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The Role of Saliva in Dental Erosion and a Prosthetic Approach to Treatment: A Case Report

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Abstract

Aim: The aim of this report is to describe the relationship of some salivary parameters to dental erosion resulting from excessive citric acid consumption and present a description of a prosthetic approach used to restore the damaged dentition of a patient with severe erosion.

Background: The high consumption of dietary sources of acids can lead to erosion or the excessive wear of dental hard tissues. Erosion may be modified by salivary parameters such as flow rate, pH, and buffering capacity. Porcelain-fused-to-metal (PFM) restorations and composite resin veneers can be used successfully to restore impaired esthetics and eliminate tooth hypersensitivity in such cases.

Results: A 37-year-old woman with a history of excessive lemon consumption presented with a complaint of tooth hypersensitivity and the poor appearance of her dentition due to erosion. Stimulated and unstimulated salivary samples of the patient were evaluated for flow rate, pH, and buffering capacity before and after treatment. The pre-treatment values were found to be higher than post-treatment values. Stimulated samples showed an increase of salivary flow rate, pH, and buffering capacity. The measured parameters put forth the defensive potential of saliva against the acidic diet, and the salivary flow rate and buffering capacity decreased after reducing acidic consumption. The excessively eroded teeth were restored using PFM restorations whereas the superficially eroded teeth were restored with composite resins.

Summary: The introduction of acidic foods, beverages, or other agents can exceed the natural buffering capacity of saliva. The result is a lowering of the pH of the oral environment which can lead to erosion of enamel and dentin. Loss of tooth structure due to erosion can compromise the esthetics of the dentition and lead to hypersensitivity of the teeth. Teeth damaged by erosion can be successfully restored by composite resin or porcelain restorations and esthetics and function of dentition can be improved.

Clinical Significance: This report is a profound example of how the over consumption of acidic agents affect not only dental tissues but also the chemical balance of the oral environment as well as the oral habitat.

Keywords: Dental erosion, salivary flow rate, pH, buffering capacity

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Introduction

Erosion of tooth structure is defined as the superficial loss of dental hard tissue due to a chemical process not involving bacteria.[1] This phenomenon is characterized as a disorder with a multifactorial etiology which could be influenced by extrinsic and intrinsic factors.[1-4]

The most common external erosive sources are dietary.[2,4,5] Reports have been published on excessive or unusual consumption of acidic fruits, fruit juices, and acidic beverages and its relationship to dental erosion.[1,6] The erosive potential of citric, malic, phosphoric, and more recently ascorbic acids have been widely accepted.[2,4,5,7] Jarvinen et al.[3] stated the consumption of citrus fruits more than twice a day was associated with an erosion risk 37 times greater than in subjects who consumed these fruits less frequently. Lussi and Hellwig[8] also reported patients with excessive acid intakes have a higher risk for erosion.

The demineralizing effect of citric acid is profound because the citrate ion is a chelating ligand that forms a soluble complex with the calcium ion in tooth structure which promotes further dissolution of hard tissue.[3,9] This action continues even after the pH increases at the tooth surface.

Clinically, the erosive lesions develop on any tooth surface coming in contact with acid.[5] Eroded tooth surfaces appear to be rounded and smooth silky-glazed and with a loss of detailed microanatomy.[3,10,11] Softer dentin is lost faster to produce depressions on the cusps of posterior teeth as well as on the incisal edges of anterior teeth. Where dentin is exposed, cupping and grooving on occlusal surfaces become the predominant features of erosion.[11]

The teeth involved become hypersensitive to temperature changes and touch.[10] Most acids of dietary origin have a very low pH such as lemon which contains citric acid with a pH of 1.8-2.4.[2] However, the erosive potential of citrus fruits depends not only on pH but also salivary functions such as buffering capacity and flow rate, bicarbonate content, pellicle thickness, gingival sulcular flow, which can modify the erosive process, as well as the susceptibility of the teeth to erosion.[4,6,12,13]

The buffering capacity of saliva is an important factor which plays a role in the maintenance of salivary pH and dental remineralization.[2] While clinical studies evaluating the interaction of erosion and low salivary buffering capacity have yielded conflicting results,[2,3,5] the concept of increasing salivary flow rate and, thus, the buffering capacity to increase the protection against erosion and to promote remineralization is generally accepted.[4]

The aim of this report is to describe the relationship of some salivary parameters to dental erosion resulting from excessive citric acid consumption and present a description of a prosthetic approach used to restore the damaged dentition of a patient with severe erosion.

