Industrial Health 2006, **44**, 481–485

Original Article

Tooth Abrasion in Workers Exposed to Noise in the Montenegrin Textile Industry

Milorad KOVACEVIC[1] and Goran BELOJEVIC[2*]

[1] Dental Clinic, Faculty of Medicine, University of Novi Sad, Serbia

[2] Institute of Hygiene and Medical Ecology, Faculty of Medicine, University of Belgrade, Dr Subotica 8, 11000 Belgrade, Serbia

Received February 1, 2005 and accepted February 7, 2006

Abstract: A cross-sectional study was performed on 225 textile workers from a wool production company in Montenegro to test the hypothesis of a relationship between exposure to intense industrial noise and tooth abrasion. The group exposed to intense noise (104 dB (A) Leq) consisted of 111 weavers (82 males and 29 females), while the control group (81 dB (A) Leq) consisted of 114 blue-collar workers (32 males and 82 females) in preparation departments. A specialist in dental prosthetics clinically examined all the subjects and additionally analyzed tooth statuses on hard plaster models. Gender, age, socioeconomic status and tooth brushing habits of workers were controlled as confounding factors. Significantly high adjusted odds ratios for tooth abrasion of 3.74 (95%CI=1.42–7.85; p<0.01) were found among female workers exposed to intense noise in comparison with the control group. The analysis of the subclass of male workers with severe tooth abrasion (grades III-IV) revealed significantly high adjusted odds ratios for tooth abrasion of 5.48 (95%CI=1.76–14.50; p<0.01) among the noise exposed group compared to the control group. This study suggests that extremely high levels of occupational noise might be related to tooth abrasion in exposed textile workers.

Key words: Industrial Noise, Tooth Abrasion, Workers, Textile Industry

Introduction

Tooth abrasion can be described as the wearing away of tooth substances by brushing, bruxism, clenching, and other mechanical causes. It is a complex biological process of solid dental tissue loss which can seriously affect the functions of chewing, speech and facial appearance. Regarding the aetiology of tooth abrasion, numerous previous investigations have pointed out the responsible parafunctions as an autodestructive process caused by stress (tooth clenching with anger or fear) or by bad habits (tooth gnashing or chewing things)[1)]. The most reliable objective signs of parafunctions are oclusal and incisal tooth abrasions.

According to a conceptual model of stress and masticatory muscle function proposed by Haber *et al.*[2)] excessive stress results in masticatory muscle hyperactivity that is expressed in various forms of parafunctional activities such as tooth clenching and grinding. One of three major theories of stress emphasizes demanding or disorganizing influences of the environment as stress producing. In this model the individual is thought to have some innate ability to withstand stress, but will deteriorate functionally when the critical level is exceeded[3)].

The relationship between noise as a stressor and masseter activity was studied experimentally by Mercuri *et al.*[4)] on twenty patients with myofascial pain-dysfunction syndrome and twenty control subjects. During exposure to 75 decibel white noise delivered through stereo headphones, myofascial pain-dysfunction syndrome patients exhibited significantly higher masseter electromyographic activity. The reaction of masticatory muscle on intense noise with consequent tooth clenching and grinding might be explained by the startle

*To whom correspondence should be addressed.

reflex. The startle occurs primarily in order to prepare for action appropriate to a possible dangerous situation signaled by sound[5]. It consists of contraction of the flexor muscles of the limbs and the spine, and a contraction of the orbital muscles that can be recorded as an eye blink. The higher the noise level, the less marked habituation to startle reflex may be expected, and the response of increased masticatory muscle activity would not require the presence of mediating cognition processes[6].

In our 25 yr clinical dental practice on textile workers, we have noticed frequent tooth abrasion in workers exposed to high levels of noise[7]. In spite of a fairly good theoretical and experimental basis, we have not found any other research in the available scientific literature on the relationship between noise exposure and tooth abrasion. Therefore, we have undertaken this study to test the hypothesis of a significant relationship between intense occupational noise and tooth abrasion in noise-exposed workers.

Materials and Methods

Environmental measurements

Noise measurements were performed in all departments from a large wool producing company in Montenegro. We used a Noise Level Analyzer Type 4426 "Brüel & Kjær" with a one-inch free-field microphone Type 4145. Prior to each measurement the instrument was calibrated with a Sound Level Calibrator Type 4230. Measurements were performed on a workplace in the middle of each department. Equivalent noise levels (Leq) were measured during one shift (8 h), using a sampling speed of 1 per second, with the total of 28,800 samples.

