Human & Veterinary Medicine
International Journal of the Bioflux Society HVM

OPEN ACCESS
Review

Dental erosion - literature update

[1]Alina M. Picos, [1]Andrea M. Chisnoiu, [2]Jean F. Lasserre, [3]Aurelia Spinei, [4]Radu M. Chisnoiu, [1]Andrei Picos

[1] Departement of Prosthetic Dentistry, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania; [2] Departement of Prosthetic Dentistry, "Victor Segalen" University of Medicine and Pharmacy, Bordeaux, France; [3] "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, Republic of Moldavia; [4] Departement of Odontology, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania

Abstract. Tooth wear is a complex, pluri-factorial process that must be taken into account in clinical practice. The main mechanisms typically related to dental wear are: abrasion, attrition, erosion and wear by fatigue. The dramatic increase in the frequency of erosive lesions, especially in younger age groups determined us to give a synthesis of the most recent scientific literature on the specific problem of erosion. Attention is drawn to the excessive consumption of acidic beverages in children and teenagers, erosion and destruction associated with gastro esophageal reflux, psychiatric disorders of bulimia and anorexia. From the study of 58 articles we have detailed the principles of diagnosis, the prevalence associated with age and finally the main etiological factors. The definition of specific population groups with intrinsic or extrinsic risk factors for dental erosion will help generate preventive approaches and will open the way for the development of new treatment protocols.

Key Words: erosion, wear, tribology, gastroesophageal reflux, acidic drinks.

Corresponding Author: A. M. Chisnoiu, dr.chisnoiu@yahoo.com

Definition

The study of dental wear is a self-standing science, tribology, which finds its applicability in various fields such as the one of physics, mechanics or medicine. According to Mair, tribology is the science and technology of surface frictions. It allows the classification of the types of wear according to the mechanisms in place (Mair *et al* 2000). Dental terminology is prone to confusion with tribologic terminology. In fact, what is described by „erosion" in dentistry corresponds to the term „tribo-chemical wear" in tribology while the latter gives a completely different meaning to the term „erosion".

Kaleka et al (2000) highlights the fact that in tribology, erosion is defined as a form of abrasion implying the existence of three bodies amongst which one is a gaseous fluid or a liquid. We are dealing with a physical action comparable to the process of geological erosion when the hard abrasive particles are displaced by a water courant and come to erode a certain surface (a mechanism that comes into play in the oral cavity during the process of alumina sandblasting or in the aero-polishing with sodium bicarbonate in prophylactic techniques). The tribo-chemical wear isn't, strictly speaking, a wear process. It is defined as a chemical action that destroys the intermolecular bonding on a surface that then becomes very sensitive to other types of wear (abrasion, attrition, wear by fatigue, adhesive wear) (Lasserre *et al* 2003).

Meanwhile, dentistry defines erosion as the loss of physical-chemical substance by an acidic dissolution of hard tissues as a result of a food-, saliva- or digestion-related acidification in the oral environment. For Kaleka et al (2000) „tribo-erosion" is a type of progressive erosion of teeth by the acidic dissolution and/or a chelating process that does not involve bacterial plaque, being associated to attrition and repeated abrasion. Synonyms for erosion could therefore be such terms as: tribo-erosion or acidic corrosion. In recent years, clinical trials have shown a worrying increase in the frequency of erosion in young people (Imfeld *et al* 1996; Al-Dlaigan *et al* 2001; Al-Majed *et al* 2002; Dugmore 2003; Lussi *et al* 2005; Peres *et al* 2005).

Mechanisms

The mechanisms leading to the destruction of the hard dental tissues may be described as follows: under the action of decalcification agents either acid or chelating, we may first of all take notice of a destruction of the saliva organic pellicle protecting the tooth surface, followed by a solubilization of the dental structures (corrosion areas according to Mair) then by a destruction of the tooth surface superficially decalcified by mechanical frictions or brushing. These losses in substance may reach the enamel and the dentin and appear as lacunae or grooves especially in the vestibular cervical regions and on the vestibular or lingual surfaces of the teeth. Erosions bring along a loss of substance that creates a blunt and rounded appearance (Lasserre 2003). The critical enamel dissolution pH is 5.5 but it is permanently compensated by the buffering action of calcium and phosphate ions present in saliva and in the gingival fluid (Rytomaa *et al* 1989; Zero *et al* 1996; Dawes *et al* 2003; Hooper *et al* 2005; Hasselkvist *et al* 2010). After the demineralization of the surface, the wear may occur as a result of even weak mechanical strain such as a non-abrasive food bolus or mere frictions of the tongue with the lips or cheeks (fig.1).

