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Effect of dental erosion on oral health among employees of battery-manufacturing units in Baddi, Himachal Pradesh, India

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Abstract:

OBJECTIVE: The objective of the study was to obtain data on prevalence and severity of dental erosion among acid industry workers in Baddi (Himachal Pradesh).

MATERIALS AND METHODS: A cross-sectional study was conducted among 800 battery industry workers. The demographic details were recorded on a prestructured pro forma. Type III examination was done. Dental erosion was recorded based on the index given by Bardsley (simplified scoring criteria for tooth wear index). Appropriate statistical tests were used to interpret the data.

RESULTS: The prevalence of dental erosion was found to be 48.6%. Prevalence increased with the duration of employment. Dental erosion was most commonly found in the labial surfaces of maxillary anterior teeth.

CONCLUSION: Erosion is a condition which is multifactorial and becomes more aggravating in the presence of acidic environment. Therefore, the workers working in such conditions should be more careful, and mandatory policies should also be followed by such industries to maintain the overall health of the workers.

Keywords:

Acidic environment, battery workers, dental erosion, prevalence, severity

Introduction

Tooth wear or tooth surface loss is a common term used to describe the surface loss of dental hard tissues by chemical processes from causes other than caries and trauma that do not involve bacteria. Tooth wear can be physiological or pathological. Physiological surface loss involves natural tooth surface loss present in elderly population, whereas pathological involves the loss of tooth surface due to some etiologies also commonly known as wasting disease. Grippo *et al.*^[1] put forward a new classification of hard tissue lesions of teeth. He defined four categories of tooth wear:

- Attrition: Loss of tooth substance as a result of tooth-to-tooth contact during normal or parafunctional masticator activity
- Abrasion: Wear of tooth substance through biomechanical frictional processes, for example, toothbrushing
- Erosion: Loss of tooth substance by acid dissolution of either an intrinsic or an extrinsic origin, for example, gastric acid or dietary acids
- Abfraction: Loss of tooth substance caused by biomechanical loading forces
- It was postulated that these lesions were caused by flexure of the tooth during loading, leading to fatigue of the enamel and dentin at a location away from the

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point of loading. Among these, dental erosion is the most common and causes great damage to dental hard tissues.

The reasons of tooth wear are multifactorial, and it also varies in severity, location, and clinical presentation.^[2] Dental erosion can occur due to intrinsic or extrinsic factors. Intrinsic factors may include gastric regurgitation, especially hydrochloric acid, and extrinsic factors include acid production from beverages, excessive intake of acidic fruits leading to acid production, tobacco chewing, exposure to acidic environment, particularly the group of people working in industries dealing with chemicals, petrochemicals, metals, and semiconductors.^[3,4] The intensity of erosion also depends on prolonged working hours and unprotected acid handling and limited safety measures, thus deteriorating oral health in such conditions.^[5,6]

The Baddi Barotiwala Nalagarh Development Authority is the biggest industrial hub of the state of Himachal Pradesh has witnessed rapid industrialization since 2003. According to the State Industrial Department, there are a total of 22 battery-manufacturing industries in Baddi-Barotiwala area with a man force of around 1500 workers.^[7]

A majority of studies have been conducted on this aspect abroad with very few studies in Asia. As per the available data, there are no reports regarding the prevalence of erosion among battery-manufacturing industrial workers in Baddi, Himachal Pradesh. Hence, the present study was conducted to obtain data on prevalence and severity of dental erosion among acid industry workers in Baddi-Barotiwala area (Himachal Pradesh).

Materials and Methods

A cross-sectional study was conducted among acid industry workers to assess the prevalence and association with acid chemical in Baddi-Barotiwala area (Himachal Pradesh). Permission to conduct the study was taken from the respective human resource departments personally/telephonically, and the screening was performed on the convenient prescheduled dates in day shifts. The study was conducted from July to December 2010.

A pilot study was performed on 100 workers to determine the test–retest reliability of survey questions. The respondents were then asked for feedback on the clarity of the questionnaire. Few modifications were made based on the response given by the study participants. Cronbach’s alpha (α) of the questionnaire was found to be good (0.83). The participants of the pilot study were not included in the final analysis.

