

Dental Erosion: An Overview

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Abstract

Dental erosion is a multifactorial disease and is increasing due to changing dietary habits and modern lifestyle. Erosive lesions are seen in all age groups so it is important to carry out clinical research on dental erosion. Dental erosion can be reduced by eliminating the etiological factors. Early diagnosis of dental erosion is very important as it prevents the deterioration of dental hard tissue. In order to stop the progression of erosive lesions we must train our dentists to identify the initial signs of erosion. However it is difficult to identify dental erosion in early stages are usually asymptomatic. Management of dental

erosion is carried out under physical, chemical and biological factors. There is variety of methods available for the diagnosis and management of dental erosion. The reason for this article is to highlight the importance of early identification of dental erosion in clinical practice and to stress upon creating awareness among general public.

Keywords: Dental erosion, Saliva, Erosion diagnosis, Erosion management.

Introduction

Dental erosion is defined as the loss of dental hard tissue due to endogenous or exogenous acids without any

bacterial involvement.¹ Dental erosion has multiple etiological factors, requires in-depth history taking as well as clinical examination for diagnosis and patient's concern.^{2,3} Dental erosion is a complex process and involves irreversible loss of enamel followed by softening of tooth surface caused by acids. Erosion can be caused either by chemical process or mechanical process or both.⁴

In earlier times dental erosion was seen mostly on the incisal, occlusal and proximal surfaces while now it is also seen on the buccal and palatal/lingual tooth surfaces. In modern era, our diet contains higher amount of acids which aggravates the process of dental erosion. Various studies conducted earlier showed that dental erosion is remarkably related to the diet.

Early diagnosis is difficult due to the very few signs and rarity of any symptoms. Various studies conducted all over the world shows that dental erosion is very commonly seen among younger populations. So it is the need of the hour that dental erosion should be given emphasis in the clinical dentistry. Topical fluoride application appears to have a preventive effect on dental erosion.⁵ various methods are available which can be used to diagnose the dental erosion. Etiology, diagnosis and prevention of dental erosion in order to make an appropriate use of available literature in clinical practice.

Prevalence

According to various Cross-sectional studies conducted in the past showed that the different countries have different prevalence of dental erosion (Table 1). These studies showed that the prevalence of dental erosion is becoming greater between children and teenagers yet these results cannot be generalized due to lack of longitudinal studies. In most countries in case of maxillary anterior teeth the palatal surfaces are found to be most affected by the dental erosion as compared to occlusal and incisal surfaces.

TABLE 1: Prevalence of dental erosion, according to studies from different countries. Prevalences, as listed, refer to erosion that reaches to the dentin or deeper.

Country	Age (yr)	No. of individuals	Prevalence (%)	Author(s) and publication yr
Children				
United Kingdom	4-5	178	30	Millward et al. 1994 [15]
United Kingdom	5	>1000	24	Downer 1995 [16]
United Kingdom	1.5-4.5	1658	8	Moyrihan and Holt 1996 [17]
Saudi Arabia	5-6	354	34	Al-Majed et al. 2002 [18]
Ireland	5	202	21	Harding et al. 2003 [19]
India	5-6	100	30	Deshpande and Hugar 2004 [20]
China	3-5	1949	1	Luo et al. 2005 [21]
Germany	2-7	463	13	Wiegand et al. 2006 [22]
Sweden	5-6	135	13	Hasselkvist et al. 2010 [23]
Adolescents				
United Kingdom	14	1035	30	Milosevic et al. 1994 [24]
United Kingdom	15	>1000	2	Downer 1995 [16]
Saudi Arabia	20	95	16	Johansson et al. 1996 [25]
Cuba	12	1010	17	Kunzel et al. 2000 [26]
Saudi Arabia	12-14	862	26	Al-Majed et al. 2002 [18]
Iceland	15	278	6	Arnadottir et al. 2003 [27]
United Kingdom	14	1308	13	Dugmore and Rock 2003 [9]
United Kingdom	14	2351	53	Bardsley et al. 2004 [28]
Turkey	11	153	28	Caglar et al. 2005 [29]
Brazil	12	389	2	Correr et al. 2009 [30]
Netherlands	15	622	24	El Aidi et al. 2010 [10]
Iceland	12	757	1	Arnadottir et al. 2010 [31]
Iceland	15	750	6	Arnadottir et al. 2010 [31]
Sweden	13-14	227	12	Hasselkvist et al. 2010 [23]
Sweden	18-19	247	22	Hasselkvist et al. 2010 [23]
Adults				
Switzerland	26-30	197	11	Lussi et al. 1991 [32]
Switzerland	46-50	194	19	Lussi et al. 1991 [32]
United Kingdom	22	1010	77	Daly et al. 2011 [33]

