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Is Mining the Main Cause of Silicosis? Case Series

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ABSTRACT

Background: *Silicosis is an irreversible progressive lung disease which leads to ultimate death. This study aimed to describe characteristics of individuals affected by silicosis, evaluate the prevalence of silicosis in miners and also introduce preventive policies.*

Materials and Methods: *Cases with pathologic diagnosis of silicosis were retrieved from archive of pathology department of national research institute of tuberculosis and lung disease (NRITLD) during 2000-2009. All hematoxylin and eosin stained slides were reviewed by two pathologists independent of clinical and imaging findings. Occupational history, clinical information, imaging findings, history of associated disease, method of biopsy and pathologic diagnosis were reviewed.*

Results: *During 2000 and 2009, 29 cases had pathologic diagnosis of silicosis, 4 of them were excluded due to unavailable occupational history. The disease presented among patients in the age range of 22-80 years. The most common occupation was sandblasting while mining was in the second position. The male patients who were miners were old except for one who was a 28-year old car painter whose previous job was mining. Most sandblasters were young except one who was 55. The most prevalent radiologic finding was pulmonary nodules. Restrictive pattern was the most common finding in pulmonary function test (PFT). Of patients, 28% had current tuberculosis. Transbronchial lung biopsy was the method of choice in 14 cases. The most prevalent pathologic finding was early silicotic nodules.*

Conclusion: *Our study demonstrated that mining was not the main occupational history in our understudy cases. We also observed the change in the age range of patients suffering from silicosis which may be due to the prevalence of sandblasting and job demands in young patients. It is recommended that protective measures be applied not only in mining industries, but also in small workshops and studios. It is also necessary that working conditions in these workplaces be evaluated regularly by the occupational safety and health administration.* ***(Tanaffos2010; 9(3): 37-43)***

Key words: *Silicosis, Case series, Mining, Sandblasting*

INTRODUCTION

The relationship between mining and lung diseases has been documented since the 1500. It was reported that dust with corrosive qualities like silica has reached and caused damage to the lungs. As time passes, industrialization of mining has led to an increased exposure to dangerous particles. Although mineworkers are exposed to multiple air born particles, exposure to silica remains as the major

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occupational health problem even after working in mine has ceased (1).

Silica or silicon dioxide (SiO_2) is the second largest and most commonly found mineral on earth. Most important forms of silica include quartz, cristobalite and tridymite. The most fibrogenic form is tridymite. Massive and intensified exposure through cutting, breaking, crushing, grinding and blasting of sandstone and rocks is very harmful to the function of human lungs. Overexposure to dust that contains crystalline silica causes damage to the lung with resultant scar tissue formation which decreases the lung capacity for oxygen delivery from the air. Silicosis, the silica related lung disease is an irreversible progressive lung disease which leads to ultimate death (1-3).

Although these lesions have been found in the lungs of Egyptian mummies (2) as a distinctive respiratory disease, it was first recognized in 1705 by Ramazzeni (Italian physician 1633-1714) who noticed sand-like substances in the lungs of stonecutters. The name silicosis comes from the Latin word “silex” or flint and is attributed to Viscontin in 1870 (4).

Three clinicopathological types have been described for silicosis. These include Chronic silicosis which is caused by inhaling dust usually containing less than 30% quartz and is measured in decades rather than years; accelerated silicosis, which happens after a shorter, heavier exposure; and acute silicosis (silicoproteinosis), which follows intense exposure to fine dust of high silica content, such as that found in sandblasting industries, for periods measured in months rather than years (2).

Because silicosis continues to be a major disease worldwide in those exposed to silica dust, and the disease is incurable, using preventable policy to reduce the exposure has a significant importance (1,5). In this article firstly we report a case of biopsy proven silicosis in the pathology department of National Research Institute of Tuberculosis and Lung Disease (NRITLD), Masih Daneshvari Hospital, between 2000 and 2009 and then discuss the preventive policies.

MATERIALS AND METHODS

In this retrospective study, all biopsy specimens with a diagnosis of silicosis, silicotuberculosis and silicoproteinosis, were retrieved from the pathology archive during 2000-2009. The ethics committee of the NRITLD approved this study to investigate the archival slides. All Hematoxylin & Eosin stained slides were reviewed by two pathologists independent of previous pathologic reports. Occupational and clinical information including symptoms, pulmonary function tests, imaging findings, history of tuberculosis and HIV infection as well as method of biopsy and pathologic diagnosis were reviewed.