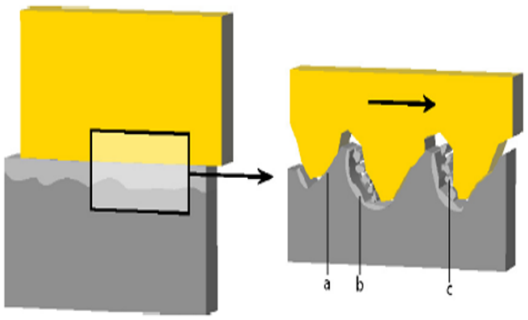


Fig. 1. Mechanisms of the tribo-chemical wear (according to Mair *et al* 2000); a. areas that were just subject to erosion and are susceptible to another acidic attack; b. corrosion areas not affected by surface friction; c. eroded corrosion debris

Diagnosis

The coding of tooth erosion

It is difficult to isolate erosion from other dental wear mechanisms because they are always connected. There are numerous anthropologic or dental classifications meant to code wear but no such classification exists for erosion (Harrack *et al* 1999; Hooper *et al* 2005). Classifications such as the ones of O'Sullivan, Mannerberg or the system of Linkosalo and Markkanen have been proven to be insufficient for its coding (Linkosalo *et al* 1985). Among those that have been used to assess erosion we may quote the one belonging to Eccles dating back 1979 and the one produced by Smith and Knight in 1984 (Eccless *et al* 1979; Smith *et al* 1984). The latter established the Tooth Wear Index (TWI). The TWI was later on used by Millward A. in his studies concerning dental erosion because it is well suited for the assessment of the severity of lesions appearing on various dental surfaces (fig.2) (Margaritis *et al* 2011).

Degree	Surface	Criteria
0	V/L/O/I/C	No loss in surface features No loss of contour
1	V/L/O/I/C	Loss of surface features Slight loss of contour
2	V/L/O I C	Loss of enamel with exposure of the dentin < 1/3 surface Loss of enamel with exposure of the dentin surface >1mm deep lacuna
3	B/L/O I C	Enamel loss with exposure of the dentin > 1/3 surface Enamel loss with important dentin loss but with no exposure of the secondary dentin or of the pulp 1-2 mm deep lacuna
4	B/L/O I C	Complete loss of the enamel with exposure of the secondary dentin and/or of the pulp Exposure of the secondary dentin and/or of the dental pulp Lacuna over 2mm deep with exposure of the secondary dentin and/or of the dental pulp
V= vestibular L=lingual O=occlusal I=incisal C=cervical		

Fig. 2 Tooth Wear Index in the classification of dental wear by Smith & Knight (1984)

Diagnosis elements

We may assess the erosive component of wear by certain observations made during the clinical trial. They are summarized in figure 3.

Given the clinical expertise, the erosive component is often very clear to the examiner. For patients however, such alterations may go unnoticed especially in early stages. They seek advice only when the extent of the destruction creates an esthetic disharmony or dentinal hypersensitivity following the complete destruction of the enamel layer. Dental wear and in particular the factors that lead to erosion are widely unrecognized by the public. Figure 4 shows a 70 year old woman suffering from a severe wear of her entire dentition. The degree of abrasive wear is indeed high but an erosive component is also inferred on account of the lacunae form around the dentin islands of the molars as well as due to the blunt and shiny appearance on all sides of the teeth and to a noticeable surface shine in amalgams though no recent polishing has been performed. Furthermore a dialogue with the patient also reveals a gastroesophageal reflux disease (GERD) problem. Figure 5 shows a young woman aged 30 who is in the bad habit of drinking freshly squeezed lemon juice each morning. The loss of enamel is total on most of the vestibular surfaces of the incisors, exposing the dentin (stage 2 TWI out of 21 and 23 – stage 3 TWI out of 22).