However in recent year longitudinal studies conducted in Germany showed that between 1997-87 and 1990-99, children are the most affected by dental erosion. In this interval of time the severity of dental erosion on at least one deciduous tooth increases from 18 to 32%, where as in case of first mandibular molars it increases from 4 to 9 %.⁶ Similar studies conducted among the teenager of United Kingdom showed indistinguishable findings.⁷ About 27% of 12 year old British teenager were advanced to new and more sever dental erosion till the age of 14 years. A current study conducted among children between 12 to 15 years age group in Netherlands showed that the occurrence of new dental erosive lesions decreased in these three years. Whereas the dental erosion increases from 2 to 24% among children who were already exposed to erosive lesions at 12 years of age. Since most of the studies are conducted outside India so in order to conclude whether regional differences have an effect on dental erosion it is important to conduct studies in our country.

Etiology

There are many factors which are responsible for dental erosion that can be broadly classified into extrinsic and intrinsic factors.⁸ On clinical examination, it has been noticed that acid erosion frequently accompanied with attrition and abrasion. The acidic products that we take from outside can be placed in the category of extrinsic factors. Occupational related dental erosion is also seen among people who are working in wine and cold drink manufacturing industries as they have significantly increased exposure to the acids. Also we can appreciate increased level of dental erosion among children and teenagers which can be attributed to increased uptake of soft drinks. There are various medical conditions and syndromes in which intrinsic factors causing dental erosion can be seen. Dental/Acid erosion is very common among people who are having eating disorders, gastroesophageal reflux disease (GERD), gag problems etc. Rumination syndrome is a gastric ailment in which the patient willingly or unwillingly regurgitates the consumed food, which is then again chewed and swallowed damaging the tooth surfaces. The acids released from the extrinsic as well as intrinsic factors have a deteriorating effect on the amount and quality of saliva. In our changing way of life there is increased consumption of acids which results in increased possibility of dental erosion than we have in the past.⁹ Thus, qualitative research is required in case of dental erosion in order to know its occurrence in a better way.

Clinical Features of Dental Erosion

Initially it is very difficult to recognize dental erosion either by visual or tactile investigation. Dental erosion is basically the deprivation of dental hard tissue by acids released from intrinsic or extrinsic sources or both. Moreover, the patients recognizes symptoms when dental erosion is more serious and interferes with their functional

wellbeing.¹⁰ Previously the dental surfaces which undergoes dental erosion were believed to be flat/matted.¹¹ Also it was believed that the acid erosion can be identified only on those tooth unaccompanied by opposed occlusal proximities.¹² These days it is clear that eroded tooth surfaces appear blank or matted and can be recognized on a tooth with opposing occlusal contacts.

Dental erosion is more common on palatal and occlusal surfaces of maxillary anterior teeth and lower first molars respectively.^[13,14] Dental erosion on proximal surfaces are infrequent and are not easy to diagnose but inverted V-sign erosive lesions are common in maxillary central incisors. Strong correlation exists between cuppings and dental erosion and are considered as the first sign of dental/acid erosion.¹⁵ Cupping is basically an indentation found on the cusp tip of posterior teeth (first molars).In severe cases the pulp tissue gets exposed mostly in maxillary central incisors of deciduous as well as permanent dentition. It is clear from the literature that the patients with initial erosive lesions does not show any discomfort so being a dentist it is our duty to identify and suggest preventive measures to the patients against dental erosion.

