PROGRESSIVE MASSIVE FIBROSIS DEVELOPING ON A BACKGROUND OF MINIMAL SIMPLE COAL WORKERS' PNEUMOCONIOSIS

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ABSTRACT

Recent British data suggest that the majority of progressive massive fibrosis (PMF) cases in coal miners develop on a background of category 0 or 1 simple pneumoconiosis. To evaluate this phenomenon in American coal miners, data from the NIOSH National Coal Study (NSCWP) and Coal Workers' X-ray Surveillance Program (CWXSP) were examined. All available 5-year film pairs on individual miners which showed PMF on the later, but not on the earlier film were studied (n=136 pairs). Readings were either the median of 3 "B" readers (NSCWP) or a single "B" reader (CWXSP). All films on each miner were reviewed in a side-by-side format with dates known by an unblinded "B" reader. Only 69 of the 136 cases were thought to be true incident cases of PMF. Of the 67 excluded cases, 26 were thought to have PMF on all films, and 11 were considered to be borderline but negative cases. Eighteen others were given other diagnoses for mass-like lesions on the chest x-ray. In the 69 confirmed cases, the prevalence of category 0, 1, 2, and 3 simple CWP on the earlier films was 14%, 43%, 33%, and 9%, respectively. These values for the PMF films were 1%, 43%, 38%, and 17%. The primary simple CWP opacity on the PMF films was: p-9%, q-20%, and r-65%. The high prevalence of "r" opacities and the rapid disease progression observed in some cases suggest that free silica over-exposure may have played an important role in PMF in this population. The results also seem to corroborate recent British data. Although further evaluation is needed, these data re-emphasize the importance of strict dust control.

INTRODUCTION

Recent British data suggest that the majority of progressive massive fibrosis (PMF) cases in coal miners develop in miners whose chest x-ray approximately 5 years previously showed category 0 or 1 simple (presumedly coal workers') pneumoconiosis.[1,2] This frequent development of PMF on a background of minimal simple coal workers' pneumoconiosis (CWP) is surprising since previous research indicates that the attack rate of PMF is near zero in those with minimal pneumoconiosis, rising rapidly in miners with the higher stages of simple CWP.[3,4] This newly described phenomenon is presumedly related at least in part to the very high prevalence of miners with minimal simple CWP in the lower dust-exposed present-day workforce. Thus the low attack rates in miners with minimal simple CWP multiplied by the very large number of miners at risk yield a substantial fraction of the total new PMF cases. However, Hurley and Jacobsen[5] have suggested from more recent data that the attack rate of PMF in working coal miners with category 1 simple pneumoconiosis may be 3 to 4 times higher than previously reported.

The existence of this phenomenon has not been clearly documented in the North American literature. Furthermore, some have questioned the reliability of the radiographic diagnosis of PMF in the absence of a background of category 2 or 3 simple pneumoconiosis and especially in miners with category 0 simple CWP.[6] This issue is obviously an important one, relating to the pathogenesis of PMF and to the effectiveness of medical surveillance as a method of prevention of PMF.

In order to evaluate this phenomenon in American coal miners, data from the National Institute for Occupational Safety and Health (NIOSH) National Study of Coal Workers' Pneumoconiosis (NSCWP), and Coal Workers' X-Ray Surveillance Program (CWXSP) were evaluated.

METHODS

Selected posterior-anterior (PA) chest x-rays from the NSCWP and CWXSP were examined. The NSCWP is a research program involving selected coal mines and miners across the country. The CWXSP is a surveillance program covering all U.S. underground coal miners. Both data bases have had four "rounds" or groupings of x-rays of U.S. coal miners taken at approximately 5-year intervals. The overall time interval ranged from 1969 to 1988. From these two files, all available film pairs in adjacent rounds on individual miners which were interpreted as showing PMF on the later, but not on the earlier film were studied (n=136 pairs). Although the NSCWP and CWXSP files contain films of over 1300 miners with PMF, the great majority of these cases have only one x-ray on file, or PMF on all available x-rays. These two programs to date have a total of 194 cases of PMF at-

tacks. Excluded from the present study were 58 cases: 37 had PMF attacks over 3 or 4 rounds (i.e., not over adjacent rounds); 6 had PMF attacks documented by 1 x-ray in each program; 2 represented disagreement between programs; and 13 had films which were involved with other studies or not located during the time of the re-readings. These x-ray readings were based on the ILO classification current at the time of the x-ray. They were the original interpretations done at the time, and were based on either the median of 3 NIOSH "B" readings (NSCWP) or a single "B" reader reading (CWXSP).[7] One additional stipulation for the NSCWP cases was that the earlier film could not be read as showing PMF by *any* reader.