RESULTS

During 10 years we had 29 biopsy specimens with pathologic diagnosis of silicosis out of them four cases were excluded due to unavailable occupational history. The remaining were 20 males (80%) and 5 females (20%), in the age range of 22-80 years.

There were 8 sandblasters and 5 miners. The remaining were 2 farmers, 2 dustmen and 5 housewives (Table 1).

Table 1. Occupations of the understudy population

Job	Number	Percent (%)
Sandblaster	8	32
Mine worker	5	20
Housewife	5	20
Farmer	2	8
Dustman	2	8
Ceramicist	2	8
Glass maker	1	4

The most prevalent complaints were cough in 13 (68%) cases, dyspnea in 12 cases, and sputum production in 7 patients. Other complaints are shown in Table 2.

Table 2. Symptoms of patients.

Symptoms	Number	Percent (%)
Cough	13	68
Dyspnea	12	63
Sputum	7	37
Loss of appetite	6	32
Chest pain	6	32
Weight loss	5	26
Fever & chills	3	16
Hemoptysis	2	10.5
Night sweating	2	10.5
Weakness	1	5
Headache	1	5

Seven patients (28%) had current TB and 2 had a previous history of treated TB. None of our patients had HIV infection.

None of our patients had current or previous history of pulmonary malignancy. One of the patients had a history of renal disease

The most prevalent radiological findings were small pulmonary nodules in 8 cases (32%), we had 3 cases of progressive massive fibrosis, and one of them also has small and large calcified mass lesions of spleen and liver. Table 3 shows the radiological findings in our patients.

Table 3. Radiological findings in patients

Radiologic Features	Number	Percent (%)
Small pulmonary nodules	8	32
Calcified nodules	3	12
Hilar lymph node enlargement	3	12
Massive fibrosis	3	12
Reticular infiltration	2	8
Others	6	24

Pulmonary function test (PFT) reports were available in only 15 cases. Nine had restrictive pattern and 6 had mixed restrictive and obstructive pattern.

Methods of biopsy included transbronchial lung biopsy (TBLB) in 14 cases, open lung biopsy in 5 cases, CT-guided lung biopsy in 3 cases, pneumonectomy in 2 cases and bronchial biopsy in 1 case.

The pathologic diagnosis in our cases was silicoanthracosis in 7 cases, silicotic nodule (hyalinized silicotic nodule) in 5 and early silicosis in 8 cases. Two cases had old hyalinized silicotic nodule associated with early silicotic nodule and 3 of our cases had accelerated (cellular) phase of silicosis associated with secondary alveolar proteinosis (Table 4).

Two patients had undergone lung transplantation.

Table 4. Pathologyic diagnosis

Pathology Diagnosis	Number	Percent (%)
Early silicosis	8	32
Silico-anthracosis	7	28
Old silicotic nodules	5	20
Accelerated silicosis + alveolar proteinosis	3	12
Old hyalinized nodule + early silicotic nodule	2	8

DISCUSSION

Silicosis is the best known occupational lung disease. It was thought that it has been mostly eliminated in developed countries, but this dust borne disease is still very common among mine workers, mill workers, sandblasters and farmers (1, 3).

In this report we had 25 biopsy-proven cases of silicosis. The disease was mainly presented among men in the age range of 22-75 yrs. The most common occupation was sandblasting. Male patients who were miners were old (over 45). The highest number of silicosis-related deaths over 45 years has reported

to be due to mining. It is well understood that this pattern of age distribution in miners is mostly attributed to lower concentration of silica in mines and that is how chronic silicosis develops (6). One characteristic of this study was that 10 of our male patients were young in the age range of 22-32 and 9 of them were sandblasters. Only one sandblaster was 55.

The age range of patients in our study was shifted to the younger age and was different from the previous studies (7). However, similar age range has also been reported among the construction workers in the United States (8, 9). High prevalence of silicosis among young individuals might be due to the higher job demand among this age group and also establishment of small sandblast workplaces. In such studios, occupational protective measures are not followed and workers are not screened for occupational diseases because the employers are usually not aware of the risk of silicosis in occupations other than mining industries. Therefore, workers in these workshops are exposed to high concentrations of silica particles without any protection.