Clinical examination and diagnostic of the erosive component of tooth wear	
Age	Important loss of enamel in a young patient
Location	Aside from contact surfaces or occlusal guidance Sectorial incisal lingual or vestibular
Surface appearance	Shiny blunt Cratered Incomplete (with lacunas)
Dental surfaces/dental fillings	Negative shifting of the enamel surfaces with the edges of the composite or Ag amalgam fillings Shiny mirror of the Ag amalgam fillings
Questioning	Highlights an exogenous etiology (food-related-drug-related-environmental) or endogenous (regurgitations – GERD)

Fig. 3. Diagnosis of dental wear

Fig. 4. Erosive component in a 70 year old patient presenting GERD related issues

The location of lesions

Children and teenagers

Numerous studies target children's school populations. The most frequent locations in children are found on the upper incisors and canines. Kunzel et al (2000) describe advanced lesions on the upper central incisors and upper lateral incisors in children drinking high quantities of orange juice. While studying a children's population in Great Britain O'Brien found that erosions are most frequently located on the vestibular and palatal sides of the upper incisors. According to Jaeggi et al and Ganns et al who studied children and teenager populations, the most frequent

Fig. 5. Severe dental erosion in a young woman, aged 30, associated with the daily consumption of fresh lemon juice

Fig. 6: Extreme erosion of palatal sides in four maxillary incisors in a bulimic patient, suffering from frequent regurgitations. Note the place of the dead tract by the production of tertiary dentin at pulp level in 11 and 21 as well as the peripheral enamel collaret in the proximal areas protected from a direct contact with the acid and in the sulcus due to the buffering role of the gingival fluid.

locations are the palatal surfaces of the upper canines and central incisors, the vestibular sufaces of the upper incisors and canines as well as the vestibular surfaces of the lower premolars and the occlusal surfaces of the first lower molars (O'Brien 1994; Jaeggi *et al* 1999; Gans *et al* 2001). In the meantime, Milosevic et al (1994) describe in a study performed on 14 year old children erosions on the lingual and occlusal surfaces. Erosive wear seems to be dominant in children. Milwards et al believe that dental wear results from erosion with the exception of the incisive edges and the occlusal surfaces that make contact. The location and the severity of the erosion depend directly on the exposure to an acidic environment. Erosion affects surfaces that make firsthand contact with an erosive environment (Milosevic *et al* 1994; Jaeggi *et al* 1999). In children the dominant set of causes are exogenous (carbonated drinks – consumption of citrus) which explains the location of the lesions.

Adults

Studies on erosion in adult populations show variable locations. In a study on an adult community Lussi *et al* indicate that erosions are most frequent on the occlusal surfaces of cuspid teeth and have the lowest frequency on lingual surfaces (Lussi *et al* 2005). Endogenous causes are most frequent in adults or the elderly (fig. 7). Problems related to GERD concern about 60% of individuals along their lifetime according to Scheutel quoted in Mair (Mair *et al* 2000).

Chronic GERD as well as chronic regurgitation (typical to bulimia or chronic alcoholism) lead to a specific clinical table of distribution of erosive lesions described as perimolysis. In GERD, erosion is visible especially on the palatal and occlusal surfaces of maxillary teeth and on the occlusal surfaces of mandibular teeth. In eating disorders such as bulimia, Linkon et al noticed a specific distribution of erosions that follows the trajectory of the regurgitated hydrochloric acid in the oral cavity. The palatal surfaces of the maxillary incisors are highly affected and at a lesser degree so are all the palatal and occlusal maxillary surfaces as well as the occlusal and vestibular surfaces of mandibular teeth. These lesions are often aggravated by the brushing that immediately follows regurgitations and that harms by mechanical abrasion the demineralized enamel layer (Linkon *et al* 1986; House *et al* 1991).

The remastication of refluxes aggravates wear lesions especially in the presence of diary foods and vegetables inducing the attrition of the incisor edges of the cusps or through a wear by fatigue in cervical areas (abfraction) (Jaeggi *et al* 1999).

Prevalence

Several longitudinal studies pointed out a correlation between the presence of extensive erosions in permanent teeth in patients presenting erosions in temporary teeth (Hunter *et al* 2000; Ganss *et al* 2001).

The erosion of enamel is more pronounced in temporary teeth while dentin erosion is more severe in permanent teeth according to Hunter.

