Histopathological Changes in Lungs Associated with Long-Term Exposure to Biomass: A Case Report

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INTRODUCTION

Pneumoconiosis is a general term used for dust accumulation in the lungs and non-neoplastic tissue reaction which evolves in response. The causative agents are most commonly inorganic substances. As exposure to biomass involves the inhalation of mixed particles and inorganic substances, it may lead to the development of obstructive and restrictive lung diseases. Our patient was diagnosed with mixed pneumoconiosis due to a 40-year exposure to biomass.

Mixed dust pneumoconiosis is characterized by a pathological condition which consists of silica crystals and non-fibrous silicates, dust macules, mixed fibrous lesions and/or silicotic nodules.

CASE PRESENTATION

A 65-year-old female presented to the Department of Pulmonary disease with complaints of shortness of breath, cough and production of sputum. She told that she has been living in the rural area and she was exposed to biomass for 40 years. Her past medical history and family history were unremarkable. She has never smoked. Her occupational and environmental history revealed that she was a housewife, the walls of her house were not painted with white soil and she denied feeding pigeons and birds. As the patient was initially followed up in another institution, we were not able to obtain the previous pulmonary function tests, blood gas analysis, chest X-rays and computed tomography.

After obtaining consent from the patient, the patient underwent transbronchial lung biopsy and bronchial lavage from the right lung in our department. No atypical cells were detected in bronchoalveolar lavage and there were 90% alveolar macrophages and 10% lymphocytes. Transbronchial biopsy specimen showed collections of histiocytic cells forming accumulations and nodules at various sizes in the lung parenchyma. Anthracotic pigmentation and various-sized fragmented particles compatible with inorganic inclusion was observed in the cytoplasm of histiocytes. These particles exhibited birefringence under polarized light. In order to avoid missing a malignancy, one month later, wedge biopsies were taken from the posterior segment of the upper lobe and superior segment of the lower lobe of the right lung. Macroscopic assessment of the sliced tissues revealed a large number of nodules with the largest being 0.3 cm in diameter. Histological assessment under low magnification demonstrated a large number of different sized nodular formations (Figure 1). Similar to the transbronchial biopsy findings, the nodules consisted of, to a large extent, macrophages containing brown-black pigment and fusiform shaped crystal-like bodies and, to a lesser extent, fibroblasts and collagen fibres (Figure 2). The nodules had a stellate (medusa head) configuration and they were in centriacinar position with irregular borders having irregular extensions towards the normal lung parenchyma (Figure 3). Visceral pleura was infiltrated by
pigment containing macrophages and fibroblasts. The crystal bodies showed varying degrees of birefringence under polarized light. According to the clinical and pathological findings, the patient was diagnosed as having mixed dust pneumoconiosis (anthracosis and silicate/silica).

**DISCUSSION**

Approximately 3 million people worldwide use biomass as an energy source for cooking and heating. Biomass may be comprised of wood, crop residues, fertilizers and agriculture products (1). Biomass is comprised of mixed particulates and gases including carbon monoxide (CO), nitric oxide (NO), sulphur oxide (SO), formaldehyde, benzopyrene, free radicals and chloride containing organics [1,2]. Exposure to biomass results in various systemic diseases and an increased tendency to diseases, including cataract, chronic obstructive lung diseases, tuberculosis and lung cancer.

Depending on the intensity of the inhaled particles, fibrous minerals, smokes and organic substances, acute and chronic effects may occur. Exposure to biomass causes obstructive and restrictive changes in the lungs. Dogan et al. reported in their study on mice that they observed perivascular and peribronchial inflammation, parenchymal infiltration and fibrosis, nodular aggregates, alveolar destruction, and emphysematous changes in the lungs of mice exposed to biomass (2). Ozbay et al. [3] reported parenchymal, peribronchial and perivasular inflammation, parenchymal fibrosis and premalignant changes in the respiratory system. Therefore, exposure to biomass has been considered within the context of occupational interstitial lung diseases in the recent years.

