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Correlation analysis between pulmonary function and chest radiograph in molybdenum mine works.

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Abstract

Objective: To study the impairment degree of pulmonary function in molybdenum silicosis miners and analysed the relationship between pulmonary function parameters and chest X-ray film.
Method: Seventy-five molybdenum mine silicosis cases and thirty-five healthy cases were reviewed. They underwent pulmonary function and chest radiography and compared the pulmonary function parameters in different chest X-ray manifestation.
Results: (1) With the step-up of silicosis category, every pulmonary function parameter decreased gradually. Compared with control, radiographic silicosis in stage showed significant difference in all parameters ($p<0.05$). And these four parameters also have statistical difference between stages I, II and III. (2)As the increased of regions related to silicotic lesions, the parameters level were slightly decrement and more significant reductions with progressive massive fibrosis in FEV1,V75,V50 and V25 ($p<0.05$). (3) The differences in small opacities classes and the density of small opacities of silicosis were not lead to transparent discrepancy in all pulmonary function parameters.
Conclusion: The pulmonary ventilation function is mainly in relation to silicosis stage and the formation or the degree of massive fibrosis.

Keywords: Clinical characteristics, Pulmonary function, Chest radiography, Molybdenum, Silicosis.

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Introduction

Silicosis is one of the pneumoconiosis which has the highest incidence rate at present. It is mostly occurrenced in coal or iron miners, building road workers, stone fragmentation and processing employers, quartz processing workers, and so on. Silicosis is not a benign disease; silica exposure is the primary cause, and the lung function loss in silicotics is directly attributable to the fibrotic lung disease [1]. More recent data have shown chronic simple silicosis to be a significant lung disease [1,2]. Silicosis reflects a failure in adequate control of occupational dust exposure. The disorder is associated with radiologic pulmonary nodular opacity. Chronic silicosis generally occurs after prolonged low in density exposure to dust containing crystalline silica. There is a consistent association between increased pulmonary function abnormalities and silica dust exposure despite the concentration within the current allowable level of Occupational Safety and Health Administration (OSHA) [3]. In this study, we recruited seventy-five subjects who are silicosis patients from the same molybdenum mine. Pulmonary function tests and chest X-ray were performed to evaluate pulmonary function test results of different stages and analyse the relationship between pulmonary function and chest radiograph.

Materials and Methods

Materials

This study was conducted in a molybdenum mine in a small town of China. This study selects seventy-five patients with silicosis patients in molybdenum mine. They are all chisel stone workers. The cases are all masculinity, aged 33 to 56 years, averaged 42.5 years. The length of occupational service was 3.5 to 23 years, averaged 10.25 years. Thirty-five healthy men who was nondust as matched control, aged 32 to 54 years, averaged 42.54 years. They were observed by routine lung function test and chest radiography. The results were compared with the measured value of 35 healthy cases. Based on the (Diagnosis of occupational pneumoconiosis) (GBZ70-2015), we diagnosed 10 silicosis of category I, 44 silicosis of category II and 21 silicosis of category III (Silicosis was defined as small opacities profusion of ≥ 1/0 for at least two lung fields and category III was defined when the area of massive fibrosis to be equal to or bigger than square centimetre 2 × 1). We have eliminated the interference of ir-investigation agents.

Methods

First, a single posterior-anterior 120~125 KV was obtained. All chest radiographs were reviewed by three occupational physicians who were certified by Ministry of Health of the People's Republic of China. After completion of the chest radiograph, the lung function tests were done according to the standards of the American Thoracic Society [4] by just one technician. The equipment used was the MIR Spirolab II. The test was performed by the single-breath method. The patients were standing when they were testing. We checked three times continuously and select the best for recording. The parameters we used was Forced Vital Capacity (FVC), forced expiratory volume in one second (FEV1), FEV1 to FVC ratio (FEV1%), Peak Expiratory Flow (PEF), 75% vital capacity (V75), 50% vital capacity (V50) and 25% vital capacity (V25). We used T-test on the values of all pulmonary function parameters.

