Assessment of tooth erosion among chemical factory workers in Gujarat, India

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Abstract:

Context: The surface loss of dental hard tissues other than by caries, trauma or developmental aberration is termed tooth wear. Based on etiology dental erosion is termed extrinsic, intrinsic or idiopathic and according to the anamnesis (case history taking) the acids producing tooth destruction may be of exogenous, endogenous or unknown origin.
Aims: To assess the tooth erosion among chemical factory workers in Gujarat, India.
Methods and Material: A descriptive cross sectional study was conducted amongchemical factory workers in Gujarat. 500 workers were randomly selected to examineErosion using Basic Erosive Wear Examination (BEWE) scoring system.
Statistical analysis used: The collected data was tabulated using Excel and analysis was done using SPSS 17.0 version. Chi-square test was used to test the significance.
Results: It was observed that the study subjects were in age group of 21 to 50 years (mean age = 31.75 ± 4.97 years) comprising of 455 (91.0%) males and 45 (9.0%) females. The prevalence of dental erosion among the study subjects was 18.6% (mean value = 0.61 ± 1.59).Working experience had significant relation with dental erosion (P = 0.000).
Conclusions: It was concluded that length of working exposure had a strong association with dental erosion. Dental erosion was more severe in the upper anterior teeth than other teeth. A comprehensive care especially in subjects suffering with environmental dental erosion should be provided.

Keywords: Dental erosion, Basic Erosive Wear Examination, Acidic chemicals, Mouth mask.
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Introduction: The surface loss of dental hard tissues other than by caries, trauma or developmental aberration is termed tooth wear. The condition is irreversible and cumulative with age. Although tooth wear is a natural consequence of aging, the process can be considers 'pathological' if the rate of loss is an excessive and causes aesthetic, functional or sensitivity problems [1]. Tooth wear is a multi-factorial condition leading to the loss of enamel and dentine [2]. Based on the etiological factors, tooth wear has traditionally been divided into three categories: attrition, abrasion and erosion. The latter is the most common and causes greatest damage [3, 4].

Attrition is a physical process, where tooth surface is removed through the movement of teeth against each another [5]. Abrasion is the pathologic wearing of teeth by unusual mechanical stress. It involves a foreign object or substance repeatedly contacting the tooth [6]. Erosion is defined as the loss of tooth substance by a chemical process that does not involve bacterial action[7].

The occurrence of erosion was reported as early as the 19th century and since then the incidence and prevalence of dentalerosion is increasingly being reported [8].Especially with the decline in caries rate in some countries, erosion is now becoming a focus of increasing interest both in clinical dentistry and research. The management of dental erosion is an area of clinical practice that is undoubtedly expanding [9].

Based on etiology dental erosion is termed extrinsic, intrinsic or idiopathic and according to the anamnesis (case history taking) the acids producing tooth destruction may be of exogenous, endogenous or unknown origin [10]. Intrinsic and extrinsic acid loads determine the acidity levels of the oral cavity. If the pH goes beyond 5.5 (the threshold level for healthy enamel), dental erosion may be triggered. [10-12].

Initially, dental erosion appears as a smooth silky-shining glazed enamel surface. Further progression may lead to the development of shallow concavities or to rounding and grooving of the edges or the cusps of the tooth surfaces [13, 14]. In patients with severe dental erosion, the enamel is often totally removed, leaving a vulnerable dentine surface which is often associated with a painful sensitivity and is prone to further erosion and mechanical wear. Advanced erosive tooth wear might also constitute near and frank exposures of the pulp requiring dental treatment or lead to complete destruction and tooth loss [15].

Dental erosion can be an occupational hazard [16]. It is caused by exposure to various types of acidic contaminants in the workplace such as chemicals, petrochemicals, metals and semiconductors [17, 18].

Hence the present study was undertaken to assess the tooth erosion among chemical factory workers in Gujarat and to suggest preventive and curative measures as needed.

Subjects and Methods: A descriptive cross sectional study was conducted during January, 2012 to June, 2012 among chemical factory workers of Gujarat, India. Prior to the start of the study proposal was submitted for approval and clearance from the Ethical review board of the relative institute. Permission to conduct the study was obtained from the H.R. Manager of the chemical factories. This survey was carried out using a self–designed pretested questionnaire**,** which consisted of three parts- First part consisted of demographic informationlike name, age, gender, total family income per month, occupation, education of head of family, address and date of examination. Second part consisted of information regarding knowledge of harmful effect of air borne acids, working details, duration of employment. Third part comprised of Basic Erosive Wear Examination (BEWE) scores [19].

