

## LUNG FUNCTION IMPAIRMENT IN SILICOSIS

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**Keywords:** silicosis, airways obstruction, smoking index.

**Abstract:** Pneumoconioses still represent a current topic, due to the persistence of some productive activities at risk. Our aim is to assess the relationship between the radiological severity of the pneumoconiosis and the changes in pulmonary function tests. **Material and method:** The study group consists of 116 subjects with activity in gold mining, diagnosed with silicosis using the ILO 2000 Classification and evaluated by using spirometry. **Results:** The pulmonary tests indicative of obstruction are significantly lower in conglomerative forms of silicosis, the highest significance corresponding to MEF<sub>50%</sub>. The functional changes in silicosis are of obstructive type, mainly at peripheral level and are not influenced by the smoker/non-smoker status, suggesting that exposure to high concentrations of free crystalline SiO<sub>2</sub> “erases” the differences given by the frequency of smoking. **Conclusions:** The main functional alteration is obstruction, more pronounced at the peripheral level of the airways, proving to be independent of the smoking habit. **Key words:** silicosis, airways obstruction, smoking index.

**Cuvinte cheie:** silicoză, obstrucția căilor aeriene, indice de fumat

**Rezumat:** Pneumoconiozele reprezintă încă un subiect de actualitate datorită persistenței unor activități productive care implică risc pneumoconiozogen. Scopul studiului este investigarea relației dintre gravitatea pneumoconiozei și alterarea funcțională ventilatorie. **Material și metodă:** Lotul de studiu este reprezentat de 116 subiecți cu activitate în sectorul aurifer, diagnosticați cu silicoză conform clasificării ILO(International Labour Office) 2000 și investigați spirometric. **Rezultate:** Parametrii ventilatori specifici sindromului obstructiv sunt semnificativ mai mici în silicozele conglomerative, cea mai înaltă semnificație corespunzând lui MEF<sub>50%</sub>(debit expirator maxim la 50% din capacitatea vitală). Tulburările funcționale observate în silicoză sunt de tip obstructiv, predominant la nivel periferic și nu sunt influențate de statutul de fumător/nefumător, sugerând că, expunerea la concentrații înalte de SiO<sub>2</sub> liber cristalin „șterge” diferențele de frecvență în raport cu obiceiul de a fuma. **Concluzii:** Principala tulburare ventilatorie este obstrucția, manifestată mai intens în sectorul periferic al căilor aeriene, fiind independentă de practicarea fumatului. **Cuvinte cheie:** silicoză, obstrucția căilor aeriene, indice de fumat.

### INTRODUCTION

Pneumoconioses are defined as “accumulation of dust in the lungs and the tissue’s reaction to their presence”. The frequency of these affections in workers exposed to fibrous dusts dropped significantly following the shrinkage of the number of workers at risk involved in mining activities, nevertheless, there are still some productive activities for which the risk of developing pneumoconioses remains real.

For a complete diagnosis, evaluating the lung function is mandatory and serves for assessing work capacity as well as for appreciating therapeutical efficiency. The mechanisms responsible for inducing ventilatory function disorders are diverse, some authors imputing them to the existence of chronic bronchitis (1,2), others to pulmonary emphysema (3,4), but there are also authors who have not established a sure correlation between the degree of emphysema found at necropsy and the impairment of lung function seen during lifetime.(5) Studies on large groups of subjects diagnosed with silicosis, for whom the coexistence of bronchitis and emphysema was excluded, were able to establish an undisputable cause-effect relationship.(6,7) Restrictive ventilatory disorders were initially considered as characteristic for pneumoconioses.(8,9) Subsequently, the studies of pulmonary condition revealed the presence of

obstructions localized at different levels of the airway, most frequently at peripheral level (10,11), even amongst subjects exposed to silica dust, but without radiological findings indicative of silicosis.(12) The affiliation of functional disorders regarding causality is still a controversial issue and subject for debate. For some, their progressive development could be consecutive to smoking (13), others consider them an intrinsic phenomenon in silicosis, their gravity depending on the radiological appearance of pneumoconiosis.(14)

### PURPOSE

This study aimed at researching the severity of the functional disorders in a group of miners with silicosis, the type of these disorders and their relation with age, duration of exposure, smoking and seriousness of the radiographic aspect.

