reduced salivary flow. [1] Liquid formulations of drugs are recommended in children for chronic diseases such as asthma, bronchitis, epilepsy etc.[5] In vitro studies have demonstrated that medications with low pH may result in loss of enamel structure.[2] Even primary teeth were also found highly susceptible to the consumable drinks with low pH. [6,7]

There is very limited data available stating about the causal relationship between pH of paediatric liquid drug formulations to alter surface smoothness of enamel as well as dental restorations. Hence we aimed present study to

evaluate effect of paediatric drug formulations on surface roughness of Zirconomer Improved, Composite resin and Glass ionomer cement.

## MATERIALS AND METHODS:

Present in vitro experimental study was conducted at the Department of Paedodontics & Preventive Dentistry, after gaining clearance from institutional Ethical committee.

### Paediatric liquid medications used:

In this study, commercially available five paediatric liquid medications were used for experimental treatment:

1. Amoxicillin+ Clavulanic acid (AMOXYCLAV DS; Abbott Healthcare Pvt. Ltd, India).
2. Metronidazole (Metrogyl; J. B. CHEMICALS & PHARMACEUTICALS LTD, India).
3. Cephalexin (Phexin REDISYP; GlaxoSmithKline Pharmaceuticals limited, India).
4. Ibuprofen (Ibugesic; Cipla LTD, India).
5. Ibuprofen + Paracetamol (Ibugesic Plus; Golden Cross Pharma Pvt. Ltd, India).

### Restorative materials used:

Following restorative materials were used to make disc shaped specimen preparation:

1. Zirconomer Improved (SHOFU INC, Universal Shade, UK).
2. Composite resin (Tetric N-Ceram, Ivoclar vivadent, India).
3. Glass ionomer cement (Gold Label, Universal Restorative 2, GC CORPORATION TOKYO, JAPAN),

### Procedure*:*

A total of 120 disc shaped specimens were prepared using brass mould of dimensions 12 mm x 1.5 mm from three different restorative materials i.e. Zirconomer Improved, Composite resin and Glass ionomer cement (40 from each material) according to manufacturer's instructions. To provide smooth finish to the surfaces of all specimens, mylar strips were used. Specimens prepared from three restorative materials (n= 40 for each material) were divided into five subgroups (n= 8) as five liquid drug formulations were used in the present study and stored in double deionized distilled water till further use. [8]

The specimens were dried with tissue paper & baseline surface roughness values of each group were recorded. [8] The surface roughness of each specimen (*Ra* - μm) was measured using a profilometer (SJ 210, Mitutoyo Co, Kawasaki, Japan), calibrated against a standard before each new measuring session. The mean value of two measurements was recorded as the surface roughness for each specimen.

Fifteen ml of each undiluted paediatric liquid formulations were dispensed in glass beakers and specimens (n=8) were immersed and agitated for two minutes every eight hours up to one week. All the samples were stored in artificial saliva in between immersion periods. [8]

After one week of cumulative immersion period, specimens were rinsed with double deionized distilled water for five seconds, gently brushed with a soft toothbrush for 15 seconds and dried gently with sterile tissue paper. At this point, second measurement for surface roughness was recorded with the same method.[8]

## STATISTICAL ANALYSIS:

The data obtained was subjected to statistical analysis. Statistical analysis was performed with SPSS version 23.0. Inter group mean and standard deviations were analyzed using One way ANOVA and statistical significance was analysed using Tukey's Post Hoc HSD test.

