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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF EROSIVE POTENTIAL OF PEDIATRIC LIQUID MEDICATIONS AND COMMONLY USED CARBONATED DRINK ON TOOTH ENAMEL AND TOOTH COLORED RESTORATIVE MATERIAL: AN IN VITRO STUDY

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Abstract

Aim: This study evaluates erosive potential of commonly used carbonated beverages, medicated syrup, and their effects on dental enamel with and without restoration,in vitro.

Materials and Methods: Test medias used in this study included carbonated beverage (Thums UP), medicatedsyrup (zincovit multivitamin syurp and moxikindcv) and saline water as the control. A total of 80 enamel sections were obtained from 40 previously extracted human premolar teeth were selected for the study. samples were divided into two groups and further subdivided into 4 subgroups each. Test specimens weredistributed to four beverages groups and comprised 10 specimens per group. Surface roughness (profilometer) readings were performed at baseline and again and following immersion for 14 days. the result was obtained and statistical analysis was carried out.

Results: For surface roughness of both carbonated beverage and medicated syrup showed the significant difference respectively compared to the control group.

Conclusion: carbonated drink shows the highest surface roughness value among all test media and thus greater erosive potential to enamel also medicated syrup showed significant changes surface roughness value compared to control group.

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Introduction:-

Dental erosion is defined as an irreversible loss of dental hard tissue by a chemical process without the involvement of microorganisms and is due to either extrinsic or intrinsic sources[3]It is a complex multifactorial permanent process that may be affected by intrinsic, extrinsic, or idiopathic causes. Contact of tooth tissues with stomach acids (i.e., regurgitation and reflux disorders) is the chief intrinsic etiological factor. The main extrinsic etiological factor is due to increased acidic food and drink utilization[2].One of the causes of extrinsic dental erosion is extravagant use of carbonated drinks, candies and infrequent use of paediatric liquid medications.

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Most of these drinks and liquid medicated syrup have low pH. making them acidic in nature. Studies reporting the frequency of consumption of soft drinks and other drinks with a low pH have shown an increased potential for the formation of dental erosive lesions.Children and adolescents consume significant amounts of erosive beverages and, therefore, their risk of developing dental erosion is high. In paediatric patients the physiological loss of tooth structure is most commonly caused by dental erosion because of the more frequent consumption of acidic food and drinks by children. As lifestyles have changed, there has been a 50% increase in consumption of soft drinks over the past few decades, especially among children and adolescents [3], along with self-medication with over-the-counter medicines has increased in recent times, the misuse of these liquid medications can increase the risk of dental erosion even in healthy children who take medicines infrequently and for short periods[4].

In addition to affecting the hard dental tissues, prolonged or periodic exposure to erosive media in the oral cavity can also affect the erosive wear of restorative materials, which can subsequently compromise the success of the restorative. In tooth erosion, the coronal margins of the restoration are usually in the enamel, while the cervical margins are in the dentin and cementum. Enamel erosion can also cause microleakage between the restoration and the hard tissue of the tooth. The subsequent erosion poses special problems for dentists in their restoration.

Considering the erosive potential of various drinks and medicated syrups on tooth enamel, this study was designed to evaluate the the erosive potential of carbonated drink, commonly used medicated syrup and their effects on enamel surface (surface roughness changes) and on the restoration of teeth.