Most of the studies concerning the incidence or dental erosion have been conducted for age groups 12-14 and 5-6 years (Milosevic *et al* 1994; Hunter *et al* 2000). Lately, on account of changing eating habits, especially due to the consumption of carbonated drinks, we noticed an increased occurrence of this pathology in children.

In Britain the prevalence of erosion has increased from 32% (Milosevic) and 30% (O'Brian) in 1993-1994 to values of 48% (Al Dlaigan) and 56.3% (Dugmore) in 2001-2003, in what concerns lesions of 1st and 2nd degree in children aged 12 to 14 (Al-Dlaigan *et al* 2001; Dugmore *et al* 2003; Peres *et al* 2005).

In Germany, Gauss conducted a study over a period of 22 years (1977-1999), indicating a prevalence of 11.6% of dental erosion on the examined teeth. Similar data has been obtained by Perres in 2005 in Brazil in a study on 12 year old children.

A study conducted on a group of 860 boys aged 12 to 14 conducted in Saudi Arabia in 2002 reported an incidence of 26% (Al-Majed *et al* 2002).

The study conducted on younger patients (5 to 6 years of age) highlighted a 46% (Al Majed) and 26.4% (Germany) dental erosion incidence (Ganss *et al* 2001).

Longitudinal observations on 5 year periods proved an increased prevalence of erosions in permanent dentitions if this affection was already existent in temporary dentitions, the relative risk being of about 3.9 (Hunter *et al* 2000; Ganss *et al* 2001).

An increased prevalence in children is explained by the fact that young enamel is porous and dissolves more easily in the presence of acidic substances. By maturation enamel becomes more enduring and less permeable to acids. Nonetheless, the maturation of enamel is a slow process which induces a high risk of dental erosion in children (Margolis *et al* 1986).

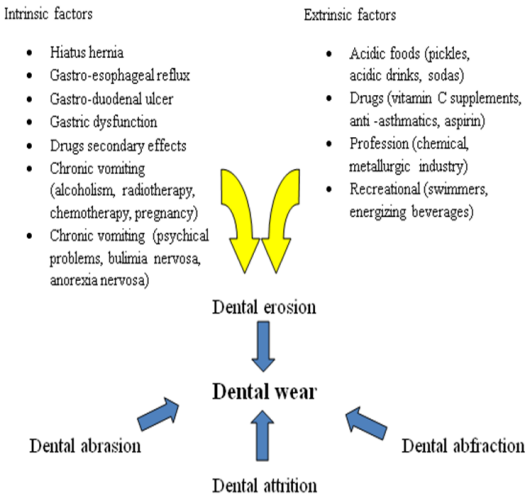
Etiologic factors involved in dental erosion

Several intrinsic and extrinsic individual factors are involved (fig.7),

The GERD has been associated to erosion ever since 1937 by Bargen and Austin. Studies in GERD by Jones in 1989 indicated a 60% frequency in the European population (Jones *et al* 1989; Barron *et al* 2003). This is in agreement with Schroeder's findings whom identified GERD in 15 patients out of 20 (75%) (Schroeder *et al* 1995).

Aside from major risk factors various other factors may favor dental erosion:

- saliva pH
- the buffering capacity of saliva
- the total titratable acidity
- the type of acid and dissociation constant
- the chelating properties of the respective substance
- the Ca, PO_4, F ion concentration in saliva
- the physical-chemical properties pertaining to the adhesion to hard dental tissues
- the possibility to stimulate the saliva flow
- temperature.



Eating habits (diet)

Even if cervical non-carious lesions have a traumatic occlusal origin they are the result of food consumption as well; they are usually found in bruxism and according to Linkosalo, they are also typical to vegetarians who indicated a consumption of citrus juice, alcohol, yogurts and effervescent vitamin C more than once a day (Giunta *et al* 1983).

A lacto-vegetarian diet favors dental erosion according to Linkosalo (1985) who found erosive lesions in 75% of vegetarians (Linkosalo *et al* 1995).

The food related factors of erosion include all types of acidic foods presenting a small concentration of Ca and PO4 ions according to Zero et al (1996). In all these situations the apatite of the enamel will dissolve without forming flouride-hydroxypatite on surfaces (Larson *et al* 1983).

