EXPERIMENTAL STUDY OF FIBROSIS EFFECT OF POLYPROPYLENE AND POLYETHYLENE DUST ON RAT LUNGS

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Polypropylene and polyethylene are all high molecular compounds and typical synthetic organic substances. To research the fibrosis effect of the dust of these two organic substances, experiments have been respectively carried out on animal—the rat. 500 mg of dust was respectively injected intratracheally into each of 134 rats (half male and half female), and observations were carried out for 18 months. The results of the experiment showed that the main change of pathological histology in the early period was the granulomatosis foci caused by the dust (the polyethylene dust group showed foreign body multinuclear giant cell granuloma) and the hyperplasia of recticular fibres. 18 months after dust injection both experimental groups were found to show pronounced hyperplasia of reticular fibres inside the foci and around the bronchi and presence of collagen fibres. The content of collagen protein in the whole lungs is higher than the physiological saline control group. Therefore, the authors consider that the dust of polypropylene and polyethylene has a light fibrosis effect on the rat lungs.

INTRODUCTION

Polypropylene and polyethylene are petroleum chemical products which are high molecular compounds obtained by polymerization of propylene and ethylene. They are solid powder in milky colour without poison and odor, insoluble in water at normal temperature, acid and corrosion resistant and good in insulation. Along with their wide use and rapid increase of output, more and more workers have the chance to be in contact with the two kinds of dust in production. The report has not yet been witnessed as to whether the dust of polypropylene and that of polyethylene can cause fibrosis. In order to study the fibrosis effect of polypropylene and polyethylene dust, experiments have been made on the animal and the results are as follows.

METHOD OF EXPERIMENT

1. Preparation of dust: The fresh dust is obtained from the workshop producing polypropylene and polyethylene from a chemical fibre company. In the dust no quartz was detected by an X-ray diffractometer, and the dust was classified by a Barkhausen-Kurtz type centrifugal classifier so that 80% of the dust was of the grain size under 5 microns. The dust was then sterilized by ultraviolet rays for 2 hours. Quartz dust for control was provided by the Labour Hygiene and Occupational Disease Research Institute under the Chinese Academy of Preventive medicine.
2. Animal selection and grouping: 134 wister rats were selected and divided at random into 4 groups (polyethylene group, polypropylene group, quartz control group and physiological saline control group).
3. Dust injection into the animal: 50 mg of physiological saline suspension solution, with a small amount of tween added, was injected at a time intratracheally. Then observations were carried out in turn respectively 1, 6, 12 and 18 months after dust injection. The animal was killed with the head cut off after slight anesthesia. The right lung was kept for collagen quantitative analysis. The left lung and hilus lymphonodi, after fixation, paraffin embedding, sectioning and staining with HE, Foot and VG, was subject to observation for histopathology.

RESULTS OF EXPERIMENT

Visible by the Naked Eye

1. Quartz group: 1 month after dust injection the hilus lymphonodi were as big as a soya bean or a broad bean. The surface of the lungs were found smooth. On partial lungs of most cases were found to have milk-white sections of different area, of which the surface was full of bumps and holes and felt hard as to have sand grains. 6, 12 and 18 months after dust injection, the above changes gradually became greater.
2. Physiological saline group: During the experiment, the hilus lymphonodi were all as big as a rice grain. The surface of the lung tissues were found smooth, soft and elastic.
3. Polypropylene and polyethylene groups: 1 and 6 months after the injection of dust, the hilus lymphonodi of both groups were of rice size. The lung tissues were soft and elastic. 12 and 18 months after dust injection, the lung tissues were still soft and elastic. Some cases showed local ecchymoma and emphysema.

Visible Under Microscope

1. Quartz group: 1 month after dust injection, the hilus lymphonodi and lung tissues were found to have 4th grade fibrous tubercula around which there were slight emphysema. 6, 12 and 18 months after dust injection, all cases showed fibrous tubercula.
2. Physiological saline group: Throughout the experiment

no dust reaction was found.

