HYALINE PLEURAL PLAQUES AND ASBESTOS EXPOSURE

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INTRODUCTION

The importance of hyaline pleural plaques as possible markers of previous exposure to asbestos and to other mineral fibres, is now recognized.[1,2,11,12] In the present study the characteristics of pleural plaques have been analyzed in a series of necropsies, carried out in Monfalcone, Italy. The first results of this investigation have been the object of previous papers.[3-7]

MATERIALS AND METHODS

The Territory of Monfalcone is a small industrial district, in northeastern Italy, at the border with Yugoslavia. It covers an area of 152 square kilometers and has a population of 59,599 (1981 census). The Monfalcone Territory includes eight towns, the major of which are Monfalcone (30,259 inhabitants), and Ronchi dei Legionari (10,052 inhabitants).

The Monfalcone shipyard, opened at the beginning of this century (1908), is the most important industry in this area. At present about 3,000 persons are employed in the Monfalcone shipyard; but the workforce was greater in the past, having reached nearly 10,000 workers in the late 1930's.

During the period October 1979-December 1987 a total of 1,620 necropsies were performed at the Monfalcone Hospital. The necropsies were carried out by three pathologists (Claudio Bianchi, Lucia Bittesini, and Alessandro Brollo). In all the cases a careful inspection of the thoracic cavities was performed, in order to detect the presence of hyaline pleural plaques. In a large majority of the necropsies, the costal and the diaphragmatic pleuras were detached from the thoracic cavity, placed on a table, and then examined. All white, fibrous patches, calcified or not, involving parietal pleura were defined as pleural plaques. Unilateral and very small patches were also considered as hyaline plaques. The cases with pleural plaques were classified in 3 classes: (1) mild, (2) moderate, and (3) severe, on the basis of the size of plaques. Small plaques (few centimeters in major diameter) were classified as mild, while very large unilateral and bilateral plaques involving the major part of a hemithorax were defined as severe. The term moderate was applied to the intermediate conditions. In expressing the results, a simplified classification ("small" and "large") is sometimes adopted, "small" corresponding to class 1, and "large" including the remaining two classes.

In a number of cases the macroscopic features of pleural plaques were photographically documented. Moreover samples were generally obtained from the pleura for histological examination.

In all the cases a sample, measuring about 3x3x2 centimeters, was taken from the lung base and formalin fixed. The piece was taken from the right lung, or from the left base when the right was largely involved by tumor. In 464 cases the sample was completely digested in a commercial 5% sodium hypochlorite solution. Asbestos bodies were then isolated and quantitated according to the method of Smith and Naylor.[16] The results were expressed as the number of asbestos bodies per gram of dried lung tissue.

In 745 cases the patients' relatives were interviewed to obtain detailed occupational data. Generally the interviews were carried out at our laboratory by one of us (C.B.). In some cases the interviewer was another doctor of our staff, and in a few cases telephone interviews were performed. The questions concerned the various occupations of the patient, the place and the time of the activities, and the occupations of his/her relatives. When sufficient information was not obtained, further members of the family were interviewed. In many cases the "work-book" (a personal document in which all the occupations and the names of employers are listed) was consulted.

The chi-square test was used to compare the prevalence of pleural plaques among the various groups of patients. The relation between pleural plaques and asbestos body content was examined by determination of the Spearman's correlation coefficient.

RESULTS

The series consisted of 1,040 men and 580 women. Tables I and II show the sex and age distribution of pleural plaques. Between the two sexes there were significant differences in the prevalences of total plaques ($p<0.001$), small plaques ($p<0.01$), and the large plaques ($p<0.001$).

In Table III the patients are subdivided according to sex, and place of residence at death. The men resident in Monfalcone Territory more frequently showed pleural plaques ($p<0.001$) and large plaques ($p<0.01$), compared with men resident in other areas. Among women higher prevalences of total plaques ($p<0.001$) and of small plaques ($p<0.01$) were observed in Monfalcone Territory residents.

The amounts of lung asbestos bodies showed marked differences between the two sexes (Table IV). A good correlation was visible between the amount of asbestos bodies and extent of pleural plaques (Table V) ($r=0.61$, $p<0.001$).

Table I

Hyaline Pleural Plaques and Age (Men)

Age (years)	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
0 - 24	13	100.0	0.0	0.0	0.0
25 - 34	4	75.0	0.0	25.0	0.0
35 - 44	24	29.2	33.3	12.5	25.0
45 - 54	99	34.3	20.2	21.2	24.2
55 - 64	209	31.6	26.8	19.1	22.5
65 - 74	327	27.5	24.8	24.8	22.9
75 - 84	305	26.2	23.3	28.2	22.3
85 - 94	59	37.3	22.0	22.0	18.6
Total	1040	30.3	23.9	23.6	22.2

Table II

Hyaline Pleural Plaques and Age (Women)