Table 1. *The average value of pulmonary function parameters of silicosis cases.*

n		The average value of pulmonary function parameters						
		FVC (L/S)	FEV1 (L/S)	FEV1 (%)	PEF (L/S)	V75 (L/S)	V50 (L/S)	V25 (L/S)
I	10	3.71 ± 0.48*	3.08 ± 0.49*▼	78.60 ±7.02▼	6.55 ± 1.15▼	5.32 ± 2.22*▼	3.51 ±1.14*▼	1.23 ±0.45*▼
Ii	44	3.85 ± 0.65▼	2.83 ± 0.66*▼	79.65 ± 7.87*	6.11 ± 2.23*▼	5.26 ± 1.89*▼	3.22 ±1.32*▼	1.14 ±0.86*▼
Iii	21	3.13 ± 0.58▼	2.22±0.56▼	70.16 ± 12.4▼	5.03 ± 2.21▼	3.87 ± 2.21▼	2.32 ±1.25▼	0.78 ±0.34▼
Control	35	4.22 ± 0.51	3.73 ± 0.49	87.9 ± 4.21	8.60 ± 1.48	7.31 ± 1.34	4.67 ± 0.98	2.25 ± 0.58

*Compared category I and II with category III, p<0.05.

Compared category I, II and III with control, p<0.05.

Results

We collected one hundred and ten lung function results (seventy-five of silicosis and thirty-five of control people) and seventy-five chest radiographs. We compared pulmonary function parameters in different stages of pneumoconiosis and normal subjects, and analysed the variation tendency of pulmonary function parameters in different distribution regions of small opacities, density of small opacities and opacities classes. In order to understand the difference of lung function between pneumoconiosis and normal population, the pulmonary function parameters of the two groups were compared. Table 1 shows that they are mostly identical in FVC between category and control, except for that, there are significantly lower than the controller in all pulmonary function parameters values of categories I-III ($p<0.05$). Furthermore, there is differ-degree discrepancy in all pulmonary function parameters values compared category I and II with category III, especially in FEV1, V75, V50 and V25. But there are no significantly difference between category I and II.

In general, with the increase in the distribution of pulmonary fibrosis, lung function should also be reduced, so we observed the relationship between the distribution regions of small opacities and pulmonary function parameters. In all seventy-five silicosis, the small opacities are relating to four lung regions at least and mostly relate to six lung regions. From Table 2, we can see that all pulmonary function parameters decreased gradually with the increased of distribution regions of small opacities and have statistical difference between massive fibrosis and 4, 5 and 6 distribution regions of small opacities, particularly in four parameters, such as FEV1, V75, V50 and V25 ($p<0.05$). But there are no significantly difference between 4 and 5, 6 distribution regions.

Table 2. *The relationship between the distribution regions of small opacities and the values of pulmonary function parameters in silicosis.*

n		The average value of pulmonary function parameters						
		FVC (L/S)	FEV1 (L/S)	FEV1 (%)	PEF (L/S)	V75 (L/S)	V50 (L/S)	V25 (L/S)
4	11	4.04 ± 0.35▼	3.02 ± 0.76▼	77.58 ± 7.11	6.22 ± 1.55	5.33 ± 2.12*	3.44 ± 1.43*	1.35 ± 0.33*
5	10	4.14 ± 0.56	3.05 ± 0.84*	85.69 ± 4.65*	6.98 ± 2.02	5.76 ± 2.15*	3.76 ± 1.21▼	1.67 ± 0.45▼
6	33	4.15 ± 0.48	2.89 ± 0.73▼	80.24 ± 8.43▼	6.54 ± 2.03*	4.88 ± 1.87*	2.88 ± 1.27▼	1.21 ± 0.64*
Massive fibrosis	21	3.47 ± 0.59	2.38 ± 0.69	69.98 ± 12.8	4.97 ± 2.32	3.67 ± 2.21	2.12 ± 1.31	0.0.89 ± 0.44

*Compared region 4, 5 and 6 with massive fibrosis, p<0.05. *Compared region 4, 5 and 6 with massive fibrosis, p<0.05.

