International Journal of Medical and Health Research
ISSN: 2454-9142
Received: 28-04-2019; Accepted: 31-05-2019
www.medicalsciencejournal.com
Volume 5; Issue 6; June 2019; Page No. 139-142

Evaluation of effects of liquid medicinal syrups on primary enamels of pediatric patients

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Abstract
Several studies have investigated the physicochemical parameters of PLMs (Pediatric Liquid Medications) to determine their cariogenic and erosive potential. Hence the current study aimed to investigate and compare the cariogenic and erosive effect of the pediatric liquid medications most commonly prescribed in the Bihar region childrens.
The present study was planned in Rama Dental, 9 Nehru Nagar, Patliputra, Patna from July 2018 to Dec 2018. Total 40 extracted and carious deciduous molars were used in the present study. The teeth were cleaned using pumice-water slurry and 0.3-µm alumina paste with a polishing brush at low-speed handpiece (5000 rpm) to remove any debris or calculus deposited on to the teeth. Then, they were preserved in artificial saliva and transported to micro hardness testing laboratory. The PLMs included each of the most commonly prescribed nutritional supplements, analgesics, antiasthma tic drugs and artificial saliva as a control
It is important to sensitize the parents of the diseased children, paediatricians, pharmacists and the manufacturers to the fact that medicated syrups cause erosion of dental hard tissues. Since the majority of the medicated syrups have acidic pH, the medical and dental specialists should be extra cautious while prescribing syrups and instruct the parents to dilute the prescribed dose of the formulation with water or to rinse their mouth with water soon after ingestion of syrup, if not diluted.

Keywords: PLMs, pediatric liquid medications, syrup, enamel

1. Introduction
Tooth decay, also known as dental caries or cavities, is a breakdown of teeth due to acids made by bacteria. The cavities may be a number of different colors from yellow to black. Symptoms may include pain and difficulty with eating. Complications may include inflammation of the tissue around the tooth, tooth loss, and infection or abscess formation [1]. The cause of cavities is acid from bacteria dissolving the hard tissues of the teeth (enamel, dentin and cementum). The acid is produced by the bacteria when they break down food debris or sugar on the tooth surface. Simple sugars in food are these bacteria's primary energy source and thus a diet high in simple sugar is a risk factor. If mineral breakdown is greater than build up from sources such as saliva, caries results. Risk factors include conditions that result in less saliva such as: diabetes mellitus, Sjogren's syndrome and some medications. Medications that decrease saliva production include antihistamines and antidepressants. Caries is also associated with poverty, poor cleaning of the mouth, and receding gums resulting in exposure of the roots of the teeth [2].
Prevention of dental caries includes regular cleaning of the teeth, a diet low in sugar, and small amounts of fluoride. Brushing the teeth twice per day and flossing between the teeth once a day is recommended by many. Fluoride may be from water, salt or toothpaste among other sources. Treating a mother's dental caries may decrease the risk in her children by decreasing the numbers of certain bacteria she may spread to them. Screening can result in earlier detection. Depending on the extent of destruction, various treatments can be used to restore the tooth to proper function or the tooth may be removed. There is no known method to grow back large amounts of tooth. The availability of treatment is often poor in the developing world. Paracetamol (acetaminophen) or ibuprofen may be taken for pain [2].
Worldwide, approximately 2.3 billion people (32% of the population) have dental caries in their permanent teeth. The World Health Organization estimates that nearly all adults have dental caries at some point in time. In baby teeth it affects about 620 million people or 9% of the population. They have become more common in both children and adults in recent years. The disease is most common in the developed world due to greater simple sugar consumption and less common in the developing world. Caries is Latin for "rottenness [3].
Four things are required for caries formation: a tooth surface (enamel or dentin), caries-causing bacteria, fermentable carbohydrates (such as sucrose), and time. This involves adherence of food to the teeth and acid creation by the bacteria that makes up the dental plaque. However, these four criteria are not always enough to cause the disease and a sheltered environment promoting development of a cariogenic biofilm is required. The caries disease process

does not have an inevitable outcome, and different individuals will be susceptible to different degrees depending on the shape of their teeth, oral hygiene habits, and the buffering capacity of their saliva. Dental caries can occur on any surface of a tooth that is exposed to the oral cavity, but not the structures that are retained within the bone [4].

Tooth decay is caused by biofilm (dental plaque) lying on the teeth and maturing to become cariogenic (causing decay). Certain bacteria in the biofilm produce acid in the presence of fermentable carbohydrates such as sucrose, fructose, and glucose [23, 24]. Caries occur more often in people from the lower end of the socioeconomic scale than people from the upper end of the socioeconomic scale [5].