A pilot study was carried out for the feasibility and validity of the study. Pilot study assessments were utilized for sample size determination, proper planning and execution of the main study protocol. By standardizing all the materials and methods, the study was conducted considering a total of 56 subjects who fulfilled the selection criteria. Based on pilot study certain modification was made in the main study. These 56 subjects who participated in the pilot study were not included in the main study. Reliability of the Questionnaire was assessed by using Test-Retest and the values of measured Kappa (k) =0.86, Weighted Kappa (k_w) = 0.9. Internal consistency of questionnaires was assessed by applying Chronbachs-Alpha (α = 0.78).The clinical examination of all subjects constituting the sample was entirely done by a single investigator. Calibration of examiner was done under the gold

standard examiner before the start of study. The method of examination and scoring was standardized. The kappa co-efficient was 0.83.

Gujarat industrial area contains more than 2000 chemical factories. Based on the productivity, the factories were categorized into medium and small scale. A total of 500 subjects (455 males and 45 females) were randomly selected in the study between the age group of 21 to 50 years. Subjects willing to participate in the study, Subjects with more than 1 year working exposure, Subjects present on the day of examination were included in the study. Subjects with any systemic disease were excluded.

The present study consisted of an interview and oral examination. BEWE index was used to record dental erosion. Examination was carried out beginning from the maxillary right quadrant and proceeding in a clockwise direction to the mandibular right quadrant.Criteria for grading erosive wear are: score 0 for No erosive tooth wear, score 1 for Initial loss of surface texture, score 2 for Distinct defect, hard tissue loss <50% of the surface area, score 3 for Hard tissue loss ≥50% of the surface area. Buccal/facial, occlusal, and lingual/palatal surfaces are examined with the highest score recorded. The examination is repeated for all teeth in a sextant but only the surface with the highest score is recorded for each sextant. Once all the sextants have been assessed, the sum of the scores is calculated which gives BEWE score [19].

The collected data was tabulated using Excel 2007 and analysis performed using SPSS 16.0 version. Chi-square test and Fisher's exact testwas used to test the significance. Level of significance was set at P ≤ 0.05.

Results: It was observed that the study subjects was in age group of 21 to 50 years (mean age = 31.75 ± 4.97 years) comprising of 455 (91.0%) males and 45 (9.0%) females. Majority of the subjects 245 (49.0%) was in the age group of 31 – 40 years. (Table –

Table 1: Distribution of the study subjects based on age group and gender (Mean age = 31.75 ± 4.97 year)

SES class	Study subjects (n = 500)			Association
	No dental erosion	Dental erosion	Total	P value
Upper	32 (91.4%)	3 (8.6%)	35	χ^2 = 13.961 *P = 0.003
Upper middle	240 (76.4%)	74 (23.6%)	314	
Lower middle	92 (90.2%)	10 (9.8%)	102	
Upper lower	43 (87.8%)	6 (12.2%)	49	
Lower	0	0	0	
Total	407 (81.4%)	93 (18.6%)	500	

Kuppuswamy's modified socioeconomic status scale was used to record socioeconomic status of the study subjects [20]. Among the study subjects, highest dental erosion (23.6%) was observed in upper middle and least (0.0%) was in lower class. (P = 0.003). (Table – 2)

Table 2: Distribution of the study subjects according to socio economic status (Kuppuswamy's modified Socioeconomic Status Scale, April 2007)

Gender	Age groups (Years) n = 500			
	21 – 30	31 – 40	41 – 50	Total
Male	205 (45.0%)	218 (47.9%)	32 (7.1%)	455
Female	16 (35.5%)	27 (60.0%)	2 (4.5%)	45
Total	221 (44.2%)	245 (49.0%)	34 (6.8%)	500