Sports

Even if exercise is beneficial to health studies show that it can favor erosion. Subjects admitting to swimming in a pool at least once a week presented non-carious cervical lesions more frequently than those practicing the same activity only once a month (Zero *et al* 1996).

Lifestyle

According to Millward factors related to behavior influence erosion. He found that 4 year old children living in bad socio-economic conditions present fewer occurrences of erosion than the ones living in good socio-economic conditions (Millvard *et al* 1994).

Zero et al (1996) found correlations between dental erosions and an ecological lifestyle: a diet rich in fruit and vegetables and practising sports leads to dehydration which increases the risk of an associated ingestion of beverages with a low pH and a high sugar content.

Drug consumption (hallucinogenic substances) has its own influences on the apparition of erosion: ecstasy produces dehydrations associated to a reduced salivary flow and a shallower enamel pellicle (the mucin content in saliva decreases) (Duxbury *et al* 1993).

Excessive tea consumption, due to its reduced 2.6-3.9 pH is also involved in the phenomenon of dental erosion, according to Angmar et al (1980).

The habits of dental hygiene

Zero et al (1996) associated the apparition of dental erosion with the lack of a muco-bacterial plaque. The plaque has a higher buffering capacity than saliva and is able to thus protect the tooth from the action of non-bacterial acids.

Professional brushing favors the incidence of erosion because it removes the superficial enamel layer rich in fluoride (Wang *et al* 2010).

Rytomaa's consideration in the studies concerning the products of dental hygiene established the erosive effect of the EDTA and its chelating capacity (Rytomaa *et al* 1989).

Tooth whitening products contain bleaching agents that destruct organic depositions and the associated superficial pellicle, increasing the tooth's susceptibility to erosion (Lussi *et al* 1993).

Foods (carbonated drinks and citrus)

Studies conducted in Britain have shown that the sales in carbonated drinks increased over the last years to about 178 l/capita, especially amongst young people (Rugg-Gunn *et al* 1999). In Germany, researchers were confronted with the same situation, over the last 10 years the consumption of coca-cola type drinks increased by 28-37 l per capita (Ganss *et al* 2001; Wiegand *et al* 2008). In his studies, Shaw reported that children aged 2 to 9 were responsible for about 42% of the citrus juice consumption (Shaw *et al* 1994).

Millward et al (1994) identified a high correlation between the consumption of acidic drinks and the occurrence of dental erosions in children. In Saudi Arabia, a study conducted by Al

Majed points to the consumption of acidic drinks at night and once or several times a week as a risk factor.
The different acids of extrinsic origin that produce erosion are: the citric acid, the malic acid (apples, plums, apricots), tartritic acid (raisins, wine), lactic acid (fermented fruits), oxalic acid and phosphoric acid (cola type drinks) (Weatherhell *et al* 1984; Rugg-Gann *et al* 1999). Researches conducted by West and Hughes demonstrated that phosphoric acid is the acid with the highest erosive capacity, higher than that of citric, malic or lactic acid while the malic acid has a minimal erosive potential (West *et al* 2000).
Carbonated drinks may induce erosions according to Jahanson who found a strong correlation in patients ages 19 to 25 (Jahanson *et al* 1997). The same risk factor was identified in a study on children from Saudi Arabia conducted by Al Majed et al (2001). During the consumption of carbonated drinks the first modifications at a microscopic level appear in 4 to 6 weeks (Wang *et al* 2010). Energy drinks consumed during physical exercise have a higher erosive effect due to the dehydration of the oral cavity that creates a lesser protective environment. In their study, Hooper and Hughes (2005) established that the erosion susceptibility is variable. For the same consumption of acidic drinks some patients presented erosive lesions while others did not. The differences are also due to alterations in the composition of saliva, the added pellicle, muscular movements typical to each patient (Hooper *et al* 2005; Owens *et al* 2007; Hasselkvist *et al* 2010; Torres *et al* 2010).
The consumption of citrus or citrus juice are etiological factors as well. Darby first reported cases of dental erosion due to an exaggerated citrus consumption. In 2000 Kunzel identified a 17.4% incidence of dental erosion amongst 350 children aged 12 whom he examined and whom consumed more than 6 oranges a day (Kunzel *et al* 2000). Meanwhile, the lesions produced by orange juice are less important than the ones produced by grapefruit juice although the most erosive are the coca-cola type drinks.
In 1991 Jarvinen established with certainty that the consumption of citrus more than 2 times a day, or that of energy drinks more than once a week are factors favoring dental erosion (Jarvinen *et al* 1991).
While studying the development of dental status in patients with eating disorders Angmar and Ohr noticed, a year into the study that in 50% of all patients lesions became more severe. These patients presented from the very beginning a lower salivary flow than the others so that the authors decided that the salivary flow may be used as a risk indicator for the prediction of dental erosion in patients with eating disorders (Ohrn *et al* 2000).
Bartlett's considerations attribute a higher role to erosion as opposed to attrition in the aetiology of dental wear while studies conduced in Nigeria by Oginni between 2002-2005 show the reverse to be true (Bartlett *et al* 1996; Oginni *et al* 2005). These differences may be caused by different eating habits.
Other extrinsic factors such as acidic vapors may also be involved: Petersen's studies indicated the presence of erosions at frontal teeth level (both maxillary and mandibular) in people working in a battery factory (sulfuric and nitric acid) (Petersen *et al* 1991). Working in the industry of proteolytic enzymes may also induce erosions according to Wesstergard in the individual conditions of mouth breathing (Wesstergard *et al* 1993).
Dental erosion has been identified in studies conducted by Giunta as well as by Sovari in patients who take vitamin C supplements (ascorbic acid) (Sovari *et al* 1988). Today, vitamin C is commonly used as an antioxidant additive in the food industry.

