STUDY OF EFFECT OF DIFFERENT KIND OF SHORT ASBESTOS ON LUNG OF RATS

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Asbestos has many properties which include acid and alkali resistance, fire resistance, and ability of electric resistance which make it indispensable in modern industry. It is well known that inhalation of asbestos dust can lead to pulmonary fibrosis and carcinoma of the lung or to the development of diffuse mesothelioma of the pleura and peritoneum. But the mechanism of asbestos carcinogenesis is not clear. Some authors believe that asbestos carcinogenesis depends on chemical action. Other authors think that the physical nature of asbestos fibre is the main factor. Especially long fibre asbestos is the main reason for either fibrosis or tumors of lung. In order to elucidate hazards of short asbestos fibre, an experiment study of effects of four kinds of short asbestos on lungs of rats was observed. (Figures 1-4)

MATERIALS AND METHODS

Dust

Chrysotile and crocidolite were obtained from a Shenyang asbestos processing factory and Qingdao No. 2 asbestos processing factory respectively. Tremolite and actinolite were obtained from mining department of a college. These fibres were prepared by grinding in a ceramic ball mill. The length and diameter distribution of these fibres were obtained by phase-contrast microscopy as in Table I. Morphology of fibres was observed by electron micrograph.

Animals

Wistar rats were used. Weights of rats were 180-220g with nearly equal number of male and female rats. They were divided into 5 groups: chrysotile, crocidolite, tremolite, actinolite and saline control group. There were seventy rats in each group. All rats were injected intratracheally with 20mg dusts suspended in 1 ml saline; one month later they were injected repeatly with suspended dust of same dose. Total dose was 40 mg in each rat. Some rats were killed at the end of 2, 4, 6, 12 and 18 months respectively after the initial injection of dust. The one third rats were allowed to live out their full lifetime. The living condition of rats was observed. The body weight of rats was measured every other month. The wet and dry weight and collagen content of the lungs were determined. The lungs and hilar nodes were examined. The native death and the development of pulmonary neoplasms of the one third rats were observed.

RESULTS

The body weight of all the animals were increasing with time. There was no difference significantly among the experimental and control groups. The dry weights of lungs of rats in all groups are shown in Figure 5.

The increasing of wet weight and collagen of lungs was similar to that of dry weight of lungs, during the sixth to twelfth months after onset of injection dust. There was significant increasing of collagen in the lung. There was significant difference among experimental and control groups. The increasing of collagen in chrysotile group was the highest among the experimental groups as in Table II.

PATHOLOGY

Gross

There were a lot of small grey-white or brown-tan spots at the surface of lungs in every group, after 2-4 months of injection dust. In the crocidolite group, the spots often were grey-blue in color. There were obvious spots at the cut surface and slight pulmonary emphysema after 6-12 months. Lymph nodes in the experimental groups were larger and harder than those of control group, especially in the chrysotile group.

Microscopic Appearance

Chrysotile group: after 2-4 months, a lot of macrophages, dust cell, asbestos fibres and debris were seen in alveoli adjacent to respiratory bronchioles and there was increasing of reticulate fibre, thickness of bronchioles and arteriolas wall (Figures 6, 7). During 6-12 months, there was slight pulmonary emphysema, a few collagen fibres in the interstice (Figure 8). At the end of 18 months, these changes were similar to former. No asbestos bodies were found in the lungs. There were a few reticular fibres and dust in the lymph nodes (Figure 9).

In the tremolite and actinolite groups, pathologic changes were nearly the same and both slighter than chrysotile group (Figure 10).

Crocidilite group: Reaction of lung tissue was initially slighter than other experimental groups. Later there was also reticular fibres hyperplasia in pulmonary interstice.

At 18th months, the epithelium hyperplasia of bronchioles and alveolus in some rats was present in the crocidolite and chrysotile groups (Figure 11).

The incidence of pulmonary malignant tumor: The asbestos fibres produced pulmonary malignant tumor (the exclusion of spontaneous lymphoblastoma) in all experimental groups. No pulmonary malignant tumor happened in the control group. The first tumor was found in the chrysotile group; rat died after 15 months of injection dust. Later, two rats with cancer were found at 22 months after injection dust, two cases in the crocidolite group and one case in both tremolite and actinolite group separately, as in Table III and Figures 12, 13.

