ASBESTOS RETENTION IN HUMAN RESPIRATORY TISSUES: COMPARATIVE MEASUREMENTS IN LUNG PARENCHYMA AND IN PARIETAL PLEURA

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INTRODUCTION

As has been extensively documented, the pleura is often the target organ for asbestos exposure (Zielhuis, 1977). A possible explanation could be that very active asbestos fibres are accumulated within the pleural tissues after their translocation from the lung. In order to verify this idea, asbestos fibres were assessed in pleural and parenchymal tissues from several autopsy cases.

MATERIAL AND METHODS

Asbestos fibre content was analysed in 112 samples from 29 cases, which had been sent to the laboratory by pathologists requesting confirmation of diagnosis. Lung parenchymal samples from different locations and parietal pleural samples were available for each case reported. In a few cases, mediastinal lymph nodes were also available.

The cases are listed in Table 1. Information concerning age, sex, history of asbestos exposure, pathological features and location of the collected samples was obtained from the pathologists.

Table 1. History of asbestos exposure and pathological features in 29 cases available for study

Case-number	Age	Sex	Asbestos exposure		Relevant occupation	Pathological features[a]
			Duration (yrs)	Latent period (yrs)		
1	45	F	1	26	Asbestos textile worker	LF, PF, PMD
2	61	M	29	47	Shipyard insulator	PMS
3	54	M	Undiscovered		Unskilled labourer	PE
4	71	M	Undiscovered		Unknown	PF, PE, PMD
5	50	M	17	25	Shipyard worker	PF
6	58	M	1	31	Asbestos mill worker	LF, BC, PF
7	75	M	4	59	Asbestos sheet cutter	PF, PMS
8	63	M	27	27	Asbestos cement worker	LF, PF, PMS
9	42	M	17	17	Dock labourer	PF, PMS
10	52	F	2	25	Asbestos insulator	PE
11	68	M	Occasional		Plumber	BC, PF
12	58	M	Probable		Glass maker	PF, PMS
13	63	F	9	19	Asbestos textile worker	LF, BC, PF
14	78	F	Undiscovered		Unskilled worker	PF, PMS
15	48	M	Specified		Unknown	PF, PE
16	53	M	Specified		Mason	PF, PE
17	39	F	3	23	Asbestos textile worker	LF, PF, PMD
18	43	M	5	17	Brake maintenance and repair worker	PF
19	58	M	7	45	Boiler cleaner	LF, PF, PE
20	72	M	1	45	Boiler maker	PE
21	57	M	8	36	Insulator	PF
22	70	M	Specified		Unskilled worker	BC
23	58	M	2	38	Boiler maker	BC, PE
24	64	M	12	12	Asbestos plant worker	PE
25	63	M	2	27	Asbestos sheet cutter	PF, PMS
26	64	M	37	40	Asbestos textile worker	LF, BC, PF
27	67	M	25	37	Shipyard worker	PF
28	50	M	35	35	Boiler maker	PF, PE
29	64	M	10	20	Dock labourer	PF, PMD

[a] LF = lung fibrosis; BC = bronchogenic carcinoma; PF = pleural fibrosis; PE = pleural effusion; PMD = pleural mesothelioma (definite by the mesothelioma panel within the register); PMS = suspected pleural mesothelioma (in discussion within the panel)

Fibres were individually characterized, counted and sized using a transmission electron analytical microscope (Sébastien et al., 1978).

Measurement data were computerized in order to assess the following parameters:

(1) Numerical concentration of fibres (10^5/cc of fixed tissue)
(2) Proportion attributable to amphibole type fibres (%)
(3) Mean diameter
(4) Mean length
(5) Proportion of fibres longer than 4 μm
(6) Proportion of fibres longer than 8 μm

RESULTS

Most of the fibres isolated from the tissue samples appeared as individual particles without overlapping or clumping. It was therefore possible to characterize fibres as objects with a length:diameter ratio greater than 3:1 and to size them individually (length and diameter).

Numerical concentrations of asbestos fibres in tissue

In 27/29 cases, results were significantly positive for fibres in lung parenchymal samples. Concentrations were in the range 'not detected' to 420 × 10^5/cc. On the other hand, in only 16/29 cases were results significantly positive for fibres in parietal pleural samples. Concentrations were in the range 'not detected' to 51 × 10^5/cc.

In Figure 1, a comparison is made of the maximal parenchymal and pleural concentrations when cases are ordered according to increasing parenchymal concentrations. This graph shows no evident relationship between parenchymal and pleural concentrations.

