The Incidence of Asbestos Bodies in the Lungs at Random Necropsies in Montreal

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The incidence of asbestos bodies in the lungs of adult patients selected at random, who died in four Montreal hospitals, was studied by examining fresh unstained smears of lungs obtained at necropsy. Two techniques were used for preparation of the smears and an arbitrary grading system was developed to estimate the degree of contamination of the lungs by asbestos bodies.

Asbestos bodies were present in 48 out of 100 necropsies; they were found in 32 of 56 men (57%) and in 16 of 44 women (34%). Men were more heavily contaminated. The proportion of positive smears depended on the technique used and the amount of lung sampled. No particular association was noted between asbestos bodies in the lungs and the presence of cancer in the 33 patients in this series with malignant disease. The high incidence in this random series suggests that asbestos is a significant air contaminant in Montreal.

La fréquence de la présence de particules d'amiante dans les poumons de malades adultes pris au hasard et qui sont morts dans des hôpitaux montréalais, a été étudiée en examinant des frottis frais non colorés, prélevés à l'autopsie. On a utilisé deux techniques pour la préparation des frottis et on a mis au point un système arbitraire d'échelle pour évaluer le degré de contamination des poumons par des particules d'amiante.

Ces particules ont été découvertes dans 48 autopsies sur 100; elles ont été constatées chez 32 hommes sur 56 (soit 57%) et chez 16 femmes sur 44 (soit 34%). La contamination était beaucoup plus prononcée chez les hommes que chez les femmes. La proportion de frottis positifs dépendait de la technique employée et de la grandeur du spécimen pulmonaire. On n'a mis en lumière aucune relation particulière entre les particules d'amiante dans les poumons et le cancer pulmonaire chez les 33 malades de cette série qui avaient une néoplasie. La grande fréquence de l'existence de particules d'amiante dans des cas pris au hasard permet de croire que l'amiante est une substance contaminante notable à Montréal.

THE occurrence of asbestos bodies in the lungs of patients with diffuse pleural mesothelioma has now been well documented.[1, 2] Wagner, Sleggs and Marchand[1] encountered 33 histologically proved cases of diffuse pleural mesothelioma in a four-year period in the Northwestern Cape Province, South Africa, a large asbestos-mining area. Asbestos bodies were found in eight of the 33 by sputum examination, lung biopsy or necropsy, and this was accepted as pathological evidence of asbestos exposure. In the remaining 25 cases, there was circumstantial evidence of asbestos exposure. Only one of the seven patients with mesothelioma reported by Thomson[2] from Cape Town, South Africa, had a history of asbestos exposure, but on histological examination asbestos bodies and fibrosis were found in the bases of the lungs in all cases. Following these observations, the frequency of asbestos bodies in the lungs was studied in routine necropsies in a hospital in Cape Town.[3] Since then, similar studies have been reported from Pittsburgh[4] and Miami.[5] In Pittsburgh, the incidence was 41%; in Miami, 27.9%; and in Cape Town, 26.4%. The present paper reports a similar study on the incidence of asbestos bodies in the lungs of patients who died in four hospitals in Montreal. In addition, we evaluated various sampling methods and studied the prevalence of asbestos bodies in patients with malignancy.

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MATERIALS AND METHODS

The material consisted of random adult necropsies from the Royal Victoria Hospital, the Montreal Neurological Institute, the Montreal General Hospital and St. Mary's Hospital, all in Montreal. The age, sex and occupation of the patients were determined from the hospital charts. In all cases the pathological diagnosis was recorded, and in cancers, special attention was paid to bronchogenic and gastrointestinal carcinomas.

The presence of asbestos bodies was determined by examining fresh unstained smears from the lungs. Two methods were used to prepare the smears. In the first, the "scraping" method, the whole left lung was bisected and the cut surface was scraped with the narrow edge of a 75 x 38 mm. glass slide. The material which accumulated on this narrow edge was spread by another slide. The resulting smear, which looked like a thick bone marrow film, was air dried and cover-slipped using Permount (Fisher Scientific Co.). Two to four slides were prepared from each lobe, depending upon the amount of fluid obtained, which was related to the degree of pulmonary congestion and edema. If markedly edematous lungs were left refrigerated for a few hours after cutting, the fluid diminished considerably and thicker smears were obtained. One hundred lungs were prepared in this way.