Defence Mechanism against Dental Erosion

Taking into consideration the difference between the morphology and salivary flow dental erosion is more noticeable in deciduous as compared to permanent dentition^[16-20] Saliva plays an important role in the protection of dental hard tissue against dental erosion. Various studies revealed that the individuals with conditions like xerostomia are at a higher risk of dental erosion as compared to individuals with normal salivary flow.²¹ The saliva of children having dental erosion in spite of having low caries activity is alike in properties to the saliva of children having high caries activity.²² The

buffering capacity of saliva is more significant in case of dental erosion.²³

Clinically, we can appreciate different thickness of pellicle at different places in the oral cavity depending upon which pellicle acts as a shield against dental erosion^{24,25} It has been seen that the pellicle gets attached on the recently eroded tooth surface inhibiting the process of remineralization. However, the ability of pellicle to safeguard against enamel is finite and not existent against dentine.²⁶ Thus we can say that the different components determining the pellicle and plaque development plays an important role in the site and seriousness of dental erosion. Protein interactivity (salivary concentration of urea)^[27,28] is also of great significance with respect to dental erosion.

Dental erosion also depends upon the drinking technique especially in case of acidic drinks. The retaining drinking technique in which the acidic drinks are kept in the mouth before swallowing grows the chances of having dental erosion. In this method the time of exposure between the acidic beverages and the surface of tooth increases resulting in dental erosion. Various researches done have shown that the people using retaining technique of drinking are more prone to dental erosion as compared to the others.

Erosion Diagnosis

Proper diagnosis of dental erosion starts with evaluation of possible factors, medical/ dental history and oral examination. Early diagnosis and proper management prevents the loss of dental hard tissue. Initial signs of dental erosion includes flat/matted buccal and palatal/lingual surfaces and cupping on occlusal surface of posteriors. Diagnostic approach for dental erosion mainly involves historical data and physical assessment.

A. Historical data

1. Medical History: We will start with complete medical history and try to figure out all the prescribed as well

as non-prescribed medicines and any other supplements. It is important to note whether the person is on any acidic medicines or vitamin C supplements or not. Under medical history we will try to know whether the patient is suffering from any medical conditions (such as excessive vomiting, rumination, eating disorders, gastroesophageal reflux disease, Sjogren's disease, oral dryness, eye dryness etc).

2. Dental history: Under dental history we need to ask whether the patient has habit of grinding /clenching the teeth during sleep. The habit can be determined by asking the person sleeping next to him/her.²⁹ Occlusal guard also aggravates the process of dental erosion. Dental erosion results in loss of enamel and teeth appears yellow. So in an attempt to improve the color of teeth people makes use of abrasives which further leads to dental erosion.
3. Dietary history: Studies conducted in the past revealed that higher intake of acidic foods increases the risk of dental erosion. So in order to know the intake of acidic foods and drinks a dietary questionnaire must be filled by the patient. The questionnaire must include the frequency and method of intake of acidic foods as highlighting points. The acidic drinks which are kept in the mouth for a longer period of time causes destruction of dental hard tissue. With the help of a straw we can bypass the acidic drinks thereby preventing dental erosion.³⁰
4. Oral hygiene practices: Under this we can ask the patient regarding his/her method of tooth brushing. It is important to determine the type of dentifrices, mouth rinses the patient uses and whether had undergone any topical fluoride application or not.
5. Occupational history: We can also relate the prevalence of dental erosion with occupation as

various studies suggested that dental erosion is more common and severe among workers of wine industries. Excessive swimming is also considered as a factor responsible for dental erosion.

B. Physical examination:

1. Head and neck examination: For proper diagnosis it is important to check if there is any muscle tenderness and hypertrophy of masseter muscle. We should also look for any signs of alcoholism as increased alcohol intake also leads to dental erosion.

2. Intra-oral examination: In some studies decreased salivary flow is related to dental erosion. Inflamed and dry mucosa are common signs which we can see in patients suffering from xerostomia or in those who are unable to express saliva from salivary ducts.³¹ In dental erosion we can appreciate incisal grooving and occlusal cupping along with pulpal exposure in severe cases.

3. General health: People having eating disorders like Bulimia nervosa are more prone to dental erosion.

4. Salivary function test: The salivary gland function can't be determined by mucosal dryness only.³² So the actual salivary flow rate can be measured in milliliters per minute by collecting saliva for some minutes under stimulated as well as non-stimulated conditions in clinics. The buffering capacity of saliva can be measured by using methods like Dentobuff (used in Europe). Dental erosion is more commonly seen in individuals with saliva having lower buffering capacity.

Along with this there are various techniques and scales [Table 2 and 3] which we can use in the clinics for the assessment of dental erosion. These scales are designed in such a manner that they can be used for epidemiological as well as clinical use.