Age (years)	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
0 - 24	5	100.0	0.0	0.0	0.0
25 - 34	5	100.0	0.0	0.0	0.0
35 - 44	13	84.6	15.4	0.0	0.0
45 - 54	26	80.8	15.4	3.8	0.0
55 - 64	69	71.0	26.1	1.4	1.4
65 - 74	125	72.8	18.4	7.2	1.6
75 - 84	236	77.1	19.5	3.4	0.0
85 - 94	96	82.3	12.5	5.2	0.0
95 - 99	5	100.0	0.0	0.0	0.0
Total	580	77.2	18.1	4.1	0.5

Table III

Hyaline Pleural Plaques and Residence

	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
MEN					
MT Residents	872	25.8	23.6	25.5	25.1
Others	168	53.6	25.6	13.7	7.1
WOMEN					
MT Residents	468	73.9	20.5	4.9	0.6
Others	112	91.1	8.0	0.9	0.0

MT = Monfalcone Territory

Table VI shows the prevalence of pleural plaques in men classified on the basis of work history data. There were marked differences from one occupational category to another, with shipyard workers and clerks being at the two extremes. The subjects employed in industries (shipbuilding, chemical, construction, and various), showed a significantly higher prevalence of pleural plaques, compared with persons employed in agriculture ($p<0.001$), or with persons included in the remaining groups ($p<0.001$).

Among the chemical industry workers there were 18 patients, who had been employed in the sodium carbonate factory of Monfalcone; a very high prevalence of pleural plaques was observed in this subgroup, large plaques having been found in 14 cases, and small plaques in 3.

Among women a large number of patients had histories of household exposure to asbestos having cleaned the work clothes of their family members employed in shipbuilding or in the chemical industry. A double classification of the cases had therefore been adopted, according to the presence (Table VII) or the absence (Table VIII) of data indicating domestic exposure. Eight women with incomplete histories have not been included in the tables. The women exposed to asbestos at home significantly differed from the others in the prevalence of pleural plaques ($p<0.001$).

In a large majority of the cases the patients with pleural plaques and with histories of employment in the shipyard or in other industries, had begun their work before 1950. However, a small number of subjects, who had their first employment in the shipyard in the 1970's, were observed; these workers showed small plaques and widely variable amounts of lung asbestos bodies (between 100 and 200,000/g dried lung tissue).

Table IV

Asbestos Bodies Amounts in 464 Cases

AB *	MEN Cases	%	WOMEN Cases	%
0 - 1	6	1.6	4	4.4
1 - 2	16	4.3	14	15.6
2 - 3	80	21.4	37	41.1
3 - 4	108	28.9	31	34.4
4 - 5	118	31.6	3	3.3
5 - 6	40	10.7	1	1.1
6 - 7	6	1.6	0	0.0
Total	374	100.0	90	100.0

* Asbestos bodies, Log10 /g dried tissue

Table V

Hyaline Pleural Plaques and Lung Asbestos Bodies

AB *	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
0 - 1	10	60.0	40.0	0.0	0.0
1 - 2	30	60.0	26.7	13.3	0.0
2 - 3	117	41.9	37.6	15.4	5.1
3 - 4	139	28.8	18.7	25.2	27.3
4 - 5	121	7.4	11.6	33.1	47.9
5 - 6	41	0.0	9.8	26.8	63.4
6 - 7	6	16.7	0.0	0.0	83.3
Total	464	26.5	21.6	23.3	28.7

* Asbestos bodies, Log10 /g dried tissue

Table VI

Hyaline Pleural Plaques and Occupations (Men)

	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
Shipbuilding industry	141	7.1	22.0	33.3	37.6
Shipbuilding and others	217	18.4	18.9	25.8	36.9
Chemical industry	26	19.2	23.1	26.9	30.8
Sailors and dock workers	19	31.6	42.1	10.5	15.8
Various industries	46	50.0	21.7	19.6	8.7
Construction industry	33	54.5	27.3	9.1	9.1
Agriculture	26	61.5	30.8	7.7	0.0
Artisans and traders	24	66.7	25.0	8.3	0.0
Clerks	12	91.7	0.0	8.3	0.0
Other	11	63.6	27.3	0.0	9.1
Insufficient data	4	25.0	25.0	50.0	0.0
Total	559	27.4	22.0	23.4	27.2

Table VII

Hyaline Pleural Plaques and Occupations in Women with Histories of Domestic Asbestos Exposure

	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
Shipbuilding industry	9	22.2	77.8	0.0	0.0
Various industries	19	26.3	52.6	15.8	5.3
Housewives	24	33.3	54.2	12.5	0.0
Textile industry	14	50.0	35.7	14.3	0.0
Agriculture	20	55.0	30.0	15.0	0.0
Artisans and traders	18	61.1	38.9	0.0	0.0
Maids	11	63.6	27.3	9.1	0.0
Other	6	50.0	50.0	0.0	0.0
Total	121	44.6	44.6	9.9	0.8