Conclusions

The physiological phenomenon of dental erosion may have a pathological development under the action of certain intrinsic and extrinsic individual factors.
Despite the existence of numerous studies dedicated to erosion, the parameters taken into consideration by each of them are very different so that the confirmation of certain etiologic factors is rendered arguable and difficult.
The existing studies were conducted over a relatively short period of time, insufficient to the long-term analysis of the rhythm and the degree of the erosion; conducting new and more extensive studies over the same timeframe is imperative. The current lifestyle renders people more susceptible to the action of etiopathogenic mechanisms typical to dental erosion: energy drinks, carbonated drinks, etc. Under such circumstances the role of the dietician is paramount in order to avoid food-related risks that may appear in various elaborated diets. The increasing frequency of dental erosion in children shows a possible aggravation of the dental wear phenomenon in the generations to come which renders the establishment of adequate prophylactic measures mandatory.

References

Al-Dlaigan, Y. H., Shaw, L., Smith, A., 2001. Dental erosion in a group of British 12-year old children. Part I. Prevalence and influence of differing socioe-economic backgrounds. Br Dent J 190:145-149.

Al-Majed, I., Maguire, A., Murray, J. J., 2002. Prevalence and risk factors for dental erosion in 5-6 year-old and 12-14 year-old boys in Saudi Arabia. Comm Dent Oral Epidem 30:38-46.

Barron, R. P., Carmichael, R. P., Marcon, M. A., Sandor, G. K. B., 2003. Dental erosion in gastro-oesophageal reflux disease. J Can Dent Assoc 69:84-89.

Bartlett, D. W., Evans, D. F., Smith, B. G. N., 1996. The relationship between gastro-oesophageal reflux disease and dental erosion. J Oral Rehab 23:289-297.

Dawes, C., 2003. What is the critical pH and why does a tooth dissolve in acid? J Can Dent Assoc 69:722-724.

Dugmore, C. R., Rock, W. P., 2003. The progression of tooth erosion in a cohort of adolescents of mixed ethnicity. Int J Paed Dent 13:295-303.

Duxbury, A. J., 1993. Extasy- Dental Implications. Br Dent J 175:38.

Eccles, J. D., 1979. Dental erosion of nonindustrial origin. A Clinical survey and classification. J Prosth Dent 42:649-53.

Eygen, I. V., Vannet, B. V., Wehrbein, H., 2005. Influence of a soft drink with low pH on enamel surfaces: An in vitro study. Am J Orth and Dentofac Orthop 128:372-7.

Ganss, C., Klimek, J., Giese, K., 2001. Dental erosion in children and adolescents- a cross sectional and longitudinal investigation using study models. Comm Dent and Oral Epidem 29:264-271.

