Silica-Dust-Exposed Mine Workers with Scleroderma (Systemic Sclerosis)*

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The incidence of scleroderma (systemic sclerosis) was found to be increased in a population of black men who were gold miners. Ten men with scleroderma were detected during a five-year period. The annual incidence of the disease in this population in the group aged 33 to 57 years was estimated to be 81.8 per million. All of the men with scleroderma had disturbances of pulmonary function which were not present in a control group of silica-dust-exposed men without scleroderma. Not all of the subjects with scleroderma had silicosis, but all had been occupationally exposed to silica dust. There was a significant increase in the prevalence of tuberculosis in the past in the group with scleroderma, compared with a group of men with silicosis from the same population. The nature of the association of tuberculosis with scleroderma has not been defined.

Ten patients with scleroderma (systemic sclerosis) were detected in a population of black men who were gold miners. The subjects with scleroderma have been compared with a group of men without scleroderma who have also been occupationally exposed to silica.

In 1914, Bramwell reported an association between "scleroderma" and occupations associated with silica dust; however, he thought that his patients, who were stonemasons, had developed their disease through having to hold cold chisels. It is now known that it is the exposure to respirable silica-containing dust which is associated with an increased risk of developing scleroderma. There have been reports of scleroderma in white South African gold miners, but no previous study has examined the disease in black South African gold miners. This study of scleroderma in black men who were gold miners was made because there is known to be a difference in the occurrence of scleroderma and of other disorders of the connective tissue in different ethnic groups and in different countries.

Materials and Methods

The ten subjects with scleroderma were detected during a five-year period when they presented themselves to the medical service. All of the subjects were assessed in terms of the American Rheumatism Association's criteria for systemic sclerosis (scleroderma). A chest roentgenogram and an electrocardiogram were obtained for each subject. Pulmonary function tests, including forced expiratory flow-volume curves and a single-breath diffusion test, were done (using a Morgan transfer test model A with a flow-volume differentiator). Predicted values for the tests of pulmonary function were those recommended by the American Thoracic Society. No adjustment was made to the predicted values for pulmonary function on the basis of race, in accordance with the guidelines of the American Thoracic Society. An occupational history was obtained to assess the number of years since first employment in a gold mine and the predominant occupation, which was then graded for intensity of exposure to silica-containing dust.

Men exposed to silica dust who had been randomly selected from those with features of silicosis on the routine periodic chest roentgenograms mandated by law for all gold miners and an age-matched group without silicosis were used as a control group. In this control group without scleroderma, there were 486 men in the same age range as the subjects with scleroderma. These 486 men had had chest roentgenograms read by two readers to assess the presence and extent of silicosis. The 486 men underwent the same studies of pulmonary function and occupational questionnaires as the men with scleroderma.

For the purpose of determining the incidence of scleroderma, the average number of men in the work force during the period when the men with scleroderma were detected (July 1981 to June 1986) was calculated. The members of our work force, which numbers approximately 95,000 men, do not have a ready knowledge of their age. In order to determine the proportion of the work force in the same age range as the ten subjects, we used a study of 5,000 men who were carefully interviewed concerning their age as they enrolled for new work contracts. Because 96 percent of the work force consists of migrant laborers who are continually leaving the industry and returning on new contracts, it was assumed that this group of 5,000 men returning for new contracts represented a random sample of the total working population.

Results

All of the ten subjects fulfilled the standard criteria for the diagnosis of scleroderma in that each at least had proximal scleroderma and bilateral basal pulmonary fibrosis. The ages of the ten men with scleroderma ranged from 33 to 57 years, (mean, 43 ± 7 years [± SD]). The age range of the 486 controls was the same, with a mean age of 46 ± 5 years.

The annual incidence of scleroderma in the population of black men aged 33 to 57 years was estimated to be 81.8 per million. This figure was based upon an estimated 24,450 men between 33 and 57 years of age who contributed to our working population during each of the five years of this study.
Six of the ten men with scleroderma and 328 of the 486 controls had features of silicosis on their chest roentgenograms. The mean period from the first to last year of occupational exposure to silica dust was 23.6 ± 4.9 years in the subjects and 24.8 ± 7.0 years in the controls. There was no significant difference in the intensity of dust exposure in the two groups.

