Research Article

Changes in pH levels of saliva before and after taking chewable tablets

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ABSTRACT

Aim: This study aims to determine the salivary pH before and after consumption of chewable tablets using pH paper. **Materials and Methods:** The salivary pH of 100 children aged 9–10 was evaluated using a pH paper before and after consuming chewable tablets. The pH was evaluated using a color scale after 30 s from dipping the pH paper in the saliva. **Results:** The pH levels after taking chewable tablets were acidic (pH <7) in 73% of the study population of which 8% had a pH value of 3 and the remaining 65% of the study population had a pH range of 5. **Conclusion:** Chewable Vitamin C tablets cause a drop in pH in ranges which can cause demineralization of the enamel. The potential tooth damage by chewable tablets should be made aware to the consumers. The physician should recommend Vitamin C in a form and dose which is considered safe for the patient.

KEY WORDS: Chewable tablets, Salivary pH, Enamel erosion

INTRODUCTION

Chewable tablets are oral dosage forms with immediate release that has to be chewed and then swallowed. They are designed such that they have a pleasant taste. Chewable tablets are safe and easy to deliver to a diverse patient population, especially for pediatric and elderly patients and also in patients who are unable to swallow intact tablets or difficulty with swallowing due to the size of the tablet.[1] Chewable tablets when chewed produce a pleasant tasting residue in the mouth that when swallowed does not leave a bitter or unpleasant after taste. The common sweeteners added to chewable tablets are brown sugar, compressible sugar, honey, dextrose or fructose, mannitol, lactose, sorbitol, and other artificial sweeteners. Sweeteners, both naturally occurring and synthetic, are one type of functional excipient commonly used in chewable tablet formulations to mask the unpleasant tastes and facilitate pediatric dosing.[2]

The term sugar includes all monosaccharides and disaccharides, the most common of which are glucose, fructose, sucrose, maltose, and lactose.[3] Sucrose is extensively used due to its various properties as a preservative, antioxidant, solvent, and also a thickening agent. These sweetened medications, when administered for prolonged periods in children, increase the risk for caries.[4,5] The detrimental effects of sugar-based medications result in medication caries when abundantly used, providing a substrate for plaque microorganisms throughout the day.[6]

Dental erosion is defined as the loss of dental hard tissue by a chemical process that does not involve bacteria.[7] Dental erosion can be due to extrinsic or intrinsic causes. The intrinsic causes include recurrent vomiting seen in patients suffering from anorexia and bulimia, cytostatic drug treatment, or propulsion of gastric contents into the mouth due to gastroesophageal reflux. Extrinsic causes comprise frequent consumption of acidic foods or drinks, the use of acidic hygiene products, and acidic medicines such as effervescent Vitamin C or aspirin.[8] If there is persistence of the erosive challenge, dissolution of consecutive layers of enamel crystals can occur, leading to a permanent loss in volume with a softened layer on top of the remaining tissue.[9] There are various physiological factors that can modify dental erosion process by either protecting the teeth against erosion or increase the degree of dental erosion. One of the important biological parameters is saliva as it provides protection against dental erosion through different ways.[10-14]

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The normal resting salivary flow rate lies within the range of 0.25–0.35 mL/min. Various mechanical, gustatory, or pharmacological stimuli may increase the production and secretion of saliva. Stimulated saliva consists of 80–90% of daily salivary production, and the stimulated salivary flow rate varies from 1 to 3 mL/min.[15] Low salivary flow rate, low pH, and low buffering capacity are associated with a higher dental caries rate.[16] The salivary pH and the salivary buffering capacity are determined by the hydrogenated bicarbonate balance in saliva. Salivary pH is approximately neutral, and buffering agents, such as inorganic phosphate in resting saliva and carbonic acid-bicarbonate system in stimulated saliva, help maintain neutrality.[17] Salivary pH and buffering capacity can contribute to the ion exchanges during remineralization and demineralization of enamel at pH 7, with supersaturation of calcium and phosphate. The concentration of hydrogen ions (pH) at the tooth surface also will affect the rate of demineralization.[18] As the concentration of organic acids increases in the inner layer of plaque on the tooth surface, pH drop occurs causing demineralization of tooth structure.[19]

Testing salivary pH levels allows to predict the activity of decay-inducing bacteria and assess the body's defensive capacity.[20] Salivary pH testing is a good and simple way to establish salivary buffering capacity. Saliva's physiological buffering capacity ranges between 5.75 and 6.5 and pH of fresh saliva is usually around 6.6. Lower values indicate acidity of the oral environment and a low pH value of saliva requires a treatment process including restoration of homeostasis in the enamel-saliva system.[21] The salivary pH is an important biomarker for dental caries. Chewable tablets provide a safe, well-tolerated alternative to traditional pediatric drug formulations. This study aims to determine the effect of chewable tablets on salivary pH and correlate the results to its cariogenicity.