The term mixed-dust pneumoconiosis was first defined by Uehlinger in 1946. Based on clinicopathologic and mineral fibre analysis, the pulmonary changes resembling mixed-dust fibrosis was defined as siderosilicosis by Stewart and Foulds in 1934. This disorder can be seen in metal miners, quarry workers, foundry workers, pottery and ceramic workers, and stonemasons [4]. Mixed dust pneumoconiosis should be differentiated from interstitial lung diseases such as usual interstitial pneumonia, eosinophilic granuloma and sarcoidosis [5]. In order to establish a clinical diagnosis of mixed dust pneumoconiosis, the condition should be differentiated from other types of pneumoconiosis such as asbestosis, coal-workers’ pneumoconiosis, berylliosis and silicate pneumoconiosis. Pathologically, dust macules of mixed dust pneumoconiosis consist of mixed dust fibrotic lesions and/or silicate nodules. The macules are non-palpable lesions and histologically contain dust laden macrophages in the interstitial area. The macules are located in the peribronchial and perivasular areas and they are patchy and reticulated. Mixed dust fibrotic lesions are palpable, irregularly contoured, stellate shaped lesions and they contain varying degrees of collagenisation. The macules and mixed dust fibrotic lesions spread throughout the lung tissue showing a pattern of diffuse interstitial fibrosis. Centriacinar emphysema may be seen around the macules and mixed dust fibrotic lesions. Silicotic nodules are acellular fibrotic nodules which contain well-developed, hard, whorled hyalinized collagen. A large number of birefringent particles may be seen under polarized light [4,6,7]. Approximately two hundred different types of particles can be seen under polarized light. One of them is quartz [8]. As dust without iron oxide and coal-carbon particles are at lower concentrations in mixed dust, lung fibrosis is milder in mixed dust pneumoconiosis than in silicosis. Progressive pulmonary tuberculosis is more common

**Figure 1.** Histiocyte-rich fibrotic nodules in the lung parenchyma (H&E x100)

**Figure 2.** The crystals mixed with black carbon and brown iron in the cytoplasm of histiocytes (H&E x200)

**Figure 3.** Centriacinar positioned and stellate shaped (medusa head) nodules (H&E x100)
in silicosis [4]. In the study of McLaughlin et al, silica rate in mixed dust mixture was <18% [4].

The macules, mixed dust fibrotic lesions and silicotic nodules may be in varying degrees and combinations. In some cases, progressive massive fibrosis and conglomerated lesions may exist. No matter whether there are silicotic nodules or massive fibrosis or not, the diagnosis of mixed dust pneumoconiosis should be made when one encounters macules or mixed dust fibrotic lesions. If the silicotic nodules are predominant in the lesion, then the diagnosis should be made as silicosis [4].

Radiographic findings of mixed dust pneumoconiosis were defined in 1980. Chest X ray findings may be normal. In mixed dust pneumoconiosis, regular contoured, small, round opacities can be seen. Large opacities may be present or not. In computed tomography one can see a network of linear or nodular opacities [9,10].

The clinical symptoms are nonspecific. The patients may present with recurrent cough and dyspnoea. Pulmonary function tests may be normal or an obstructive, restrictive or mixed pattern may be present. In the study of Hiroaki et al, according to computed tomography findings 11.5% of 243 patients with mixed dust pneumoconiosis and silicosis had chronic interstitial pneumonia. There is a lower level of decrease in pulmonary functions when compared to classical silicosis and asbestosis [4]. There is also an increased risk for cancer development depending on the time of exposure and age. Koichi et al. reported that, 19.1% out of a total of 764 autopsy cases with pneumoconiosis, except the cases with asbestosis, were accompanied by lung cancer. It was reported that silicosis was more common than mixed dust pneumoconiosis among patients with lung cancer [11,12].

Lung fibrosis is milder in mixed dust pneumoconiosis than in silicosis and rapidly progressive pulmonary tuberculosis is more common among patients with silicosis [4]. In their study on 340 autopsy cases with pneumoconiosis, excluding those with asbestosis, Taguchi et al. investigated the relationship between silicosis, mixed dust fibrosis and tuberculosis. Response to treatment varies in combined (tuberculopneumonia) and complicated (pneumoconiosis with tuberculosis) pneumoconiosis cases.

Exposure to biomass affects multiple systems. In our country, being initially diagnosed as an obstructive respiratory disorder has a role in the etiopathogenesis of chronic obstructive pulmonary disease, especially in women, and it is thought to cause serious interstitial lung diseases. We reported here the histopathologic findings of mixed dust pneumoconiosis which evolved due to exposure to biomass.

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**REFERENCES**