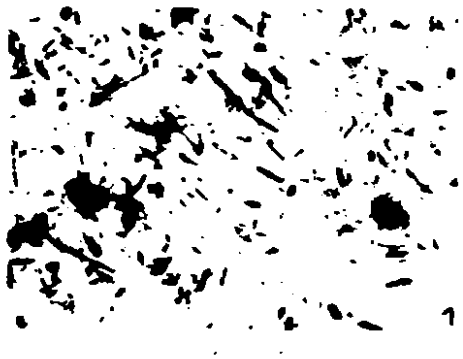

Figure 1. Electromicrograph of chrysotile (× 2500).

Figure 3. Electromicrograph of tremolite (× 2500).

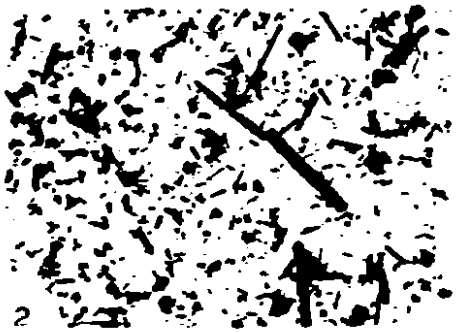

Figure 2. Electromicrograph of crocidolite (× 2500).

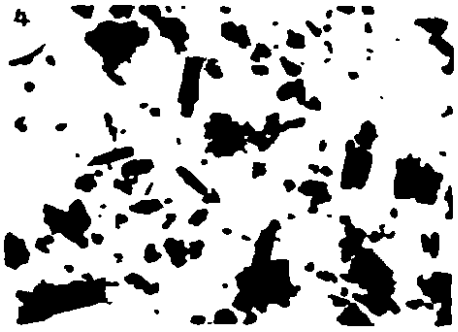

Figure 4. Electromicrograph of actinolite (× 2500).

Table I

Length and Diameter Distribution of Different Asbestos and SiO_2

Asbestos	Length of fibre(%)					Fibre in diameter (%)					SiO%
Fibre	<3	-5	-10	-20	>20	<1.2	-1.6	-2.5	-5	>5	
Chrysotile	76	15	6	2	1	100					0.31
Crocidoite	88	8	3	1	0		100				4.7
Tremolite	88	6	3	3	0	19	55	20	4	2	0.13
Actinolite	76	14	7	2	1	26	55	11	6	2	0.34

Table II

Result of Collagen Content of Lungs in Every Group

Group	2			4			6			12			18		
	No. (T P)	$\bar{X}$	S.E.	No. (T P)	$\bar{X}$	S.E.	No. (T P)	$\bar{X}$	S.E.	No. (T P)	$\bar{X}$	S.E.	No. (T P)	$\bar{X}$	S.E.
Cont	5	45.79	5.04	7	48.15	3.22	6	54.98	2.94	8	57.17	2.31	7	71.94	4.80
Chr	4	53.66	3.74	5 (2.49, <0.05)	68.40	6.40	4 (6.59, <0.001)	81.78	2.20	8 (3.08, <0.01)	80.10	1.40	7	85.86	5.10
Cro	4	35.59	2.70	6	48.64	2.33	6	55.89	3.37	8 (2.25, <0.05)	72.26	6.29	7	78.05	4.14
Tre	4	49.20	3.88	5	53.30	6.46	6	69.30	3.93	8 (2.93, <0.01)	71.20	4.21	8	77.23	5.0
Act	5	40.37	2.03	6 (2.32, <0.05)	59.78	3.64	5 (2.761, <0.05)	71.71	6.70	5 (2.396, <0.05)	78.07	10.67	6	79.10	5.18

Table III

Pathologic Type and Time of Inducing Tumor

Group	No. of Animals	No. of Pulmonary Tumors	15	17	19	21	23	25	27(Months)
Chrysotile	38	3	sq			Fibro			Adeno
Crocidolite	39	2			Adeno			Fibro	
Tremolite	40	1				Adeno			
Actinolite	35	1				sq			
Control	38	0							

Sq, Squamous cell carcinoma;
Fibro, Fibrosarcoma;
Adeno, Adenocacinoma;