All 136 x-ray pairs, along with any additional x-rays available on the 136 miners, were then reviewed in a side-by-side format with dates known by a single "B" reader. This reader (the first author) knew the purpose of the study, the fact that the x-ray sets were thought to represent incident cases of PMF, and the source of the films. However he was unaware of prior actual ILO readings, and miner tenure and job title. The 1980 ILO classification[8] and standard films were utilized in these readings. In addition to the usually recorded ILO classification data, the location, number, and calcification of PMF lesions were noted.

RESULTS

One hundred fifteen of the 136 cases came from the CWXSP, and the remaining 21 came from the NSCWP. For 54 miners (40%), PA films were available from either 3 or 4 rounds. In review, only 69 of the 136 cases were thought to be true incident cases of PMF. The reviewer's interpretation of the 67 non-incident cases of PMF is summarized in Table I. Twenty-six of the cases were thought to have PMF on both films, and 11 were considered to be borderline (showing "ax"—coalescence of small opacities) but negative cases. Eighteen others were given other diagnoses for mass-like lesions on the chest x-ray. Most were considered granulomata, either multiple or calcified solitary nodules. In 10 of these 18 cases, the abnormality was in fact present on both films. It should be noted that in 6 cases, the program readings reported a regression in PMF in a later film. As the data in Table I suggests, there seemed to be better agreement between the reviewer and the NSCWP compared to the CWXSP.

In 69 film pairs, the later film was thought to show a new abnormality consistent with PMF. These decisions were made regardless of the background of simple CWP. The new lesions regarded as PMF (Table II) were unilateral in 35

Table I
Reviewer Interpretation of Non-Incident Cases of PMF*

Review Interpretation	NSCWP++	CWXSP+	TOTAL	
A. PMF on both films	2	24	26	(39%)
B. Not PMF				
1. Ax	3	8	11	(16%)
2. No apparent PMF lesions	0	12	12	(18%)
3. Other diagnosis likely				
a. Granuloma	0	12	12	(18%)
b. Other	1	5	6	(9%)
Total	6	61	67	(100%)
Total cases in Study	21	115	136	

* Values are numbers of films (%)
++ NSCWP = National Study of Coal Workers' Pneumoconiosis
\+ CWXSP = Coal Workers' X-Ray Surveillance Program

Table II
Descriptive Aspects of Incident PMF Cases
(n = 69)

Detail	Numbers of Cases	(%)
Category A	61	(88%)
Unilateral	35	(51%)
Mid or Lower Lung Zones	6	(9%)
Calcified	0	(0%)

cases, category A in 61 cases, and calcified in no case. Subsequent films were available in 13 cases, and of these 8 showed progression to a higher PMF stage, and 6 showed progression of simple pneumoconiosis.

The prevalence of category 0, 1, 2, and 3 simple pneumoconiosis in the earlier (non-PMF) films in the 69 cases was 14%, 43%, 33%, and 9%, respectively (Table III). Three of the category 0 films were classified as negative (category 0/0) and seven were classified 0/1. The distribution in category 1 was: 1/0—8 films; 1/1—12 films, and 1/2—10 films. The prevalence of category 0, 1, 2, and 3 simple pneumoconiosis for the PMF films was 1%, 43%, 38%, and 17%, respectively. The one category 1 film was classified as 0/1.

In 9 cases, there was a progression of simple pneumoconiosis between the non-PMF and PMF films of 3 to 6 minor profusion categories. In 6 of these, "r" type small opacities predominated.

In the 67 reviewed cases which were not thought to demonstrate attacks of PMF, there was a higher prevalence of category 0 simple pneumoconiosis. The prevalence of category 0, 1, 2, and 3 simple pneumoconiosis in the earlier films was 42%, 36%, 18%, and 4%, respectively. These values for the later films were 34%, 39%, 24%, and 3%.

The type (size and shape) of small opacity in the incident PMF cases is shown in Table IV. Rounded opacities predominated, and of those, the "r" lesions were most common, occurring as the primary opacity in 69% of the PMF films.

DISCUSSION

This study has reviewed a small group of presumed incident cases of PMF in coal miners, primarily to determine the background of simple CWP present on the PMF x-ray and on a film taken approximately 5 years earlier. With the aid of side-by-side reading and using a single reader, almost half of the cases were not thought to be true PMF incident cases. There are several possible explanations for these rather surprising results. Obviously the review interpretations could be incorrect, and because of the largely unblinded nature of the reading trial, this may indeed explain at least part of the discrepancy. However, the side-by-side technique should reduce reading errors caused by variable film technique and quality.[9] It seems likely therefore, that the results can also be explained in part by the variability in detecting PMF on single films among different readers at different times. Although intuitively one might consider the accurate detection of large opacities (PMF) to be easily achieved, other research indicates this is not the case.[6,10,11] In addition, in at least some cases the disagreement was not in detecting the (often obvious) large opacity *per se*, but rather in interpreting the large opacity as being "consistent with pneumoconiosis."[8] These findings have several practical implications regarding x-ray reading format that are being further evaluated.