Table VIII

Hyaline Pleural Plaques and Occupations in Women without History of Domestic Asbestos Exposure

	No. of cases	Hyaline Pleural Plaques (%) Absent	Class 1	Class 2	Class 3
Various industries	2	50.0	0.0	0.0	50.0
Clerks	6	66.7	16.7	16.7	0.0
Shipbuilding industry	10	70.0	30.0	0.0	0.0
Textile industry	4	75.0	25.0	0.0	0.0
Maids	5	80.0	20.0	0.0	0.0
Artisans and traders	8	87.5	12.5	0.0	0.0
Housewives	18	94.4	5.6	0.0	0.0
Agriculture	4	100.0	0.0	0.0	0.0
Total	57	82.5	14.0	1.8	1.8

DISCUSSION

Data on the prevalence of hyaline pleural plaques, in the general population or in specific occupational groups, are available for various regions.[1,2,6-8,11-13,15] Several studies are based on chest X-ray findings, and others on necropsy material. Since the sensitivity of X-ray examination in detected pleural plaques is low,[12] the comparisons between the two types of investigation are of limited value.

The prevalence we observed in the present series appears to be very high when compared to those found in other necropsy series.[1] The residents in the Monfalcone area seem to be particularly involved.

The marked difference in the prevalence of pleural plaques between the two sexes is a first indication that an occupational source might represent the most important cause of the plaques in our cases. This idea is strongly corroborated by occupational histories.

Some researchers[12] believe that at retirement probably nearly all the shipyard workers have pleural plaques. The present findings confirm such an opinion. In our material over 90% of the subjects, who had worked only in the shipyard, showed hyaline pleural plaques. Moreover other industries have been identified as causes of plaques. In particular, working in a sodium carbonate factory, a plant active in Monfalcone until 20 years ago, was almost constantly associated with the presence of plaques.

In clarifying the etiology of pleural plaques in the Monfalcone series, occupational data as well as the findings concerning lung asbestos content have to be considered.

A history of employment in the shipyard represents a strong indication of asbestos exposure so that pleural plaques, we found in shipyard workers, may be attributed to asbestos. As far as the majority of the other workplaces appearing in the occupational histories were concerned, we were able to ascertain that they implied an asbestos exposure. However, the meaning of some data remains uncertain. For instance pleural plaques (mostly small) have been observed in some subjects with histories of employment in agriculture. We could not ascertain the etiology of the plaques in these cases; an environmental exposure to asbestos is a possible cause, but incompleteness of the history data or the role of factors other than asbestos cannot be excluded.

Information furnished by quantitation of lung asbestos bodies supports the idea that asbestos is by far the most important cause of pleural plaques in the present series. In fact a good correlation was observed between the amount of asbestos bodies and pleural plaques. Nevertheless in several cases with histories indicative of important occupational asbestos exposure and with large pleural plaques, low numbers of asbestos bodies were found. Conversely some heavily exposed subjects showed large amounts of asbestos bodies, not associated with the presence of pleural plaques.

The low number of asbestos bodies in exposed subject may be explained by different factors, such as the clearance of asbestos fibers,[14] or individual differences in the production of asbestos bodies.[9] Moreover it should be remembered that the sensitivity of the Smith-Naylor method, the techniques used in the present investigation, has recently been questioned.[10] Concerning the absence of pleural plaques in heavily exposed persons, in our material this situation was usually associated with the presence of firm, diffuse adhesions between the visceral and parietal pleura.

CONCLUSIONS

In the Monfalcone area a consistent portion of the male population has spent some part of their life in the shipyard. Consequently it is not surprising that a very high prevalence of hyaline pleural plaques has been observed in this territory. However, the present investigation furnishes data on the intensity of asbestos exposure in the Monfalcone shipyard. Moreover other sources of asbestos exposure, before unsuspected, have been identified and the magnitude of the phenomenon "domestic asbestos exposure" in this territory has been defined. In our experience detection of pleural plaques represents a valid way of monitoring asbestos exposure.

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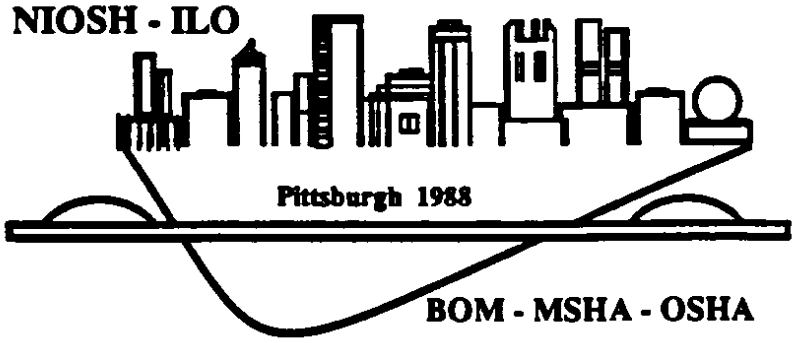
II



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