Bacteria in a person's mouth convert glucose, fructose, and most commonly sucrose (table sugar) into acids such as lactic acid through a glycolytic process called fermentation.[24] If left in contact with the tooth, these acids may cause demineralization, which is the dissolution of its mineral content. The process is dynamic, however, as remineralization can also occur if the acid is neutralized by saliva or mouthwash. Fluoride toothpaste or dental varnish may aid remineralization. If demineralization continues over time, enough mineral content may be lost so that the soft organic material left behind disintegrates, forming a cavity or hole. The impact such sugars have on the progress of dental caries is called carcinogenicity. Sucrose, although a bound glucose and fructose unit, is in fact more cariogenic than a mixture of equal parts of glucose and fructose. This is due to the bacteria utilising the energy in the saccharide bond between the glucose and fructose subunits. S.mutans adheres to the biofilm on the tooth by converting sucrose into an extremely adhesive substance called dextran polysaccharide by the enzyme dextransucranase [6].

Dental caries is the most prevalent infectious disease affecting children. This multifactorial disease occurs through the interaction of oral bacteria, carbohydrates, teeth, and time. The production of acids through the fermentation of dietary carbohydrates by the biofilm on tooth surfaces leads to a fall in plaque pH, which results in enamel dissolution and tooth cavitation [7-8]. Oral pediatric liquid medications (PLMs), such as suspensions, syrups and solutions, are the best line of treatment for younger children. The prolonged use of such liquid medications, particularly in children who suffer from chronic diseases (asthma, respiratory sensitivity and convulsions) or frequent acute conditions (allergic rhinitis, sinusitis, otitis media, and tonsillitis) can have a deleterious effect on tooth structure [9]. Sugar is added to the majority of oral PLMs (Pediatric Liquid Medications) to make them palatable and hence acceptable for the child [10]. Sucrose is the most commonly used sweetener for such medications, as it is an easily processed as well as cost-effective substance. Fructose and glucose are also added to some of these medications [11]. These sugars, particularly sucrose, act as a substrate for the oral bacteria, which are responsible for their fermentation, leading to the production of acids and a subsequent drop in intraoral pH. [12] Acids are added to medicines as buffering agents in order to maintain the chemical consistency and regulate the tonicity of the medicines, or to ensure their physiological compatibility. Acids are commonly used to ameliorate flavor. They are necessary for the acid base reactions that are used in the case of dispersible and effervescent tablets, designed to be added to water [13]. Since many PLMs have low pH, which is mostly

Several studies have investigated the physicochemical parameters of PLMs to determine their cariogenic and erosive potential. Hence the current study aimed to investigate and compare the cariogenic and erosive effect of the pediatric liquid medications most commonly prescribed in the Bihar region childrens.

2. Methodology

The present study was planned in Rama Dental, 9 Nehru Nagar, Patliputra, Patna from July 2018 to Dec 2018. Total 40 extracted and carious deciduous molars were used in the present study. The teeth were cleaned using pumice-water slurry and 0.3-µm alumina paste with a polishing brush at low-speed handpiece (5000 rpm) to remove any debris or calculus deposited on to the teeth [14]. Then, they were preserved in artificial saliva and transported to micro hardness testing laboratory. The PLMs included each of the most commonly prescribed nutritional supplements, analgesics, antiasthmatic drugs and artificial saliva as a control

Assessment of the initial enamel surface micro hardness was done using Vickers hardness testing machine (Digital display micro hardness tester HVS-1000A) at micro hardness testing laboratory at outside laboratory. The force of 25 g was applied with the diamond indenter on to the enamel surface at three points 100 µm apart, and the average of the readings was obtained as Vickers hardness number [14].

3. Results & Discussion

Tooth erosion is the chemical dissolution of the dental tissues without bacterial involvement. The underlying etiology of erosion is believed to be a source of acidic action on the susceptible tooth [15]. The erosive effect of dietary acids on dental tissue can be influenced by a number of factors including pH, dissociation constant of acid (pKa), titratable acidity, temperature, acid character, concentration and chelation potential. Furthermore, frequency, timing of intake, duration of exposure in the oral cavity and fluoride content in the liquid preparation are some other important factors to be considered [16]. In addition to the above factors, pellicle layer and variations in tooth structures also contribute to the erosion process [17-18].