The high prevalence of category 0 and 1 simple CWP on the 69 incident PMF x-rays, and on films taken approximately 5 years earlier (Table III), seems to corroborate recent British reports.[1,2] However, one must hasten to point out that none of the PMF cases have been confirmed pathologically. Thus other diagnoses including tumor and tuberculosis are possible. Especially in cases with no background of simple CWP, many would argue that ascribing a large opacity to PMF is going beyond the ILO General Instructions to record appearances that *might* be due to pneumoconiosis.[8] The NIOSH Study Syllabus, prepared by the American College of Radiology, for example, illustrates a lung mass as a carcinoma, stating, "Do not confuse this with a large opacity of pneumoconiosis. There is not a background of small opacities."[12] In 13 cases, the availability of subsequent films made the former alternative somewhat less likely however. On the other hand, the presence of a background of simple pneumoconiosis does not guarantee that a large lesion is PMF. Unfortunately,

Table III

Major Profusion Category of Simple Pneumoconiosis in Incident PMF Cases* (n = 69)

Major Profusion Category of Simple Pneumoconiosis	Earlier (non-PMF) Film		PMF Film	
0	10	(14%)	1	(1%)
1	30	(43%)	30	(43%)
2	23	(33%)	26	(38%)
3	6	(9%)	12	(17%)
Total	69	(100%)	69	(100%)

* Values are numbers of films (%)

Table IV

Type (Size and Shape) of Small Opacities in Incident PMF Cases* (n = 69)

Type of Small Opacity	Earlier (non-PMF) film+		PMF Film	
	Predominant Opacity	Secondary Opacity	Predominant Opacity	Secondary Opacity
p	9 (14%)	3 (5%)	6 (9%)	5 (7%)
q	19 (29%)	24 (36%)	18 (20%)	25 (36%)
r	37 (56%)	36 (55%)	45 (65%)	35 (51%)
s		3 (5%)		1 (1%)
t	1 (1%)			3 (4%)
u				
Total	66 (100%)	66 (100%)	69 (100%)	69 (100%)

* Values are number of films (%).
\+ Three films were category 0/0.

especially when unilateral as occurred in 50% of cases in this study (Table II), the lesions of PMF are not very characteristic; Parkes has noted the variability of the presentation of PMF.[13]

To confirm a diagnosis of PMF with greater certainty, one would need clinical information including longitudinal radiological follow-up, and in many cases pathological specimens. However, the British data[1,5] is strengthened by the finding of increased attack rates of PMF with increasing simple pneumoconiosis category, starting with category 0. One would not expect mass lesions of other etiologies to follow such a pattern. Unfortunately, the data in this present study is too limited for such an analysis.

Another assumption that needs to be considered is that the small opacities on the chest x-ray represent pneumoconiosis, and specifically CWP. The rapid progression of these lesions in several cases, as well as the high prevalence of "r" opacities suggest that free silica may be the important etiological agent in at least a part of this population. Further evaluation to determine job titles and dust exposure data in this cohort in continuing. It seems safe to conclude however, based on the more "classic" cases of PMF developing on a background of category 2 or 3 simple pneumoconiosis, that strict dust control remains an important issue.

It must be emphasized, however, that this is a very restricted study population. The design also excluded 37 new PMF cases which occurred over non-consecutive rounds of the NSCWP or CWXSP. In addition, it is possible that miners who knew they already had the higher categories of simple pneumoconiosis may have acted differently than miners who knew they had either no or minimal disease. More of the former group, for example may have left the industry, or refused further x-rays for various reasons. Thus the cohort selection was biased towards rapidly developing PMF cases, and perhaps towards PMF cases in those with minimal pneumoconiosis 5 years previously. Furthermore, the prevalences of simple pneumoconiosis found here should not be considered representative of all miners developing PMF, because of the selection factors and study design features discussed above.

While interesting observations on film reading technique, medical surveillance, PMF in coal miners, and dust control can be made from this small study, one must emphasize the preliminary nature of the findings. Further research is clearly needed before conclusive answers will be available.

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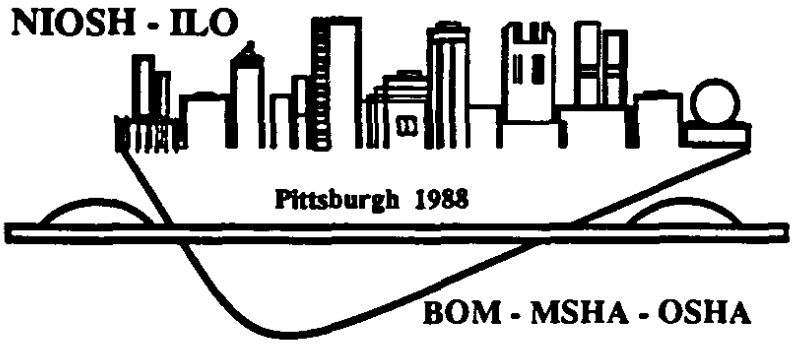

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