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SPUTUM CYTOLOGY IN OCCUPATIONAL EXPOSURE TO HEAVY METALS – A PRELIMINARY STUDY

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Abstract. Our study aimed the early detection of respiratory injuries afflicted with occupational exposure to chromium, cadmium, nickel and their compounds, with a known high carcinogenic risk. 23 platers (average of exposure 15.57±5.05 years) and matched controls have been investigated by clinical examination (including otolaryngology exam) completed by sputum cytology and an individual questionnaire.
Heavy metals concentration, as well as the microclimate factors, were measured in working area and revealed the values near to the admitted limits.
Sputum investigations found the type I cytology in 37.8% of workers *vs.* 82.6% of controls, type II cytology in 43.5% *vs.*17.4%, respectively. Two workers had sputum cytology of III type, with nucleolar alterations and suspected tumor cells. At 60.8% of people in exposed group were identified ferruginous bodies, in all types of sputum cytology, comparatively with only one case in control group.
74% of platers had chronic upper respiratory diseases *vs.* 26.1% of controls; 56.5% had pulmonary emphysema *vs.* 0% in control group.
Plating industry is responsible for chronic respiratory diseases, with possible malignancy risk, even the concentrations of heavy metals in the air are in admitted limits.
Precancerous injuries can be seen by sputum cytology a simple, noninvasive, and not expansive method, requiring a carefully monitoring of workers.
The presence, in a high proportion, of ferruginous bodies, unspecific to heavy metals exposure, entails revaluation of the exposure in working place.
Key words: sputum cytology, plating industry, heavy metals, ferruginous bodies

Rezumat. Studiul a avut drept obiectiv depistarea precoce, la nivel respirator, a leziunilor cu potențial de transformare malignă, în expunerea la metale grele recunoscute carcinogene umane (crom, cadmiu, nichel şi compuşii lor). S-au investigat 23 de subiecți dintr-o secție de acoperiri metalice, având o vechime medie profesională de 15,57±5,05 ani, comparativ cu un lot martor, având caracteristici asemănătoare lotului expus.
Investigațiile efectuate au fost: ex. clinic al aparatului respirator, ex. O.R.L., ex. citologic al sputei (clasificare citologică Babeş-Papanicolau), chestionar individual, monitorizarea toxicologică şi a microclimatului din mediul de muncă.
Valorile toxicelor (metale grele) în aerul locului de muncă se situau în apropierea limitelor admise legislativ.
37,8% din expuşi prezentau citologie de spută de tip I *vs.* 82,6% la lotul martor; 43,5% tipul II vs.17,4%. În două cazuri din expuşii profesional s-a obiectivat citologie tip III (degenerescențe nucleolare şi celule suspecte tumorale). S-a remarcat prezența la un număr foarte mare de

galvanizatori (60,8%) de corpi feruginoşi, în toate cele trei tipuri citologice, faţă de existenţa acestora la un singur subiect din lotul martor. 74% din expuşii la metale grele aveau afecţiuni cronice respiratorii ale căilor aeriene superioare, faţă de doar 26,1% la martori; 56,5% aveau emfizem pulmonar comparativ cu 0% în lotul martor.
Expunerea la metale grele determină leziuni cronice la nivelul aparatului respirator, cu potenţial de transformare carcinogenetică.
Citologia sputei, metodă simplă, neinvazivă şi necostisitoare, poate depista modificări posibil precanceroase, impunând monitorizarea acestora. Obiectivarea de corpi feruginoşi, într-un număr foarte mare de cazuri, aspect total necaracteristic expunerii la metale grele, impune reevaluarea riscului profesional la locul de muncă, în complexitatea lui, adesea neaşteptată.
Cuvinte cheie: citologia spute, industria acoperirilor metalice, metale grele, corpi feruginoşi

INTRODUCTION

In plating industry the main operations include electrolytic chromium, cadmium and nickel-plating. After long time exposure, these heavy metals are developing effects on upper respiratory system: irritant and corrosive on mucous membranes – ulcers and perforation of nasal septum, chronic rhinits with hypo- or anosmia (exposure to Cr, Ni), or pathological changes of the pharyngx, larynx and sinus (exposure to Cr, Ni) (1-3,5,6, 13). Chronic effects on lung (other than cancer) are represented by emphysema, with or without obstructive syndrome and restrictive lesions (linked to exposure to Cd), fibrosis („nickel pneumoconiosis"- at workers inhaling Ni dust or fumes), or even chronic obstructive pulmonary disease (exposure to aerosols of compounds of Cr VI) (3-7) and asthma (Cr, Ni) (6,8).

