

PEDIATRIC SYRUPS: A RISK TO ENAMEL MICROHARDNESS???

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ABSTRACT: **Objectives:** To assess and compare the effect of commonly prescribed pediatric syrup formulations on primary tooth enamel hardness over a period of 7 days. **Materials and Methods:** An *in vitro* study was done on 40 non-carious deciduous molar teeth. 10 teeth in each group were dipped in 4 pediatric syrups (Amoxicillin, Metronidazole, Paracetamol, Ibuprofen + paracetamol) for 1 min thrice daily for 7 days and the enamel surface micro-hardness was checked at baseline and at the end of 7th day by Vickers hardness testing machine. **Results:** ANOVA test indicated that the reduction in mean micro hardness at the end of 7th day was maximum in Group A (Amoxicillin) and least in Group D (Ibuprofen + Paracetamol). **Conclusion:** Pediatric liquid medicines can cause dental erosion and have a hazardous effect on the enamel hardness.

KEYWORDS: pediatric, syrup, Microhardness, erosion, enamel

INTRODUCTION

Children are the future of our society and ensuring their overall good health is of utmost importance. As mouth is known as the mirror of our body, oral health is essential for children's growth, development, and general health. Dental caries is the most common and prevalent infectious disease in the oral cavity. Caries is caused by the action of acids produced by bacterial fermentation of sugars from the diet. However, some diseases and medications may increase the risk or severity of caries which includes dental erosion also.¹

Dental erosion is often solely described as a progressive loss of dental hard tissues by chemical dissolution without bacterial involvement. The changing lifestyle in the modern society has contributed to an increased incidence of dental erosion both in children and adolescents. Erosive tooth wear is a multifactorial irreversible process which can be caused by extrinsic, intrinsic, or idiopathic factors.² The contact of tooth with stomach acids like in regurgitation and reflux disorders relates to intrinsic factors. The primary extrinsic source of dental erosive agents includes increased consumption of acidic foods like fruit juices, aerated drink etc. Various acidic medicines have also been identified as extrinsic etiologic factors in dental erosion.^{3,4}

Liquid oral medications are the most commonly prescribed form of medicine for children in order to avoid the difficulty encountered in taking in other forms. Most of these medicines are acidic preparations as they are often necessary to improve flavor, for the dispersion of the drug, maintenance of chemical stability and to ensure physiological compatibility. Factors such as prolonged and frequent ingestion, between meals consumption, taking syrups just before going to bed, high viscosity of the liquid

medications, and reduced salivary flow may contribute to dental erosion.^{5,6}

Various studies have reported that liquid oral medications can affect the hardness of the enamel and cause alterations in morphological pattern.⁶ Liquid oral medications are of course a part of the daily routine of children affected with chronic diseases. Antibiotics, analgesics and antitussives (cough syrups) are the most common liquid oral medications that are widely used for young children. Sugar substitutes have been found to be non-cariogenic. But the use of sugar substitutes in the preparation of pediatric liquid oral medicines is found to be still at a very minimal level. So, the aim of the present study was to assess *in vitro*, the effect of four commonly prescribed pediatric syrup formulations on the hardness of the primary tooth enamel.⁷

Materials and methods

The present study was an *in vitro* study to assess and compare the effect of four commonly prescribed pediatric syrups from the Department of Pedodontics and Preventive Dentistry, Mar Baselios Dental College, Kothamangalam on the primary tooth enamel hardness.

Materials:

Study design

1. Preparation of specimens

Non-carious deciduous molars were collected from the Department of Pedodontics, Mar Baselios Dental College, Kothamangalam. At the commencement of the study the

pH of all the syrups were noted. Amoxicillin and Metronidazole was in the range of 1-3. Paracetamol had a pH between 3-5 and that of the combination of Ibuprofen and paracetamol was between 5-6. The tooth specimens were subjected to cleaning using ultrasonic scaler to remove any debris or calculus deposited on to the teeth.⁸ Then, they were preserved in demineralized water and transported to microhardness testing laboratory.



Fig 1: Crown fixed in metallic mould with buccal surface exposed



Fig 2: Agitating the undiluted test syrup in an agitator

Each crown was fixed with self-cured acrylic in a cubical metallic mould of 1inch size (Fig.1) . The tooth was placed in a manner such that the buccal surface is facing upwards. The specimens had their buccal enamel surfaces flattened with 320 grit Aluminium Oxide abrasive paper. The specimens were then ultrasonically cleaned in deionized water for 10 minutes. The test sites were demarcated by using a piece of insulating tape with a 2 mm diameter central hole on the exposed surface. The teeth were rendered acid-proof by coating with two layers of cosmetic nail polish over the buccal surface. The previously delimited circular area on the exposed buccal surface was left uncoated. The specimens were then stored at room temperature in demineralized water.⁹