The results of pulmonary function tests are summarized in Figure 1. There were significant differences in both the forced vital capacity (FVC) and the single-breath diffusing capacity for carbon monoxide (Dbs) between the subjects and the controls. The mean FVC of the subjects was 65 ± 17 percent of predicted. The FVC was less than 75 percent of predicted in eight of the ten men. The mean FVC in the control group was 93 ± 13 percent of predicted, and there was no significant difference within the group between those with and those without silicosis. Only 8 percent of the control group had an FVC of less than 75 percent of predicted. The Dbs was less than 65 percent of predicted in all of the subjects. Only 2 percent of the control group had a Dbs of less than 65 percent of predicted.

A diagnosis of tuberculosis had been made in four of the subjects at 1.5 years, 2 years, 3.5 years, and 6 years before the diagnosis of scleroderma. In three the tuberculosis was pulmonary, and in one, it was disseminated. All four had completed treatment and were considered to have been free of tuberculosis for at least ten months before the diagnosis of scleroderma.

**DISCUSSION**

This study of a group of subjects with scleroderma from a population of black men working in the gold mines in the Orange Free State in South Africa has confirmed that the incidence of the disease is increased in this working population. The annual incidence of 81.8 per million black men in the group aged 33 to 57 years is significantly increased compared with that of approximately 3.4 per million in a general population of black men of similar age (p < 0.001). The incidence in this working population might well be higher, given that no formal survey was made to detect cases of scleroderma. It is also relevant that those who were detected had presented themselves because of other diseases and not with symptoms of scleroderma. They did not complain of esophageal dysfunction nor of Raynaud's phenomenon, even when there was obvious objective evidence of these disorders. It would, therefore, appear that this population has an unusually high tolerance for these symptoms and that self-presentation is not a sensitive method for the detection of scleroderma.

In some previous reports, it was said that the changes in pulmonary function attributable to exposure to silica dust and silicosis were difficult to distinguish from those attributable to scleroderma. Through the use of a control group of silica-dust-exposed men without scleroderma, it has been possible to show that this is not true (Fig 1). The men with scleroderma have a significant (p < 0.05) reduction of vital capacity and an even more striking reduction (p < 0.001) of transfer factor (Dsb) when compared with the similarly dust-exposed control group.

There has been some uncertainty whether the increased risk for scleroderma is confined to those silica-exposed men with silicosis. In this study the chest roentgenogram of six (60 percent) of the ten subjects had the pulmonary nodular opacification of the type usually associated with silicosis. In other studies, silicosis was associated with scleroderma in 13 percent, 32 percent, and 42 percent of the silica-dust-exposed subjects. It would therefore appear that it is exposure to silica dust per se and not only silicosis which is associated with the increased risk of scleroderma.

An association between tuberculosis and scleroderma has not been noted previously, other than through the observation that isoniazid has been reported to produce arthritis and might have a relationship with scleroderma through its interference with the metabolism of serotonin. The four subjects who had had tuberculosis had received isoniazid, but treatment had been stopped for 10 to 60 months before the diagnosis of scleroderma was made. The incidence of tuberculosis in the past in this group (40 percent) is far in excess of that found in a group of 859 men with silicosis without scleroderma (12 percent; unpublished data) from the same working population (p = 0.025; Fisher's exact test). Thus, the high incidence of tuberculosis cannot be ascribed only to the silicosis associ-
ated with their scleroderma. It is known that autoimmune diseases and tuberculosis are more prevalent in subjects with silicosis. In addition, it is said that the association with autoimmune disease or with tuberculosis may cause a rapid progression of silicosis. While these interlinking events might account for the association of tuberculosis with scleroderma, it is noteworthy that none of the men with treated tuberculosis had the advanced or complicated forms of silicosis with which autoimmune disease and mycobacterial infections are most strongly associated. In fact, two had no evidence of silicosis, and the other two men had simple silicosis graded as 1/2 q/q and 1/1 q/p after 21 and 16 years of dust exposure, respectively.

In conclusion, this study has confirmed that scleroderma is an occupation-associated disorder in black men exposed to silica dust. All of the subjects had evidence of pulmonary dysfunction which has been shown to be separate from that associated with silica dust exposure with and without silicosis. An association between scleroderma and tuberculosis has been noted in this group of gold miners, but the nature of this association remains undefined.

REFERENCES