## RESULTS:

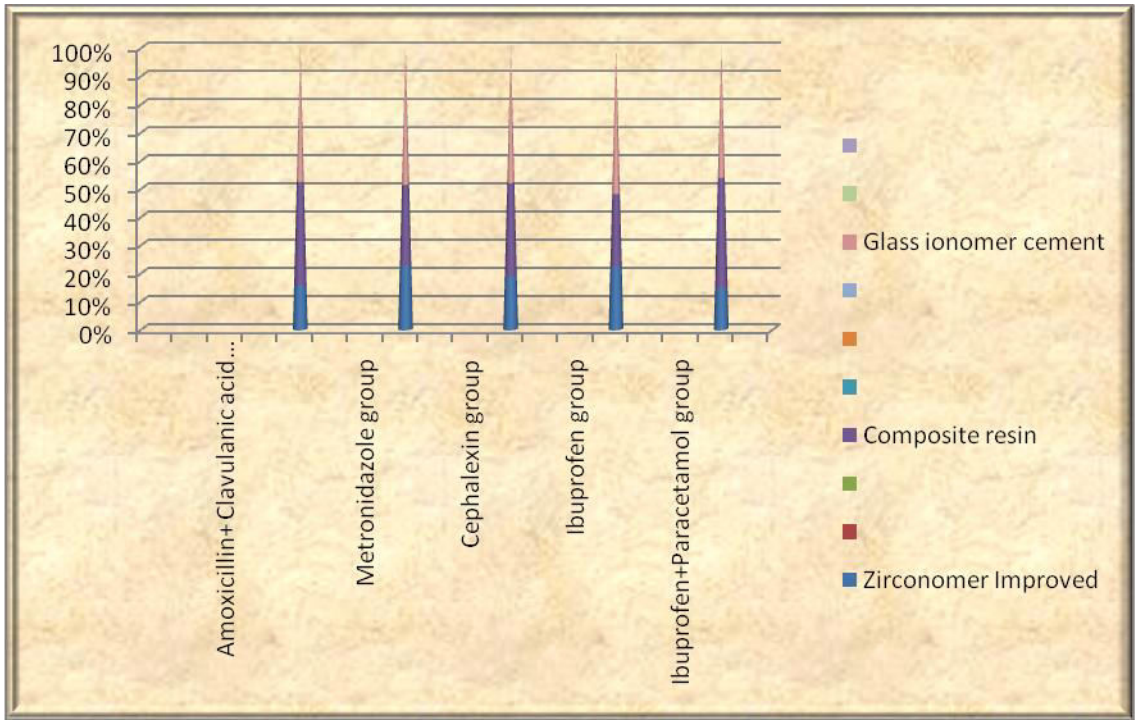
The mean and standard deviations were calculated for the comparison of surface roughness of all groups. Highly significant increase in surface roughness was observed after immersion in paediatric drug formulations among all experimental restorative materials ($p$<0.001). Amoxicillin+ Clavulanic acid caused highest increase in surface roughness in Glass ionomer cement (0.235μm) & least in Zirconomer Improved (0.78 μm). In Metronidazole group, highest increase in surface roughness was observed in Glass ionomer cement (0.208 μm) whereas least in Zirconomer Improved (0.98 μm). In Cephalexin group, highest increase in surface roughness was observed in Glass ionomer cement (0.366 μm) & least in Zirconomer Improved (0.145 μm). In Ibuprofen and Ibuprofen+Paracetamol group, Glass ionomer cement showed highest increase in surface roughness whereas least in Zirconomer Improved. Amongst all the liquid medications, Metronidazole showed highest surface roughening ability followed by Amoxicillin+ Clavulanic acid group, Cephalexin group, Ibuprofen group and least by Ibuprofen+Paracetamol group. Maximum change in surface roughness was seen in Glass ionomer cement followed by composite resin and least in Zirconomer Improved. (Table 1 and Graph 1).

**Table 1:** Overall comparison between various drugs and materials before & after immersion

| | Zirconomer Improved | | | Glass ionomer cement | | | Composite resin | | |
|---|---|---|---|---|---|---|---|---|---|
| **Group** | **Before** | **After** | **Difference** | **Before** | **After** | **Difference** | **Before** | **After** | **Difference** |
| **Group - Amoxicillin+Clavulanic acid group** | | | | | | | | | |
| **Mean & (S.D.)** | 0.649 ±0.179 | 0.726 ±0.136 | 0.078 ±0.065 | 1.160 ±0.103 | 1.397 ±0.123 | 0.235 ±0.093 | 0.552 ±0.210 | 0.733 ±0.201 | 0.181 ±0.075 |
| **Ratio** | 1.15 | | | 1.2 | | | 1.38 | | |
| ***p* value** | <0.001** | | | <0.001** | | | <0.001** | | |
| **Group – Metronidazole** | | | | | | | | | |
| **Mean & (S.D.)** | 0.432 ±0.136 | 0.522 ±0.151 | 0.098 ±0.058 | 1.220 ±0.168 | 1.432 ±0.186 | 0.208 ±0.112 | 0.235 ±0.163 | 0.357 ±0.209 | 0.122 ±0.069 |
| **Ratio** | 1.25 | | | 1.17 | | | 1.65 | | |
| ***p* value** | <0.001** | | | <0.001** | | | <0.001** | | |
| **Group – Cephalexin** | | | | | | | | | |
| **Mean & (S.D.)** | 0.943 ±0.038 | 1.088 ±0.052 | 0.145 ±0.052 | 1.000 ±0.181 | 1.366 ±0.134 | 0.366 ±0.154 | 0.224 ±0.092 | 0.475 ±0.152 | 0.251 ±0.144 |
| **Ratio** | 1.15 | | | 1.4 | | | 2.37 | | |
| ***p* value** | <0.001** | | | <0.001** | | | <0.001** | | |
| **Group –Ibuprofen** | | | | | | | | | |
| **Mean & (S.D.)** | 1.340 ±0.137 | 1.500 ±0.103 | 0.161 ±0.091 | 0.407 ±0.176 | 0.780 ±0.282 | 0.372 ±0.115 | 0.390 ±0.278 | 0.573 ±0.270 | 0.183 ±0.205 |
| **Ratio** | 1.12 | | | 1.97 | | | 1.82 | | |
| ***p* value** | <0.001** | | | <0.001** | | | <0.001** | | |
| **Group - Ibuprofen +Paracetamol** | | | | | | | | | |
| **Mean & (S.D.)** | 0.366 ±0.198 | 0.503 ±0.188 | 0.137 ±0.079 | 0.351 ±0.186 | 0.775 ±0.209 | 0.423 ±0.179 | 0.463 ±0.256 | 0.818 ±0.130 | 0.356 ±0.315 |
| **Ratio** | 1.53 | | | | | | 3.04 | | |
| ***p* value** | <0.001** | | | | | | <0.001** | | |