The initial enamel surface micro hardness (baseline values) was assessed using Vickers hardness testing machine. A force of 25 g was applied with the help of a diamond indenter on the enamel surface at three different points which were placed 100 µm apart. The average of the three readings thus obtained was taken as the Vickers hardness number.⁹

2. Subjecting specimens to the test syrups

After the assessment of baseline values of the enamel microhardness, the specimens were demounted and randomly allocated in a group of 10 teeth each. **Group A** – Amoxicillin syrup (Sun Pharmaceuticals India Ltd.), **Group B** - Metronidazole syrup (Abbott healthcare pvt Ltd.) ,**Group C** - Paracetamol syrup (Glaxosmithkline pharmaceuticals Ltd.), **Group D** – ibuprofen + paracetamol (Golden Cross Pharma Pvt Ltd). 10 teeth in each group were immersed into 10 ml of the undiluted test syrup in a test tube and agitated for 1 min in an agitator (Fig.2), washed with distilled water and preserved in artificial saliva. This was done thrice daily for 7 days. Distilled water and artificial saliva solutions were changed everyday. The specimens were transported to microhardness testing laboratory where they were remounted and the surface enamel microhardness was checked.⁹

Statistical analysis

The pretreatment values (Table-1), post treatment (Table-2) and the mean difference (Table-3) are shown. The mean difference in the values obtained after 7 days were analyzed statistically. The change in enamel microhardness was analyzed using mean VHN score employing ANOVA test with time and liquid oral medications as the study parameters. (Table-4, Graph-1)

Results

The mean hardness was least in Group A and maximum in Group D on 7th day (Table 4 and Graph 1). On 7th day mean surface hardness of A,B, and C was lower than D difference was statistically significant ($P < 0.05$).

Discussion

The present study reveals that the tested medicines could potentially erode deciduous tooth enamel after successive immersion cycles. The surface enamel microhardness of the teeth was decreased after 7 days in all the four groups of medicinal syrups. However, the teeth immersed in Group A (Amoxicillin syrup) showed the maximum reduction in microhardness as compared to other three groups.

Various acids are added to drug formulations as buffering agents for maintaining the chemical stability and physiological compatibility, to control the tonicity ,to enhance the flavor and thus the palatability to children can be increased.⁵ Despite being a weak acid, the most commonly used primary acid in the liquid oral medicines is the citric acid. Though weak citric acid is a very potent erosive agent.^{3,9} The pH of all the pediatric syrups used in the present study were lower than the critical pH of demineralization. As the pH decreases, the potential of enamel erosion increases.^{2,9,10}

There was a microhardness reduction seen in all the four groups on the 7th day as compared to baseline values, and the Amoxicillin syrup showed the maximum reduction in microhardness and was statistically

significant. The reason for more reduction in microhardness on the 7th day as compared to baseline values could be due to longer duration of exposure to medicinal syrups.

In the present study, there was a linear percentage reduction in microhardness of all groups from baseline to the 7th day. Moreover the reduction was more pronounced in the Amoxicillin group than other group after 7 days. This difference observed in different groups is attributed to the difference in pH, the acids used, the buffers added, and the compositions of the medicinal syrups.⁸

Studies on deciduous tooth substrates are of scientific relevance because it has been observed that there exists a structural and morphological difference between the deciduous and permanent teeth. The differences in the chemical composition, rate of formation and ultrastructural appearance between the pellicle on primary and permanent teeth have been reported. Primary enamel is more susceptible to enamel erosion with 50% more mineral loss and 30% more lesion depth. The primary enamel is less mineralized and the density of its outermost layer is lesser when compared to permanent teeth.⁷

Valinoti et al⁸ conducted an in-vitro study to find out the alterations in dental enamel exposed to acidic medicines. Specimen surfaces were evaluated for roughness and hardness at baseline and again after the in vitro experimental phase, which included 30 min immersions in the medicines twice daily for 12 days. The study concluded that all medicines produced a significant reduction in hardness and promoted greater roughness after 12 days.

Studies done by Mali et al⁹ have been observed that the erosive potential of liquid oral medicines could alter the enamel surface microhardness and the morphology of the tooth surface. However, most of these kind of studies were performed on a permanent tooth substrate. Very few studies have evaluated the erosive effects of the liquid oral medications on the enamel of the deciduous teeth. So primary teeth were selected in the present study to check for any change in the enamel microhardness.

An in-vitro study done by Scatena et al¹⁰ evaluated the erosive potential of pediatric liquid medicines in primary tooth enamel, depending on the exposure time. The immersion cycles in the medicines were undertaken under a 1-min agitation, which was performed three times daily, during 28 days. Surface microhardness was measured at 7, 14, 21 and 28 days. Scanning Electron Microscopy (SEM) images revealed that after 28 days the surfaces clearly exhibited structural loss. Erosion of deciduous enamel was dependent on the type of medicine and exposure time.