MATERIALS AND METHODS

This study was conducted in St. Antony's Matriculation Higher Secondary School, Avadi, Chennai. The study group comprised a total of 100 children, of which 46 were boys and 54 were girls who were between the age group of 9–10 years. Assessment of salivary pH was carried out using litmus paper.

Salivary sample was collected before and after the administration of Vitamin C chewable tablets.

The saliva pH test was performed in the following way:

- A vial of around 1 mL of unstimulated saliva
- A pH paper strip calibrated at 1.

The result of the test was read by means of a color scale after 30 s after dipping the pH paper in saliva. This test was performed before and after the patient consumed the chewable tablets.

RESULTS

The results indicate that salivary pH was neutral in 64% and slightly basic in the remaining 36% of children before administration of chewable tablets [Figure 1]. The salivary pH was found to remain neutral after the administration of the Vitamin C chewable tablets in about 27% of children [Figure 2]. The remaining study population (73%) showed an acidic pH (<7), of which 8% had a pH value of 3 and the remaining 65% of the study population had a pH range of 5 [Figure 3]. This drop in pH was found to be statistically significant ($P < 0.001$). The results of the study are summarized below.

DISCUSSION

One aspect that has received attention in recent times is the effect of over-the-counter medications and

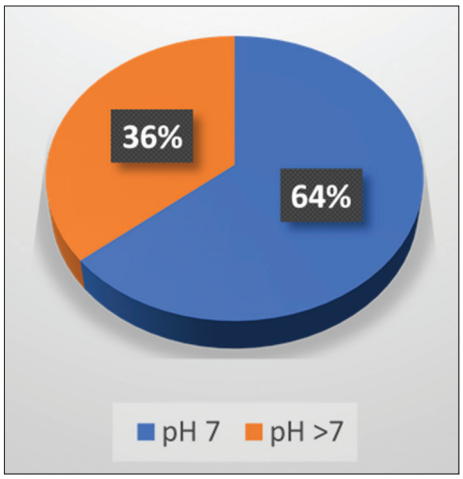

Figure 1: Salivary pH before the administration of chewable tablets

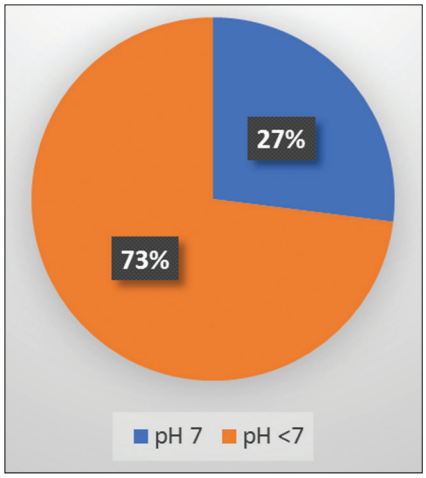

Figure 2: Salivary pH after the administration of chewable tablets

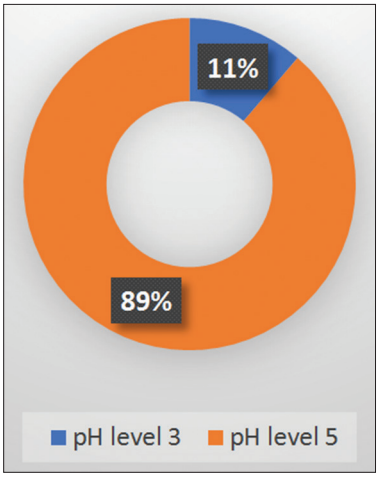

Figure 3: Acidic pH range after the administration of chewable tablets

liquid or chewable pharmaceutical preparations on the dentition of children. For example, a number of liquid or chewable pharmaceutical preparations are made palatable for ease of administration to children by the addition of sweeteners such as sucrose, glucose, or fructose. Medications that contain these sweeteners, which include analgesics, antibiotics, and vitamins, supplements are either given to the children before bedtime or remain in the mouth for extended periods of time which increases the duration of contact. This will, in turn, increase the risk of caries. A controlled study of pediatric patients taking chronic doses of medications in liquid or chewable forms for a minimum of 6 months has reported a considerable increase in dental caries and gingivitis.[2] A study among 6–9-year-old children conducted to assess the effect of chewable brushes reported a significantly reduced salivary pH before and after the use of chewable brushes.[22]

The increasing popularity of supplemental Vitamin C (L-ascorbic acid) which is prescribed either professionally or self-prescribed is due to the markedly increased use during the last years. There are different preparations available in the market, which include chewable tablets, syrup, and effervescent Vitamin C tablets.[23]

Vitamin C preparations in the chewable form may cause erosion when it is consumed frequently and left in direct contact with the teeth for prolonged periods of time.[24] The chemical dissolution by extrinsic or intrinsic acids of the dental hard tissues is called erosion. A principal cause of loss of tooth structure that is being increasingly identified in not only adults but also both children and adolescents is dental erosion.[25-29]. Dental erosion causes tooth sensitivity, altered occlusion, and in severe cases pulp exposure and abscess.[30] Extrinsic causes of dental erosion arise from several sources, including those which may be occupational, in medications, or through lifestyle practices.

