Journal of Zhejiang University SCIENCE B
ISSN 1673-1581 (Print); ISSN 1862-1783 (Online)
www.zju.edu.cn/jzus; www.springerlink.com
E-mail: jzus@zju.edu.cn

Case Report:

Dental erosion and severe tooth decay related to soft drinks: a case report and literature review*

Ran CHENG, Hui YANG, Mei-ying SHAO, Tao HU†‡, Xue-dong ZHOU

(*Department of Operative Dentistry and Endodontics, West China College of Stomatology, Sichuan University, Chengdu 610041, China*)

†E-mail: acomnet@263.net

Received Aug. 13, 2008; Revision accepted Dec. 1, 2008; Crosschecked Mar. 24, 2009

Abstract: Soft drinks have many potential health problems. The inherent acids and sugars have both acidogenic and cariogenic potential, resulting in dental caries and potential enamel erosion. In this report we present a 25-year-old man complaining with the severe worn-out of the front teeth during the past 3 years. He had a history of drinking cola for more than 7 years and had a poor oral hygiene. Severe decays were present in the incisors and the canines, while less severe lesions were noted on the premolars and the molars. The review is to show the relationship between dental erosion and caries and soft drinks. Some efforts have been taken to reduce the harmful effect of soft drinks.

Key words: Dental erosion, Caries, Soft drinks, Toothbrushing
doi:10.1631/jzus.B0820245 **Document code:** A **CLC number:** R78

INTRODUCTION

Dental erosion (erosive tooth wear) is the situation of a chronic loss of dental hard tissue that is chemically etched away from the tooth surface by acid and/or chelation without bacterial involvement. Acids of intrinsic (gastrointestinal) and extrinsic (dietary and environmental) origins are the main etiologic factors (ten Cate and Imfeld, 1996; Hefferren, 2004). Rampant caries is defined as quickly spreading caries that affecting at least two of the upper incisors (Winter *et al*., 1966). In epidemiologic studies, rampant caries is defined as a decayed, missed and filled teeth (DMFT) value of 5 or more, and labial caries is regarded as a specific entity (Cleaton-Jones *et al*., 1978).

Soft drinks containing inherent acids and sugars have both acidogenic and cariogenic potential. Many studies showed a positive relationship between caries and dental erosion and the consumption of soft drinks (Sayegh *et al*., 2002; Johansson *et al*., 1996; Harding *et al*., 2003; Al-Majed *et al*., 2002; Luo *et al*., 2005). Accordingly, the clinical manifestations and diagnosis of diseases caused by soft drinks should be regarded as a combination of erosion and caries, and clinicians should pay more attention to it. In this paper, we report a case of dental erosion and rampant caries caused by extensive consumption of soft drinks. A review of the literature on the etiology and the related factors was presented.

CLINICAL DATA

A 25-year-old man presented with the severe worn-out of the front teeth during the past 3 years. The patient reported that he had a history of drinking cola for more than 7 years and had a poor oral hygiene. In the first 3 years, he drank 0.5~0.75 L cola a day and toothbrushed once a day. During the period of 4~5 months into the 4th year, he drank 1.5 L cola a day and some fruit juices (especially grape and citric

‡ Corresponding author

* Project (No. NCET-05-0790) supported by the Program for New Century Excellent Talents in University, China

juices), and he brushed his tooth or gargled with water once a day, mostly in the morning. In the latest 3 years, he continued dranking 1.5 L cola a day and toothbrushed once or twice daily.

He described his job as a bank worker with no exposure to acid substances. The patient recalled a busy-working period of about 4 to 5 months 3 years ago when he started consuming cola much more frequently (a total of 1.5 L a day). He likes holding the drink in the mouth for several seconds and tasting before swallowing. He denied anything unusual in his diet, medical history, allergic history, and family history of dental problems. He also denied symptoms of gastroesophageal reflux, odontalgia, xerostomia, and bruxism.