The second, the "squeezing" method, was originally used when the lung had to be preserved for subsequent inflation with formalin. The base of the lung was incised and the surrounding tissue was squeezed gently and the fluid collected on a

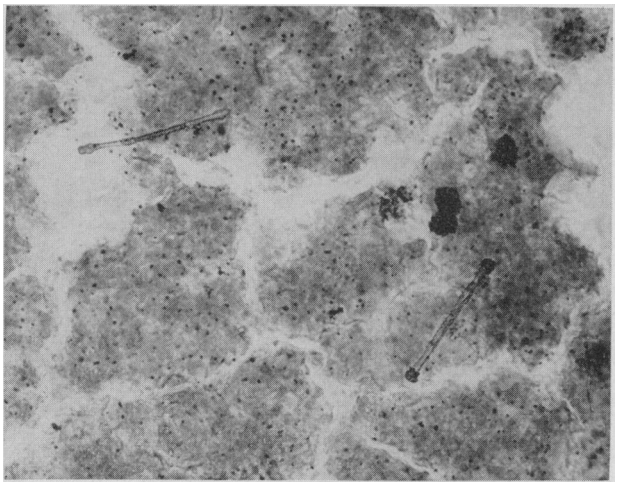

Fig. 1.—Typical asbestos bodies (unstained lung smear).

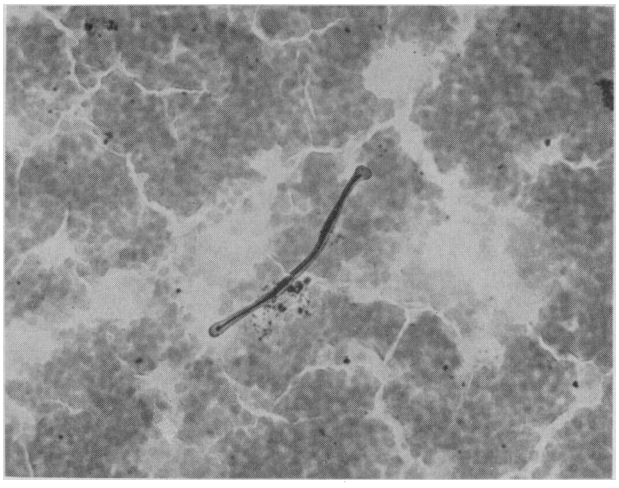

Fig. 2.—A pseudoasbestos body (unstained lung smear). Note the central black core.

slide, as in the first method. Thick even smears with one or two macrophages per low-power field were considered satisfactory. Smears showing only blood were discarded. Eighty lungs were examined by this method. In 45 patients, one lung was examined by the scraping technique, and the other by the squeezing method.

Asbestos bodies, recognized on morphologic grounds only, were identified by their typical orange-brown colour and by their segmented or beaded bodies, with club-shaped ends (Fig. 1). Only typical asbestos bodies were counted. It should be emphasized that these bodies were morphologically identical with the asbestos bodies encountered in asbestosis. All doubtful or atypical bodies or "pseudoasbestos bodies"[5, 6] were excluded. Atypical bodies, seen especially in pigmented lungs, resembled asbestos bodies in that they were linear but were jet black, and none had the orange-yellow beading of typical bodies. In addition, other "bodies" had club-shaped ends which were orange-yellow with a prominent black centre and were smooth, but did not have the segmentation seen in typical asbestos bodies. These were termed "pseudoasbestos bodies" (Fig. 2) by Thomson and Graves.[6]

The smears were examined by the method customarily used to study cytology smears using a low-power field (16 mm. objective). The following arbitrary grading system was used to estimate the degree of contamination:

Less than five asbestos bodies per slide ..... +
Average of five to 10 asbestos bodies per slide .. ++
Over 10 asbestos bodies per slide ..... +++
Average five asbestos bodies per low-power field ++++

Statistical comparison between groups was made using chi-square tables and the null hypothesis.

Finally, routine histological sections of 67 lungs from the Royal Victoria Hospital and the Montreal Neurological Institute that had been examined by the scraping method were examined for pulmonary fibrosis and asbestos bodies. The sections were stained with HPS (hematoxylin, phloxine and safranine) stain and with Perl's stain for iron.

RESULTS

Asbestos bodies were found in 48 of 100 necropsies in which smears were obtained by the scraping method. Asbestos bodies were found in 32 (57%) of the 56 males in this series, and in 16 (36%) of the 44 females. The difference is significant at less than 1 in 20 ($P < .05$). Table I shows the average number of asbestos bodies in these cases. Asbestos bodies were generally scanty. Men were more heavily contaminated than women.