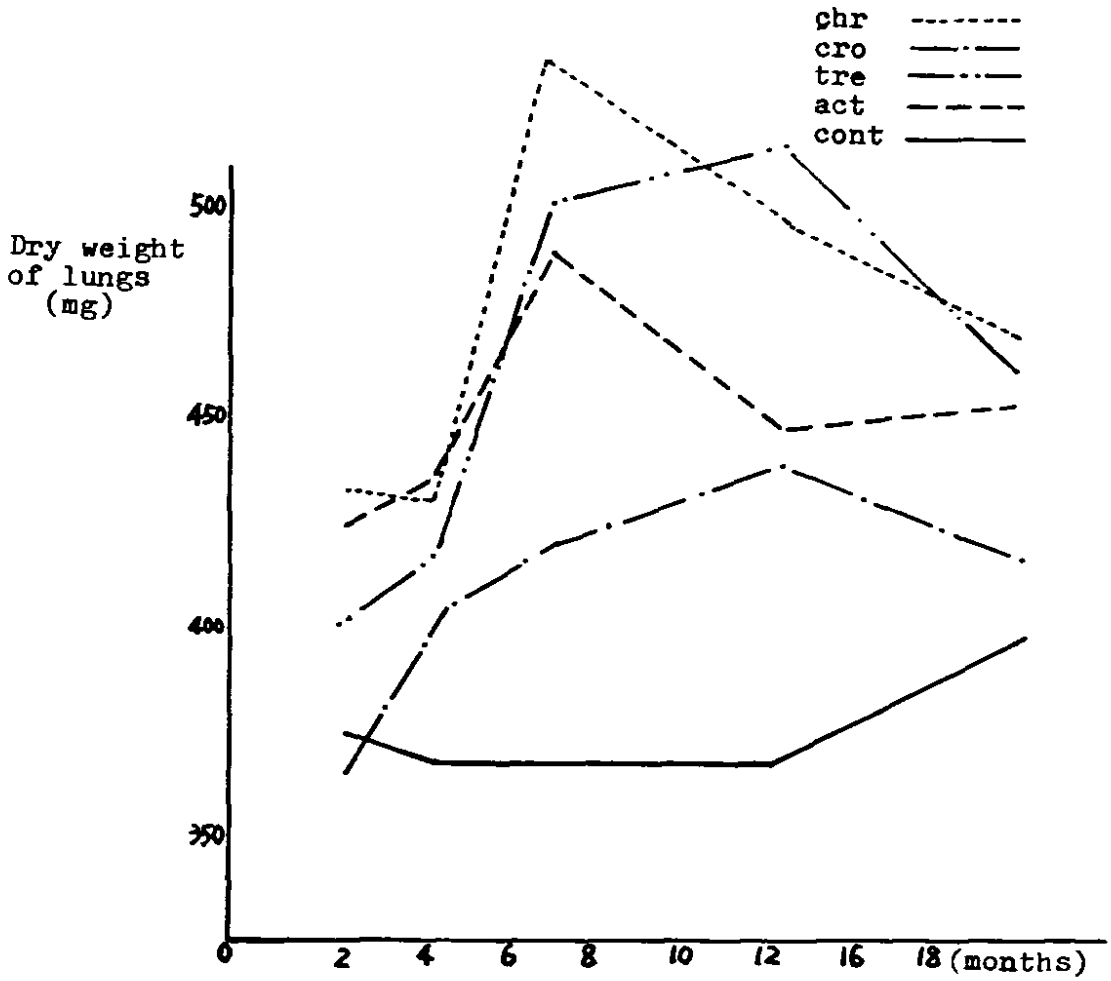

Figure 5. Changes of dry weight of lung in rats of every group.

DISCUSSION

For the different types of asbestos or the same asbestos type in different area, inhalation or injection asbestos can lead to various reaction of lung in the animal.[1,2,3] In addition inhalation of same asbestos in different kinds of animals produced also various results. All four short asbestos in the experiment produced increasing of wet and dry weight of lung in rats. A lot of reticular fibres and a few collagen were found in the pulmonary interstice. These results correspond to Fu Shao Chang's report.[4,5,6]

Inhalation of injection of asbestos fibres may produce pulmonary tumors.[7,8,9] Seven rats with lung tumors in this experiment, the first lung tumor was found in a rat that had died at the 15th month after initial injection of chrysotile fibres. Most tumors were found during 21-25 months. No cancer happened in the control group. This experiment indicated that short asbestos fibres produced not only pulmonary fibrosis but also pulmonary cancer. This result corresponds with Gross's report. Besides, epithelium hyperplasia of bronchioles and alveoli was sometimes present. There changes were not seen in the control group. It seems possible that pulmonary malignant tumors resulted from these changes.