Dental examination found that crescent-shaped lesions were present on the cervical region of the buccal and labial surfaces of the teeth of this patient (Figs.1a~1c). No lesions were found in the palatal and lingual surfaces (Fig.1d). Different stages of lesions could be seen on the teeth. Severe decays (caries cavities shown by arrows in Figs.1b and 1c) were present in the incisors and the canines, while less severe lesions (white spot lesions shown by arrowheads in Figs.1b and 1c) were noted on the premolars and the molars. The pulpal surfaces of erosive lesions contained brown-colored, leathery, carious dentin. None of the pulp cavities were involved. The patient did not report pain or sensitivity associated with any of the affected teeth. A comprehensive periodontal examination revealed no signs of attachment loss, and plaque deposits and calculus were only found on the mandibular incisors, with minimal bleeding on probing. The maxillary front teeth remained asymptomatic on percussion, palpation, and cold testing.

Buccal caries had also impacted teeth 17 and 27. And more extensive buccal and occlusal caries were seen in teeth 18 and 28. Caries of tooth 27 had impacted the pulp, above which there were lots of grey debris. The patient reported no pain on cold testing and percussion, but a severe pain when probing into the pulp cavity.

The oral mucosa was moist, pink, and without lesions. There was no salivary gland enlargement bilaterally. The saliva was clear and flowed freely from salivary ducts bilaterally. Normal pooling of saliva was noted on the floor of the mouth. The remainder of the soft-tissue examination was normal.

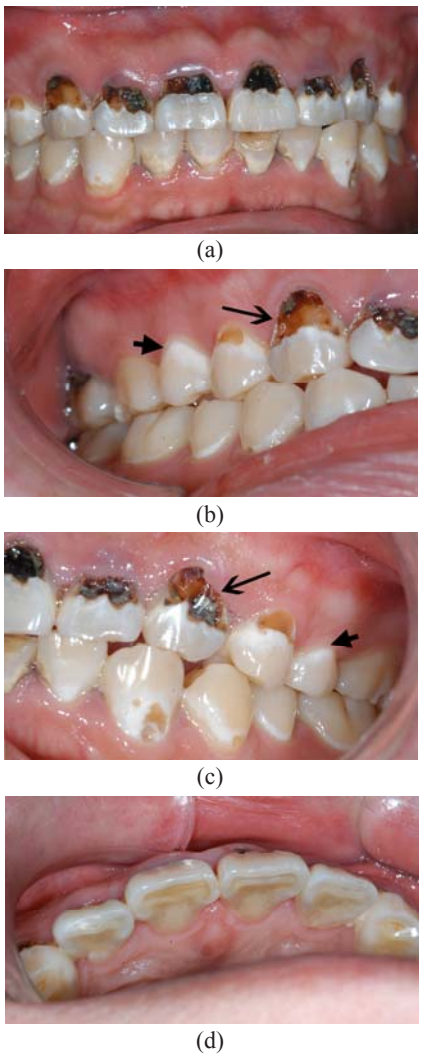

Fig.1 The maxillary and mandibular teeth
(a) The front view; (b) The right buccal view; (c) The left buccal view; (d) The incisal and palatal view. Arrows: caries cavities; Arrowheads: white spot lesions

Finally, the history and the symptoms of this patient confirmed the complex diagnosis of dental erosion and dental caries. On one hand, dental erosion is defined as the physical result of acid without bacterial involvement. Early stage of dental erosion includes a smooth surface. Advanced stages include developing enamel concavities, lesions with longer depth than width, undulating borders, and an intact border of enamel along the facial gingival margin. In severe cases of dental erosion, the entire occlusal morphology of the tooth disappears (Lussi *et al*., 1993; 2004; 2006). The pattern of erosion is related to the frequency the dental tissue is exposed to acidic fluid. In this case, the patient likes holding the drink in

around the vestibular groove. The erosive acid of drink may have demineralized the cervical region of the tooth. On the other hand, the high sugar intake and bad oral hygiene pattern of the patient also caused bacterial infection, i.e., the dental caries.

Considering that excessive intake of soft drink and poor oral hygiene pattern are likely etiologic factors, we recommended the patient to reduce soft drink intake and contact time of acids, not to hold drinks in the mouth, and to use fluoride or remineralizing toothpaste to brush the teeth at least twice a day, but avoid toothbrushing immediately after soft drink intake.

Since there was gingival hyperplasia around the lesions, treatment plan for the patient included gingivectomy and composite resin restoration. The high-frequency electrosurgery was used to remove excessive gingival tissue following a local anesthesia, and a composite resin Filtek™ Z350 (3M ESPE, St. Paul, MN, USA) was applied to restore the lost tooth structure.