Studies have shown prevalence of dentin erosion in around 30% primary molars of 5 years old, and 2% in incisal surfaces of permanent incisors in 14 years old. For example, the UK Child Dental Health Survey has showed that erosion on palatal surfaces of the primary teeth was prevalent in about 8% in 2 years old and 52% in 5 years old with the proportion of children exhibiting erosion extending into dentin being 24% in 5 years old.[31] The prevalence of erosion on palatal surfaces in permanent dentition was 8% in 7 years old and increased up to 31% in 14-year-old children.[31] Children exhibiting erosion extending into dentin was 2% in 15 years old.[31] A study by Millward *et al*. conducted in children of 4–16 years of age group found dentin exposure in 30% of primary molars.[32]

In other studies, Bartlett *et al*. found erosion of enamel in around 57% of 11–14 years old and erosion of dentin in about 2%.[33] Milosevic *et al*. in a study population consisting of 14-year-old children found 30% had exposed dentin incisally, and 8% had exposed dentin on occlusal and/or lingual surfaces.[34] In the primary dentition, the reduced thickness of enamel and greater acid solubility contribute to the higher susceptibility to erosion.[35,36] Results from clinical surveys suggest a strong positive correlation between the consumption of Vitamin C supplements and the prevalence of erosions.[37-39]

Saliva is a complex fluid consisting of secretions from the major and minor salivary glands. Whole saliva can be collected non-invasively by individuals with limited training using simple equipment. Analysis of saliva can offer a cost-effective approach to screen for a larger population. Salivary analysis may be useful for diagnosing systemic oral disorders, as well as for monitoring hormone and therapeutic levels of drug.[40] Of all the factors involved in modifying the erosion process, saliva is probably the most important factor as it is known to have protective properties against dental erosion as it forms a pellicle that protects enamel from acid demineralization, but the nature of this role is not fully established.[39,41]

The thickness of pellicle varies within different areas of the mouth and this may influence the sites and severity of erosion.[41] Salivary flow is critical in maintaining the health of oral soft and hard tissues. Children with decreased salivary flow may be more susceptible to smooth surface caries.[42]

Unstimulated salivary flow rate has shown to be directly associated with dental erosion.[43-45] A direct relationship has been established between oral clearance of dietary acids and reduced salivary flow rates and buffering capacity.[45] The salivary flow rate

is related to the bicarbonate level of saliva; hence, lower buffering capacity is seen in association with low salivary flow rate.[45] Reduced protection by saliva from intrinsic and extrinsic acids can be contributed to decreased salivary flow due to dehydration.[46] Salivary buffer capacity has also been found to be significantly lower in patients with erosion in comparison to control groups.[47,48]

Giunta *et al*. concluded from a case report and an *in vitro* test that the pH of saliva can drop while chewing Vitamin C tablets and that chewable Vitamin C tablets can cause a pH <2.0 in the oral cavity.[49] In the present study, the pH levels produced in 73% of the study population was significantly lower and was in the range of 3–5.

A cross-sectional study by Gurunathan *et al*. involving 478 pairs of parents and children showed a significant higher dental neglect score among the parents who reside in the suburban location and consequently a higher DMFT and debris score among the high dental neglect group.[50]

The potential tooth damage caused by chewable tablets should be made aware to the consumers. The physician should recommend Vitamin C in a form and dose which is considered safe for the patient. This is in accordance with the findings of Meurman and Murtomaa who found that for individuals with normal salivary flow rate the consumption of Vitamin C preparations do not necessarily have erosive effects, unless the chewable tablets are left in direct contact with the teeth.[52] Although the pH level produced by chewable Vitamin C tablets varies from manufacturer to manufacturer, the level of acidity in Vitamin C preparations is always high. The time and the area of contact with the teeth may be high since tablets are hard, large, and chewable.

CONCLUSION

Vitamin C is available in numerous forms which allow protracted exposure of the teeth to ascorbic acid. Although a buffering agent like sodium ascorbate is added in most Vitamin C preparations, it may be added in quantities that may be insufficient and the repeated use of chewable mega dose tablets of Vitamin C can damage the teeth by causing dissolution of enamel. Hence, the physician should prescribe chewable Vitamin C forms and doses appropriate to the patient and formulations that contain fluoride to reduce the risk of erosion.

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