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Lung Function Changes in Pleural Asbestosis

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A B S T R A C T

The aim of this study was to examine the relationship between radiographically detectable pleural changes and lung function in pleural asbestosis. One hundred and twenty chrysotile asbestos-exposed workers were enrolled in this retrospective study. For each examinee the length of asbestos exposure and the degree of dust cover at the workplace were assessed as well as the radiological and functional tests has been performed. The examinees were divided into two groups based on radiologically detectable changes: a) group with pleural changes (29%) and b) group without perceived pleural changes (71%). The obtained results indicate association between the length of asbestos exposure, pleural changes and the impairment of lung function.

Key words: *pleural asbestosis, radiographs, lung function*

Introduction

Asbestos is a mineral for which it has been proved to induce a series of diseases including asbestosis, lung cancer, mesothelioma and benign changes in the pleura[1–5]. Since many industrial workers are still exposed to asbestos, in this study we examined the association between length of exposure to asbestos with radiologically detectable diffuse pleural thickening and changes in basic parameters of lung function.

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Materials and Methods

For the purposes of this study, we recruited 120 employees of the asbestos and cement products factory »Salonit« in Vranjic who have been occupationally exposed to chrysotile asbestos. Only male nonsmokers exposed to asbestos dust over a period of 20±9.8 years were enrolled in this study.

Lung function was examined by means of »JAEGER MASTER-LAB« spirometer. The forced expiration was measured three times and the best measurement is used. Lung function was evaluated based on difference between the obtained and predicted, normal values. The directions of *The European Community for Coal and Steel* (CECA)[6] were followed. Diffusing capacity for carbon monoxide (DLco) was measured on the »JAEGER MASTER--LAB« instrument and the obtained values were evaluated according to Cotes[7]. Arterial blood gas analysis was performed using the Radiometer ABL 5 instrument. The number of fibers/cm^3 in the working area was measured by means of optic microscope method with phase contrast according to *The International Standards Organization*[8]. Based on the number of asbestos fibers/cm^3 in the atmosphere, working places were divided into four groups as follows: high-risk group (<5 fibres/cm^3 in work atmosphere), medium risk group (2–5 fibres/cm^3 in work atmosphere), low risk group (0.2–2 fibres/cm^3) and non-risk group (>0.2 fibres/cm^3).

Examinees in this study were classified into the first and second groups according to the number of asbestos fibers in the working space.

The degree of lung function damage was estimated by comparison of expected and obtained values. Differences in arithmetic means between groups were analyzed using t-test for independent samples. The analysis of variance was used for testing the differences between different groups of variables. The chi-square test was used for frequency analysis. The difference between groups at $p<0.05$ was considered as statistically significant. The data were processed on an IBM STATGGRAFF.

Results and Discussion

The purpose of the present study was to examine the association between radiographically perceived changes in pleura of the workers exposed to asbestos and their lung function. The examinees were divided in two groups: with and without radiologically perceived changes of pleura. The study did not include examinees whose pleura thickening degree was 1a, 1a; 2a,2a according to the ILO scoring system[6–8] because of the unreliability in pleural thickness caused by fat tissue accumulation.

Early detection of pleural asbestosis is difficult because clinical symptoms appear only when the disease reaches an advanced stage[9]. Some authors point out that functional parameters (reduction of VC and DLco) are sensitive indicators of radiological changes scored in compliance with the ILO classification system[10,11]. Other studies recommend the high-resolution computed tomography (HRCT) as a sensitive method in the early detection of changes[12,13]. Rosenstock et al. (1988) and Kilburn et al. (1992) state that VC fall is the most important change in lung function which is perceivable at an early stage of the disease and that it depends on asbestos fibers concentration[14,15]. The examinees with radiographically perceived pleural changes have significantly lower vital capacity (VC) and forced expiratory volume in the first second (FEV_1) values. Baker et al. (1985) have proved that significant changes of VC and FEV_1 happen when the pleural thickening exceeds an »a« score according to the ILO classification system because pleural changes beco-

me visible at the point when the change encompasses two thirds of the lateral wall since lung ventilation is accomplished mostly by basal parts[16].

A biphasic change in the median expiratory flow ($MEF_{25–75}$) has been implied as a sensitive test in the early detection of obstructive difficulties in ventilation[17–21]. Experimental studies on animals have shown that asbestos fibers are stored in respiratory bronchioles and alveolar ducts and that they cause a peribronchial inflammation with irritation of alveolar macrophages and neutrofila[22,23]. Late reaction includes formation of discrete fibrous changes on bronchiole walls with asbestos plaque. Churg et al. (1985) found similar lesions (increased fibrosis in the walls of respiratory bronchioles) and significant abnormalities of FEV_1 and VC in relation to mineral dust exposure[24].