### METHODS

The study group consisted of 116 patients with pneumoconiosis that have been admitted for check-ups and treatment at the Occupational Health Clinic Cluj-Napoca in the timeframe 2007-2009, miners and former miners. The subjects included in the study have been working in the gold mining sector, recognized for it’s wealth in sterile with high free SiO<sub>2</sub>

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## CLINICAL ASPECTS

content, a fact that justifies the pneumoconiosis contracted as being silicosis. Data was obtained regarding age, duration of exposure to risk, smoking habit and the smoking index was calculated according to the formula: smoking index = (number of years of smoking × number of cigarettes smoked per day) / 20. Radiological findings were noted according to the ILO (International Labor Organization) 2000 Classification of Pneumoconioses and the ventilatory function testing was completed using a Collins DS Plus device, the results being expressed in percentage of the predictive value recommended by ERS (European Respiratory Society), respectively the absolute value for the Tiffeneau index.

In order to achieve the aim of the study, we collected the reported values of VC (vital capacity), FEV<sub>1</sub> (forced expiratory volume in the first second), FEV<sub>1</sub>/VC and MEF<sub>50%</sub> (maximal expiratory flow at 50% of VC). The functional parameters were studied in comparison by dividing the entire group in two sets of patients: nodular silicoses, including categories 1, 2 and 3 of profusion, with type p, q, r opacities, and conglomerative silicoses, including types 3 ax, A, B and C. The database was statistically analyzed by using the univariate ANOVA test and the interpretation of the test was made for a significance threshold of 5% (p<0,05).

### RESULTS

The medium age for the entire group was 61.5±10.6years, and the medium duration of activity underground of 20.0±7.8years. The age difference between the subjects with nodular forms of silicosis (59,18± 11,24years) and those with conglomerative forms (65.45± 8.47years) is statistically significant (p=0.001), and the difference regarding the duration of exposure (20.2±7.97 versus 19.6 ± 7.80) is statistically insignificant (p=0.68). Of the entire group, 67% of the subjects were smokers and 33% non-smokers. The proportion of smokers was of 73.6% in the group of subjects with nodular forms of silicosis and of 55.8% in the group of the ones with conglomerative forms, the differences being statistically insignificant (p=0,17). The medium values for the studied variables, for the entire group are shown in table no. 1.

**Table no. 1. The values of the researched parameters, according to the gravity of the silicosis**

Variable	Nodular silicosis		Conglomerative silicosis		p*
	Mean	DS	Mean	DS	
Age (years)	59,18	11,25	65,46	8,42	0,002
Smocking index	17,55	15,06	12,06	14,27	0,05
CV%	83,83	19,49	82,16	15,11	0,62
MEF <sub>50%</sub> %	55,47	34,23	38,61	24,75	0,008
VEMS%	76,64	23,89	67,34	21,41	0,03
VEMS/CV	71,63	12,45	63,84	14,45	0,003
Activity duration (years)	20,24	7,98	19,61	7,76	0,68

\*calculated using the univariate ANOVA test

The ventilatory parameters that define the obstructive syndrome are significantly smaller in conglomerative silicosis, the highest significance being for MEF<sub>50%</sub> and FEV<sub>1</sub>/VC.

Analyzing the same parameters for smokers and non-smokers, there results a shrinkage of the medium values of the main indicators for the obstructive syndrome, a decrease more accentuated, although statistically insignificant, for the conglomerative silicoses as opposed to nodular ones, the most affected parameter being MEF<sub>50%</sub> (table no. 2).

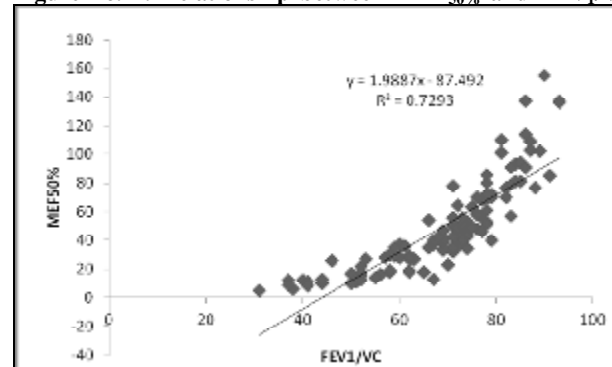
**Table no. 2. Medium values of the studied ventilatory parameters in nodular and conglomerative silicosis, smokers (78 observations) and non-smokers (38 observations)**