3. Polypropylene and polyethylene groups: 1 month after dust injection, the hilus lymphonodi of neither group showed coniosis cell foci. Inside the lung tissues there were cell foci of different shape and size which consists of macrophages, epithelioid cells, coniosis cells and a great amount of dust particles. The polyethylene group showed that there were divergent Langhams' or foreign body giant cells in the cell foci. In the foci slight hyperplasia of reticular fibres were found. On some of the air sacs the epithelioid cells got swollen. Some of the bronchi showed hyperplasia or disappearance of epithelioid cells. 6 months after dust injection, all hilus lymphonodi were found to have a small amount of coniosis cell foci and translucent dust particles, on the surface of which there was a brown coloured layer. Inside the lung tissues there were still visible cell foci of different sizes and in the foci there are still macrophages, coniosis cells and dust particles with a brown coloured layer on the surface of the particles. Hyperplasia of reticular fibres were visible in the foci. 12 months after dust injection both groups showed foci consisting of cells as those 6 months after dust injection. But the number of foci decreased whereas the foci became bigger with clear boundaries. The polyethylene group was still found to have foreign body multinuclear giant cells. Inside the foci and in between the foci there were hyperplasia of reticular fibres. In some of them fine collagen fibres were visible. In some of the foci, pronounced hyperplasia of reticular fibres were found in between the air sacs as well as around the bronchi and around blood vessels, and collagen fibres were also visible. Bronchi of various sections got seriously harmed.

The analytical results of the collagen protein content in the whole lungs are given in Table I and Figure 1.

DISCUSSION

Polypropylene and polyethylene are all synthetic organic substances without free silicon dioxide. Different views exist as to the research of fibrosis effect of synthetic organic dust. The present experiment on the dust injected animal, through observation 1 to 18 months intervals, showed that polyethylene and polypropylene dust may cause slight hyperplasia of fibre tissues of lungs. The hyperplasia of fibre tissues is more obvious in the lung mesenchyme and around the bronchi. The tissular structure of the lungs were obviously damaged but no typical experimental nodular change was found.

The two experimental groups, polyethylene and polypropylene, showed similar pathological features and course of affection. At the early period of dust injection (1~6 months), a considerable number of granuloma changes were irregular in shape and different in size. The granulomas were rich in cells and were generally found around terminal or respiratory bronchioles. Some of the granulomas leaned against the bronchi walls. The harmed bronchi showed epitheliosis. There were secretions in the cavities and inflammatory infiltration around them. 12 to 18 months after dust injection, granuloma foci decreased. Pronounced hyperplasia of reticular fibres inside the foci and around the bronchi. Some leaned against the bronchi walls with collagen fibres inside. Normal structure of air sacs around the foci disappeared.

There were, however, slight differences between the two groups. In the granuloma foci of the polyethylene group there were divergent Langhans' or foreign body multinuclear giant cells. But in the polypropylene group such cells could hardly be seen. The cause remains to be studied.

The analysis of collagen protein content in the whole lungs tallied with the features of pathological changes.

Table I

Analytical Results of Collage Protein Content in Whole Lungs (mg)

Period of observation (month)	1		6		12		18	
	N	$\bar{X}$ + SD	N	$\bar{X}$ + SD	N	$\bar{X}$ + SD	N	$\bar{X}$ + SD
Polyethylene group	9	41.1±5.8	9	37.5±7.9	24	68.5±17.5	8	91.6±21.5
Polypropylene group	8	48.9±18.2	8	44.9±8.0	21	101.6±28.0	4	68.2±8.3
Quartz group	5	57.9±15.0	8	97.8±63.0	10	110.5±64.6	6	94.8±51.8
Physiological saline group	7	33.4±4.5	9	24.3±6.5	23	46.4±11.0	11	46.4±10.6