Aim

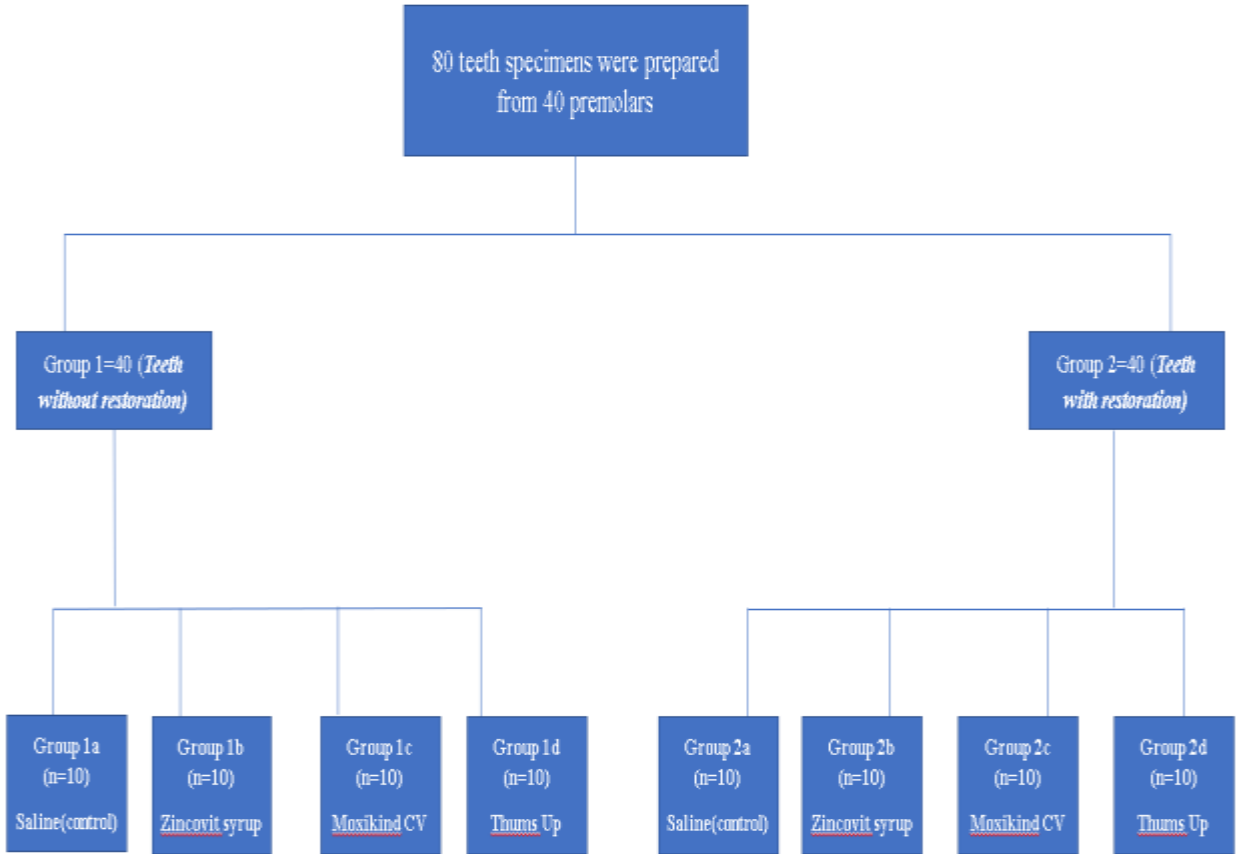
To comparatively evaluate the of erosive potential and pH of pediatric liquid medications and commonly used carbonated drink on tooth enamel and tooth coloured restorative material using surface profilometer and pH meter.

Material And Method:-

Forty recently extracted permanent premolars fulfilling inclusion criteria were collected, the selected teeth were free fromcaries, free of hypocalcification, teeth without fractures, teeth without any restorative material. Teeth were carefully cleaned of calculus and other debris and stored in distilled water, prior to the usage in the study.

Three test beverages, Carbonated beverage (Thums UP), medicated syrup (Zincovit multivitamin syrup and Moxikind C V) was used for the study and saline was kept as the control.