Although the common occupation in this study was sandblasting, and this hospital is a referral center for pulmonary disease, we cannot estimate the number of individuals who suffer from silicosis or determine the prevalent occupation in the country because of the low number of our understudy cases.

The reasons for the small number of understudy patients are as follows:

1) Only cases having the biopsy samples were entered the study and those who were diagnosed based on chest X-ray or occupational screening methods were not enrolled.
2) Patients who presented to the hospital were suffering from severe forms of disease and those with milder form of disease were diagnosed as outpatient.

Five understudy patients were females who were housewives, some of them also worked at the farm. Although silicosis is still common among farmers (1, 3) domestically acquired pneumoconiosis has also been described, which is attributed to inhaling smoke from cooking fires in poorly ventilated houses (10), Exposure to outdoor dusty environments was also responsible (11). Grobbelaar reported cases of silicosis in young females (in their 20s). He suggested that heavy dust exposure was present from early age due to cooking fire (11), but female patients in our study were old (52-80 years old). In Grobbelaar report, most patients had mild radiologic abnormality while our cases had considerable radiologic changes.

The most prevalent complaints of our cases were cough and dyspnea in 13 (68%). Cough and sputum production are common symptoms and usually relate to bronchitis. Chest pain is not a feature of silicosis (5), but in our study chest pain was reported in 10 cases.

One limitation of this study was that the PFTs were not available in all patients for comparison with other studies. Meanwhile 9 of our cases had restrictive pattern and 6 had mixed restrictive and obstructive pattern. Lung function changes among patients with a history of long silica exposure are not only due to effects of exposure to dust but are also related to other concomitant factors especially smoking, which is an important determinant of lung function. Although silicosis is among restrictive lung diseases, emphysematous changes due to smoking which may associate with silicosis can produce mixed restrictive and obstructive pulmonary function test (12).

Radiologic features of chest in exposed workers are also complex and difficult for interpretation because of smoking related findings and association of tuberculosis and lung cancer (13). The most prevalent CT finding in our study was variable-sized

pulmonary nodules (26%), which is compatible with finding of Arakawa (32 out of 34 patients) (14). Antao in 2005 also found that among 41 stone carvers, the most prevalent HRCT finding after centrilobular nodular structure (68.3%) was lung nodules (56.7%) (15). We had only 3 cases who had progressive massive fibrosis, 2 of them were females.

Three of our cases, in addition to diffuse bilateral centrilobular nodules revealed ground glass opacity. These patients were sandblasters, and revealed silicoproteinosis in addition to early silicotic nodules in biopsy specimen. Silicotic nodules may develop occasionally in the liver and spleen (5). One of our cases who had progressive massive fibrosis of the lung also had calcified mass lesions of spleen and liver on CT-scan.

Individuals with silicosis are at increased risk of tuberculosis (1, 2, 5). The superimposed infection not only causes the worsening of the progression but also may impose difficulty in diagnosis (16). Overall, 28% of our patients had current TB which is higher than cases reported by Rosenman et al. in a large scale study (7). The association between silicosis and tuberculosis has long been recognized in subjects exposed to silica and is 2 to 3 fold more than those in workplaces without silica exposure. High prevalence of TB was seen in cases with silica exposure even in the absence of silicosis (1, 2, 5, 17, 18).

Although there have been a large number of cohort studies focusing on lung cancer, a meta-analysis of 17 studies of silica and lung cancer by Steenland et al. found a moderate relative risk for exposure to silica(1,2,5,6,19).We had no concomitant cancer with silicosis.

Because the silicotic nodules are centri-acinar (2), they are best accessible by TBLB; 14% of our cases were diagnosed by this method.

The pathologic hallmark of silicosis is silicotic nodules which consist of sharply circumscribed nodule of whorled hyalinized collagen surrounded by collagen bundles at periphery (2). Five cases in our study had silicotic nodules (Figure 1) and 7 cases had anthracosilicosis (Figure 2). Eight cases had nodular aggregation of macrophages, signifying early stage of silicosis. Most of these patients were sandblaster. We had 3 cases of coexistent silicotic nodule with alveolar proteinosis which signify previous chronic exposure associated with recent heavy exposure to silica. Patients with extremely high exposure to very fine silica particles may develop a pattern of lung injury which clearly resembles alveolar proteinosis (2).