Therefore, we hold that the effect of short fibre asbestos must be considered as recommended hygienic standard.

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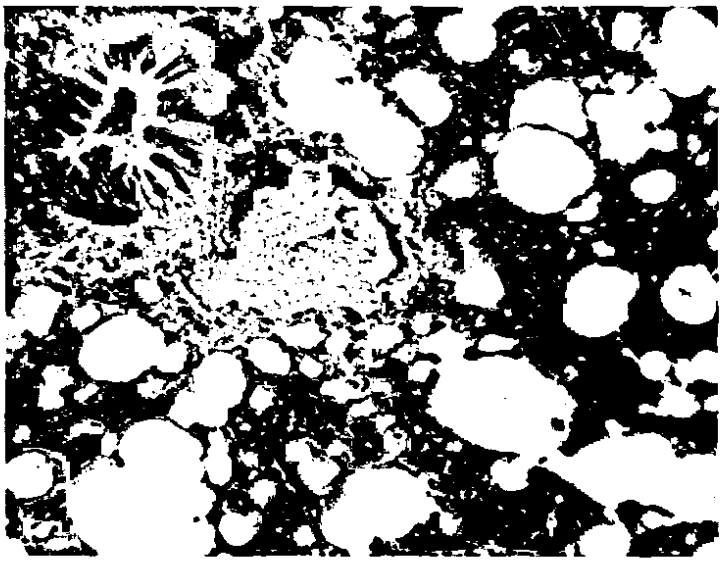

Figure 6. Chrysotile: Extensive areas of reticular fibre abutting on the terminal bronchioles and involving respiratory bronchioles. At the 2 months after injection of dust (H.E. × 78).

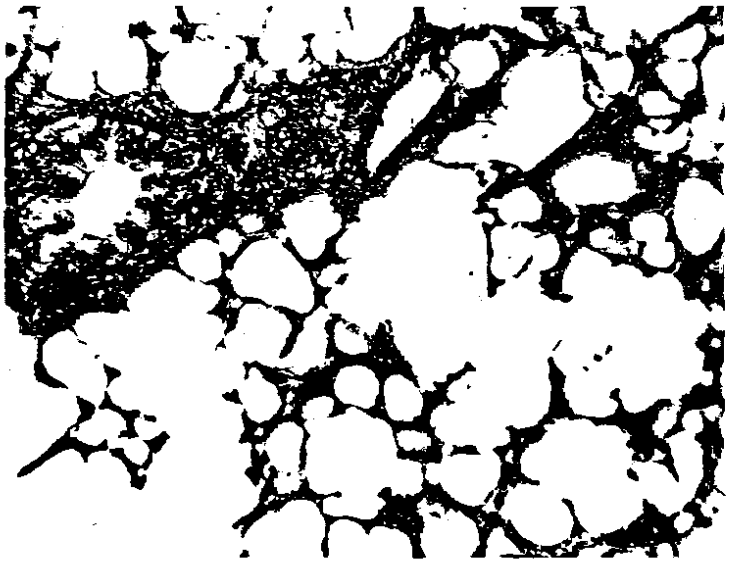

Figure 8. Chrysotile: Slight centrilobular emphysema and slight thickening of alveolar wall in different areas of the lungs. 6 months (G.S. × 78).