Giunta, G. L., 1983. Dental erosion resulting from chewable vitamin C tablets. J Am Dent Assoc 107:253-256.

Harrack, L., Stay, J., Story, M., 1999. Soft drink consumption among U.S. children and adolescents: Nutritional consequences. J Am Diet Assoc 99:436-441.

Hasselkvis, A., Johansson, A., Johansson, AK., 2010. Dental erosion and soft drink consumption in Swedish children and adolescents and the development of a simplified erosion partial recording system. Swed Dent J 34(4):187-95.

Hooper, S.M., Hughes, J. A., Newcombe, R. G., Addy, M., West, NX., 2005. A methodology for testing the erosive potential of sport drinks. J Dent 33:343-348.

Hooper, S., Hughes, J., Parker, D., Finke, M., Newcombe, RG., Addy, M., West, N., 2005. A clinical study in situ to asses the effect of a food approved polymer on the erosion potential of drinks. J Am Diet 35:541-546.

House, R. C., Grisius, R., Bliziotes, M. M., Licht, J. H., 1981. Perimolysis: unveiling the surreptitious vomiter. Oral Surg 51:152-155.

Hunter, M. L., West, N. X., Hughes, J. A., Newcombe, R. G., Addy, M., 2000. Erosion of deciduous and permanent dental hard tissue in oral environement. J Dent 28:257-263.

Imfeld, T., 1996. Dental erosion. Definition, classification and links, Eur J Oral Sci 104:151-155.

Jaeggi, T., Scaffner, M., Burgin, W., Lussi, A., 1999. Erosionen und keilformige Defekte bei Rekruten der Schweitzer Armee, Sch Mon Zahnmed 109:1171-7.

Jarvinen, V. K., Rytomaa, H., Heinonen, O. P., 1991. Risk factors in dental erosion, J Dent Res 70:942- 947.

Jones, R., Lyeard, S., 1989. Prevalence of symptoms and dyspepsia in the community. Br Dent J 298:30-32.

Kaleka, R., Saporta, S., Bouter, D., Bonte, E., 2000. Lésions cervicales d'usure (LCU): étiopathogénie. Réal Clin 12(4):367-385.

Kunzel, W., Cruz, MS., Fischer, T., 2000. Dental erosion in Cuban children associated with excessive consumption of oranges. Eur J Oral Scien 108:104-109.

Lussi, A., Schaffner, M., Hotz, P., Suter, P., 2005. Dental erosion in a population of Swiss adults. Comm Dent Oral Epidemio 19(5):286- 290.

Lussi, A., Jaeggi, T., Scharer, S, 1993. The influence of different factors on in vitro enamel erosion. Caries Res 27:387-93.

O'Brien, M., 1994. Children's dental health in the United kingdom, London, HMSO, Office of Population Censures and Surveys.

Oginni, A. O., Agbakwuru, E. A., Ndububa, D. A., 2005. The prevalence of dental erosion in Nigerian patients with gastro-oesophageal reflux disease. BMC Oral Health 5:1.

Ohrn, R., Angmar-Mansson, B., 2000. Oral status of 35 subjects with eating disorders- A 1-year study. Eur J Oral Scien 108:275-280.

Owens, B. M., Kitchens, M., 2007. The erosive potential of soft drinks on enamel surface substrate: An in virto scanning electron microscopy investigation. J Cont Dent Pract 7:11-20.

Mair, L. H., 2000. Tooth wear and sensitivity. London 188.

Margaritis, V., Mamai-Homata, E., Koletsi-Kounari, H., Polychronopoulou, A., 2011. Evaluation of three different scoring systems for dental erosion: a comparative study in adolescents. J Dent 39(1):88-93.

Milosevic, A., Young, PJ., Lennon, M. A., 1994. The prevalence of tooth wear in 14-year-old school children in Liverpool. Comm Dent Health 11:83-86.

Margolis, H. C., Marena, E. C., Murphy, B. J., 1986. Efect of low levels of fluoride in solution on enamel demineralization in vitro. J Dent Res 65:23-9.

Millward, A., Shaw, L., Smith, A., Harrington, E., 1994. The distribution and severity of tooth wear and the relationship between erosion and dietary constituents in a group of children. Int J Paed Dent 4:151–157.

