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Study of erosive alterations in dental enamel exposed to medicinal syrups

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Abstract
Background: Some medications may increase the risk as well as the severity of caries including dental erosion. Prescriptions in liquid form is very common prescribed form of medicine for children in order to avoid the difficulty encountered in taking in other forms.
Aim: To study erosive alterations in dental enamel exposed to selected medicinal syrups.
Methods: In this prospective study thirty extracted/exfoliated noncarious deciduous molars were used. Before use, the teeth were hand scaled and cleaned. Erosive potential was planned to check for those formulations that are commonly prescribed like Ferium XT and Crocin syrup. Artificial saliva was taken as control. Surface microhardness was tested using the universal microhardness machine at 2, 3 and 4 weeks.
Results: Both Ferium XT and Crocin produced a gradual loss of surface microhardness over a period of time i.e. at the end of 2, 3 and 4 weeks. Ferium XT showed significant loss of surface microhardness between 2nd and 3rd week. Loss of surface microhardness was observed at the end of 4 weeks in case of Ferium XT and Crocin also but it was not significant.
Conclusion: The tested medicinal syrups could potentially erode deciduous tooth enamel after a series of immersion cycles over time. Further larger controlled trials are warranted to support our findings.

Keywords: Syrup, micro hardness, erosion, enamel

Introduction
Some medications may increase the risk as well as the severity of caries including dental erosion. Dental erosion is defined as a progressive loss of dental hard tissues by chemical dissolution without bacterial involvement [1, 2]. The changing lifestyle in the modern society may be a cause for rising incidence of dental erosion both in children and adolescents.
Erosive tooth wear is a irreversible process which depends on many factors. It may be caused by intrinsic, extrinsic, or idiopathic factors [3]. The intrinsic etiologic factors are related to the contact of tooth tissues with stomach acids (i.e, regurgitation and reflux disorders) [4]. Increased acidic food and drink consumption has become the primary extrinsic source of dental erosive agents, although acidic medicines, and behavioral factors have also been identified as extrinsic etiologic factors in dental erosion [5].
Prescriptions in liquid form is very common prescribed form of medicine for children in order to avoid the difficulty encountered in taking in other forms. Various studies have reported that liquid oral medications can affect the hardness of the enamel and cause alterations in morphological pattern [6]. Acidic preparations are often necessary for drug dispersion and chemical stability maintenance to ensure physiological compatibility and to improve flavor. Thus, this study was planned to study erosive alterations in dental enamel exposed to selected medicinal syrups.

Methods
The study was conducted at a tertiary care teaching dental hospital of northern India. In this prospective study thirty extracted/exfoliated no carious deciduous molars were used. Before use, the teeth were hand scaled and cleaned. The roots were removed at the Cement enamel junction. The crowns were fixed in a wax block parallel to the surface. The specimen before immersion cycle was stored at 37°C in artificial saliva. Erosive potential was planned to check for those formulations that are commonly prescribed like Ferium XT and Crocin syrup.

Artificial saliva was taken as control. Composition of artificial saliva was Methylhydroxybenzoate 2.0 g, carboxymethylcellulose 10.0 g, KCl 0.625 g, MgCl2.6H2O 0.059 g, CaCl2. 2H2O 0.166 g, K2HPO4 0.804 g, and KH2PO4 0.326 g in 1000 ml of deionized water [7].

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 [8]. The pH value of the syrups used for the immersion of the teeth and the amount of base required to raise the pH to 7.0 (titratable acidity) were measured with a pH meter. To measure titratable acidity, 20 g of each drink or solution was titrated with 0.5 M NaOH in 0.02 ml increments at 25°C. The buffering capacity was calculated.

Specimens were immersed with the exposed area up for 1 min in 5 mL of the each medication, under agitation, three times daily with 6-h intervals between the immersion cycles. After each immersion cycle, the specimens were washed with distilled water and maintained in 10 mL of artificial saliva at 37°C until next immersion cycle. The medicines were replaced before each immersion. The control specimens were kept in artificial saliva during the experiment (28 days), with the solution refreshed daily. Surface microhardness was tested using the universal microhardness machine at 2, 3 and 4 weeks.