*p* >0.05 – not significant **p* <0.05 – significant ** *p* <0.001 – highly significant

**Graph 1: Mean difference of surface roughness (Ra) value of three restorative materials with different drugs**



**DISCUSSION:**

Erosion is a process of gradual destruction of the surface of an element, usually through unfavorable electrolytic, biological, physical or chemical stimulus.[6] An intact and smooth surface of restorative materials is an important criterion for clinical success of restorations in oral cavity. Loss of integrity and smoothness of such surface may lead to more plaque retention, bacterial adherence and initiation of gingival irritation.[9] Erosion has a multi factorial etiology, which includes extrinsic as well as intrinsic factors. The intrinsic factors for dental erosion include upper gastro-intestinal disorders, metabolic and endocrine disorder, anorexia and bulimia nervosa.[6] Extrinsic factors for dental erosion includes excessive use of carbonated beverages, low pH fruit juices and frequent use of oral drug formulations having low pH in chronically, medically compromised patients.[2] Compositional difference between hard tissues of primary and permanent teeth is also one of the contributing factors for early initiation and occurrence of erosion in primary teeth.[6] Studies have revealed the erosive properties of liquid drug formulations with low pH, high titratable acidity, presence of acidic preservatives and absence or minimal quantities of calcium and phosphate ions. [1]

Keeping all these clinical problems in mind, present study aimed to evaluate effect of paediatric drug formulations on surface roughness of composite, zirconia reinforced GIC & glass ionomer cement. In present study, we observed that, amongst all liquid medications, Glass ionomer cement (Gold Label, Universal Restorative 2, GC CORPORATION TOKYO, JAPAN) has shown highest roughening of the surface after immersion in different drugs. Such occurrence can 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. Consequently the material presents a rough surface with voids and protruded, undissolved glass particles. H+ ion concentration and the formation of soluble complexes between acid anions and metal cations in the set cement control the degree of erosion of glass ionomer cement in organic acid solutions. [10]

We found that, surface roughness value of composite resin (Tetric – N Ceram) was in between Zirconomer Improved & GIC respectively. 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. Thus, reduction in space between the inorganic nano-clusters is possibly responsible for superior physical properties of nano-filled composite resin (Tetric – N Ceram). [10]

However in this experimental study we found an interesting finding about alteration of surface roughness of Zirconomer Improved that was relatively lower than composite resin and GIC respectively. Zirconia reinforced glass ionomer cement (Zirconomer Improved, SHOFU INC, Universal Shade, UK) was introduced with the purpose of enhancing mechanical properties of conventional GIC as well as to overcome drawbacks of previously used tooth coloured restorative materials. The polyalkenoic acid and the glass components of this material have been specially processed to impart superior mechanical and handling qualities to this high strength GIC. [11] As Gu et al in their experimental study revealed that, the final mechanical properties of the cements are significantly dependent upon the cross-linking formation during setting. The setting reaction of GICs is an acid–base reaction forming a salt hydrogel which acts as the binding matrix within which the glass or zirconia is filler. Upon mixing the acid with the powders, the acid attacks the powders, releasing metal ions. The released metal ions act as cross-linking species, allowing the formation of stable cement. Continued formation of cationic bridges that cross-link the polymer chains enhances the strength and insolubility of the cement and decreases the water content, thereby improving the strength and other mechanical properties of this cement.[12] In our study, we observed that, least surface alterations in Zirconia reinforced GIC that can be explained by the fact that nano sized zirconia filler particles ranging from 96.5 to 98.5% is the main component of zirconia reinforced GIC (Zirconomer Improved). [13] This Nano-sized filler particles of zirconia reinforced GIC facilitate the smoother surface on this material. [14]

