Hard Metal Pneumoconiosis: A Case of Giant-Cell Interstitial Pneumonitis in a Machinist

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Introduction

Pneumoconioses are a group of non-neoplastic pulmonary disorders caused by inhaled inorganic particles. Well-described forms of pneumoconiosis include those from asbestos, silica, coal dust, beryllium, and hard metals. Giant-cell interstitial pneumonia is an uncommon pneumoconiosis, usually due to exposure to hard-metal compounds, primarily cobalt and tungsten carbide. The natural course of the disease is interstitial fibrosis and accumulation of giant cells in the alveolar spaces.

In 1968, Liebow and Smith developed the original histologic classification for chronic interstitial pneumonias, including giant-cell interstitial pneumonia, usual interstitial pneumonia, desquamative interstitial pneumonia, lymphoid interstitial pneumonia, and bronchiolitis obliterans interstitial pneumonia (diffuse alveolar damage).[1] Today it is recognized that most cases of giant-cell interstitial pneumonia are secondary to hard-metal exposure, and the entity is not included in current classifications of idiopathic interstitial lung disease. We present a case of a machinist who demonstrated the diagnostic features of giant-cell interstitial pneumonia.

Case Report

A 58-year-old man of Finnish descent presented with a 2-year history of persistent dry cough and rare episodes of blood-tinged sputum. The patient is employed as a machinist; he repairs heavy paper mill equipment, and the job involves cutting and grinding various materials, in a poorly ventilated area, without respiratory protection. He has performed this type of work for most of his adult life, including at the time of this presentation. In addition, he is a weekend volunteer fireman, but has not had any recent toxic exposures. He quit smoking 35 years ago. He denied cardiac-related chest discomfort, fevers, chills, night sweats, unintentional weight loss, orthopnea, paroxysmal nocturnal dyspnea, joint tenderness or abnormalities, change in bowel habits, or hematuria.

Medical therapy prior to presentation consisted of over-the-counter cough remedies, which rarely provided relief. The serologic workup, which included antineutrophilic cytoplasmic antibodies, antinuclear antibody, creatine kinase, aldolase, complete blood count, and electrolytes, was unremarkable. The patient's rheumatoid factor was mildly elevated at 27 units. Pulmonary function tests indicated mild restrictive disease and a mild decrease in diffusion capacity.

Physical examination was notable for bibasilar crackles (right more than left) and bipedal edema. The cardiac examination was unremarkable, and there was no evidence of left or right-heart failure. There was no cyanosis, clubbing of the extremities, or lymphadenopathy. High-resolution computed tomography (HRCT, with a LightSpeed 16 scanner, GE Healthcare) showed patchy ground-glass attenuation and patchy interstitial densities, with right middle and lower lobe predominance (Fig. 1). The HRCT showed no lymphadenopathy (images not shown).

The patient gave consent for a video-assisted thoracoscopic biopsy of the right lung. Right middle and right lower lobe biopsies were obtained, and the lung parenchyma showed patchy chronic inflammatory-cell infiltrates centered predominantly around the bronchioles. Several of the bronchioles also exhibited peribronchiolar fibrosis and bronchiolar metaplasia of the adjacent alveolar septa. The peribronchiolar alveolar spaces contained tight aggregates of macrophages, which contained occasional multinucleate giant cells but did not form granulomas. Scattered