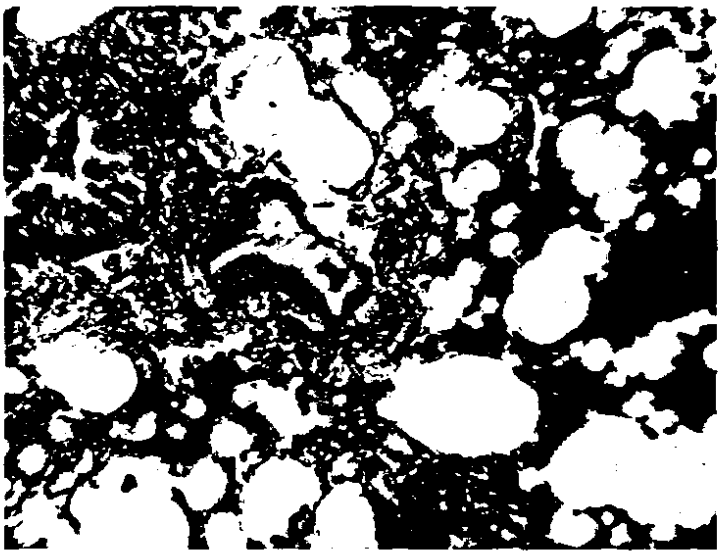

Figure 7. Bid (G.S. × 78).

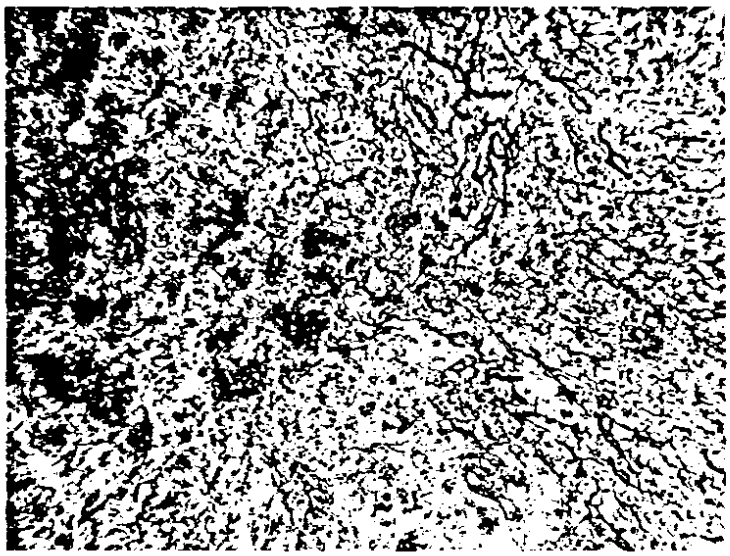

Figure 9. Chrysotile lymph node: Many more reticular fibres. 18 months (G.S. × 78).

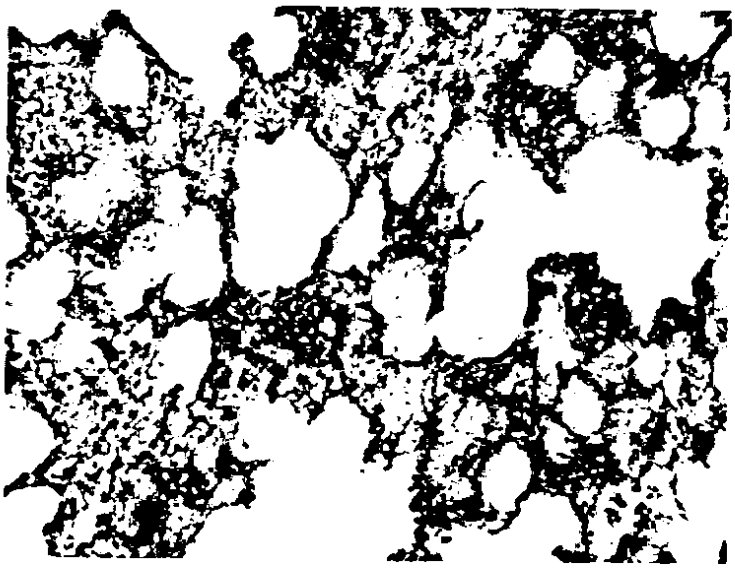

Figure 10. Tremolite: Extensive reticular fibres in pulmonary interstice. 12 months. (G.S. × 78).