Millward, A., Shaw, L., Smith, A., 1994b. Dental erosion in four-year-old children from different socioeconomic back-grounds. J Dent Child 61:263-266.

Peres, K. G., Armenio, M. F., Peres, M. A., Traebert, J., De Lacerda, JT., 2005. Dental erosion in 12 year old schoolchildren: a cross sectional study in Southern Brazil. Int J Paed Dent 15:249-255.

Petersen, P. E., Gormsen, C., 1991. Oral Conditions among german battery factory workers. Comm Dent Oral Epidemio 19:104-106.

Rugg-Gunn, A. J., Nunn, J. H., 1999. Diet and dental erosion, In: Nutrition, Diet and Oral Health. Ch. 4, Oxford: Oxford University Press.

Rytomaa, I., Meurman, JH., Franssila, S., Torkko, H., 1989. Oral Hygiene products may cause dental erosion. Proc Finn Dent Soc 85:161-166.

Schroeder, P. L., Filler, S. J., Ramirez, B., Lazachik, D. A., Vaezi, M. F., Richter, J. E., 1995. Dental erosion and acid reflux disease. Ann Intern Medicine 122:809-815.

Shaw, L., Smith, A., 1994. Erosion in children, an increasing clinical problem. Dent Update 21:103-6.

Sorvari, R., Kiviranta, I., Luoma, H., 1988. Erosive effects of a sport drink mixture with and without addition of fluoride and magnesium on the molar teeth of rats. Scan J Dent Res 96:226- 231.

Smith, B. G. N., Knight, J. K., 1984a. An index for measuring the wear of teeth. Br Dent J 156:435-438.

Smith, W., Marchan, S., Rafeek, R. N., 2008. The prevalence and severity of non-carious cervical lesions in a group of patients attending a university hospital in Trinidad. J Oral Rehab 35:138-134.

Torres, C. P., Chinelatti, M. A., Gomes-Silva, J. M., Rizóli, F.A., Oliveira, M.A., 2010. Surface and subsurface erosion of primary enamel by acid beverages over time. Braz Dent J 21(4):337-45.

Wang, X., Lussi, A., 2010. Assessment and management of dental erosion. Dent Clin North Am 54(3):565-78.

West, N. X., Hughes, J. A., Addy, M., 2000. Erosion of dentine and enamel in vitro by dietary acids: the effect of temperature, acid character, concentration and exposure time. J Oral Rehab 27:875- 880.

Wiegand, A., Muller, J., Werner, C., Attin, T., 2005. Prevalence of erosive tooth wear associated risk factors in 2- 7 year old German kindergarten children. Oral Dis 12(2):117-124.

Zero, D. T., 1996. Etiology of dental erosion- extrinsic factors. Eur J Oral Sci 104:162-77.

Authors

•Alina M. Picos, Departement of Prosthetic Dentistry, "Iuliu Hatieganu" University of Medicine and Pharmacy, 32 Clinicilor Street, 400006, Cluj-Napoca, Cluj, Romania, EU

•Andrea M. Chisnoiu, Departement of Prosthetic Dentistry, "Iuliu Hatieganu" University of Medicine and Pharmacy, 32 Clinicilor Street, 400006, Cluj-Napoca, Cluj, Romania, EU, email: dr.chisnoiu@yahoo.com

•Jean F. Lasserre, Departement of Prosthetic Dentistry, "Victor Segalen" University of Medecine and Pharmacy, Bordeaux, France, EU

•Aurelia Spinei, "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, Republic of Moldavia

•Radu M. Chisnoiu, Departement of Odontology, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Cluj, Romania, EU

•Andrei Picos, Departement of Prosthetic Dentistry, "Iuliu Hatieganu" University of Medicine and Pharmacy, 32 Clinicilor Street, 400006, Cluj-Napoca, Cluj, Romania, EU

Citation	Picos, A. M., Chisnoiu, A. M., Lasserre, J. F., Spinei, A., Chisnoiu, R. M., Picos, A., 2013. Dental erosion - literature update. HVM Bioflux 5(3):135-141.
Editor	Ştefan C. Vesa
Received	29 October 2013
Accepted	10 December 2013
Published Online	14 December 2013
Funding	None reported
Conflicts/ Competing Interests	None reported