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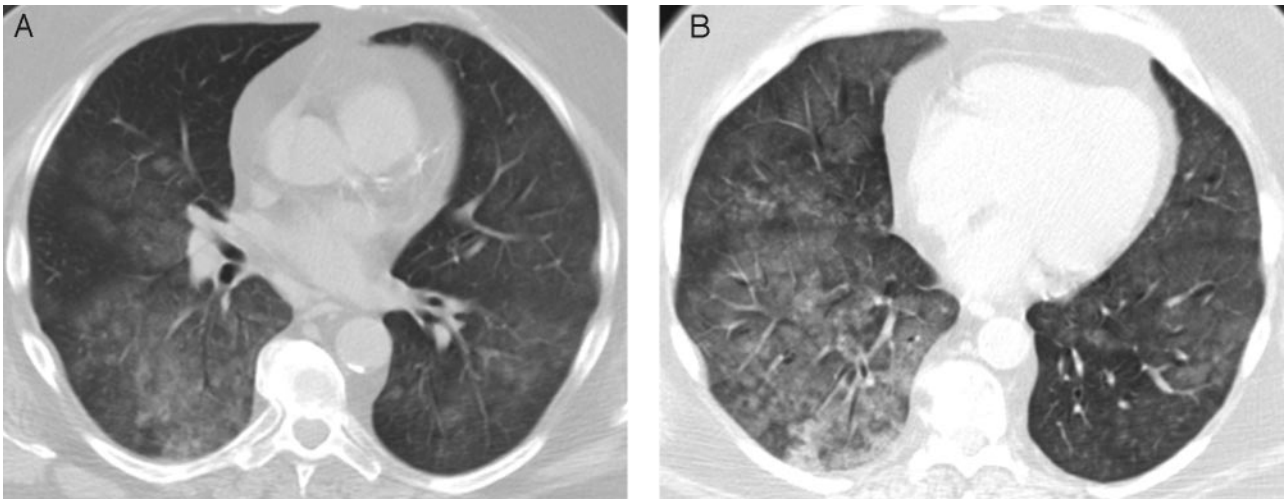

Fig. 1. Two slices from the noncontrast high-resolution computed tomogram of the chest, showing diffuse bilateral ground-glass attenuation and interstitial infiltrates associated with giant-cell interstitial pneumonitis.

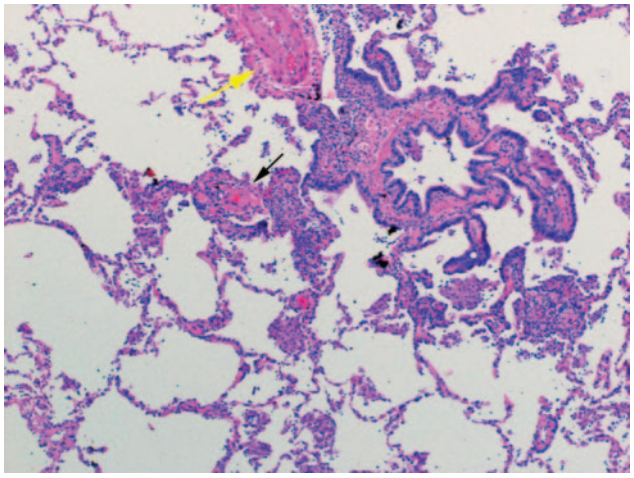

Fig. 2. Low-power micrograph of hematoxylin and eosin stained biopsy sample from a patient with giant-cell interstitial pneumonitis. There are characteristic aggregates of macrophages in the surrounding air spaces (black arrow) and fibrosis lining the interstitium (yellow arrow).

multinucleate cells were also found lining the alveolar septa in these areas. No viral cytopathic changes were seen, and no microorganisms were identified on acid-fast or fungal stains. (Fig. 2).

After the biopsy procedure the patient convalesced for nearly one month, during which time he did not work. After the diagnosis of giant-cell interstitial pneumonitis was made, he was started on a course of steroid therapy, which substantially improved his symptoms within 2 weeks. At that time an HRCT showed substantial improvement in the ground-glass attenuation. On further inquiry regarding the patient's occupational environment, we were informed that the tools and materials that he normally used contained cobalt, and during a typical work day he cuts and grinds these cobalt-containing materials.

The patient returned to work at his usual job almost a month after the biopsy. Within 2 months, he had worsening symptoms of increased dyspnea and cough, despite continued steroid therapy. A repeat HRCT at this time showed increased ground-glass attenuation, similar to that of his initial examination. Despite warnings of probable progression of the disease, the patient refused to stop work because of financial concerns. The patient suffered a work-related wrist injury and was disabled for more than 2 months, during which his symptoms improved, his steroid regimen was tapered, and his HRCT findings began to normalize.