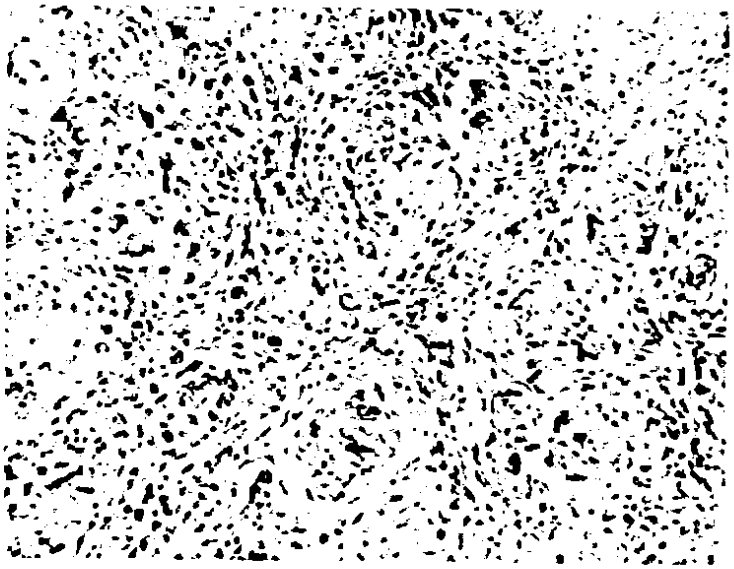

Figure 12. Chrysotile: Squamous cell carcinoma. 15 months (H.E. × 78).

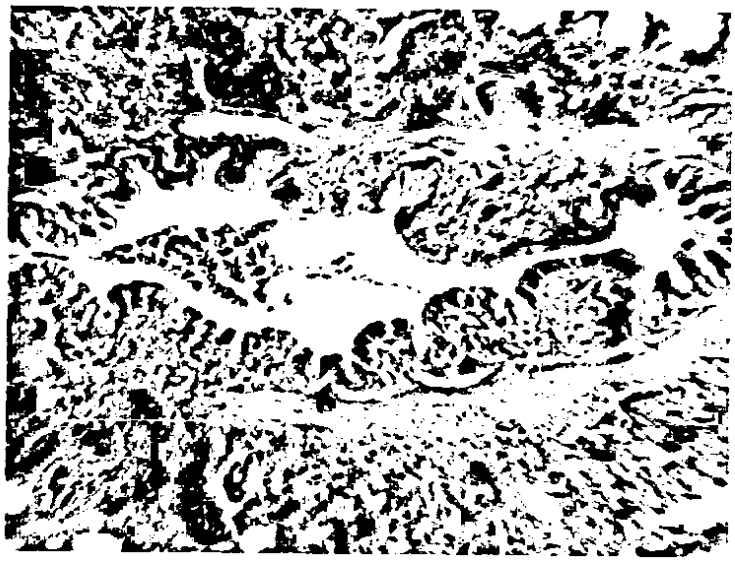

Figure 11. Chrysotile: Epithelium hyperplasia of bronchioles. 18 months (H.E. × 120).

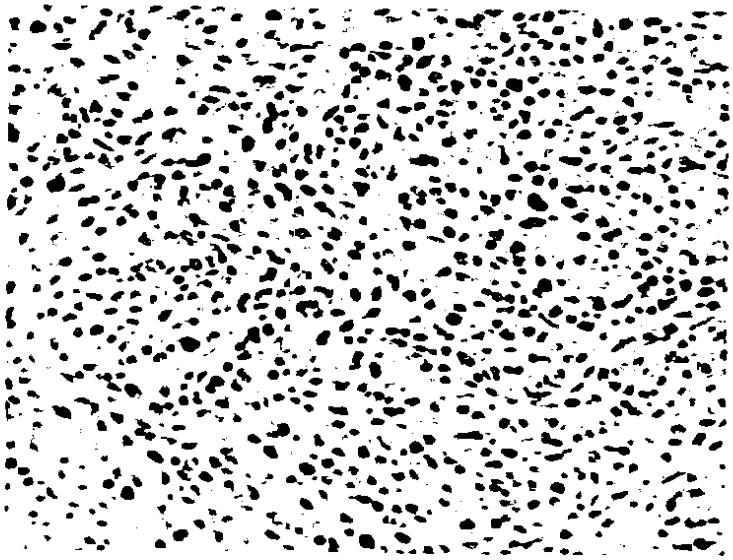

Figure 13. Chrysotile: Fibrosarcoma. 22 months (H.E. × 78).

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