The coronal portion of forty extracted premolar was removed and then sectioned buccolingually using with micromotor and handpiece with disc bur and eighty teeth specimens were obtained. Then the tooth specimens were divided equally into two groups i.e., group 1- teeth without restorations and group 2- teeth with restoration. A window of 3 mm × 2 mm × 2 mm was prepared on group 2 teeth specimens with high-speed handpiece using diamond bur with air-water spray. Then the cavities were restored with Glass ionomer cement according to manufacturer's instructions. Finally, teeth specimens were embedded in acrylic blocks leaving the enamel surface exposed. Samples in both groups were again subdivided into 4 subgroups respectively having 10 teeth specimens per sub group (flow chart 1).



Flow Chart 1:-

Measurement of pH. and titrable acidity

The pH of each test media was measured using a digital meter ((DIC μ pH meter GOLD 533) (figure 1). The titrable acidity (neutralizable acidity) of each test media was measured by placing 20 ml of the product in a glass beaker. Then, 0.1 M sodium hydroxide solution was gradually pipetted into the beaker until the pH became neutral.

Figure 1:- Measurement of p H.

Enamel Surface Roughness

The average surface roughness (Ra) is the arithmetic average height of roughness component irregularities from the mean line measured within the sampling length and is expressed in microns (um). Smaller Ra values indicate smoother surfaces.

Measurement of enamel surface roughness

All measurements of enamel surface roughness (indicate enamel loss) were made using profilometer (Mitutoyo surftest profilometer).

Eighty premolar teeth sections (10 /media) were used for enamel surface roughness (Ra) measurement. The teeth were then embedded in block of acrylic resin leaveing the enamel surface exposed to the testing media. All teeth samples were checked for initial surface roughness values with Profilometer (figure 2) before placing into test medias.

Figure 2:- Baseline surface roughness evaluation.

The samples were then subjected to the immersion cycles in the media which mimics the frequency of intake of each syrup and carbonated drink. Each sample was immersed in 50 ml of the respective media for 5 minutes in each of the test groups once daily for 14 days. Following this exposure cycle, the enamel specimens were rinsed in deionized water and then air dried. Teeth were preserved in deionized water after each the immersion cycles.

Assessment of post immersion enamel surface roughness was done on the 14th day using the Mitutoyo surftest profilometer machine. The results were tabulated and statistically analysed using analysis of variance (ANOVA).

Results:-

Table 1 shows that assessment of the digital pH and neutralizable acidity on opening the test media. Digital pH of all test media is as follows: Carbonated beverage > medicated syrup >saline.

Table 1:- Digital pH. And Titrable acidity.

S.No.	Sample	pH	Titrableacidity (%)
	Normal saline	6.1	0.02%
	Zincovit	5.34	0.20%
	Moxikind CV	3.82	0.159%
	Thums UP	2.48	0.343%

Surface roughness (Ra) value obtained for each test media

1.Mean values of pre and post immersion surface roughness of Group 1- teeth without restoration. In all the subgroups the mean values of surface roughness increased after 14 days of treatment process. The increase in surface roughness from baseline level was seen maximum in Group 1d (Carbonated drink) followed by 1b (zincovit multi vitamin syrup), then Group 1c (Antibiotic paediatric syrup) and least in Group 1a (saline). [Table 2].

	Baseline	Post immersion	T value	P value
Group 1a	1.416±0.277	1.760±0.343	2.744	0.003 (NS)

Group 1b	1.623±0.609	2.150±0.551	9.959	0.011 (Sig)
Group 1C	1.714±0.621	2.214±0.595	5.623	0.001 (Sig)
Group 1d	1.623±0.357	2.704±0.373	8.051	0.001 (Sig)

Group 1a:- Saline, Group 1b: Multivitamin Paediatric syrup, Group 1c: Antibiotic Paediatric syrup, Group 1d: Carbonated Drink- Thums up

Table 2:- Mean values of pre and post immersion surface roughness.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.113	3	1.038	9.072	0.001 (Sig)
Within Groups	4.118	36	.114		
Total	7.231	39			

2.Mean percentage increase in surface roughness in Group 2 - teeth with restoration Inall the subgroups the mean values of surface roughness increased after 14 days of treatment process. The increase in surface roughness from baseline level was seen maximum in Group 2d (Carbonated drink) followed by Group 2c (Antibiotic paediatric syrup) then 2b (zincovit multi vitamin syrup) and least in Group 2a (saline).[Table 4]

Table 3:- one-way anova.