Discussion

In 2002, the American Thoracic Society and the European Respiratory Society adopted a consensus statement that redefined the criteria and classification of the idiopathic interstitial pneumonias.[1] The original classification proposed by Liebow et al[2] in 1968 was modified, and giant-cell interstitial pneumonia was removed from the original classification of idiopathic interstitial pneumonias.[2] It is now considered to be a hard-metal pneumoconiosis.[2]

Production and application of hard metal began in Germany in the 1920s,[3] where the respiratory complications were first described in the 1940s.[4] Hard metal is an alloy of tungsten carbide and a cobalt matrix to which smaller amounts of titanium, nickel, chromium, niobium, vanadium, tantalum, or molybdenum are added.[5] Its extreme hardness and resistance to high temperature make hard metal ideal for oil-well drill bits, machine parts, armor plate, and jet engine exhaust ports.[6] Metallic dust particles

$< 2\ \mu m$ are a by-product of the manufacturing process, and particles of that size are ideal for alveolar deposition.[6] Animal models have demonstrated that, though cobalt alone drives the development of pulmonary fibrosis, a synergism between tungsten carbide and cobalt causes even greater harm.[6]

In 1971, Coates and Watson[7] put forth the following diagnostic framework for hard-metal disease: exposure to hard-metal dust, characteristic radiographic, clinical, and pathologic findings, and identification of hard metal in lung tissue specimens. Generally, the signs and symptoms associated with giant-cell interstitial pneumonia include shortness of breath, dyspnea on exertion, hypoxia, cough, weight loss, wheezing, and clubbing/cyanosis. Pneumothorax was reported in one case.[8] Pulmonary function tests can show either a restrictive or obstructive pattern. Carbon monoxide diffusion capacity tends to be reduced.[3] Grinding, cutting, shaping, repairing, and diamond polishing of hard metals are among the more common occupational hazards.[3]

Choi et al[9] and Akira[10] attempted to correlate HRCT findings with histopathology specimens, but both those studies were limited by small sample size. In the study by Choi et al,[9] plain film radiographs generally showed bilateral patchy ground-glass plus reticular densities. On HRCT, all 4 study participants showed bilateral ground-glass opacities and irregular linear opacities.[9] Other isolated findings included honeycombing, centrilobular nodules, and emphysema. Correlative histopathology in areas where there were ground-glass and irregular linear opacities on HRCT revealed interstitial fibrosis with mononuclear cell infiltration predominately in the peribronchiolar interstitium, and accumulation of macrophages and multinucleate giant cells in the alveoli. Of note, pathology specimens contained hard-metal concentrations 10 times greater than those of controls. The results from the 2 subjects studied by Akira[10] were similar. Computed tomography findings were notable for air-space consolidation with traction bronchiectasis and air bronchograms.[10]

Three types of pulmonary reaction to cobalt exposure, described by Cugell et al,[11] are (1) asthmatic reactions, (2) hypersensitivity lung disease or allergic alveolitis, and (3) interstitial pulmonary fibrosis. Hypersensitivity reactions are seen in the acute phase after hard metal exposure. Early fibrosis can appear within several years, followed by honeycombing.

Ohori et al[2] reported that the earliest histopathologic manifestations of fibrosing hard-metal lung disease are bronchiolitis obliterans and bronchitis. Additional histopathology findings among Ohori's subjects included desquamative interstitial pneumonia and usual interstitial pneumonia.

In Akira's study,[10] the pathology specimens showed components of subacute fibrosing alveolitis and diffuse mural fibrosis with honeycombing. It is now recognized that the features of giant-cell interstitial pneumonia overlap with the features of desquamative interstitial pneumonia and hypersensitivity pneumonitis. The late stages of giant-cell interstitial pneumonia may resemble usual interstitial pneumonia, but lack the characteristic giant cells within alveolar spaces and lining alveolar walls, which typifies giant-cell interstitial pneumonia.