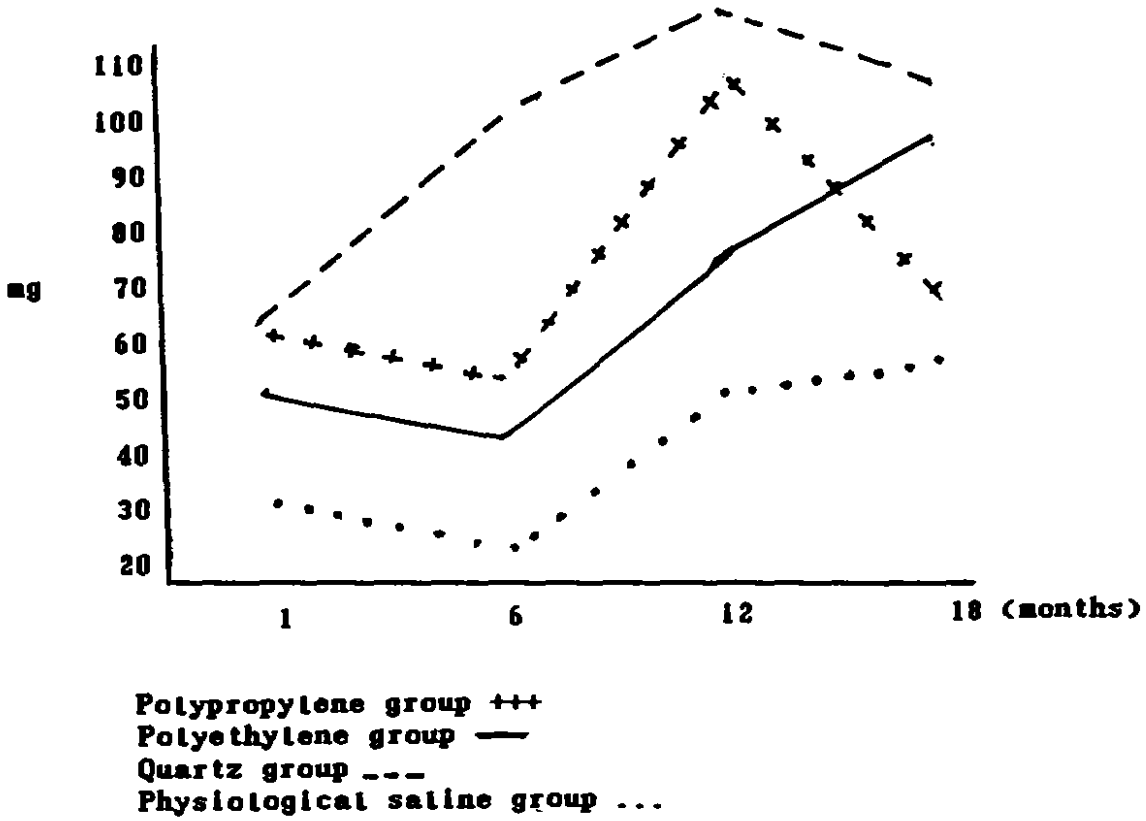

Figure 1. Variation curve of collagen protein content in the whole lungs.

SUMMARY

By unexposed injection intratracheally of 50 mg of dust at a time and through 1~18 months histopathological observation and analysis for collagen protein content of whole lungs, we consider according to the experimental results that the dust of polyethylene and polypropylene dust has a slight fibrosis effect on rats. In the earlier period (1~6 months) after dust injection the effect is mainly manifested in the form of granuloma changes, whereas in the later period (12~18 months) after dust injection the lung tissues mainly show granuloma changes and hyperplasia of interstitial fibre tissues of the lungs.