TABLE I.—ASBESTOS BODIES IN MEN AND WOMEN

Asbestos bodies	*Total*	*Males*	*Females*
+.....	35	20	15
++.....	9	8	1
+++.....	3	3	—
++++.....	1	1	—

The age distribution by sex of those with positive smears ("positives") is shown in Table II, and the lobar distribution of positives is shown in Table III. Using the chi-square test, the observed difference does not reach conventional levels of

TABLE II.—INCIDENCE OF ASBESTOS BODIES BY AGE AND SEX

	Males			*Females*			*Males and females*		
Age (yrs.)	*Total*	*Positive*	*%*	*Total*	*Positive*	*%*	*Total*	*Positive*	*%*
26 - 45.....	6	2	33	4	1	25	10	3	30
46 - 65.....	23	12	52	13	6	46	36	18	50
66+.....	27	18	67	27	9	33	54	27	50

TABLE III.—THE DISTRIBUTION OF ASBESTOS BODIES IN UPPER AND LOWER LOBES

No. of left lower lobes examined	100
No. of left upper lobes examined	100
Asbestos bodies in both lobes	31
Positive in lower lobes alone	9
Positive in upper lobes alone	8
Total positive in lower lobes	40
Total positive upper lobes	39

significance (P is approximately 0.1 for either age or distribution).

Table IV shows the difference that results from using the two techniques. In the smears collected by scraping, almost twice as many cases were positive, and the difference is significant at the level of less than one in 1000 ($P < .001$).

TABLE IV.—RESULTS BY TWO DIFFERENT SAMPLING METHODS

Methods used	*Total*	*Positive for asbestos bodies*	*% positive*
Smears by scraping	100	48	48
Smears by squeezing	80	17	21

Tables V and VI show the percentage of positive smears among those with malignancy. The category "other types of cancer" includes carcinoma of the larynx, liver and testes, astrocytoma and lymphomas. In all instances the malignancy was the major cause of death. The difference is not significant at conventional levels ($P < 0.1$).

TABLE V.—INCIDENCE OF ASBESTOS BODIES IN PATIENTS WITH AND WITHOUT MALIGNANT DISEASE

				Males			*Females*		
Pathological diagnosis	*Total*	*Positive*	*%*	*Total*	*Positive*	*%*	*Total*	*Positive*	*%*
All types of cancer	33	12	36	18	10	55	15	2	13
Other diseases	67	36	54	38	22	58	29	14	48

In the histological examination of 67 lungs, referred to above, interstitial pulmonary fibrosis consistent with asbestosis was not seen. In two of these cases, asbestos bodies were found with great difficulty in routine sections stained with HPS and in sections stained with Perl's stain. There was no reaction around these bodies. No asbestos bodies could be found in the other cases even on diligent searching. Sections of the lungs in which the pseudoasbestos body shown in Fig. 2 was found, showed silicoanthrocotic nodules with fibrosis. Asbestos bodies were also found in this case.

TABLE VI.—THE INCIDENCE OF ASBESTOS BODIES BY TYPE OF MALIGNANCY

	Males		*Females*	
Types of malignancy	*Total*	*Positive*	*Total*	*Positive*
Bronchogenic carcinoma	4	2	—	—
Carcinoma of the stomach	2	—	—	—
Carcinoma of the colon	3	2	1	—
Carcinoma of the pancreas	1	—	4	—
Carcinoma of the breast	—	—	4	2
All other types of cancer	8	6	6	—
Total	18	10	15	2

Since 36 of the 56 men were "retired—previous occupation unknown" and the women were generally designated as housewives, data were not available to establish the relationship between occupation and the incidence of asbestos bodies.

DISCUSSION

In this study in Montreal, the prevalence of asbestos bodies in the lungs is high, the overall incidence being 48%. This is comparable to the findings of a survey in Pittsburgh[4] where the overall incidence was 41%. In Montreal the incidence among women (36%) is almost identical with the Pittsburgh incidence (34%). In Montreal the incidence among men is 57%, while in Pittsburgh it was 47%. Thomson[5] reported an overall incidence of 26.4% in Cape Town and a similar incidence, 27.9%, in Miami. The observed differences in incidence are probably not meaningful, since the surveys were conducted by different observers using different techniques. The smears in the Cape Town and Miami studies were obtained from the base of the lower lobe only by the scraping method.[7] Cauna, Totten and Gross,[4] on the other hand, made an incision into the lung tissue and squeezed a small quantity of blood on to a glass slide. It is quite clear that the same observer using different methods may produce different prevalence rates. This is well shown in our own study where asbestos bodies were found in 48% of lungs examined by the scraping method but in only 21.5% by the squeezing method. This difference is particularly striking since in 45 of the cases one lung was sampled by squeezing and the other by scraping. The scope of sampling within the lung also may affect the result: if only lower or upper lobes were sampled, only 39 or 40% of lungs would be positive by the scraping technique (Table III). It is also possible that if both lungs were sampled, instead of only the left lung as was done here, the incidence of asbestos bodies would have been increased.