IARC (International Agency for Research on Cancer) concluded that there are sufficient evidence for the carcinogenity of Cr (VI) compounds (group I carcinogen) in plating industry (9,10). Chromium induces as histological type of lung cancer, an epithelial carcinoma (3). Cadmium has been accepted by IARC as a category I (human) carcinogen, based on the available human (primarily on its relationship to pulmonary tumors) and animal data. These studies concluded that occupational exposure to Cd in some forms, possibly the oxide, increases the risk of lung cancer (9). The toxicity of Ni depends to its water solubility, with Ni sulfate being most toxic, followed by Ni subsulfide and Ni oxide (8,9).

Workers in the electrolysis section have a highest risk of lung cancer and an excess risk of nasal cavity cancer. Both types of cancer have increasing risk correlated with the length of occupational exposure, nasal cancer having a strong positive relationship with the age at first exposure, whereas lung cancer has not (8).

A correlation between local toxic effects and Cr VI status has been demonstrated by cytologic studies: the presence of atipical cells on rhynosinus mucosa. From that point of view, the examination of nasal cytology in medical surveillance of Cr-VI exposed workers is essential. Collecting of the samples (by

brushing) is a simple, noninvasive and good diagnosing method (11).
There is evidence for an additive effect of smoking and sputum cytology is the method of choice to detect peripheral lesions, in an early stage (peripheral carcinoma – squamous cell), complementary with brush cytology (12).

MATERIAL AND METHODS

23 subjects from plating industry and a control group matched by sex, age, years of length of occupational exposure, and smoking habit have been investigated. The features of exposed group are shown in figures 1-3. Four categories of smoking habit have been used: never smoker, ex-smoker, current smoker (1-19 cigarettes daily), and heavy smoker (more than 20 cigarettes daily).

The protocol of investigation comprised:

- an occupational anamnesis;
- a physical exam of respiratory tract;
- otolaryngoscopic examination;
- sputum cytology (May Grűnwald Giemsa staining and Babeş-Papanicolau classification);
- individual questionnaire about subjective symptoms;
- monitoring of the air working areas for Cr VI, Ni, Zn, Na and nitrogen oxyde, cyanats, hydrocloric acid and sulphur dyoxide, and also for microclimate conditions.