Temperature, relative air humidity and air velocity were measured four times (every two hours) during the first shift in the central part of departments, from which mean values and standard deviations were calculated. We used a "Testo 452" (Testo AG, Germany) measuring system with calibration certificates in accordance with the DIN EN ISO 9001.

Illuminance was measured with a PLM-3 (Iskra, Slovenia) Photometer with selenium photocells. Measurements were performed at all workplaces and mean values and standard deviations were calculated.

Air dust levels were measured with a "Casella type 113.A" personal dust collector with a membranous filter. The period of sampling was one shift (8 h) in the central part of a department.

To check for microbiological contamination of air in the working areas, the Koch's sedimentation method was used, with the exposure of agar plate during an 8 h shift. After incubation of the agar plate on 37°C for 48 h colonies were counted and identified.

To check for chemical contamination of air in the working areas a gas sampling pump with specific sensydine detector tubes (Dräger, Germany) were used. One liter of air was aspirated for each measurement in the middle of the working departments, for determination of SO_2, CO, NO_x and Cl_2, by linear colorimetric method.

Study Sample

Based on the results of measurements, we chose two departments with significantly different noise exposures. The noise exposed group (104 dB(A) Leq) consisted of blue-collar workers from a weaving department (total of 111 workers: 82 males and 29 females). The control group (81 dB (A) Leq) included blue-collar workers from preparation department (total of 114 workers: 32 males and 82 females). There were no foreign workers in the investigated groups. The workers from both departments worked in three shifts, they did not use any personal hearing protection devices and they did not have the habit of cutting thread with their teeth. Permanent standing position was typical for the workers from both departmens, with similar light physical strain during thread manipulation.

Audiometry

Tonal liminal audiometry was performed in all workers using a "Peters AP6" audiometer, from which the arithmetic mean of hearing levels at 1, 2 and 4 kHz was calculated. If this value exceeded 30 dB, it was considered to be noise induced hearing loss[8].

Questionnaire

To control for demographic and socio-economic factors and tooth brushing habits a self-administered questionnaire was distributed to all workers. Questions requested data on gender, age, career length, marital status, apartment size, number of apartment dwellers, bathroom in the apartment, family monthly income and number of tooth brushings per day.

Clinical examination

A specialist in dental prosthetics clinically examined the subjects and additionally analyzed tooth status on hard plaster models. Tooth status was assessed from normal to tooth abrasion grade I-V, according to the level of tooth tissues affected: Abrasion localized on superficial parts of enamel (I), the whole enamel and parts of dentin affected (II), superficial abrasion of dentine with insensitiveness of a tooth

on outer stimulation (III), deeper abrasion of dentine with the loss of at least the third of the crown (IV), and total loss of crown with pulp lesions (V)[9].

Statistical analysis

We used student's t-test to compare the mean values of parametric data with normal distribution. To compare the mean values of non-parametric data and parametric data without normal distributions we used the Mann-Whitney U-test. To establish potential risk factors, adjusted odds ratios were estimated using the multiple logistic regression model. In testing the null hypothesis we chose 0.05 as the significance level for all tests. Statistical analyses were performed using data analysis software system Statistica (StatSoft Inc., ver. 6, www.statsoft.com.)

Results

Environmental measurements showed that noise appeared to be the essential differentiating environmental factor between the investigated departments. The results of other measurements besides noise were similar, and also fell within the limits according to Serbian regulations for occupational environments (Table 1). No chemical or biological noxious factors were detected in the manufacturing areas.

The noise-exposed group and control group were similar in terms of age and exposure duration (Table 2). The mean values of hearing levels in the groups of weavers and the workers from preparation department were 36.2 ± 5.1 dB and 21.9 ± 1.6 dB, respectively. The percentage of workers with hearing impairment was 5–6 times higher in the weaving department as compared to the preparation department, both among men (55% and 10%, respectively) and women (42% and 8%, respectively).

Concerning basic socioeconomic parameters (marital status, apartment size, bathroom in the apartment and monthly income per family member) the groups did not differ significantly (all p values>0.05). The average number of toothbrushings per day was 1.5 ± 0.6 for weavers, and 1.4 ± 0.5 in the preparation department (p>0,05).