Grade	Criteria
0	No visible changes, developmental structures remain, macromorphology intact.
1	Smoothed enamel, developmental structures have totally or partially vanished. Enamel surface is shiny, matt, irregular, "mehled," rounded or flat, and macromorphology generally intact.
2	Enamel surface as described in grade 1. Macromorphology clearly changed, faceting or concavity formation within the enamel, no dentinal exposure.
3	Enamel surface as described in grades 1 and 2. Macromorphology greatly changed (close to dentinal exposure of large surfaces) or dentin surface exposed by $\leq 1/3$.
4	Enamel surface as described in grades 1, 2 and 3. Dentin surface exposed by $>1/3$ or pulp visible through the dentin.

Note: approximal erosion, presence of "shoulder" and "cuppings" should be recorded.

Table 2: Scale for grading of dental erosion on buccal and lingual surfaces of anterior teeth[13]

Grade	Criteria
0	No cupping/intact cusp tip
1	Rounded cusp tip
2	Cupping ≤ 1 mm
3	Cupping > 1 mm
4	Fused cuppings: at least two cuppings are fused together on the same tooth

Table 3: Scale for grading cuppings on occlusal surfaces of first deciduous and permanent molars [33]

We can record the severity of dental erosion by grading of all the teeth (i.e. full mouth) or marker teeth (i.e. partial mouth recording) by using the above tables. However, full mouth recording becomes more chaotic and time consuming than partial mouth recording. Also full mouth recording is more valuable for research purposes than clinical use. Keeping all this in mind a simplified erosion partial recording system (SEPRS) is more frequently used in the clinics for assessment of dental erosion. In this system, in case of deciduous dentition six surfaces are used (i.e. palatal surface of maxillary central incisors and cupping on all molars) for assessment of severity of dental erosion. And in permanent dentition four surfaces (i.e. palatal surface of maxillary central incisors and cupping on lower first molars) are used. By using this method also we can calculate the severity of dental erosion effectively.

Erosion Management

After proper diagnosis of dental erosion its management can be carried out in the following four steps: behavioral control, chemical control, physical control and maintenance phase.

1. Behavioral characteristics: In order to prevent and check the development of extrinsic dental erosion it is important to change our way of living. We can prevent the dental erosion to some extent by creating awareness regarding the causes and effects of the disease on oral health related quality of life. The patients should be encouraged to take plenty of water in the middle of meals. By reducing the intake and substituting the acidic drinks by non-acidic drinks (milk) we can halt the progression of dental erosion. The acidic foods like fruits and drinks should be consumed with the help of a straw. Along with this the patients should be advised not to brush their teeth for at least 30 minutes after consumption of acidic drinks. Immediate cleansing of mouth with water, milk or 0.2% NaF mouth rinse after consumption of acidic drinks or foods helps in the management of dental erosion.

2. Chemical control: The application of topical fluorides in concentrated form can prevent dental erosion. In case of patients suffering from medical conditions (GERD) ant-acids can be used for neutralization of gastric acids. The potential of acidic drinks to cause erosive lesions can be reduced by the addition of calcium, magnesium, fluoride ions.

3. Physical protection: The fluoridated and casein-derived pastes which contains CPP-ACP(i.e. casein phosphopeptide-amorphous calcium phosphate) are very useful in the remineralization of tooth structure. CPP-ACP releases the calcium and phosphate ions as the pH drops in the oral cavity. The adequate number of calcium and phosphate ions are released in the saliva through ‘continuous’ low dose fluoride vulnerability.^[34,35,36]

Deciduous Teeth	Permanent Teeth
<ul style="list-style-type: none"> Smaller erosive lesions- if sensitive can be covered with 	<ul style="list-style-type: none"> Dental surfaces at risk- unfilled or GIC restoration

composite resins <ul style="list-style-type: none"> Larger erosive lesions- composite crowns on anterior and preformed metal crowns on posterior teeth. 	<ul style="list-style-type: none"> Active erosion-no complex treatment
In case of severe erosion and symptoms –extraction of teeth.	Medical conditions(GERD)-Night guard

Table 4- Physical protection^[34,35,36]