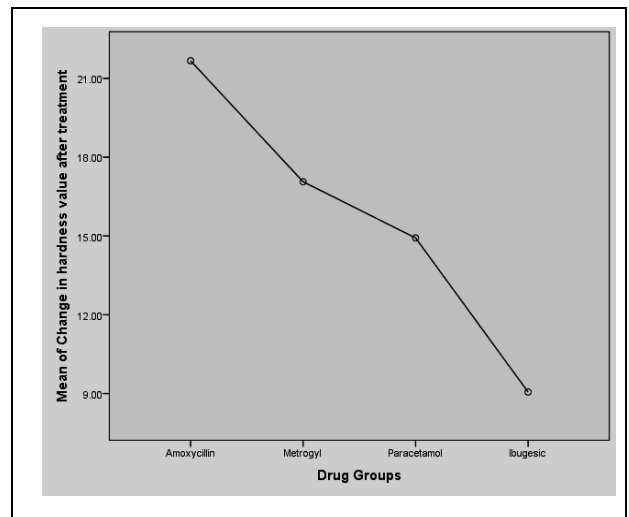
Zhao D et al¹¹ suggested that pediatric liquid oral medications that are dispensed as over the counter (OTC) soften the enamel of the primary teeth and make them susceptible to dental caries. Hence a strong association can be made between the drug formulations and their erosive potential.

A comparative study conducted by Dhawan L et al¹² analyzed the erosive potential of pediatric liquid medicinal

syrups on deciduous teeth and concluded that there is a continuous loss of enamel microhardness. Mahmoud NM¹³ did a study to determine the effect of liquid oral medicines that are used for long time by children on caries of deciduous teeth. The conclusion of his study was that all liquid oral medications affect the enamel of teeth by varying degrees.

The erosive potential of these liquid oral medications might be related to the frequency and time of acid exposure. It is also related to the total volume of syrups ingested. Despite the properties of these medications, the indiscriminate use of liquid formulations (syrups) by young children can increase the risk for dental erosion. The administration of liquid oral medications at bed-time which is not followed by proper oral hygiene after ingestion of the substance will only worsen the condition.^{1,2} Therefore, the experimental period of 7 days was chosen for this study to assess the effect of medications for a longer duration.

The syrups used in the present study were selected because they were the most commonly prescribed pediatric syrups from the department of pedodontics and preventive dentistry and are easily available. In the current study, the protocol used was based on the following frequency of syrup ingestion as 10 ml taken 3 times a day, under agitation of the solution during the specimen immersion period of 7 days. The agitation was done because according to some authors, when a substance is ingested, a certain kind of agitation occurs, which favors the substance capacity to cause erosion.⁹



Graph 1: Graph-I- Depicting the changes in the mean Hardness values

Various sugar substitutes have been widely used in food products and beverages to avoid tooth decay from sugar and other fermentable carbohydrates.¹⁴ But the other ingredients such as the citric or phosphoric acids in beverages can cause dental erosion.²

The present study emphasized to assess and compare the effect of four commonly prescribed pediatric oral medications on primary tooth enamel hardness due to dental erosion. The Parameters like pH and time used in

Table -1. Pre Treatment hardness value

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Amoxicillin	10	337.0970	.72896	.23052	336.5755	337.6185
Metrogyl	10	337.1520	.67402	.21314	336.6698	337.6342
Paracetamol	10	337.0950	.82676	.26145	336.5036	337.6864
Ibugesic	10	337.0950	.67725	.21417	336.6105	337.5795
Total	40	337.1098	.70119	.11087	336.8855	337.3340

Table -2. Post Treatment Hardness value

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Amoxicillin	10	315.4270	.80251	.25378	314.8529	316.0011
Metrogyl	10	320.0880	.70123	.22175	319.5864	320.5896
Paracetamol	10	322.1690	.95764	.30283	321.4839	322.8541
Ibugesic	10	328.0370	.74403	.23528	327.5048	328.5692
Total	40	321.4303	4.65148	.73546	319.9426	322.9179

Table-3. Change in hardness value after treatment

	N	Mean change	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Amoxicillin	10	21.6700	.89469	.28293	21.0300	22.3100
Metrogyl	10	17.0640	.86145	.27241	16.4478	17.6802
Paracetamol	10	14.9260	1.26653	.40051	14.0200	15.8320
Ibugesic	10	9.0580	.88997	.28143	8.4214	9.6946
Total	40	15.6795	4.68932	.74145	14.1798	17.1792

Table-4 Comparison of Changes in hardness value after treatment-ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	822.150	3	274.050	278.315	.000
Within Groups	35.448	36	.985		
Total	857.598	39			

the current study have an impact on the microhardness, Along with these parameters, the compositions of these pediatric syrups and the total dissolved sugars should also be assessed to see the exact impact on the enamel microhardness.¹⁵

CONCLUSION

- Pediatric syrups have a hazardous effect on the enamel hardness.
- Administer pediatric syrups only if indicated.
- Indiscriminate use of pediatric syrups at bed time should be avoided.
- Rinsing after taking syrups and brushing before sleep has to be emphasized.

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