Treatment of hard-metal exposure depends on the stage of the disease. In the acute to subacute phase, such as in patients experiencing symptoms similar to asthma or hypersensitivity pneumonitis, giant-cell interstitial pneumonia is managed by preventing further exposure to hard metals (ie, work cessation) and treating with bronchodilators and inhaled corticosteroids. As fibrosis begins, systemic steroid treatment may be used. The clinical response is usually palliative; there is minimal radiographic or pulmonary-function improvement.[8,12] Lee et al[13] reported full symptomatic improvement in a gas station employee with giant-cell interstitial pneumonia. The patient was prohibited from working in the occupational hazard and received daily doses of prednisone (60 mg). After 2 months of treatment his symptoms and radiographic findings had improved.

Teaching Points

Giant-cell interstitial pneumonia is a hard-metal pneumoconiosis with characteristic imaging findings. Plain film radiographs show bilateral patchy ground-glass and reticular opacities. HRCT findings include ground-glass densities and irregular linear densities, and may also include honeycombing, nodules, consolidation, traction bronchiectasis, and emphysema. The pathology findings are variable—predominantly bronchiolocentric inflammation and fibrosis and the characteristic giant cells in the alveolar spaces and in the lining of the alveolar walls. Treatment of hard-metal exposure depends on the stage of the condition. Most importantly, symptoms dramatically improve after the patient is removed from exposure to the occupational hazard (cobalt). Steroids and bronchodilators are often used in the treatment of giant-cell interstitial pneumonia.

REFERENCES

1. American Thoracic Society; European Respiratory Society. American Thoracic Society/European Respiratory Society International Multidisciplinary Consensus Classification of the Idiopathic Interstitial Pneumonias. This joint statement of the American Thoracic Society (ATS) and the European Respiratory Society (ERS) was adopted by the ATS board of directors, June 2001 and by the ERS Executive Committee, June 2001. Am J Respir Crit Care Med 2002;165(2):277–304. *Erratum in: Am J Respir Crit Care Med 2002;166(3):426.*
2. Ohori NP, Sciurba FC, Owens GR, Hodgson MJ, Yousem SA. Gi-

ant-cell interstitial pneumonia and hard-metal pneumoconiosis: a clinicopatholgic study of four cases and review of the literature. Am J Surg Pathol 1989;13(7):581–587.
3. Parkes WR. Occupational lung disorders. Boston: Butterworths; 1982: 464,466.
4. Jobs H, Ballhausen C. Powder metallurgy as a source of dust from the medical and technical standpoint. Vertrauenarzt Krankenkasse 1940;5:142–148.
5. Cugell DW. The hard metal diseases. Clin Chest Med 1992;13(2): 269–279.
6. Sprince NL, Oliver LC, Eisen EA, Greene RE, Chamberlin RI. Cobalt exposure and lung disease in tungsten carbide production: a cross-sectional study of current workers. Am Rev Respir Dis 1988; 138(5):1220–1226.
7. Coates EO Jr, Watson JH. Diffuse interstitial lung disease in tungsten carbide workers. Ann Intern Med 1971;75(5):709–716.
8. Wahbi ZK, Arnonld AG, Taylor AJ. Hard metal lung disease and pneumothorax. Respir Med 1997;91(2):103–105.
9. Choi JW, Lee KS, Chung MP, Han J, Chung MJ, Park JS. Giant cell interstitial pneumonia: high-resolution CT and pathologic findings in four adult patients. AJR Am J Roentgenol 2005;184(1):268–272.
10. Akira M. Uncommon pneumoconiosis: CT and pathologic findings. Radiology 1995;197(2):403–409.
11. Cugell DW, Morgan WK, Perkins DG, Rubin A. The respiratory effects of cobalt. Arch Intern Med 1990;150(1):177–183.
12. Davison AG, Haslam PL, Corrin B, Coutts II, Dewar A, Riding WD, et al. Interstitial lung disease and asthma in hard-metal workers: bronchoalveolar lavage, ultrastructural, and analytical findings and results of bronchial provocation tests. Thorax 1983;38(2):119–128.
13. Lee SM, Moon CH, Oh YB, Kim HY, Ahn Y, Ko EJ, Joo JE. Giant-cell interstitial pneumonia in a gas station worker. J Korean Med Sci 1998;13(5):545–547.

A man using a grinding wheel
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