4. Maintenance phase: Since the relapse is high in case of dental erosion so constant observation is must after restorative procedure or gaining control. Repetitive dentinal sensitivity suggests continued demineralizaion of dental hard tissue especially in case of exposed roots. The short term continuing loss of enamel can be determined by:

a. Placing a small circle of unfilled resin on the lingual surface of teeth. The loss of enamel around the area surrounding the unfilled resin is suggestive of existing dental erosion.^[37]

b. We can also perform a Scratch test. The loss of scratch within a duration of one month also suggests active dental erosion.^[34]

Conclusion

Long term and uninterrupted exposure to acids results in the demineralization of dental hard tissue. Early diagnosis of dental erosion is very important to prevent irreversible loss of dental hard tissue. For proper diagnosis, it is important to identify the cause of erosive lesions so as to understand whether the process is still undergoing or not. The management should focus on the elimination of the underlying causative factors and if not possible then reduce the affects of the acid erosion. Early intervention is the best way to prevent dental erosion. To achieve the goal

of early intervention our dentists should be given training for early detection of erosion.

References

1. Pindborg JJ. Pathology of the dental hard tissues. Philadelphia: Saunders; 1970. p. 274-320.
2. Featherstone JD, Singh S, Curtis DA, Caries risk assessment and management for the prosthodontic patient. *J Prosthodont* 20(1):2-9, January 2011.
3. Sorvari R, Kiviranta I, A semiquantitative method of recording experimental tooth erosion and estimating occlusal wear in the rat. *Arch Oral Biol* 33(4):217-20, 198
4. Addy M and Shellis RP. "Interaction between attrition, abrasion and erosion in tooth wear". *Monographs in Oral Science* 20 (2006): 17-31.
5. Carey, C.M.; McCracken, J.M.; Schmuck, B.D. Fluoride concentration required to prevent citric acid erosion of enamel. Available online:
6. C. Ganss, J. Klimek, and K. Giese, "Dental erosion in children and adolescents—a cross-sectional and longitudinal investigation using study models," *Community Dentistry and Oral Epidemiology*, vol. 29, no. 4, pp. 264–271, 2001.
7. J. H. Nunn, P. H. Gordon, A. J. Morris, C. M. Pine, and A. Walker, "Dental erosion—changing prevalence? A review of British national childrens' surveys," *International Journal of Paediatric Dentistry*, vol. 13, no. 2, pp. 98–105, 2003.
8. J. M. ten Cate and T. Imfeld, "Dental erosion, summary," *European Journal of Oral Sciences*, vol. 104, no. 2, part 2, pp.241–244, 1996
9. F. Khan and W. G. Young, Eds. *Toothwear. The ABC of the Worn Dentition*, Wiley-Blackwell, Chichester, UK, 2011
10. B. Daly, J. T. Newton, J. Fares et al., "Dental tooth surface loss and quality of life in university students," *Primary Dental Care*, vol. 18, no. 1, pp. 31–35, 2011
11. F. Mannerberg, "Saliva factors in cases of erosion," *Odontologisk Revy*, vol. 14, pp. 156–166, 1963.
12. B. G. Smith and J. K. Knight, "An index for measuring the wear of teeth," *British Dental Journal*, vol. 156, no. 12, pp. 435–438, 1984.
13. A. K. Johansson, A. Johansson, D. Birkhed, R. Omar, S. Baghdadi, and G. E. Carlsson, "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 Odontologica Scandinavica*, vol. 54, no. 6, pp. 369–378, 1996.
14. H. El Aidi, E. M. Bronkhorst, and G. J. Truin, "A longitudinal study of tooth erosion in adolescents," *Journal of Dental Research*, vol. 87, no. 8, pp. 731–735, 2008
15. F. Khan, W. G. Young, V. Law, J. Priest, and T. J. Daley, "Cupped lesions of early onset dental erosion in young southeast Queensland adults," *Australian Dental Journal*, vol. 46, no. 2, pp. 100–107, 2001.
16. C. G. Crossner, J. C. Hase, and D. Birkhed, "Oral sugar clearance in children compared with adults," *Caries Research* vol. 25, no. 3, pp. 201–206, 1991.
17. A. K. Johansson, R. Sorvari, D. Birkhed, and J. H. Meurman, "Dental erosion in deciduous teeth—an in vivo and in vitro study," *Journal of Dentistry*, vol. 29, no. 5, pp. 333–340, 2001.
18. B. T. Amaechi, S. M. Higham, and W. M. Edgar, "Factors influencing the development of dental erosion in vitro: enamel type, temperature and exposure time," *Journal of Oral Rehabilitation*, vol. 26, no. 8, pp. 624–630, 1999.