Amongst all the experimental liquid medications, Metronidazole and Amoxicillin+Clavulanic acid showed highest increase in surface roughness. The pH of Amoxicillin+ Clavulanic acid syrup is around 5.39 and that of Metronidazole syrup is also lower than the critical pH. [4, 15] Other medications used in present study, have pH above the critical pH i.e. 5.5. Low pH, high titratable acidity, frequent ingestion and sugar content in liquid medications may lead unfavourable effects like erosion, roughened surface, intrinsic /extrinsic staining of tooth surfaces etc. [4] Nevertheless, further investigations, including in situ, clinical and epidemiological studies, are required as present study was carried under in vitro condition. The high occurrence of noncarious lesions in dental tissues, present-day eating habits, dynamics of the oral cavity and the effects of saliva should be considered in future studies.

**CONCLUSION:**

From the above experimental study it can be concluded that, Zirconomer Improved can be used as a suitable

alternative to conventional glass ionomer cement & composite resin in terms of resistance to surface roughness. Also it was observed that, frequent exposure to low pH paediatric drug formulations is directly related to the marginal integrity and surface texture of the materials studied.

For this reason, it is incumbent for us as paediatric dental surgeons to counsel our patients following restorative procedures to eliminate the abusive habits associated with excessive usage of these liquid drug formulations.

**REFERENCES**:


1. John SA, Mallikarjun SB, Narasimha Rao VV. Potential erosive effects of antihistamine containing syrup on primary teeth. Afr J Med Health Sci 2014;(13):15-18.
2. 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.
3. Alexandria A, Meckelburg N, Puetter U, Salles J, de Souza I, Maia L. Do pediatric medicines induce topographic changes in dental enamel? Braz Oral Res 2016;30:1-8.
4. Gupta M, Panda S. Cariogenic Potential of the commonly Prescribed Paediatric Liquid Medicaments in Kingdom of Saudi Arabia: An in vitro Study. J Contemp Dent Pract 2017;18(4):307-311.
5. Scatena C, Galafassi D, Gomes-Silva JM, Borsatto MC, Serra MC. In Vitro Erosive Effect of Paediatric Medicines on Deciduous Tooth Enamel. Braz Dent J 2014;25(1):22-27.
6. Maganur P, Satish V, Prabhakar AR, Namineni S. Effect of Soft Drinks and Fresh Fruit Juice on Surface Roughness of Commonly used Restorative Materials. Int J Clin Pediatr Dent 2015;8(1):1-5.
7. Grando LJ, Tames DR, Cardoso AC, Gabilan NH. In vitro study of enamel erosion caused by soft drinks and lemon juice in deciduous teeth analyzed by stereomicroscopy and scanning electron microscopy. Caries Res 1996;30(5):373-378.
8. Tüzüner 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 2017:9684193.
9. Ayaz E, Bagis B, Turgut S. Effect of Antiasthmatic Medication on the Surface Roughness and Color Stability of Dental Restorative Materials. Med Princ Pract 2014;23:24–28.
10. Bajwa N, Pathak A, "Change in Surface Roughness of Esthetic Restorative Materials after Exposure to Different Immersion Regimes in a Cola Drink. Int Sch Res Notices 2014:1-6.
11. Chalissery VP, Marwah N, Almuhaiza M, AlZailai AM, Chalisserry EP, Bhandi SH. Et al. Study of the Mechanical Properties of the Novel Zirconia-reinforced Glass Ionomer Cement. J Contemp Dent Pract 2016;17(5):394-398.
12. Gu Y, Yap A, cheang P, Khor K. Zirconia–glass ionomer cement—a potential substitute for Miracle Mix. Scripta Materialia 2005;5:113–116.
13. Zirconomer Improved Zirconia Reinforced Restorative. Available from:http://www.shofu.com.sg/downloads/ pdf/ZirconomerImproved Brochure. Pdf. Accessed December 23, 2018.
14. Mallya PL, Acharya S, Ballal V, Ginjupalli K, Kundabala M, Thomas M. Profilometric study to compare the effectiveness of various finishing and polishing techniques on different restorative glass ionomer cements. J Interdiscip Dentistry 2013;3:86-90.
15. Metronidazole. Available from: https://www.accessdata.fda.gov/ drugsatfda_docs/ label/ 2015/ 018890s050lbl.pdf. Accessed December 22, 2018.