*Level of significance P ≤ 0.05

Among the study subjects, 89.0% answered that they didn't know the effect of air borne acids on teeth.Among the study subjects, 90.8% did not wear mouth mask during working hours. Only 9.2% of the study subjects wore a mouth mask. It was observed that the study subjects who didn't wear mask had more chance of dental erosion in comparison with study subject who wore mask (P = 0.027).A total of 90.2% of the total study subjects did not gargle while 9.8% of the study subjects gargled during and/or after work. Majority of the study subjects worked from 5 – 10 years, in which 11.5% suffered with dental erosion. Length of working exposure was strongly associated with dental erosion. (P = 0.000) (Table – 3)

Table 3: Distribution of the study subjects based on knowledge and practices

Knowledge and practices	**Study subjects (n = 500)**			**Association**
	No dental erosion	**Dental erosion**	**Total**	**P value**
Are air born acids harmful for teeth?				
Yes	46 (90.2%)	5 (9.8%)	51	$\chi^2 = 3.926$ *P = 0.14**0**
No	4 (100%)	0 (0.0%)	4	
Don't know	357 (80.2%)	88 (19.8%)	445	
Total	407 (81.4%)	93 (18.6%)	500	
Do you wear a mouth mask during working hours?				
Yes	43 (93.5%)	3 (6.5%)	46	$\chi^2 = 4.881$ *P = 0.027
No	364 (80.2%)	90 (19.8%)	454	
Total	407 (81.4%)	93 (18.6%)	500	
Do you gargle during and/or after work?				
Yes	44 (89.8%)	5 (10.2%)	49	$\chi^2 = 2.529$ *P = 0.112
No	363 (80.5%)	88 (19.5%)	451	
Total	407 (81.4%)	93 (18.6%)	500	
Duration of employment				
1 – 5 years	38 (86.4%)	6 (13.6%)	44	$\chi^2 = 25.513$ *P = 0.000
6 – 10 years	238 (88.5%)	31 (11.5%)	269	
> 10 years	131 (70.1%)	56 (29.9%)	187	
Total	407 (81.4%)	93 (18.6%)	500	

*Level of significance P ≤ 0.05

The cumulative BEWE score was recorded to measure the dental erosion. Out of 500 study subjects, 18.6% had been observed with dental erosion. (Table – 4)

Table 4: Distribution of the study subjects based on Basic Erosive Wear Examination cumulative score (Mean value = 0.61 ± 1.59)

Cumulative BEWE score	**Study subjects n = 500**
0	407 (81.4%)
1	9 (1.8%)
2	30 (6.0%)
3	32 (6.4%)
4	10 (2.0%)
5	2 (0.4%)
6	1 (0.2%)

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7	1 (0.2%)
8	0 (0.0%)
9	3 (0.6%)
10	5 (1.0%)
11 – 18	0 (0.0%)
Total	500 (100%)

The sextant affected with dental erosion among the study subjects was more between upper left canine to right canine (18.2%) followed by lower left canine to right canine (8.0%).(Table – 5)

Table 5: Distribution of the study subject's BEWE score based on sextant

Sextant (teeth)	**No dental erosion**	**Dental erosion**			
	0	1	2	3	Total
1 (17 – 14)	489	2 (18.2%)	9 (81.8%)	0 (0.0%)	11
2 (13 – 23)	409	15 (16.5%)	68 (74.7%)	8 (8.8%)	91
3 (24 – 27)	474	14 (53.8%)	12 (46.2%)	0 (0.0%)	26
4 (34 – 37)	496	2 (50.0%)	2 (50.0%)	0 (0.0%)	4
5 (43– 33)	460	21 (52.5%)	17 (42.5%)	2 (5.0%)	40
6 (47 – 44)	496	3 (75.0%)	1 (25.0%)	0 (0.0%)	4

Based on dental erosion risk level, Majority of the study subjects (89.4%) had cumulative score 0 to 2, indicated risk level none. (Table – 6)

Table 6: Distribution of the study subjects based on risk level

Risk level (Cumulative score)	**Study subjects n = 500**
None (0 – 2)	447 (89.4%)
Low (3 – 8)	45 (9.0%)
Medium (9 – 13)	8 (1.6%)
High (≥ 14)	0 (0.0%)
Total	500 (100%)

Discussion: Gujarat state of India has More than 2000 industries, consisting of chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber and packaging etc. are located in industrial estate.