Variable	Non-smokers			Smokers		
	Nodular silicoses Mean (SD)	Conglomerative silicoses Mean (SD)	P*	Nodular silicoses Mean (SD)	Conglomerative silicoses Mean (SD)	P*
Age (years)	60,68 (12,09)	67,37 (8,14)	0,01	58,64 (11,00)	64,00 (8,49)	0,03
Smocking index	-	-	-	23,84 (12,53)	21,23 (12,74)	0,39
VC%	84,11 (22,18)	80,84 (17,89)	0,6	83,74 (18,67)	83,16 (12,90)	0,86
MEF <sub>50%</sub> %	54,58 (27,75)	35,58 (26,47)	0,55	55,79 (36,50)	40,92 (23,66)	0,11
FEV <sub>1</sub> %	78,32 (25,38)	65,47 (24,72)	0,8	76,04 (23,55)	68,76 (18,92)	0,18
FEV <sub>1</sub> /VC	72,68 (10,81)	62,47 (13,83)	0,1	71,25 (13,06)	64,88 (15,10)	0,06

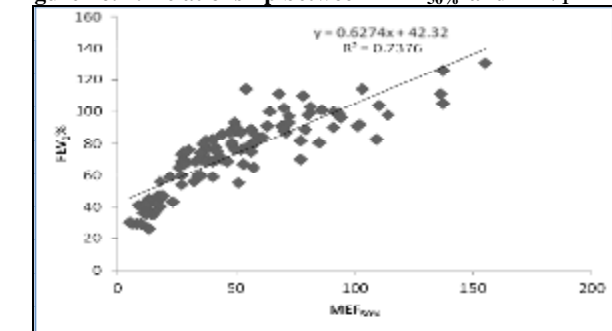
\*calculated using the univariate ANOVA test

Between MEF<sub>50%</sub> and the other functional parameters for obstruction (FEV<sub>1</sub> and FEV<sub>1</sub>/VC) there was a linear relationship observed, translating into a correlation coefficient with high statistical significance (figures no. 1 and 2).

**Figure no. 1. Relationship between MEF<sub>50%</sub> and FEV<sub>1</sub>/VC**



**Figure no. 2. Relationship between MEF<sub>50%</sub> and FEV<sub>1</sub>**



This kind of relationship was not observed between these indicators and the smoking index. This data accordingly, the decline of MEF<sub>50%</sub> is prior to the one of FEV<sub>1</sub> and FEV<sub>1</sub>/VC.

### DISCUSSIONS

The subjects with conglomerative forms have an increased age, as a result of the duration of radiological progression from nodular forms to conglomerative ones, the exposure duration being similar for both groups. Seeing as there were no differences regarding the smoking index for both studied groups, it can be concluded that the progress of silicosis to advanced forms does not depend upon smoking.

## CLINICAL ASPECTS

According to our findings that revealed normal values of VC in both sets of patients, the main ventilatory disorders were the ones of obstructive and not restrictive type, the ventilatory decline being a slow one, similar to the observations published by L'Abbate.(15) It is very probable that the substrate for these is inherent for silicosis and not entirely attributable to smoking as decisive factor for chronic bronchitis (1,2), or emphysema (4), as some authors claim. Our point of view is supported by the absence of a relationship between the parameters for obstruction and the smoking index. Confronting the results of functional tests prior to death with the changes shown in autopsy, Hnizdo and co.(12) could not confirm an direct link between the presence of morphological changes of emphysema and the degree of functional disorder, whereas Ulvestad and co. (7) proved the existence of a relationship between cumulative exposure to dust and accelerated functional decline.

The most altered test and probably the earliest to be modified, was MEF<sub>50%</sub>, considered an expression of the small airway damage due to mineral dust, a pathological state first described by Churg and Wright in 1983.(10) Related to the current knowledge regarding airway inflammation, the morphological aspects described by these authors correspond the ones that characterize the bronchial remodelling process, a crucial element for the onset of the obstructive syndrome.

The more pronounced ventilatory disorders observed in conglomerative silicosis, imply furthermore the participation of the fibrous process with changes in bronchial geometry.(16)

### CONCLUSIONS

The functional disorders observed with silicosis are of obstructive type, concern mainly the small airways and are more pronounced in advanced forms of pneumoconioses. The study's observations did not confirm a dependency of the ventilatory functional disorders on the intensity of the smoking habit, evaluated through the smoking index.

The most affected parameter of the ones studied proved to be MEF<sub>50%</sub>, its decrease marking the onset of small airway disease, a prelude of the classic obstruction concerning also the large airways.

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