	Pre	Post	T value	P value
Group 2a	2.398±0.673	3.005±0.678	8.051	0.001 (Sig)
Group 2b	2.747±0.478	3.050±0.413	2.101	0.041 (Sig)
Group 2c	2.581±0.430	3.128±0.303	6.073	0.011 (Sig)
Group 2d	3.017±0.277	4.003±0.343	6.043	0.003 (Sig)

Group 2a: Saline ,Group 2b: Multivitamin Paediatric syrup ,Group 2c: Antibiotic Paediatric syrup ,Group 2d: Carbonated Drink- Thums up

Table 4:- Mean values of pre and post immersion surface roughness.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.427	3	.809	4.589	0.008 (Sig)
Within Groups	6.346	36	.176		
Total	8.773	39			

Table 5:- One-way anova table.

Discussion:-

Teeth are exposed to number of physical and chemical insults, which contribute to the wear and tear of dental hard tissues. The variety of processes include the friction of exogenous material e.g., during mastication, toothbrushing, holding tools forced over tooth substances (abrasion), the effect of antagonistic teeth (attrition), the impact of tensile and compressive forces during tooth flexure (abfraction), and the chemical dissolution of tooth mineral (erosion). All of these factors to a greater or lesser extent occur in the dentition, and wear of teeth results from the simultaneous and/or synergistic action of these processes[5]. Nevertheless, tooth dissolution can also be caused by erosion, which is the mineral loss of dental tissue when its surface is exposed to acids or chelates, in a systematic manner and without bacterial involvement.

Dental erosion is defined as an irreversible loss of dental hard tissue by a chemical process without the involvement of microorganisms and is due to either extrinsic or intrinsic sources[1].

This process may be caused by extrinsic agents like acidic foodstuffs, beverages, snacks, environmental exposure to acidic agents or intrinsic agents that may present intra-orally following vomiting, regurgitation, gastro-oesophageal reflux or rumination[6].

As lifestyles have changed, there has been a 50% increase in consumption of soft drinks over the past few decades, especially among children and adolescents [7] , along with self-medication with over-the-counter medicines has

increased in recent times, the misuse of these liquid medications can increase the risk of dental erosion even in healthy children who take medicines infrequently and for short periods[4]**.** Besides affecting hard dental tissues, prolonged or periodical exposure to erosive media in the oral cavity can also affect the erosive wear of restorative materials, which can consequently jeopardize the success of restoration[8] .The three most significant characteristics for any restorative material's longevity are colour stability, surface roughness and surface micro hardness[9]. The surface hardness of the restorative material is important. Low surface hardness makes the material vulnerable to scratches and causes restoration failure.

So, the present in vitro study was designed to assess the erosive potential of two commonly used pediatricsyrups,(Moxikind c v and Zincovit) and a carbonated drink (Thums up) on tooth enamel and tooth-coloured restorative material and it was shown that there is a significant change in the surface roughness of the enamel and restorative material when subjected to immersion cycles in the test medium. This could be attributed to the loss of minerals from the enamel surface which is caused by the intake of the tested pediatric syrups and carbonated drink. In the study it is also shown that pH and titrable acidities are the factors that could influence the loss of surface microhardness.

Two ways to quantify the acid content of a foodstuff or beverage include pH and total or titratable acidity. The pH or actual acidity is the negative logarithm of the hydrogen, ion concentration (actual hydrogen ion concentration) and is measured on a scale of 0 to 14 with a reading below 7 indicating an acid content or environment. Neutralizable acidity is the total number of acid molecules, both protonated and nonprotonated and determines the actual hydrogen ion availability for interaction with the tooth surface. Beverages with lower pH values have greater erosive effect; However, the neutralizable acidity level may be a more realistic and accurate method for measuring the potential acidity in a given beverage.