Workers in the mineral, battery, chemical, tin, dyestuff manufacturing industries, along with those in the metal industries involved with galvanizing, plating, silicone sealing, and acid pickling, are more likely to be exposed to airborne acids such as sulfuric, hydrochloric, nitric, tartaric, chromic, phosphoric, and acetic acids [21-24]. These acids may have irritant effects on mucous membranes and epithelia (such as the respiratory tract, eyes, or skin) and chemical corrosive effects on teeth [25].

In the present study, mean value of the dental erosion was 0.61 ± 1.59 which was lower than other study [26]. In the present study, prevalence of dental erosion was 19.6% which was similar to the some studies [16, 27, 28]. Prevalence of dental erosion was higher in the other studies [17, 29-33]. This might be result of insufficient preventive measures to decrease acid exposure or a violation of the governmental regulations concerning maximal tolerable concentration of potentially erosive agents at workplaces [28].

Traditionally, wearing masks as personal protective equipment is the most common recommendation for protection from hazardous environment. If workers do not understand the reasons for using a mask, they are likely to misuse the devices and consequently do not receive the necessary protection. A study done in Korea showed that overall occupational dental erosion was less for workers wearing respiratory masks

than for workers not wearing masks. In the present study 80.8% of the study subjects did not wear mouth mask during working hours. The finding was similar to the Korean study [28].Possible reason being, masks had been found to be uncomfortable to wear for longer period of time and people tending to avoid using them [27].In the present study the prevalence of dental erosion had a significant (P=0.027) association with the use of mouth mask.

Dental erosion is reduced by mouth rinsing caused by internal factors as compared to erosion caused by environmental factors. Mouth gargling has been a routine program of a worksite health promotion. In the present study 19.5% of the study subjects had dental erosion who did not gargle. This result was not significant (P > 0.05). Similar finding was observed in the study done in Korea [10, 28].

Boyes stated that the first signs of erosion may appear within 1 - 6 months of exposure. Length of exposure showed a stronger association with dental erosion in the present study, supporting findings to some other studies [17, 25, 34-36].

The present study stated that dental erosion was found more in the anterior teeth than in posterior teeth. Similar finding was observed in some other studies [17, 29, 32, 37]. The incisal one third to one half of the labial surfaces is more exposed to industrial environment [17].The canines, premolars and molars were least susceptible to industrial dental erosion because they were adequately protected by the lip, cheek and also more constantly bathed by saliva.[35] In contrast to this pattern, erosion caused by internal factors (excessive vomiting) affect the lingual surfaces of all teeth [17]. Our study had some limitations. First, Many studies on industrial dental erosion conducted all over the world used different indices. However findings of the various studies were very difficult to be compared with those of other studies, because these indices used different in clinical criteria, scale and selection of teeth. In addition there was no available data of dental erosion measurements with the use of the BEWE. Second, being a cross-sectional study the present investigation did not intend to demonstrate causation. Third, measurement of the acid concentration in the workplace does not exist at any of the industrial sites investigated.

In order to prevent dental erosion in industrial settings with acidic exposure, some safety measures can also be recommended. Erosive effects of these workplace acids may be prevented by exhaust and ventilation systems. Airborne acid levels may have to be constantly monitored and recorded. Longitudinal study is recommended to get definitive evidence of causality. However, a more effective preventive approach is reducing the accepted threshold limit values of industrial airborne acids to safer degrees that address the risk of dental erosion along with other acid related occupational diseases. Use of mouth masks and safeguards has been recommended in order to avoid the hazards effect of chemicals. The use of alkaline mouth washes and fluoride products have also been suggested. Regular medical and dental care services are recommended for detection of early lesions and planning of preventive strategies.

Conclusion: Some industrial areas in Gujarat are highly polluted areas with maximum exposure of acidic chemicals. Length of working exposure had a strong association with dental erosion. Dental erosion was more severe in the upper anterior teeth than other teeth. Industrial acidic chemicals leave no doubt that the erosion of the upper incisors was due to the direct impingement of fine droplets of acid in environment. As a part of professional approach towards the study subjects, regular dental care services should be provided for detection of early lesions and planning of preventive strategies. A comprehensive care especially in subjects suffering with environmental dental erosion should be provided. However, a more effective preventive approach is to reduce the level of airborne acids in the industrial area and to educate workers about ill effects on oral and general health, so that occupational environmental exposure can be reduced.

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