We found significantly raised odds ratio for tooth abrasion among female weavers compared to workers from the preparation departments. For male workers, this increased odds ratio was not statistically significant (Table 3). When exposure period was put as an independent factor, age as a covariate and tooth abrasion as a dependent factor in a multinomial logistic regression model, significantly high odds ratios and 95% C.I. for tooth abrasion were found both in weaving and preparation departments [1,54 (1,12–2,13) and 1,98 (1,42–2,71), respectively (p<0,01)].

Table 1. Results of environmental measurements from the investigated departments of a textile plant (mean ± SD)

Environmental factor	Department		Upper Limit*
	Weaving	Preparation	
Noise (Leq8 h/dBA)	104	81	85
Air relative humidity (%)	62 ± 9	51 ± 7	75
Air Temperature (°C)	20.5 ± 3.0	21.0 ± 2.5	24
Air velocity (m/s)	0.04 ± 0.01	0.07 ± 0.01	0,5
Air dust (mg/m^3)	1.2	2.1	10
Illuminance (lux)	350 ± 150	362 ± 120	150

*According to current Montenegrin regulations for industrial environment.

However, when we analyzed the subclass of male workers with severe tooth abrasion (grade III–V) we found significantly raised odds ratios for tooth abrasion among workers exposed to extremely high levels of occupational noise, when compared to workers exposed to low noise (Table 4). In female weavers, there were 3 cases (10%) with severe tooth abrasion and no such cases in the preparation department.

Concerning the type of abrasion, we found the horizontal type to be most frequent both in the noise-exposed and control group (81% and 94%, respectively). Vertical type abrasion was relatively rarely found (3% and 2%, respectively).

Combined type of tooth abrasion was four times more frequent in the experimental group than in the control one (16% and 4%, respectively).

Discussion

We have shown that exposure to high level occupational noise might be significantly related to produce tooth abrasion. This may result from sustained repetition of masticatory muscle contraction and parafunctional activities in noisy environments, perhaps as an acute startle effect. Studies performed in the Russian textile industry also showed a high prevalence of tooth abrasion, although main attributing factor was suggested to be teeth clenching during physical strain[10].

Both gender and age were controlled in our study, as it has been shown that they (male gender and elderly) significantly influence the occurrence of tooth wear[11]. We have also controlled other environmental factors aside from noise, as they have been attributed to tooth abrasion in previous studies. Exposure to acids in the air has been related to tooth abrasion in a cross-sectional study on two samples of workers from Finland and Tanzania[12]. A study on workers

Table 2. Age and career length of the investigated textile workers (yr, mean ± SD)

Variable	Males		Females		P*
	Noise-exposed (n=82)	Control (n=32)	Noise-exposed (n=29)	Control (n=82)	
Age	42.5 ± 8.5	39.2 ± 8.5	33.1 ± 9.0	32.9 ± 7.2	>0.05
Career length	17.2 ± 8.0	15.9 ± 7.1	11.3 ± 8.4	11.8 ± 7.3	>0.05

*Student's t-test.

Table 3. Odds ratios (OR) and 95% confidence intervals (CI) for tooth abrasion among textile workers in relation to noise levels at workplace

Gender	Noise level Leq dB(A)	Tooth Abrasion N (%)	Total Workers N	Crude OR (95% CI)	Adjusted OR (95% CI)$	P#
Male	104	68 (83)	82	2.54 (1.00–6.44)	2.36 (0.9–5.43)	>0.05
	81*	21 (66)	32	1	1	
Female	104	21 (72)	29	3.90 (1.54–9.84)	3.74 (1.42–7.85)	<0.01
	81	33 (40)	82	1	1	

*Reference category, $Adjusted for age, exposure period and the number of tooth brushings per day, #Multiple logistic regression.