In general, the higher the density of small opacities, the more diffuses the lesion. Therefore, we studied the changes of pulmonary function in different density of small opacities. With the increased of the density of small opacities of silicosis,

almost every pulmonary function parameter take on a tendency of descent. But after statistical analysis, there is no significantly difference in all parameters based on different density. Only of FVC, it has statistical difference compared density 1 with density 3 ($p<0.05$). As for the average value of FEV1%, PEF, V75 and V25 of density 2 are higher than those of density 1 probably resulted by the reason that there are few cases in density 1 and it has little effect on the change tendency of the population (Table 3).

Table 3. *The relationship between the density of small opacities and the values of pulmonary function parameters in silicosis.*

Density	n	The average value of pulmonary function parameters						
		FVC (L/S)	FEV1 (L/S)	FEV1 (%)	PEF (L/S)	V75 (L/S)	V50 (L/S)	V25 (L/S)
1	8	3.76 ± 0.54*	3.05 ± 0.43	79.54 ± 6.78	6.20 ± 1.55	5.44 ± 2.21	3.54 ± 1.12	1.41 ± 0.38
2	17	3.54 ± 0.76	3.01 ± 0.62	81.78 ± 7.54	6.51 ± 2.67	5.58 ± 2.14	3.56 ± 1.24	1.47 ± 0.55
3	29	3.33 ± 0.75	2.71 ± 0.40	86.12 ± 7.17	6.21 ± 1.43	4.98 ± 1.89	2.88 ± 0.86	1.23 ± 0.43

*Compared density 1 with density 3, $p<0.05$.

Arguably, different small opacities classes on lung function effects should not be the same. We speculate that with the increase of small opacities diameter, lung function damage should also be increased. From the follow Table 4, the values are decreased gradually with the increased of the diameter of small opacities in every pulmonary function parameter, but have no statistical difference ($p>0.05$).

Table 4. *The relationship between the small opacities classes and the values of pulmonary function parameters in silicosis.*

Classes	n	The average value of pulmonary function parameters						
		FVC (L/S)	FVC (L/S)	FVC (L/S)	FVC (L/S)	FVC (L/S)	FVC (L/S)	FVC (L/S)
q	21	4.14 ± 0.33	3.01 ± 0.33	82.23 ± 6.07	6.21 ± 1.33	5.03 ± 1.32	3.41 ± 0.88	1.29 ± 0.44
r	36	4.36 ± 0.56	3.11 ± 0.54	80.31 ± 7.56	6.55 ± 2.21	5.46 ± 2.23	3.13 ± 1.12	1.32 ± 0.54

Discussion

Molybdenum is a kind of rare metal. The sixty five patients select for this paper come from one of China's largest molybdenum mines, where the mining and processing of molybdenum have become the most important growth driver for the local economy, majority of the local residents are thereby involved in the rock-digging work inside the well. The content of silicon in the rock layer of the concerned region ranges from 40% to 50%; meanwhile, the bad production environment along with the poor protection measures all contribute to the high incidence, fast development as well as severity of silicosis, as is rarely seen nationwide. Silicosis always attacks workers after their 5 to 10 years of rock-digging work. The chest radiograph indicates that the lungs are permeated by small opacities classes, the shape is mainly classes r, followed by classes q, without classes p; density is mainly grade 3, grade 2 and grade 1 account for a very small proportion; six lung regions are usually attacked, some patients have massive fibrosis of silicosis, in a distinctive form of "snow flake".