The pH of all drinks investigated in the present study ranged between 2.48 to 5.34, which was well below the critical pH of 5.5 at which enamel dissolution occurs. Also, in the present study Thumsup(Group d) exhibited highest titratable acidity followed by Zincovit (Group c) and Moxikind CV (Group b) and the least was for control, saline(group a). This was quite similar to the findings of other studies by **Radomir et al 2015[10] Passos et al**. **2010[11]** and **Xavier et al**.**2013[12]** and**Deshpande et al .2020[13].**The carbonated soft drink and liquid medications contain carbonic acid and organic acids (commonly citric acid). Citrate anions chelate calcium ions, decreasing the amount of free ionic calcium available in both the saliva and at the enamel surface, thereby enhancing demineralization and limiting the potential for remineralization[14]**.**

Quantitative (profilometer) analysis was performed verifying theerosive potential of all test medias. Arithmetic average roughnesshas been conventionally evaluated on enamel as an indicator ofacid erosion using the contact stylus surface profilometry.Surface roughness value in present study significantdifferences was exhibited between different beverages.Surface roughness evaluation was chosen because it is well documented that surface micromorphology can play a role in bacterial colonization and maturation of plaque on tooth and restorative surfaces. Based on the results of the present study, in group 1 (teeth without restoration) all the subgroups the mean values of surface roughness increased after 14 days of treatment process. The increase in surface roughness from baseline level was seen maximum in Group 1d: Carbonated drink (1.623 to 2.704) followed by 1b (1.623 to 2.150)zincovit multi vitamin syrup, followed by Group 1c: Antibiotic paediatric syrup (1.714 to2.214) and least in Group 1a (1.416 to 1.760).

In Group 2(teeth restored with Cention N GIC) In all the subgroups the mean values of surface roughness increased after 14 days of treatment process. The increase in surface roughness from baseline level was seen maximum in Group 2d: Carbonated drink (3.017 to 4.003) followed by Group 2c :Antibiotic paediatric syrup (2.581 to 3.128) followed by 2b (2.747 to 3.050) zincovit multi vitamin syrup and least in Group 2a (2.398).

The present study shows a significant increase in Ra value as compared to baseline after the test period of 14 days in case of both groups. A long-term use of sugar containing drugs has been considered a cause of dental caries in children. As the sugar content in liquid medication tend to dissolve enamel quickly when they remain for a longer time. This contributes toward the increase in surface roughness (Ra) value.

Conclusion:-

The present study was conducted with the aim and objective to comparatively evaluate the erosive potential and pH of paediatric syrups and carbonated drink on tooth enamel and restorative material.

Following conclusion were drawn from the study:

1. In Group 1 (teeth without restoration), the mean values of surface roughness for all the subgroups increased after 14 days of immersion cycle. The maximum change of surface roughness from baseline level to post immersion was in Group 1d (Carbonated drink) followed by Group 1b (zincovit multi vitamin syrup) then Group 1c (Antibiotic paediatric syrup)and was least in Group 1a (saline).
2. In Group 2(Teeth with restoration), the mean values of surface roughness for all the subgroups increased after 14 days of immersion cycle. The maximum change of surface roughness from baseline level to post immersion was in Group 2d (Carbonated drink) followed by Group 2c(Antibiotic paediatric syrup)then Group 2b (zincovit multi vitamin syrup)and was least in Group 2a (saline).
3. The pH and titrable acidity was maximum in Group d (Thums UP) followed by group b (Zincovit multivitamin syrup) then group c(Moxikind CV syrup) and least in group a (Saline)
4. Saline showed least erosive potential on both tooth enamel and restorative surface which authenticates the study
5. Therefore, the regular use of carbonated drink should minimise and the medicaments should not be consumed without medical prescription.

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