Table 4. Odds ratios (OR) and 95% confidence intervals (CI) for severe tooth abrasion (grades III–V) among male textile workers in relation to noise level at workplace

Noise level Leq dB(A)	Tooth Abrasion N (%)	Total Workers N	Crude OR (95% CI)	Adjusted OR (95% CI)$	P#
104	38 (46)	82	6.04 (1.94–18.97)	5.48 (1.76–14.50)	<0.01
81*	4 (12)	32	1	1	

*Reference category, $Adjusted for age, exposure period and the number of tooth brushings per day, #Multinomial logistic regression.

in the Danish granite industry revealed a 100% prevalence of tooth abrasion on the front teeth in subjects exposed to quartz dust. The severity of abrasion and the affection ratio increased by duration of exposure to dust[13]. Poor working habits have also been related to tooth abrasion in industrial workers. In this regard Prpic-Mehicic *et al.*[14] showed that incisal tooth abrasion was present in 90% of workers in the clothing industry who were in the habit of cutting thread with their teeth instead of using scissors. We controlled the number of toothbrushings per day, as over-brushing has been associated with tooth wear in previous studies[15].

There is a difference in the mechanism of noise on tooth abrasion, when compared to other occupational factors. Whilst dust, acids or bad chewing habits act directly on teeth, the effect of noise is indirect, which increase higher masseter activity and consequently induce tooth clenching and grinding. According to our study, it might be expected that the prevalence of tooth wear would have been much lower if they had used ear plugs or ear muffs to guard against noise. Hearing impairment that may be a protective factor against hormonal stressful reactions in weavers[16] did not moderate the effect of noise on tooth abrasion.

References

1) Litonjua LA, Andreana S, Bush PJ, Cohen RE (2003) Tooth wear: attrition, erosion, and abrasion. Quintessence Int **34**, 435–46.
2) Haber JD, Moss RA, Kuczmierczyk AR, Garrett JC (1983) Assessment and treatment of stress in myofascial pain dysfunction syndrome: a model for analysis. J Oral Rehabil **10**, 187–96.
3) Lundeen TF, Sturdevant JR, George JM (1987) Stress as a factor in muscle and temporomandibular joint pain. J Oral Rehabil **14**, 447–56.
4) Mercuri LG, Olson RE, Laskin DM (1979) The specificity of response to experimental stress in patients with myofascial pain dysfunction syndrome. J Dent Res **58**, 1866–71.
5) Molinie J (1916) Réflexes oculaires d'origine auditive. Rev Laryngol Otol Rhinol **1**, 358–93.
6) Rylander R, Dancer A (1978) Startle reactions to simulated sonic booms: Influence of habituation, boom level and background noise. J Sound Vib **61**, 235–43.
7) Kovacevic M (1989) Influence of noise and vibrations on teeth abrasion. Stomatol Glas Srb **36**, 123–6.
8) Berglund B, Lindvall T, ed. (1995) Community Noise. Archives of the Center for Sensory Research, 2, Stockholm University and Karolinska Institute, Stockholm.
9) Grippo JO, Simring M, Schreiner S (2004) Attrition, abrasion, corrosion and abfraction revisited: a new perspective on tooth surface lesions. J Am Dent Assoc **135**, 1109–18;
10) Alekseev VA, Brozgolj AM (1970) Patologiceskoe stiranie zubov. Medicina, Moskva.
11) Bernhardt O, Gesch D, Splieth C, Schwahn C, Mack F, Kocher T, Meyer G, John U, Kordass B (2004) Risk factors for high occlusal wear scores in a population-based sample: results of the Study of Health in Pomerania (SHIP). Int J Prosthodont **17**, 333–9.
12) Tuominen M, Tuominen R (1992) Tooth surface loss and associated factors among factory workers in Finland and Tanzania. Community Dent Health **9**, 143–50.
13) Petersen PE, Henmar P (1988) Oral conditions among workers in the Danish granite industry. Scand J Work Environ Health **14**, 328–31.
14) Prpic-Mehicic G, Buntak-Kobler D, Jukic S, Katunaric M (1998) Occupational tooth-wear in clothing industry workers. Coll Antropol **22** (Suppl), 241–9.
15) Akgul HM, Akgul N, Karaoglanoglu S, Ozdabak N (2003) A survey of the correspondence between abrasions and tooth brushing habits in Erzurum, Turkey. Int Dent J **53**, 491–5.
16) Belojevic G, Nikolic M, Kecman G (1990) Failure of industrial noise to change the patterns of vanilmandelic acid and 17-hydroxycorticosteroids in the urine of the female weavers with hearing loss. Int Arch Occup Environ Health **62**, 441–4.