The examination of pulmonary function is designed to objectively reflect the functions of lungs without any hurt, to discover any damage to respiratory system at early stage and to conduct clinical analysis, observation of curative effect, appraisal of work ability as well as professional epidemiology study. Pulmonary dysfunction was found to be associated with silicosis and to increase in proportion with the degree of silicotic nodule profusion. The average value of the lungs function obtained from this group of patients is obviously lower than those of the controlled group. Because there is an association between silica exposure levels above the allowable OSHA exposure limits and pulmonary function loss in individuals without silicosis [1,5-8]. So we can believe that the dust concentration in this mine is very high although there haven't actually measurement in the working environment. In some completed studies [9-11]. FVC and FEV1 often has been investigated and decreased noticeable. Ooi et al. even confirmed that progressive massive fibrosis was significant determinants of FEV1 [12]. And silicosis found at autopsy was associated with lung function impairment [13]. In this study, other parameters besides FVC and FEV1 have been also decreased of silicosis, especially in FEV1, V75, V50 and V25. Therefore, various parameters shall be taken into consideration when applying FVC% and FEV1% to determine whether or not the patients have been attacked by respiratory difficulties. But determination of the specific limit value; however, shall be supported by much more epidemiology study information and based on the patients' condition.

Another notable point is that the average value of FEV1% in category II is larger than category I, distribution of small opacities in five regions is larger than that in four lung regions and grade 2 density is bigger than grade 1 density. Reasons

behind this fact maybe that VC of the former drops more evidently, but flexibility and retraction of lungs are not reduced, so majority of VC is breathed out within one second, thus leading to abnormal rise in FEV1%. Someone else suggest that it may be due to building of muscles in this job [14]. The facts agree with the pathological and physiological features of silicosis.

Just early, someone have a suggestion that impaired lung function with silicosis is due to progressive massive fibrosis [15]. As indicated in this study, once the massive fibrosis attacks the silicosis patients, various parameters of lung function shall decrease evidently Even compared with the six lung regions affected patients, their parameters are still sharply different in terms of statistics, particularly in FEV1, V75, V50 and V25. The four indicators reflect the obstruction condition of upper and lower respiratory, respectively. Through the investigation, the whole respiratory system, thereby, of silicosis patients at later stage is believed to be damaged to various extents.

As we all know, with the increase of silicosis stage, the incidence percentage of pulmonary function damage and mixed respiratory difficulties increased evidently as well. Combined with this study, the difference in terms of small opacities classes, density and number of regions affected are not result in evident difference in abnormality of lung function. So we think that respiratory function evaluation of silicosis patients shall be comprehensively assessment based on the silicosis stage, type of lung damage as well as damage degree. The small opacities classes, density and distribution scope is the marker by which the silicosis stage determined they cannot serve as the single indicators for evaluation of the respiratory function.

As reported by recent documents, there are new opinions. Tiwari demonstrated that HRCT were better in diagnosing dust-related interstitial lung fibrosis compared to chest radiographs. Computed Tomography (CT), especially High-Resolution CT (HRCT), plays a very important role in determining the diagnosis of respiratory diseases such as pneumoconiosis [16]. The experts developed the International Classification of HRCT for Occupational and Environmental Respiratory Diseases (ICOERD) [17]. And Berk et al. [18] suggested that HRCT can be considered a useful support to conventional chest radiography. So we propose if we can formulate series diagnosis standard films of computed tomography to use in the future.

Conclusion

In this study, we analysed the characteristic changes of chest X-ray changes and pulmonary function in patients with molybdenum silicosis and trying to find the relationship between the change of chest X-ray and lung function parameters. To sum up, it is difficult to accurately determine the pulmonary function of pneumoconiosis patients only with the change of chest radiograph, but the comprehensive analysis of the parameters can be used to understand the changes of lung function in patients with pneumoconiosis. For chest X-ray changes, can only say that the development of massive fibrosis can be inferred that there may be adverse effects on lung function and more evidences are needed to confirm the conclusion.

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