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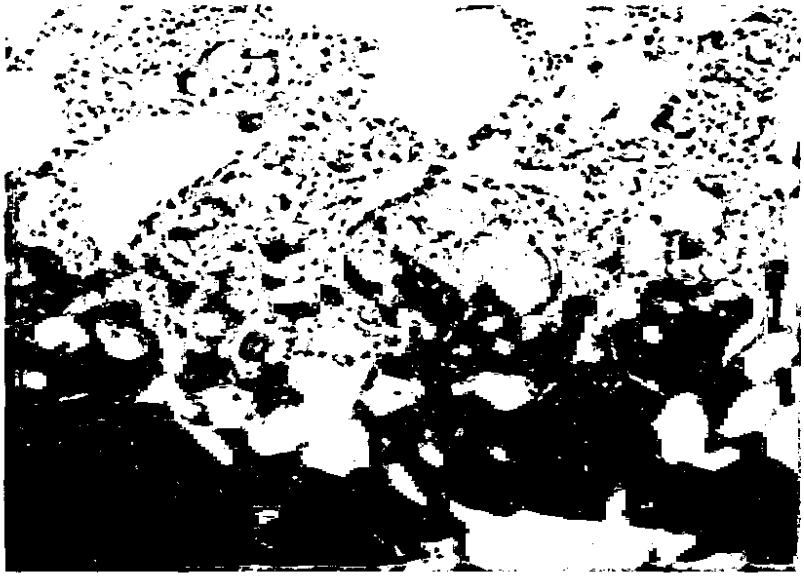
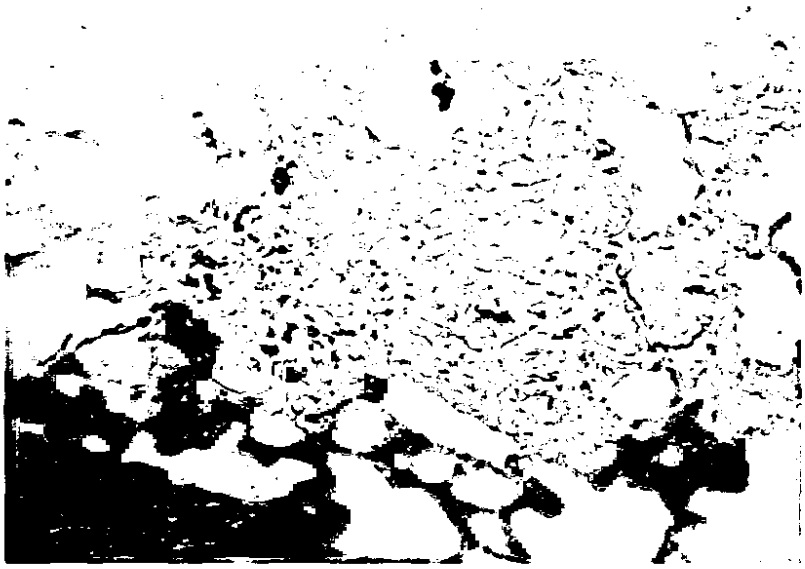
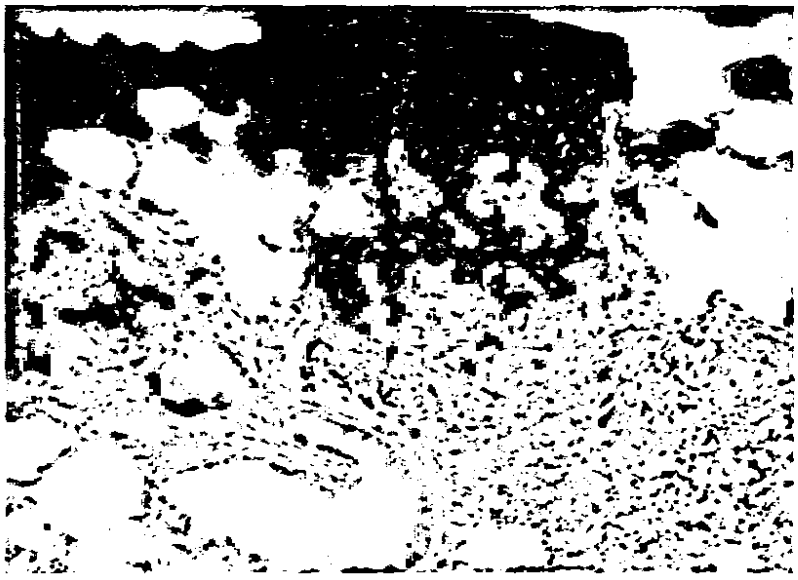


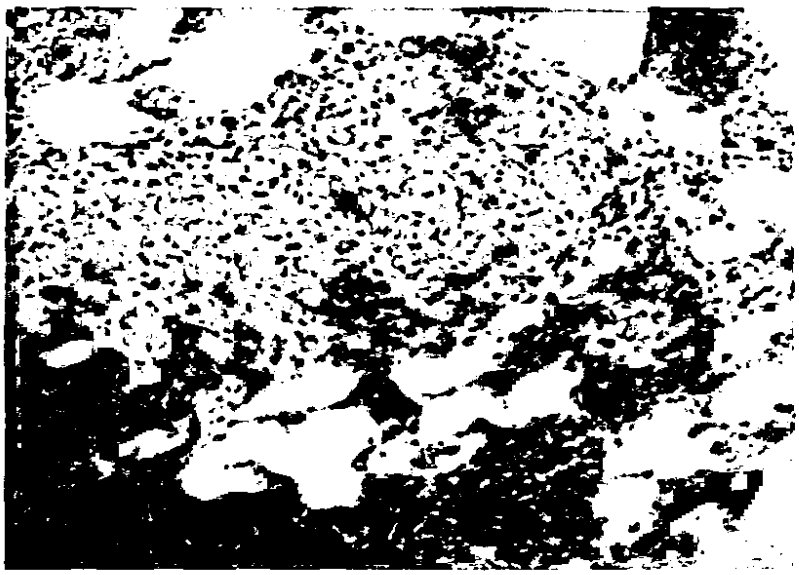
Polyethylene (One month) 34578 HE 6,7*10



Polyethylene (Six months) 35678 Foot 6,7*10



Polyethylene (One month) 34679 HE 6,7*10



Polyethylene (Twelve months) 3467 HE 6,7*10

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