FIG. 1. NUMERICAL CONCENTRATIONS (no./cc) OF ASBESTOS FIBRES IN LUNG PARENCHYMA (■) AND PARIETAL PLEURA (●)

From Sébastien et al. (1979)

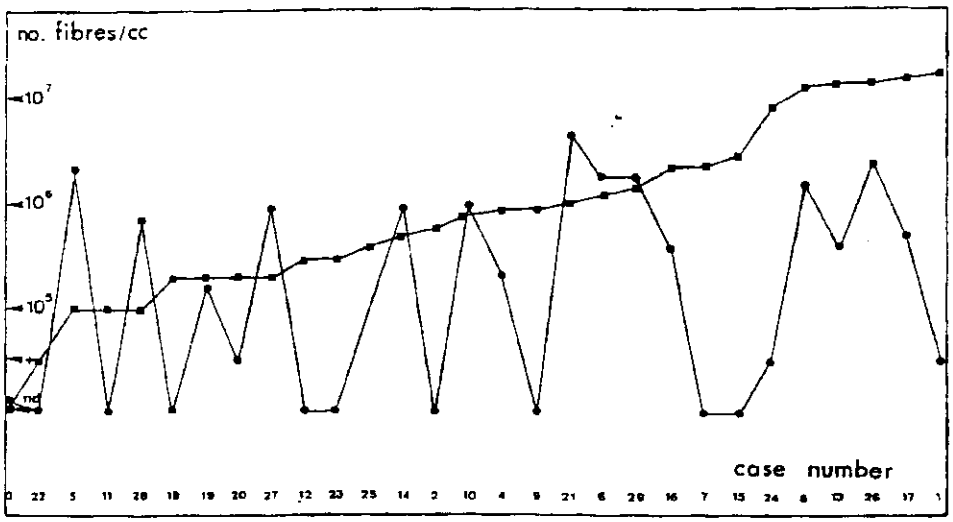

Table 2. Parameters of size distribution of asbestos fibres in lung parenchyma and parietal pleura

	Lung parenchyma	Parietal pleura
Mean length (µm)	4.9	2.3
Mean diameter (µm)	0.13	0.06
Longer than 4 µm (%)	42	16
Longer than 8 µm (%)	15	2

Table 3. Size distribution (in percent) of chrysotile-type fibres in lung parenchyma (LP) and parietal pleura (PP)

Diameter (µm) / Length (µm)	From 0.03 to 0.25		From 0.25 to 1	
	LP	PP	LP	PP
From 0.4 to 4	60	84	1	0
> 4	38	14	0	0

data clearly show the increased frequency of short fibres and the decreased frequency of long fibres from lung to pleura. It can also be seen that only a few thick chrysotile fibres, more than 0.25 µm in diameter, were observed in those lungs.

In only one case was a significant amount of amphibole-type fibre found in the pleura. The size distributions of amphibole-type fibres are given in Table 4. It is clear that, as in Table 3, with thin fibres there is an increase of short fibre and a decrease of long fibre frequencies from lung to pleura, while for fibres thicker than 0.25 µm the frequencies of short and long fibres are not significantly different.

Table 4. Size distribution (in percent) of amphibole-type fibres in lung parenchyma (LP) and parietal pleura (PP) in one case (number 26)

Diameter (µm) / Length (µm)	From 0.03 to 0.25		From 0.25 to 1	
	LP	PP	LP	PP
From 0.4 to 4	44	61	14	15
> 4	26	10	15	14

stiff amphibole fibres might pass more readily through the lung tissue from a mechanical point of view (Zielhuis, 1977). If pulmonary macrophages are also involved in this translocation (Webster, 1977), the effect of different mineral dusts (chrysotile and amphiboles) on the mechanism of phagocytosis must be considered (Miller et al., 1978).

(c) Thirdly, the presence of asbestos in non-lymphoid organs suggests that some fibres may enter the blood stream, which may be involved in their translocation. If such transportation mechanisms are type and size selective, this could be an explanation for the preferential accumulation of short chrysotile fibres in pleura.

Autopsy studies are of limited value for elucidating the history of the translocation of fibres in the respiratory tract. The retention of fibres in tissue as assessed by transmission electron microscope measurements is the result of dust retention, translocation and clearance which occurred in the past. Moreover, these biological events took place within tissues which were greatly modified by pathological changes. Thus, experimental data are required for a better understanding of the migration of fibres in the respiratory system.

(3) There seems to be general agreement that the risk of mesothelioma is related to fibre type in the following descending order: crocidolite, amosite, chrysotile, anthophyllite (Zielhuis, 1977). Moreover, some animal experiments have shown that the risk is related to fibre size, since fibres thinner than 0.25 µm and longer than 8 µm have the greatest ability to induce tumours when implanted into the pleural cavity of rats (Stanton et al., 1977). The present study shows that although such carcinogenic fibres (amphibole-type fibres longer than 8 µm) are present in lung parenchyma, in parietal pleural tissues short chrysotile fibres greatly outnumber long fibres of the amphibole type. These findings stress our poor understanding of mesothelioma induction in humans.

SUMMARY

Asbestos fibres in respiratory tissues from 29 cases diversely exposed to asbestos dusts have been characterized, sized and counted using a transmission electron microscope.

Comparison of data obtained by measurement of fibres in lung parenchyma and in parietal pleura samples showed the following:

Cette étude montre qu'on ne peut déduire les caractéristiques de rétention de l'amiante dans la plèvre pariétale des mesures effectuées dans le parenchyme pulmonaire. Si l'on se fonde sur les cas ici analysés, qui ont été exposés à des mélanges de poussières d'amiante, le chrysotile semble être la variété presque exclusivement retenue dans les tissus de la plèvre pariétale; observation dont on pourrait tenir compte pour évaluer le risque de maladies pleurales (mésothéliome notamment) imputable à chaque variété de fibre d'amiante.

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