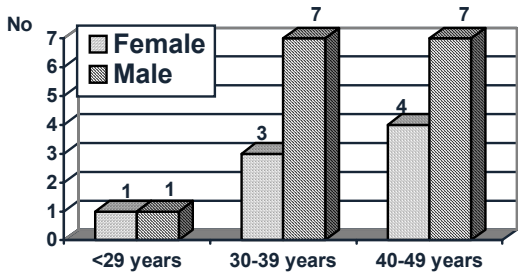


Fig. 1 Age and sex distribution of exposed group

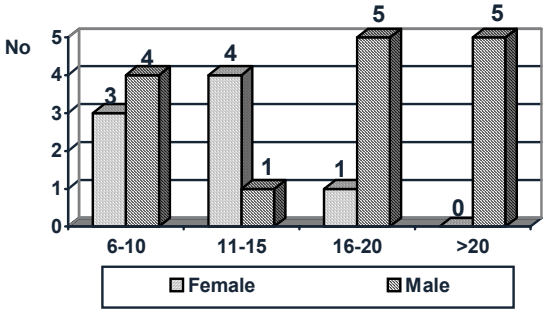


Fig. 2 Length of occupational exposure in exposed group

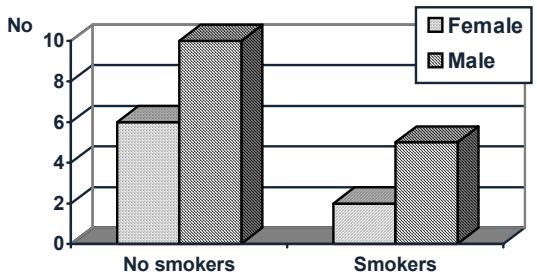


Fig. 3 Smoking habit of the exposed group

RESULTS AND DISSCUSION

The air measurements (table 1) for each of heavy metals showed values under the admitted limits of national standards. Only nitrogen oxyde and natrium oxyde had Threshold Limit Value-Time Weight Average (TLV-TWA) increased (13). But each toxic agent having additive, irritating effects, by summation their calculated cumulative index exceeds the unity (1.95). The components of microclimate in plating area were within the threshold limits, for the period of the year it they were measured (November), with a slight increase of relative humidity (table 2).

Chronic respiratory effects, in exposed group mainly on upper respiratory system found were: chronic rhinitis 30.4% *vs.* 17.4% in control group; chronic pharyngitis 21.7% *vs.* 0% at controls. As associated diseases, and only in the exposed group, was chronic rhyno-pharyngitis (17.4%) and 4.3% (one case) chronic rhyno-pharyngo-laringitis (fig. 4).

Table 1. The mean concentrations of airborne toxic substances

Work area	Noxious (mg/m³)							
	Chromium (VI)	Zinc oxyde	Nickel	Natrium oxyde	Hydrocloric acid	Sulphur dyoxide	Nitrogen oxyde	Cyanats
Plating section	0.0056	0.235	Under detectable limit	2.0	0.56	0.88	7.06	0.065
TLV-TWA*	0.05	5	0.1	1	5	5	5	0.5
Cumulative index for mixture = 1.95 (C1/T1+C2/T2+…+Cn/Tn, where C1, C2,…,Cn=concentration of the noxious in the air, and T1, T2,..,Tn=TLV) *TLV-TWA=Threshold Limit Value-Time Weight Average								

Table 2. The mean values of microclimate in working area

Work Area	Working atmosphere					
	Temperature (°C)	Relative Humidity (%)	Air Current Speed (m/s)	Globe - Thermometer Assmann psyhrometry (°C)	Effective Equivalent Temperature	Observations
Outside working place	15	86	1.633	-	-	Raining
Plating section	18.58	73.33	0.213	17.2	16.63	At 1.5 m level

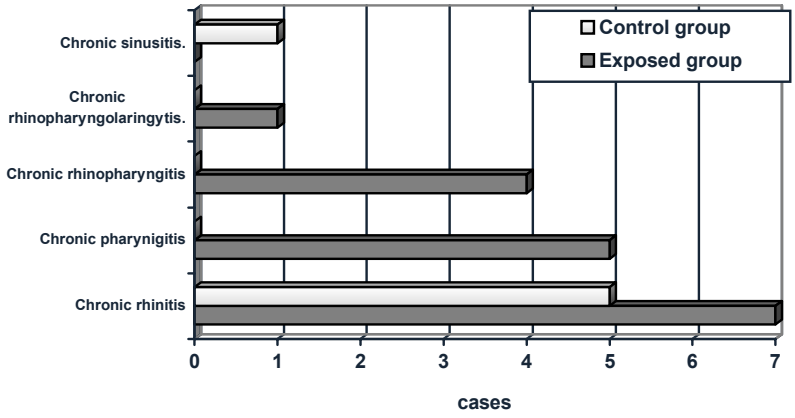


Fig. 4 Chronic diseases of upper respiratory system

Pulmonary effects, represented by emphysema, was found at 56.5% of platers and no case in the control group, fact that could be assigned to Cd chronic exposure, only (1-5). On second place, as frequency, was chronic bronchitis (34.8% *vs.* 8.7%), with contribution of smoking habit in both groups (fig. 5).