Information regarding demographic details, oral hygiene habits, systemic diseases, especially gastric problems, employment duration, dietary and deleterious habits, dental sensitivity, and exposure to acidic environment were recorded on a modified prestructured pro forma. The examination was carried out using mouth mirror, probe, and adequate light. The data were recorded with the help of a trained recording assistant. The workers who voluntarily agreed to participate were included and the rest were excluded. Recording of various grades of dental erosion was based on the criteria given by Bardsley *et al.* (simplified scoring criteria for tooth wear index) [Table 1].^[8]

Descriptive statistics were used to summarize the data, followed by the Chi-square test to check significant differences between the responses. Correlation between responses was analyzed through the Spearman’s rank correlation. Statistical analysis was done using SPSS 17 (software version 16.0; Inc., Chicago, IL, USA). All significant tests were two tailed and $P < 0.05$ was considered to be statistically significant.

Results

A total of 800 workers were examined, of which 72% (576) were males and 28% (224) females. The mean age was 40.9 years (minimum 19 years and maximum 61 years). The mean duration of employment was 13.09 years [Table 2]. Nearly 89.7% (718) used toothbrush, 3.2% (26) used tree stick, and 7.1% (56) used only finger

Table 1: Simplified scoring criteria for tooth wear index given by Bradsley

Score	Criteria
0	No wear into dentin
1	Dentin just visible (including cupping) or dentin exposed
2	Dentin exposure >1/3 of surface
3	Exposure of pulp or secondary dentin

Table 2: Demographic details of study participants

Variable	Frequency	Percentage
Total	800	100
Gender		
Males	576	72
Females	224	28
Age-wise distribution		
19-25	108	13.5
26-34	193	24.1
35-44	211	26.3
45-54	191	23.8
55-61	97	12.1
Duration of employment (years)		
<5	91	11.3
5-10	331	41.3
>10	378	47.2

to clean their teeth. Almost 86.1% (689) used toothpaste, 5.5% (44) and 2.3% (19) used tooth powder, and 6.1% (48) used no material for brushing. Nearly 82.3% (1193) brushed.

The prevalence of varying grades of dental erosion was found to be among 48.6% (389) of workers [Table 3]. Out of the majority of workers using toothpaste, almost 28.3% (227) were using antisensitive paste for cleaning their teeth due to hypersensitivity.

Smoking and tobacco chewing were found among 73.6% (589) of the workers. Medical history revealed that 1.3% (11) employees were suffering with dermatitis while 7% (56) were suffering from unknown irritation. The history of gastric problem in the study group was found to be very less (11.1%, 89), which was statistically insignificant ($P \leq 1.83$).

There was a strong association found between acid exposure and duration of employment. Dental erosion was more prevalent in workers with <10 years of experience. Score 3 (exposure of pulp or secondary dentin) was mostly observed in 21.6% of workers with <10 years of work experience. A significant difference was found between the acid exposure and duration of employment [Table 4]. There was no significant association found between dietary intake and dental erosion.

Dental erosion was most commonly found in the maxillary anterior teeth. Labial surfaces were more affected than the palatal surfaces. It was less commonly detected in posterior teeth and mandibular anterior teeth. The prevalence of erosion was found to be more in males (34.3%) than females.

Table 3: Varying grades of dental erosion in study participants

Score	Frequency	Percentage
0	411	51.4
1	173	21.6
2	127	15.8
3	89	11.2
Total	800	100

Table 4: Subjects with dental erosion and year of employment

Number of years in employment (years)	Tooth wear scores				Total	P
	Score 0	Score 1	Score 2	Score 3		
<5	79	12	0	0	91	<0.011*
5-10	201	87	36	7	331	<0.003*
>10	131	74	91	82	378	<0.001*
Total	411	173	127	89		
Grand total	800				800	

*Statically significant

Discussion

Accidental exposure can occur due to discharges from open containers and leakage from pipes while occupational exposure occurs directly or indirectly (air borne) to acid fumes. These both have biohazardous effects, leading to dermatitis, ulcerations, and in advance cases, perforations of nasal septum. These fumes also have an adverse effect on oral cavity causing discoloration and dental erosion.