DISCUSSION AND CONCLUSION

In the present case, the lesions of the patient indicated the long-term damage of soft drinks. The white spot lesions confirmed the diagnosis of dental erosion. Severe caries were also found in the upper incisors, making the diagnosis complicated.

Soft drinks have many potential health problems, including dental caries and enamel erosion (Majewski, 2001). Dental caries may result from a long-term high intake of soft drinks and deterioration in oral hygiene patterns. In other cases, slowly progressed caries may suddenly become rampant. This may result from frequent exposure to erosive acids (McIntyre, 1992). The most frequent source of the acids is soft drinks like cola. It is also indicated that the cariogenicity of cola is higher than that of milk and sucrose (Bowen and Lawrence, 2005). To reduce dental caries risk, the low-calorie and sugar-free food was recommended. However, sugar-free soft drinks often have as high erosive potential as sugar-containing soft drinks.

Compared with caries, dental erosion seems to have much stronger relationship with soft drinks. The erosive potential of drinks is mainly represented by their pH and the buffering capacity. In previous reports, the initial pH values of some soft drinks and their buffering capacities were determined. Carbonated drinks had lower pH than fruit juices. The buffering capacities are in the following order: fruit juices>fruit-based carbonated drinks>non-fruit-based carbonated drinks (Edwards *et al*., 1999; Owens, 2007). Carbonated drink could reduce surface hardness of enamel, dentine, microfilled composite, and resin-modified glass ionomer. Sports drink and juices are merely effective to enamel (Wongkhantee *et al*., 2006). Even the sports drinks have a stronger softening effect than fruit juices (Lussi *et al*., 1995; Lippert *et al*., 2004; Jensdottir *et al*., 2005). Moreover, some supplements of drinks, such as calcium, could reduce the progress of enamel demineralization (Hara and Zero, 2006).

More studies showed that dental erosion was associated with the drinking methods. Holding the drink longer in the mouth leads to a more pronounced pH drop (Johansson *et al*., 2004). Drinking with an increasing flow rate and with decreasing outlet diameter could increase the erosion depth (Shellis *et al*., 2005). The effect is also strengthened when acid temperature grows higher (Eisenburger and Addy, 2003).

Toothbrushing is a way to keep a good oral hygiene. Hard tissue loss after erosion and toothbrushing is significantly greater than erosion alone (Rios *et al*., 2006; Magalhães *et al*., 2008). However, after intra-oral periods of 30 and 60 min, wear was not significantly higher in toothbrushing than in unbrushed controls. It is concluded that keeping tooth unbrushed for at least 30 min after an erosive attack is necessary for protecting dentin (Attin *et al*., 2004).

Even some kinds of toothpastes accelerate tooth wear due to the removal of superficial enamel layer (Rios *et al*., 2006). Non-fluoride toothpaste could increase dentine loss compared with drinks alone (Ponduri *et al*., 2005). Whitening dentifrice also leads to significantly greater wear of sound enamel and of both eroded and sound dentine (Turssi *et al*., 2004). On the contrary, fluoride and remineralizing toothpastes (containing NaF, calcium, phosphate, and fluoride ions) are effective in inhibiting enamel erosion. The fluoride concentration around 1100×10^{-6} in dentifrices helps to reduce dentin wear by erosion and erosion+abrasion, but the protection does not increase with fluoride concentration (Magalhães *et al*., 2008).

Remineralizing toothpaste is more effective in intact and decalcified enamel (Muñoz *et al*., 1999; Magalhães *et al*., 2007). It could improve tooth-surface smoothness and gloss with regular use (Muñoz *et al*., 2004).

In conclusion, excessive intake of soft drinks could cause complex dental consequences including dental erosion and caries. Although the diseases are different in their histological appearance, the two conditions occurring concurrently could be deleterious to dental hard tissues. It is necessary to educate patients about the harmful effects of excessive soft drink consumption and to advise them with the following tips to prevent dental erosion and caries: limiting soft drinks intake, choosing the low erosive soft drinks, improving the drinking habit, toothbrushing at least twice a day, avoiding brushing tooth within 1 h after consuming acidic food, and using fluoride or remineralizing toothpaste.