Table 1: Observation of Microhardness

Sample	7 days	14 days	21 days	28 days
Control: Artificial Saliva	310.2 – 313.9	309.8 – 313.5	310.5 – 313.2	310.3 – 311.1
Nutritional Supplements	303.2 – 305.6	302.9 – 303.2	299.5 – 300.7	299.5 – 300.1
Analgesics	303.1 – 304.2	302.8 – 303.2	300.5 – 302.1	299.5 – 300.7
Antiasthmatic	300.4 – 302.1	300.7 – 301.6	298.5 – 300.1	296.5 – 297.2

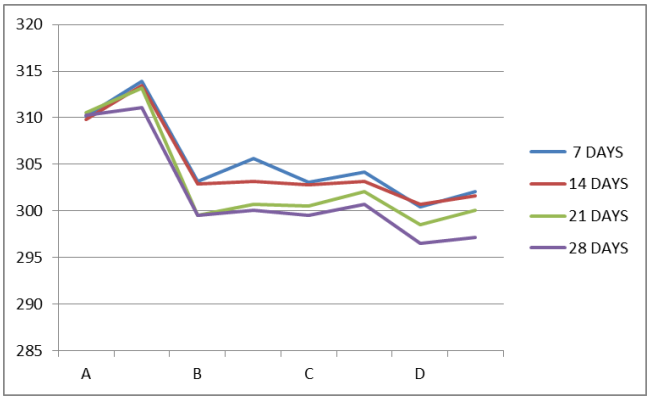

Fig 1: Plot of Microhardnes; A - Control: B - Artificial Saliva; C - Nutritional Supplements; D - Analgesics Antiasthmatic

Dental erosion becomes a potential issue when medicines with prolonged oral clearance are taken long term for chronic illness. The active ingredients in these medicines are necessary for improvement or maintenance of health whereas some inactive ingredients pose dangers like dental caries and dental erosion [19].

The medications with low pH have greater potential for causing erosion. Alessandro Leite Cavalcanti *et al.* [20] showed that many pediatric antitussives had pH below the critical value and had greater cariogenic and erosive potentials. Passos *et al.* [21] reported that pediatric syrups with low pH have ability to initiate the dental demineralization by direct action on enamel surface, without any influence on the oral micro flora. The development of erosion was also influenced by the enamel type, temperature and acid exposure time.

The pH is an accurate indicator and an important variable in investigating the erosive potential of liquid medicines. In addition to pH and neutralizable acidity, viscosity of the syrup also influences degree of surface enamel dissolution. Syrups with high viscosity retain on the tooth surface for a longer duration leading to enamel erosion. Liquid medicines with low pH and high viscosity when administered frequently have greater synergetic potential to cause dental erosion.

Perhaps, the degree of enamel loss caused by the medications in this laboratory study could be greater than clinical situations as the oral environment cannot be exactly simulated. In oral cavity, the enamel surface is covered by a protective pellicle and/or plaque layer and subjected to flushing, buffering and remineralizing effects of saliva [22].

Enamel is likely to lose more of these ions to the surrounding medium in order to acquire a new state of equilibrium when the teeth are subjected to substances that have a low concentration of these ions [23]. Furthermore, the dissolution of enamel is highly dependent on the pH of the substance surrounding it [24-25].

Sugars are commonly added to oral liquid medications to give them a pleasant taste. Sugar-rich medicines cause a drop in the pH of dental plaque, increasing the risk of demineralization [26]. Pediatric medicines including sucrose and/or other fermentable carbohydrates and having low pH display cariogenic and erosive effects. Other factors are also noted, e.g., frequency of administration, dose and pattern of use, as well as acidity of the formulation [27].

Primary teeth are known to be less mineralized than permanent teeth, and particularly as the enamel surface of deciduous teeth is not as mature as that of permanent teeth, it is more liable to dental caries [28] Added to this, most of the syrups are given in two to three divided doses - the night dose, especially, has a deleterious effect on the enamel due to the following reasons:

1. Although saliva is the key defense mechanism against demineralization, at night, its flow rate is diminished [29]. Some medications, such as anticonvulsants, sedatives or antihistamines also lower the salivary flow. [30]
2. In young children, the oral clearance process can be expected to be less effective than in adults, due to lower salivary flow and less pronounced oral muscular coordination ability [29].
3. Lack of the fully developed interest and ability to eliminate particles retained in the mouth after food/liquid intake [32].

4. Conclusion

It is important to sensitize the parents of the diseased children, paediatricians, pharmacists and the manufacturers to the fact that medicated syrups cause erosion of dental hard tissues. Since the majority of the medicated syrups have acidic pH, the medical and dental specialists should be extra cautious while prescribing syrups and instruct the parents to dilute the prescribed dose of the formulation with water or to rinse their mouth with water soon after ingestion of syrup, if not diluted.

5. References

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