Erosion was most commonly found in males than females. This could be due to the reason that most of the male workers are exposed to acidic environment directly in the manufacturing wing of the industries, while most of the females were working in the packaging department, thus having an indirect exposure.

Prevalence of erosion was found to be in 48.6% of workers. There is a positive relation between toothbrushing and erosion. It was found that if toothbrush and acidic environment is combined, the tooth wear escalates dramatically. This could be due to the fact that acid contact is often associated with softening of the outer layer of the tooth surface, making them more susceptible to mechanical abrasion such as toothbrushing, thus leading to the development of shallow concavities or rounding and grooving of the edges or the cusps of the tooth surfaces.^[9-11]

Acid fumes in the working environment are related to the higher prevalence of erosion, which also depends on the exposure and duration of employment. Dental erosion was more present in workers with more than 10 years of working in such industries. This finding was in agreement with the study done by Amin *et al.*^[2] and Basavaraj *et al.*^[12] The threshold limit for repeated occupational exposure to acids in a normal 8-h shift amounts to 1 mg/m³, which becomes irritating at 1.0–2.0 mg/m³ and obvious signs are thought to be visible at 5.0–6.0 mg/m³ of exposure.^[2]

A total of 86.1% of workers were found using toothpaste and 28.3% used antisensitive paste due to hypersensitivity. It occurs when the external stimulus contacts the exposed dentin and triggers a rapid outflow of the dentin fluid, and the resultant pressure change across the dentin activates intradental nerve fibers to cause immediate pain.^[13,14] Various commercially available antisensitive pastes include strontium chloride, potassium nitrate, potassium fluoride, and potassium citrate which are believed to block the exposed dentinal tubules of the teeth, thus helping in relieving pain.

Studies have suggested an association between consumption of drinks and erosion. Both fruit juice and

carbonated drinks have been shown to have low pHs and high titratable acidity, leading to risk of erosion.^[15,16] However, in the present study, no association was found between erosion and consumption of fruit juice and carbonated drinks.

The association of gastroesophageal reflux disease with dental erosion has been established in a number of studies in adults. Gastric acids with pH levels <1, reach the oral cavity and come in contact with the teeth causes excessive vomiting and hence can erode the outer enamel layer. This is caused by increased abdominal pressure, inappropriate relaxation of the lower esophageal sphincter, or increased acid production by the stomach.^[17,18] No such finding was seen in our study.

The present study revealed that the erosion was mostly present in the upper anterior teeth, especially on the labial surfaces. It may be attributed to the fact that these teeth are the first to be directly exposed to the environment. Lower anterior teeth were the least affected as they are overlapped by the upper anterior teeth. The erosion of posterior teeth was rarely observed possibly because they are protected by the cheeks and lips.

The management of such kind of cases is conservative. Use of anti-sensitive tooth pastes in subjects with dentin exposure has proved to be effective. Restorative treatment can range from placement of bonded composites in a few isolated areas of erosion to full mouth reconstruction (crowns and veneers). However, in subjects with pulp exposure, root canal treatment followed by crowns is one of the preferred treatments. Extractions can also be done in severe nonrestorable cases.

Baddi-Barotiwala area is one of the major emerged industrial hubs in India. Baddi Pollution Board had prescribed certain mandatory norms which are to be followed by the each industry concerning maximal tolerable concentration of potentially erosive agents at workplaces. Thus, educating workers about occupational hazards, positive worksite oral health promotion, and training for standardized behaviors such as wearing respiratory protective equipment and gargling during and after working should be the main priority. To avoid environmental exposure, the postings of workers should be changed time to time. Proper health checkups should be done at regular intervals. Visits by the concerned officials should be made mandatory so that proper steps should be followed by the industries to maintain a good eco-friendly environment for the workers.

Conclusion

There are a number of contributing factors causing dental erosion. In the present study, it was concluded that an

acidic environment tends to have more adverse effects on the teeth with other contributing factors also. Citric fruit consumption and gastric influx also have an indirect effect on oral cavity, but there was no such association found. Dental erosion can be diagnosed at such work places, and such conditions can be intervened and treated conservatively.

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Conflicts of interest

There are no conflicts of interest.

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