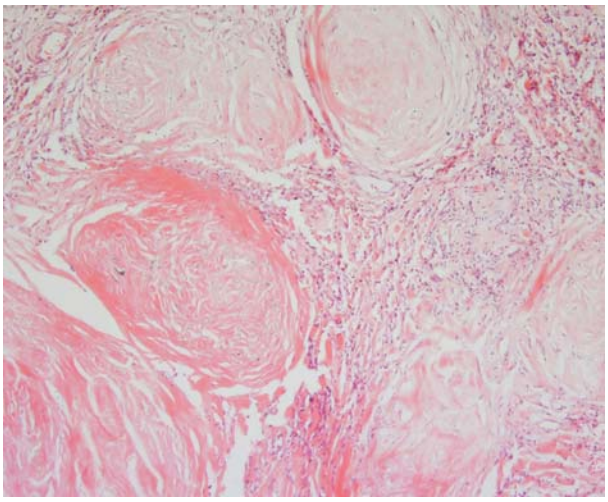

Figure 1. Microscopic examination showed silicotic nodules.

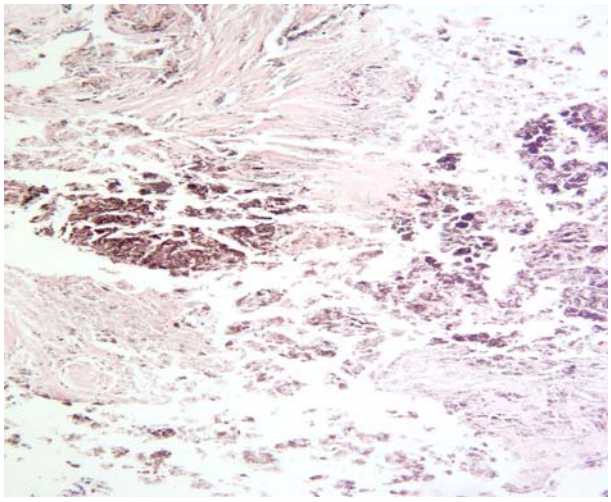

Figure 2. Microscopic examination showed anthracosilicosis.

One of our patients had a history of renal disease. Although his renal disease was attributed to tuberculosis, there is no definite document in the history of the patient to approve this diagnosis. In the last 10 years several studies have suggested that crystalline silica is linked with renal disease (19). Five cohort studies have shown 2-3 fold increase in the prevalence of renal disease among silica-exposed workers. Overall, the evidence is not conclusive (1).

Because there is no specific therapy for silicosis, the important aspect of the management of silicosis is prevention. It is necessary to set up effective preventive strategy to provide better quality of life for employees (1, 5, 18). The prevention policy should include training programs, managing of dust control, and medical surveillances (18). The silicotic particles should be kept to an acceptable minimum level in workplaces (16). Employers must set up a good ventilation system that provides negative pressure. Using wet method is less hazardous than dry one (3).

It is necessary to ensure that ventilation does not exhaust the general environment (20). Monitoring and quantitative evaluation of air borne dust and comparing it to adopted standard measures and also evaluation of the effectiveness of control policies are all important (18, 20, 21).

The workers should be trained to use warning signs and avoid eating and drinking or using tobacco products in work areas. They also should be trained to wash their hand and face before eating or drinking. It is advised that medical examination should be performed for all workers before being placed in jobs with dust exposure and medical examination should be conducted every 3 years till death, regardless of whether the worker still works in a silica-exposed workplace or not (17, 18). Management of all forms of silicosis should also be directed to control of MTB. All subjects with silicosis should have a tuberculin test (1, 3, 5, 18, 21, 22)

CONCLUSION

Our study demonstrated that mining was not the main occupational history in the studied cases. We also observed the change in the age range of patients suffering from silicosis which may be due to prevalence of sandblasting and job demands in younger ages. It is recommended that protective measures be applied not only in mining industries, but also in small workshops and studios. It is also necessary that working conditions in these workplaces be evaluated regularly by the occupational safety and health administration.

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