Written and informed consent was obtained from study subjects. Permission of ethical committee was obtained from the Institutional Ethics Committee. All the questionnaires were manually checked and edited for completeness and consistency and were then coded for computer entry. After compilation of collected data, analysis was done using Statistical Package for Social Sciences (SPSS), version 21 (IBM, Chicago, USA). The results were expressed using appropriate statistical variables.

Results

Both Ferium XT and Crocin produced a gradual loss of surface microhardness over a period of time i.e. at the end of 2, 3 and 4 weeks. Ferium XT showed significant loss of surface micro hardness between 2nd and 3rd week. Loss of surface microhardness was observed at the end of 4 weeks in case of Ferium XT and Crocin also but it was not significant. (Table 1)

Table 1: Comparison of microhardness created by medicinal syrups at various time intervals

Medicinal syrup	Follow up visits			P value
	At the end of 2 weeks	At the end of 3 weeks	At the end of 4 weeks	
Ferium XT	298.34±0.18	297.88±0.14	297.12±0.05	>0.05
Crocin	301.54±0.52	299.67±0.32	298.42±0.78	<0.05
Control	308.87±1.65	308.03±0.75	307.23±0.74	>0.05

Changes in hardness value after treatment among Ferium XT, Crocin syrup and artificial saliva was investigated by ANOVA test which showed statistically significant changes between groups as well as within groups. (Table 2)

Table 2: Changes in hardness value after treatment among groups

Variables	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	816.165	3	282.165	283.735	<0.001
Within Groups	38.748	37	.867		
Total	865.385	40			

Discussion

Now a day's dental erosion is looked as an important cause of tooth structure loss in adults but children and adolescents. Acidic preparations are often necessary for drug dispersion and chemical stability maintenance to ensure physiological compatibility and to improve flavor. Acids are added to drug formulations as buffering agents to maintain chemical stability, control tonicity, physiological compatibility, to enhance flavor, and thereby increasing the palatability to children [9]. Citric acid is the most commonly used primary acid in the oral medicines, despite being a weak acid, citric acid is a potent erosive agent [10]. These acids were present in the medicinal syrups used in this study and pH of all the syrups were above the critical pH of demineralization. Potential of enamel erosion increases with reduction in pH.

In this study Erosive potential was checked for Ferium XT and Crocin syrup. Surface microhardness was tested using the universal micro hardness machine at 2, 3 and 4 weeks. We observed that both Ferium XT and Crocin produced a gradual loss of surface microhardness over a period of time i.e. at the end of 2, 3 and 4 weeks. Ferium XT showed significant loss of surface micro hardness between 2nd and 3rd week. Loss of surface micro hardness was observed at the end of 4 weeks in case of Ferium XT and Crocin also but it was not significant. The difference could be due to the compositions of the syrups, the alcohols added, the viscosity, the surface tension of syrups, the acids present in their formulations (citric, phosphoric, hydrochloric, tartaric, benzoic, etc.), and the buffering agents (citrate buffers) added in their preparations. The properties of the different constituents present in the syrup may have also caused a difference in the buffering capacities.

An author from Federal University of Rio de Janeiro[7] 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.

Another study from University of São Paulo, Brazil[6] 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 from University of Hong Kong [11]. 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.

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 [12].

Dhawan L *et al*. [13] studied the erosive potential of pediatric liquid medicinal syrups on deciduous teeth and concluded that there is a continuous loss of enamel micro hardness. Mahmoud NM [14] conducted an investigation to determine the effect of liquid oral medicines that are used for long time by children on caries of deciduous teeth. He concluded that all liquid oral medications affect the enamel of teeth by varying degrees.

Conclusion

On the basis of findings of this study, it can be stated that the tested medicinal syrups could potentially erode deciduous tooth enamel after a series of immersion cycles over time. Further larger controlled trials are warranted to support our findings. Rinsing after taking syrups and brushing before sleep has to be advocated.

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