References

Al-Majed, I., Maguire, A., Murray, J.J., 2002. Risk factors for dental erosion in 5~6 year old and 12~14 year old boys in Saudi Arabia. *Community Dentistry And Oral Epidemiology*, **30**(1):38-46. [doi:10.1034/j.1600-0528.2002.300106.x]

Attin, T., Siegel, S., Buchalla, W., Lennon, A.M., Hannig, C., Becker, K., 2004. Brushing abrasion of softened and remineralized dentin: an in situ study. *Caries Res*., **38**(1):62-66. [doi:10.1159/000073922]

Bowen, W.H., Lawrence, R.A., 2005. Comparison of the cariogenicity of cola, honey, cow milk, human milk, and sucrose. *Pediatrics*, **116**(4):921-926. [doi:10.1542/peds.2004-2462]

Cleaton-Jones, P., Richardson, B.D., McInnes, P.M., Fatti, L.P., 1978. Dental caries in South African white children aged 1~5 years. *Community Dentistry And Oral Epidemiology*, **6**(2):78-81. [doi:10.1111/j.1600-0528.1978.tb01125.x]

Edwards, M., Creanor, S.L., Foye, R.H., Gilmour, W.H., 1999. Buffering capacities of soft drinks: the potential influence on dental erosion. *J. Oral Rehabil*., **26**(12):923-927. [doi:10.1046/j.1365-2842.1999.00494.x]

Eisenburger, M., Addy, M., 2003. Influence of liquid temperature and flow rate on enamel erosion and surface softening. *J. Oral Rehabil*., **30**(11):1076-1080. [doi:10.1046/j.1365-2842.2003.01193.x]

Hara, A.T., Zero, D.T., 2006. Analysis of the erosive potential of calcium-containing acidic beverages. *Am. J. Dent*., **19**(6):319-325.

Harding, M.A., Whelton, H., O'Mullane, D.M., Cronin, M., 2003. Dental erosion in 5-year-old Irish school children and associated factors: a pilot study. *Community Dent. Health*, **20**(3):165-170.

Hefferren, J.J., 2004. Why is there and should there be more attention paid to dental erosion? *Compendium of Continuing Education in Dentistry*, **25**(Suppl. 1):4-8.

Jensdottir, T., Bardow, A., Holbrook, P., 2005. Properties and modification of soft drinks in relation to their erosive potential in vitro. *J. Dent*., **33**(7):569-575. [doi:10.1016/j.jdent.2004.12.002]

Johansson, A.K., Johansson, A., Birkhed, D., Omar, R., Baghdadi, S., Carlsson, G.E., 1996. Dental erosion, soft-drink intake, and oral health in young Saudi men, and the development of a system for assessing erosive anterior tooth wear. *Acta Odontol. Scand*., **54**(6):369-378. [doi:10.3109/00016359609003554]

Johansson, A.K., Lingstrom, P., Imfeld, T., Birkhed, D., 2004. Influence of drinking method on tooth-surface pH in relation to dental erosion. *Eur. J. Oral Sci*., **112**(6):484-489. [doi:10.1111/j.1600-0722.2004.00172.x]

Lippert, F., Parker, D.M., Jandt, K.D., 2004. Susceptibility of deciduous and permanent enamel to dietary acid-induced erosion studied with atomic force microscopy nanoindentation. *Eur. J. Oral Sci*., **112**(1):61-66. [doi:10.1111/j.0909-8836.2004.00095.x]

Luo, Y., Zeng, X.J., Du, M.Q., Bedi, R., 2005. The prevalence of dental erosion in preschool children in China. *J. Dent*., **33**(2):115-121. [doi:10.1016/j.jdent.2004.08.007]

Lussi, A., Jaeggi, T., Scharer, S., 1993. The influence of different factors on in vitro enamel erosion. *Caries Res*., **27**(5):387-393.

Lussi, A., Jaeggi, T., Scharer, S., 1995. Prediction of the erosive potential of some beverages. *Caries Res*., **29**(5):349-954.