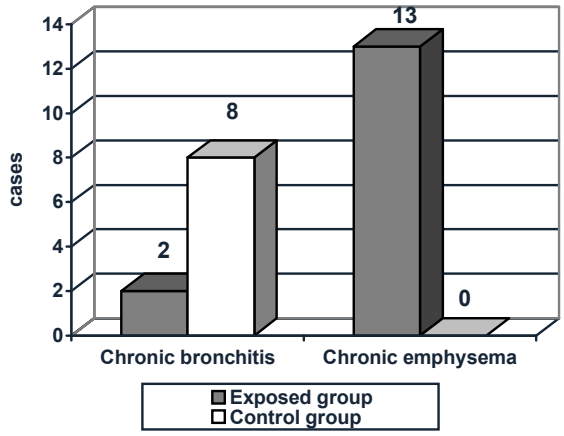


Fig. 5 Chronic pulmonary diseases

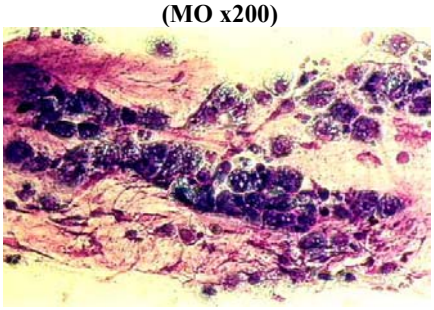
For the assessment of carcinogenic effect on pulmonary tract we used a simple, easy to sample, not so expensive and noninvasive method: sputum cytology.

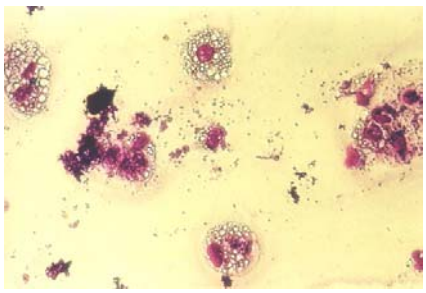
In the exposed group, type I of cytology were seldom (37.84%) *vs.* controls (82.6%).

Type II cytology predominates (high density of macrophages, and some with vacuolar cytoplasm modifications) at 43.5% *vs.* 17.4% (controls).

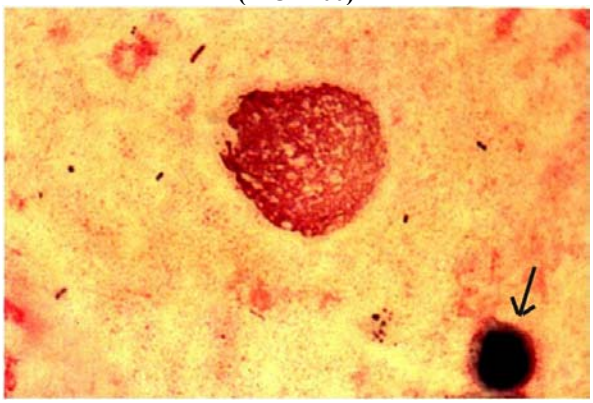
The sputum cytology type III (2 cases-18.7%) with nucleolar segmentation and a suspect tumor cells, have been detected, also.

Cytology aspect type II Papanicolau – macrophages field (MO x200)





Type III cytology Papanicolau – nucleus alterations and tumoral cell (MO x200)



Because, one subject never smoked, and the other a moderate one (up to10 cigarettes daily), the smoking habit was considered with a small influence. The workers found with suspect cytology (type III) must be follow up on each sixth month, and if the modifications persist they have to be investigate by pulmonary broncho-scopy with broncho-alveolar lavage.

All three types of cytological classification of sputum revealed the presence of ferruginous bodies in a high percentage of exposed workers (60.8%) *vs.* 4.3% of unexposed (fig. 6,7 and 8).