19. A. Lussi, N. Kohler, D. Zero, M. Schaffner, and B. Megert, "A comparison of the erosive potential of different beverages in primary and permanent teeth using an in vitro model," *European Journal of Oral Sciences*, vol. 108, no. 2, pp. 110–114, 2000.
20. G. M. Correr, R. C. Alonso, S. Consani, R. M. Puppini-Rontani, and J. L. Ferracane, "In vitro wear of primary and permanent enamel. Simultaneous erosion and abrasion," *American Journal of Dentistry*, vol. 20, no. 6, pp. 394–399, 2007.
21. V. K. Jarvinen, I. I. Rytomaa, and O. P. Heinonen, "Risk factors in dental erosion," *Journal of Dental Research*, vol. 70, no. 6, pp. 942–947, 1991.
22. E. A. O'Sullivan and M. E. Curzon, "Salivary factors affecting dental erosion in children," *Caries Research*, vol. 34, no. 1, pp. 82–87, 2000.
23. J. Tenovou, "Salivary parameters of relevance for assessing caries activity in individuals and populations," *Community Dentistry and Oral Epidemiology*, vol. 25, no. 1, pp. 82–86, 1997.
24. J. H. Meurman and R. M. Frank, "Scanning electron microscopic study of the effect of salivary pellicle on enamel erosion," *Caries Research*, vol. 25, no. 1, pp. 1–6, 1991.
25. B. T. Amaechi, S. M. Higham, W. M. Edgar, and A. Milosevic, "Thickness of acquired salivary pellicle as a determinant of the sites of dental erosion," *Journal of Dental Research*, vol. 78, no. 12, pp. 1821–1828, 1999.
26. A. T. Hara, M. Ando, C. Gonzalez-Cabezas, J. A. Cury, M. C. Serra, and D. T. Zero, "Protective effect of the dental pellicle against erosive challenges in situ," *Journal of Dental Research*, vol. 85, no. 7, pp. 612–616, 2006.
27. A. K. Johansson, P. Lingstrom, and D. Birkhed, "Comparison of factors potentially related to the occurrence of dental erosion in high- and low-erosion groups," *European Journal of Oral Sciences*, vol. 110, no. 3, pp. 204–211, 2002.
28. T. Piangprach, C. Hengtrakool, B. Kukiattrakoon, and U. Kedjarune-Leggat, "The effect of salivary factors on dental erosion in various age groups and tooth surfaces," *The Journal of the American Dental Association*, vol. 140, no. 9, pp. 1137–1143, 2009.
29. Lavigne GJ, Rompre PH, Montplaisir JY. Sleep bruxism: validity of clinical research diagnostic criteria in a controlled polysomnographic study. *J Dent Res* 1996; 75:546-552.
30. Edwards M, Ashwood RA, Littlewood SJ, et al. A videofluoroscopic comparison of straw and cup drinking: the potential influence on dental erosion. *Br Dent J* 1998; 185:244-249.
31. Navazesh M, Christensen C, and Brightman V. Clinical criteria for the diagnosis of salivary gland hypofunction. *J Dent Res* 1992; 71:1363-1369.
32. Fox PC, van der Ven PF, Sonies BC, et al. Xerostomia: evaluation of a symptom with increasing significance. *J Am Dent Assoc* 1985; 110:519-525.
33. A. Hasselkvist, A. Johansson, and A. K. Johansson, "Dental erosion and soft drink consumption in Swedish children and adolescents and the development of a simplified erosion partial recording system," *Swedish Dental Journal*, vol. 34, no. 4, pp. 187–195, 2010.
34. Kaidonis JA. Oral diagnosis and treatment planning: part 4. Non-cariou tooth surface loss and assessment of risk. *Br Dent J* 2012; 213(4):155-61.
35. Wang X, Lussi A. Assessment and management of dental erosion. *Dental Clinics*. 2010; 54(3):565-78.
36. Lussi A, Hellwig E. Risk assessment and causal preventive measures. *Monogr Oral Sci*. 2014; 25:220-229.