Lussi, A., Jaeggi, T., Zero, D., 2004. The role of diet in the aetiology of dental erosion. *Caries Res*., **38**(Suppl. 1):34-44. [doi:10.1159/000074360]

Lussi, A., Hellwig, E., Zero, D., Jaeggi, T., 2006. Erosive tooth wear: diagnosis, risk factors and prevention. *Am. J. Dent*., **19**(6):319-325.

Magalhães, A.C., Rios, D., Delbem, A.C., Buzalaf, M.A., Machado, M.A., 2007. Influence of fluoride dentifrice on brushing abrasion of eroded human enamel: an in situ/ex vivo study. *Caries Res*., **41**(1):77-79. [doi:10.1159/000096110]

Magalhães, A.C., Rios, D., Moino, A.L., Wiegand, A., Attin, T., Buzalaf, M.A., 2008. Effect of different concentrations of fluoride in dentifrices on dentin erosion subjected or not to abrasion in situ/ex vivo. *Caries Res*., **42**(2):112-116. [doi:10.1159/000117807]

Majewski, R.F., 2001. Adolescent caries: a discussion on diet and other factors, including soft drink consumption. *J. Mich. Dent. Assoc*., **83**(2):32-34.

McIntyre, J.M., 1992. Erosion. *Aust. Prosthodont. J*., **6**:17-25.

Muñoz, C.A., Feller, R., Haglund, A., Triol, C.W., Winston, A.E., 1999. Strengthening of tooth enamel by a remineralizing toothpaste after exposure to an acidic soft drink. *J. Clin. Dent*., **10**(Special 1):17-21.

Muñoz, C.A., Stephens, J.A., Proskin, H.M., Ghassemi, A.,

2004. Clinical efficacy evaluation of calcium, phosphate, and sodium bicarbonate on surface-enamel smoothness and gloss. *Compendium of Continuing Education in Dentistry*, **25**(Suppl. 1):32-39.

Owens, B.M., 2007. The potential effects of pH and buffering capacity on dental erosion. *Gen. Dent.*, **55**(6):527-531.

Ponduri, S., Macdonald, E., Addy, M., 2005. A study in vitro of the combined effects of soft drinks and tooth brushing with fluoride toothpaste on the wear of dentine. *Int. J. Dent. Hyg.*, **3**(1):7-12. [doi:10.1111/j.1601-5037.2004.00110.x]

Rios, D., Honorio, H.M., Magalhães, A.C., Buzalaf, M.A., Palma-Dibb, R.G., Machado, M.A., da Silva, S.M., 2006. Influence of toothbrushing on enamel softening and abrasive wear of eroded bovine enamel: an in situ study. *Braz. Oral Res.*, **20**(2):148-154. [doi:10.1590/S1806-83242006000200011]

Sayegh, A., Dini, E.L., Holt, R.D., Bedi, R., 2002. Food and drink consumption, sociodemographic factors and dental caries in 4-5-year-old children in Amman, Jordan. *Br. Dent. J.*, **193**(1):37-42. [doi:10.1038/sj.bdj.4801478a]

Shellis, R.P., Finke, M., Eisenburger, M., Parker, D.M., Addy, M., 2005. Relationship between enamel erosion and liquid flow rate. *Eur. J. Oral Sci.*, **113**(3):232-238. [doi:10.1111/j.1600-0722.2005.00210.x]

ten Cate, J.M., Imfeld, T., 1996. Dental erosion, summary. *Eur. J. Oral Sci.*, **104**(2):241-244. [doi:10.1111/j.1600-0722.1996.tb00073.x]

Turssi, C.P., Faraoni, J.J., Rodrigues, A.L.Jr., Serra, M.C., 2004. An in situ investigation into the abrasion of eroded dental hard tissues by a whitening dentifrice. *Caries Res.*, **38**(5):473-477. [doi:10.1159/000079629]

Winter, G.B., Hamilton, M.C., James, P.M., 1966. Role of the comforter as an aetiological factor in rampant caries of the deciduous dentition. *Arch. Dis. Child*, **41**(216):207-212. [doi:10.1136/adc.41.216.207]

Wongkhantee, S., Patanapiradej, V., Maneenut, C., Tantbirojn, D., 2006. Effect of acidic food and drinks on surface hardness of enamel, dentine, and tooth-coloured filling materials. *J. Dent.*, **34**(3):214-220. [doi:10.1016/j.jdent.2005.06.003]