This survey confirms the findings of others[4, 6] that asbestos bodies are more common in men than women, and that men[6] are more heavily contaminated. In our study the effect of age was inconclusive. In men there was an increase in incidence in the groups ranked according to age, but in women the intermediate age group (46-65 years) had the greatest incidence. In the series as a whole, age did not appear to affect the incidence of asbestos bodies. No real difference was noted between upper and lower lobes, in contrast to other reports[3, 5, 6] that asbestos bodies tend to be found more frequently in the bases of the lower lobes.

Unfortunately, the clinical histories were inadequate and did not permit the assessment of occupational exposure. However, one patient, whose lung smears showed +++ asbestos bodies, had worked as a steam-boiler operator for several years. Routine histological examination of his lungs showed no fibrosis. This was one of the two cases in which asbestos bodies were found on routine histological sections. In the remaining cases asbestos bodies were not found in such sections despite careful search. Since routine paraffin sections represent a very small portion of the lung, the likelihood of finding asbestos bodies is small.

In our series, there seemed to be no particular association between malignancy and the presence of asbestos bodies. This is of interest because the incidence of malignancy among asbestos workers is higher than among the general population. Hammond, Selikoff and Churg[8] in the United States have reported an increased incidence of carcinoma among asbestos workers, particularly that of the lung and gastrointestinal tract. Reports from Britain[9] also indicate that there is a significant relation between carcinoma and asbestos. However, this association was seen in surveys of people working with asbestos, such as insulation workers. Since it is unlikely that more than a very small proportion of our patients worked with asbestos, the increased incidence of malignancy noted in asbestos workers would not be apparent in our cases. It is clear, however, that asbestos bodies are not more common in patients with malignant disease in the autopsy populations we have studied, and thus casual exposure to asbestos is not an important cause of malignancy in the general population. The number of cases that we have studied is very small, and we are now conducting a survey in all patients who die of malignant disease.

For some years, Canada has been the world's largest producer of asbestos. Much of this comes from the Eastern Townships of the Province of Quebec, but important deposits are being mined in British Columbia and Newfoundland. Further developments are under way in the Yukon, North West Territories, the Ungava region of northern Quebec and northern Ontario, which already is a significant producer. Asbestos has varied and extensive uses in brake linings, electrical insulation, cement, roofing, pipe covering and numerous household articles. Industrial exposure occurs in plants where asbestos products are manufactured, and the widespread use of these products exposes a high proportion of the non-industrial population. It has been claimed[10] that chrysolite, the type of asbestos mined in Quebec, has fewer impurities—natural oils—than crocidolite and amosite fibres, the types found in South African and Australian mines. Canadian asbestos fibres may not be carcinogenic. In 1958 Braun and Truan[11] did a survey in Canada and could not demonstrate an increased incidence of cancer in asbestos workers.

Recently the relation of true asbestos bodies and "pseudoasbestos" bodies has been examined and the possibility has been raised that minerals, other than asbestos, may form asbestos bodies. According to Thomson[6] other substances may occasionally produce bodies that mimic asbestos bodies, but these must be very uncommon because such substances are rare to begin with. The only criteria used in the present study for the recognition of asbestos bodies was their morphological appearance. These bodies are the same morphologically as those in asbestosis, and are quite easy to distinguish from pseudoasbestos bodies and other atypical bodies in deeply pigmented lungs. It may be that these structures are not formed by asbestos fibres at all, although this does not appear likely at the present time. Whatever their origin or structure, asbestos bodies are common in a high proportion of cadavers in Montreal. For this reason, asbestos is probably a significant air contaminant.

SUMMARY

Asbestos bodies were found in the lungs of 48 of 100 random adult necropsies performed in four hospitals in Montreal. The proportion of positive smears depended on the technique and amount of lung sampled; this made comparison with other similar surveys difficult. Asbestos bodies were more common in men, whose lungs were also more heavily contaminated. No association was noted between the presence of asbestos bodies and death from malignant disease.

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