Case Report

A 37-year-old woman presented to Gazi University, Faculty of Dentistry, Department of Prosthodontics with complaints of hypersensitivity to acidic beverages and to hot and cold conditions as well as an unpleasant appearance of her teeth. She reported an average lemon consumption of two kilograms every three days since her childhood. The method of consumption was by sucking the juice directly from the fruit.

Medical anamnestic data showed no evidence of systemic disease that might compromise salivary function. Intraorally, the progressive loss of enamel was observed predominantly on the facial surfaces of the teeth. The maxillary anterior teeth were the most affected with the mandibular anterior teeth being the least affected (Figures 1, 2, and 3).

The occlusal and facial surfaces of all premolars and molars were affected whereas the lingual surfaces showed no signs of enamel loss. The third molars also showed no sign of enamel loss. The surfaces involved had lost anatomical details such as developmental ridges and stain lines resulting in smooth glazed appearance. Cupping was especially severe on the incisal edges of the maxillary anterior teeth and on the occlusal surfaces of premolars and molars (Figure 4).

Although oral hygiene and the periodontal status were adequate, the wide spread cervical erosion associated with gingival recession was evident especially on the left side of the dentition. Analysis of a complete set of intraoral radiographs confirmed missing maxillary left and mandibular right first molars and no active carious lesions present. A diagnosis of dental erosion was made based on the clinical findings and a long history of substantial lemon sucking.

Treatment

Prior to treatment, ethical approval was granted by the Ethics Commitee of Gazi University in order to take salivary samples and make examinations about salivary flow rate and buffering capacity.

Salivary pH, salivary flow rate, and buffering capacity were first determined. After discussion of several treatment options, the patient agreed to a treatment plan which included the following:

Figure 1. Frontal view of the dentition.

Figure 2. Right view of dentition.

Figure 3. Left view of dentition.

Figure 4. Localized facets on the incisal and occlusal surfaces.

- All affected teeth except the mandibular incisors and third molars were restored with porcelain-fused-to-metal (PFM) crown and bridge restorations.
- The labial surfaces of mandibular anterior teeth were veneered with a composite resin material (Filtek Z 250, 3M ESPE, Seefeld, Germany) using an incremental technique and polymerized with a conventional halogen lamp (Hilux, Benlioglu, Ankara, Turkey) (Figures 5 and 6).

Stimulated and unstimulated salivary pH, flow rate, and buffering capacity were measured at pre- and post-treatment periods. The patient's habitual lemon consumption was continued until salivary parameters were evaluated for the first time (i.e., pre-treatment). Final evaluation was done when the habit was discontinued and normal consumption of the fruit had begun.

Before the saliva samples were collected the patient was instructed not to eat or drink anything for up to two hours preceding the appointment. Saliva samples were collected between 10:00-11:00 a.m. While collecting the unstimulated samples, patient sat in straight position, after an initial swallow, she expectorated into a gradient tube for five minutes. For stimulated saliva samples, she was asked to chew a piece of paraffin wax (approximately one gram) for two minutes while changing her chewing side every fifteen seconds and swallowing the initial saliva. Then she continued to chew and the saliva produced was collected at five minute intervals. The amount of saliva was recorded and results converted to ml per minute. The pH and buffering capacity of salivary samples were measured as soon as possible and not later than 30 minutes after collection.

The pH of salivary samples was measured directly by using a pHmeter (Sentron AG, Zug, Switzerland). Incrementally 10µl of 0.1 N HCl was

Figure 5. Porcelain fused to metal and composite resin restorations.

Figure 6. Anterior view of the final restorations.

Table 1. Salivary parameters measured.

Parameter	Pre-treatment		Post-treatment	
	Stimulated	Unstimulated	Stimulated	Unstimulated
pH	7.50	7.10	6.90	6.70
Flow Rate (ml/min)	1.72	0.48	1.59	0.31
Buffering Capacity (mmol/L)	6.80	6.10	5.40	4.90

titrated into the 0.5 ml of both saliva samples up to total titration of 160 µl during which the buffering capacities were determined by reading the pH value in each step.

The results of salivary flow rate, pH, and buffering capacity measured for stimulated and unstimulated samples at pre- and post-treatment periods are shown in Table 1. All values obtained for stimulated samples were higher than those for unstimulated ones at both periods. Also, pre-treatment records were found to be higher than those of the post-treatment.