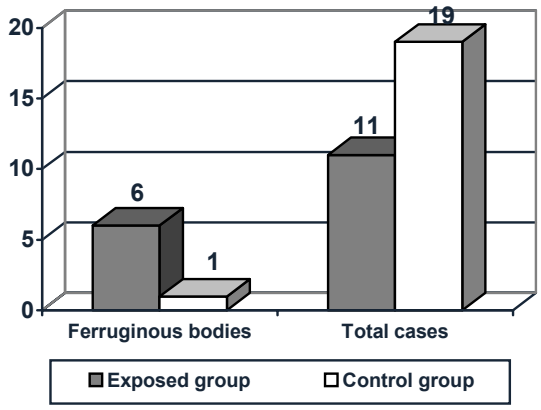


Fig. 6 Ferruginous bodies in sputum cytology type I

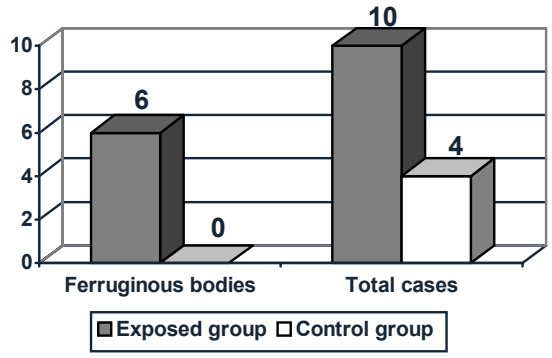


Fig. 7 Ferruginous bodies in sputum cytology type II

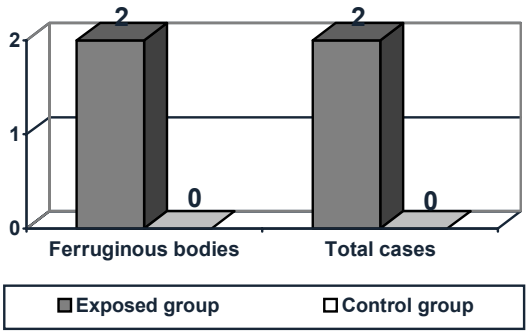
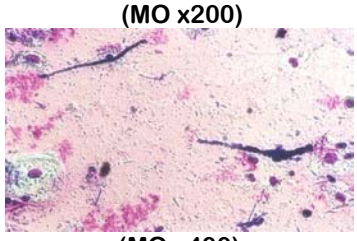


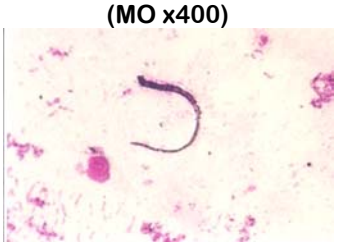
Fig. 8 Ferruginous bodies in sputum cytology type III

Different forms of ferruginous bodies from exposed group

(MO x200)



(MO x400)



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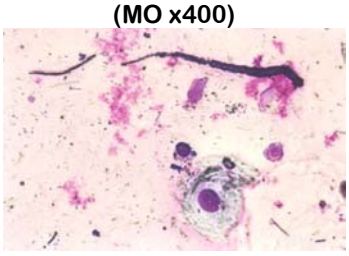

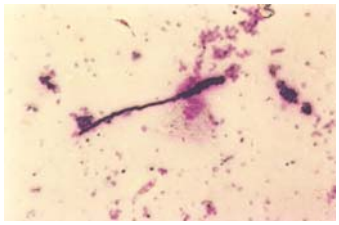

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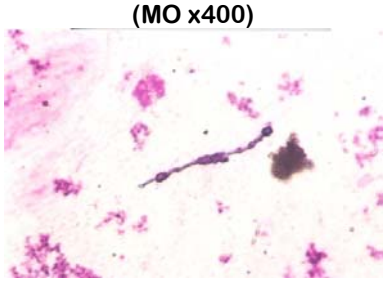

Because the ferruginous bodies (proteic conglomeration on a mineral fiber) are not specific to heavy metal exposure, we carried to revaluate the platers real exposure, to find what other air pollutant could interfere in technological process, and could explain our results. Thus, we found that for sanding, glass dust was used in a small room annexed to plating section. We presumed that the presence of these particles in the working air could be understood as a contributory factor for ferruginous bodies appearance, and air determinations for dust and mineral fibers are needed.

CONCLUSIONS

- The exposure to heavy metals in plating industry has a high risk of inducing chronic effects on respiratory tract, with possible malignant lesions, even at low exposure limits.
- Sputum cytology, a simple and noninvasive method can provide important information (suspect modifications-precocious malignant stage).
- Monitoring of workers with suspicious sputum cytology modifications is necessary.
- The unspecific ferruginous bodies found in plater's sputum draw attention on the possible presence of another noxious agent in working area, possible intensifying the chronic respiratory effects.

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