In the present study, the relationship between the length of asbestos exposure and the presence of pleural changes is indicated by increasing number of examinees with pleural changes with increasing years of exposure to asbestos (Table 1). Tested by chi-square statistics, the differences in frequencies among groups proved to be significant.

Deterioration of the lung function with the accumulation of asbestos exposure also showed to be statistically significant. Namely, tested by ANOVA, the differences in mean values of basic spirometric parameters (VC, FEV_1 and $MEF_{25–75}$) between groups with increasing length of asbestos exposure was significant for 7 of 9 inter-group comparisons (Table 2).

The relationship between pleural changes and lung function is demonstrated on Table 3, where it is shown that examinees belonging to the group with radiographically detectable changes in pleura have statistically lower VC and FEV_1 values (tested by t-test).

TABLE 1
THE PROPORTION OF EXAMINEES WITH PLEURAL CHANGES WITH RESPECT TO DURATION OF EXPOSITION TO ASBESTOS DUST

	Exposition (years)		
	< 10 N (%)	10–20 N (%)	>20 N (%)
Total number of examinees	35 (100)	48 (100)	37 (100)
Examinees with pleural radiological changes	4 (11.4)	11 (22.9)	20 (54.1)

Chi-square: 9.012; $p<0.05$

TABLE 2
LENGTH OF EXPOSITION TO ASBESTOS AND LUNG FUNCTION PARAMETERS

	Exposition (years)			ANOVA		
	< 10	10–20	> 20	(p among groups)		
	$\bar{x}$±SD	$\bar{x}$±SD	$\bar{x}$±SD	<10:10–20	<10:>20	10–20:>20
VC (%)	102.80±11.65	99.37±10.91	87.54±1.52	ns	<0.05	<0.05
FEV_1 (%)	111.16±18.28	102.25±16.95	97.18±12.05	<0.05	<0.05	<0.05
$MEF_{25–75}$	100.62±28.58	95.75±38.97	100.97±35.94	<0.05	ns	<0.05

TABLE 3
LUNG FUNCTION PARAMETERS IN EXAMINEES WITH AND WITHOUT PLEURAL CHANGES

	Without pleural changes N = 85	With pleural changes N = 35	t	p
VC (l)				
$\bar{x}$	96.81	76.28	9.12	<0.05
SD	8,90	14.92		
FEV_1 (l/s)				
$\bar{x}$	107.02	86.77	6.73	<0.05
SD	13.51	17.22		
FEV_1/VC (%)				
$\bar{x}$	84.85	84.05	0.52	ns
SD	7.56	7.61		
DL_{CO} (mmol $min^{-1}KPa^{-1}$)				
$\bar{x}$	107.18	106.44	0.28	ns
SD	12.24	13.02		
$DL_{CO/VA}$ (mmol min^{-1} KPa^{-1} L^{-1})				
$\bar{x}$	105.93	114.68	2.08	ns
SD	16.96	20.35		
pO_2(KPa)				
$\bar{x}$	12.66	12.76	0.27	ns
SD	1.80	1.42		
pCO_2(KPa)				
$\bar{x}$	4.86	4.81	0.0	ns
SD	0.44	0.48		

$DL_{CO/VA}$ – diffusing capacity per unit; VC – vital capacity; pO_2 – partial pressure of O_2; FEV_1 – forced expiratory volume in one second; pCO_2 – partial pressure of CO_2; FEV_1/ VC – Tiffenaux index; DL_{CO} – lung diffusing capacity for carbon monoxide

Conclusion

In conclusion, the results of the present study could be summarized as follows:

- Significant association between the length of exposure to asbestos and the presence of changes in the pleura.
- Significant association between the length of exposure to asbestos and decrease in lung function parameters (VC, FEV_1 and $MEF_{25–75}$).
- Significant association between presence of pleural changes and lung function parameters (lower VC and FEV_1 values in the group of examinees with pleural changes).

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PROMJENE PLUĆNIH FUNKCIJA U PLEURALNOJ AZBESTOZI

SAŽETAK

Cilj ovog rada je usporedba plućnih funkcija i radiološki vidljivih pleuralnih promjena u pleuralnoj azbestozi. Provedena je retrospektivna studija koja je uključila nalaze 120 radnika koji su bili eksponirani krizotilskom azbestu. Za svakog radnika procijenjeno je trajanje i stupanj zagađenosti azbestnom prašinom njegove radne sredine, te je napravljena specijalistička pulmološka obrada koja je uključivala radiološku i spirometrijsku dijagnostiku. S obzirom na radiološki detektabilne promjene, ispitanici su podijeljeni u dvije skupine: onu s radiološki vidljivim pleuralnim promjenama (29%) te onu u kojoj su ispitanici bez vidljivih promjena na pleuri (71%). Autori zaključuju da postoji značajna povezanost između trajanja izloženosti azbestu, promjena na pleuri i smanjenja spirometrijskih pokazatelja plućne funkcije.