Discussion

A number of studies have shown acidic fruits lead to both loss and softening of enamel and dentin causing erosive lesions. Bassiouny et al.[14] have evaluated the changes in the topography, morphology, and radiographic profiles of human permanent teeth that had been exposed to citrus fruit juices and compared the changes with acetic acid and water as the control group. They found lemon juice displayed the most erosion, followed by acetic acid, grapefruit juice, orange juice, and water, which had no effect. The distribution of the lesions may depend on the manner in which these acidic substances are consumed. Acid from citrus fruits may predominantly affect the labial surfaces of maxillary incisors if the fruit is sucked as observed in this case.[10] Probably the most obvious effect of such excessive wear is the alteration of the esthetics of the upper anterior teeth which is often the basic motivation for the patient to seek treatment.[1] On the other hand dentin hypersensitivity is another motivating factor for the patient. In the present case the erosion was much more aggressive on the left side of the dentition which is likely due to the brushing direction and force applied as a result of patient being right-handed.

Generally the timing of restorative treatment options in erosion cases is dependent on individual circumstances and perceived needs and concerns of the patient. Depending on the degree of erosion treatment options can range from placement of bonded composites in a few isolated areas of erosion to a full-mouth reconstruction.[2,10] Adhesive-retained composite resin restorations could be used in areas that are not susceptible to high biting forces such as in the mandibular anterior region.[6] This is a more conservative approach compared to the more destructive use of crowns or veneers.[15]

In the present case the patient placed considerable importance on the appearance of her anterior teeth and complained about inadequate function due to her missing molars. In the anterior segment of the mandible adequate appearance and function as well as protection from further erosion was accomplished by placement of composite resin veneers. Initially laminate veneer restorations were considered for the maxillary anterior teeth due to presence of sound lingual surfaces, however, there was inadequate enamel on the facial surfaces to achieve adequate bonding with a luting agent. Sundaram et al.[15] have reported resin tag penetration into eroded dentin to be 30 µm compared to 100 µm for sound dentin. Considering the need for long-term service of any rehabilitation of the dentition, the decision was to restore the teeth using PFM restorations to improve the patient's appearance and masticatory function. The anatomy and occlusion of the worn teeth as well as the edentulous spaces due to missing molars were restored by the fixed restorations with a high degree of accuracy and satisfactory esthetics.

In the differential diagnosis of erosion the measurement of salivary functions can be useful. Several investigators point out the importance of the unstimulated salivary flow rate as a factor for determining the probability of the occurrence of dental erosion.[3,13] A low salivary flow naturally results in a deficient rinsing and buffering of demineralizing acids on tooth surfaces.[3] The buffering capacity of saliva refers to its ability to resist a change in pH when an acid is added to it and it is largely due to the bicarbonate content of saliva which is dependent on salivary flow rate.[2,16] Bicarbonate concentration also regulates salivary pH.[2,13] Therefore, a parallelism exists between salivary pH, buffering capacity, and flow rate with the pH and buffering capacity increasing as the flow rate increases.[2,3,6] Prolonged acidic stimulation activates the parotid glands, thus, the bicarbonate level increases. This leads to an increase in buffering capacity of both stimulated and unstimulated saliva as was found during the pre-treatment period in the present case. Stimulation of saliva significantly enhanced flow

rate, pH, and buffering capacity regardless of the measurement periods in this case due to the high bicarbonate level of saliva secreted by the parotid glands. Normally, when an acid enters the mouth from an intrinsic or an extrinsic source, salivary flow rate increases along with pH and buffering capacity within minutes. The acid is neutralized and cleaned from the oral cavity and the pH returns to normal. Therefore, normal salivary flow rates may be associated with the lack of the acidic stimulus on the parotid glands as was obtained during the period of excessive lemon consumption by the patient. Although the stimulated saliva values obtained were higher than the unstimulated values as seen in previous studies,[13,16,17] they did not exceed average values (0.8-1.9 ml/min) as defined by Ciolino et al.[16]

After treatment, unstimulated salivary parameters were found to be lower than stimulated ones (pH: 6.7/6.9; buffer capacity: 4.9/5.4 mmol/L; flow rate: 0.31/1.59ml/min). Bardow et al.[17] reported average flow rates for stimulated and unstimulated saliva to be 1.60±0.64 and 0.55±0.22 ml/min, respectively. However, Palomeres et al.[13] found salivary flow rates to be in the range of 0.10-2 ml/min (average 0.42 ml/min) while the pH and buffer capacity were 6.76 and 5.3 mmol/L, respectively. Both of these studies have included healthy females. On the other hand Larsen et al.[18] reported the individual range of pH to be between 5.76-7.96 in unstimulated saliva. In the present case the parameters measured dropped after treatment. The stimulated salivary values were relatively similar to the average numbers mentioned above, whereas unstimulated ones remained below the limits. This data was found to be especially important because it reflects the actual condition of the patient[3,13,18] and it may be considered as the primary risk factor for erosion.

Summary

The results obtained from salivary tests show there was a close relationship between erosion and flow rate and buffering capacity of unstimulated saliva. Significantly increased parameters have been measured during periods of excessive acidic consumption via lemon sucking. The values dropped during the period of post-treatment in which the lemon sucking habit was eliminated and normal consumption of the fruit was established. The excessive consumption and strong acidity of the lemon surpassed the preventive capacity of the saliva.

Clinical Significance

This report is a profound example of how the over consumption of acidic agents affect not only dental tissues but also the chemical balance of oral environment as well as the oral habitat.

References

1. Mount GJ, Hume WR. Preservation and restoration of tooth structure. St.Louis: Mosby , 1998: 31-5.
2. Gandara BK, Truelove EL. Diagnosis and management of dental erosion. J Contemp Dent Pract 1999; 1:16-23.
3. Jarvinen VK, Rytömaa II, Heinonen OP. Risk factors in dental erosion. J Dent Res 1991; 70:942-7.
4. Moss SJ. Dental erosion. Int Dent J 1998; 48:529-39.
5. Bartlett D. The implication of laboratory research on tooth wear and erosion. Oral Dis 2005; 11:3-6.
6. Amaechi BT, Higham SM. Dental erosion: possible approaches to prevention and control. J Dent 2005; 33:243-52.
7. Barbour ME, Rees JS. The laboratory assessment of enamel erosion: a review. J Dent 2004; 32:591-602.
8. Lussi A, Hellwig E. Risk assessment and preventive measures. Monogr Oral Sci 2006; 20:190-9.
9. Barbour ME, Parker DM, Allen GC, Jandt KD. Human enamel dissolution in citric acid as a function of pH in the range 2.30< or =pH< or =6.30 – a nano indentation study. Eur J Oral Sci 2003; 111:258-62.
10. Litonjua L A, Andreana S, Bush PJ, Cohen RE. Tooth wear: Attrition, erosion and abrasion. Quintessence Int 2003; 34:435-46.
11. Lussi A, Hellwig E, Zero D, Jaeggi T. Erosive tooth wear: diagnosis, risk factors and prevention. Am J Dent 2006; 19:319-25.
12. Barbour ME, Parker DM, Allen GC, Jandt KD. Human enamel erosion in constant composition citric acid solutions as a function of degree of saturation with respect to hydroxyapatite. J Oral Rehabil 2005; 32:16-21.
13. Palomares CF, Montagud JVM, Sanchiz V, Herreros B, Hernandez V, Minquez M, Benages A. Unstimulated salivary flow rate, pH and buffer capacity of saliva in healthy volunteers. Rev Esp Enferm Dig 2004; 96:773-83.<
14. Bassiouny MA, Yang J, Kuroda S. Topographic and radiographic profile assessment of dental erosion. Part II: effect of cirrus fruit juices on human dentition. Gen Dent 2008; 56:136-43.
15. Sundaram G, Bartlett D, Watson D . Bonding to and protecting worn palatal surfaces of teeth with dentin bonding agents. J Oral Rehabil 2004; 31:505-9.
16. Ciolino LA, McCauley HA, Fraser DB, Wolnik KA. The relative buffering capacities of saliva and moist snuff: Implications for nicotine absorption. J Anal Toxicol 2001; 25:15-25.
17. Bardow A, Moe D, Nyvad B, Nauntofte B. The buffer capacity and buffer systems of human whole saliva measured without loss of CO2. Arch Oral Biol 2000; 45:1-12.
18. Larsen MJ, Jensen AF, Madsen DM, Pearce EIF. Individual variations of pH, buffer capacity and concentrations of calcium and phosphate in unstimulated whole saliva. Arch Oral Biol 1999; 44:111-7.

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