SUDANOPHILIC INCLUSIONS IN THE MACROPHAGES IN IMPRESSIONS OF RATS' LUNG TISSUE IN NORMAL CONDITIONS, IN ALIMENTARY FAT LOADING, AND IN EXPERIMENTAL SILICOSIS

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In previous investigations [6, 7, 9] the author discovered an increased content of total lipids and phospholipids in the lungs of rats with experimental silicosis, in agreement with data in the literature [10, 13, 21].

Many investigators [6, 11, 14, and others] share Fallon's hypothesis [13] of the injurious action of quartz dust on the macrophages, resulting in degeneration and disintegration of the coniophages with liberation of lipic compounds into the extracellular spaces.

However, as the author's subsequent investigations showed [11], one of the main reasons for the increased lipid content in the lungs in silicosis is disturbance of the physiological function of this organ in lipid metabolism (increased lipopexia and decreased lipolytic activity of the lung tissue).

Lipopexia takes place as a result of phagocytosis of lipids by the cells [4-6, 9, 20, 24], identified by some authors [5] as "dust" cells. For this reason, an increase in lipopexy would be expected under the influence of quartz dust, which evokes an intensive phagocytic reaction, which still continues in the late stages of development of silicosis [16, 19].

The object of the present investigation was to discover which cells of the lung tissue ingest lipids and to determine the role of degeneration of the macrophages in the process of lipid accumulation in the lung in silicosis.

EXPERIMENTAL METHOD

Experiments were carried out on albino rats receiving an intratracheal injection of 50 mg quartz dust and, subsequently sacrificed in a fasting state or 4-4.5 h after a single fat load. The load consisted of administration of melted margarine (1 ml margarine/100 g body weight) through a gastric tube to animals previously fasted for 18 h. Control rats were sacrificed at the same time (in a fasting state or after a fat load respectively). Impressions from the surface of a recent incision of the lungs were made on fat-free glass slides, gently dried, fixed in formalin vapor (40%), and stained with Sudan black B [26], after which they were counter stained with azure-eosin by Romanovsky's method.

In each preparation, under a magnification of 15 x 90 (immersion) no fewer than 100 macrophages were counted; the number of cells showing no signs of degeneration and without sudanophilic inclusions, the number without signs of degeneration but containing sudanophilic inclusions (with "a small amount of fat" and "a large amount of fat"), and cells with obvious signs of degeneration were determined separately (in all the cells, besides disturbances of the staining properties of the cytoplasm and sometimes with breakdown of the cytoplasm, accompanied by karyorrhexis or karyolysis, a certain number of sudanophilic inclusions was always present). The cells of these types were counted in three rats from each of the four groups of animals (receiving dust and healthy; sacrificed in a fasting state or after the fat load) 5, 14, 60, 180, and 270 days after the beginning of injection of the dust.

EXPERIMENTAL RESULTS

Oral administration of fat always caused a considerable increase in the percentage of degenerating macrophages with lipids in the impressions of the lungs of the control rats. The percentage of cells containing "a large quantity of fat" in the cytoplasm also increased (at all times except after 14 days), thus confirming reports in the literature that lipopexia in the lungs is performed by the macrophages and manifested both as an increase in the

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number of cells containing lipids and an increase in the quantity of fat in each cell. The fat load also affected the number of degenerating macrophages containing sudanophilic inclusions, in varying numbers, in their cytoplasm. However, this effect was less constant than in the undergenerated cells.

In the lungs of the rats developing silicosis and sacrificed without preliminary fat loading, the percentage of unchanged macrophages with sudanophilic inclusions was practically the same, and sometimes higher (and the percentage of cells with "a large quantity" of inclusions was considerably higher) than in the healthy animals receiving fat, and this may be regarded as a sign of increased lipopexia. In addition, these impressions contained more degenerating macrophages than those from the lungs not containing dust, a result of the injurious action of quartz dust on the cell responsible for its phagocytosis.

However, the increase in the number of degenerated cells in silicosis by comparison with the control was much less than the increase in the number of lipid-containing unchanged macrophages. This confirmed the previous conclusion that it is the increased lipopexia (possibly together with the slower breakdown of the ingested fat) and not the degeneration of the macrophages which is the main cause for the early and significant increase in total lipids in the lung tissue in silicosis. Moreover, in the animals with silicosis, the percentage of macrophages with degenerative changes and containing "a large amount" of fat was much higher in the animals with silicosis than in the healthy animals. This may be regarded as an indication that increased ingestion of fat by these cells was taking place before the onset of degeneration.

These investigations confirmed the previous hypothesis [1] of the comparatively rapid exhaustion of the capacity of the lung fat depot in silicosis. In fact, in the earliest phases of development of silicosis a single fat load causes an increase in the number of unchanged macrophages containing fat in the lungs after injection of dust. The same principles also apply to the effect of the fat load on the percentage of degenerating cells with "a large quantity" of fat. This is further evidence of the unity of the mechanisms of lipid accumulation in the lungs in silicosis and fat loading (ingestion of fat is effected by the same cell). The important difference is that in normal lungs this accumulation is observed only after an alimentary fat load, whereas in silicosis it is seen practically constantly, and is relatively independent of fat loading.

In another histological investigation undertaken jointly with F. S. Ragol'skaya, it was shown on animals of the same groups that the fat in the lungs is fixed in macrophages which, in healthy animals, are diffusely scattered throughout the lung, while in rats receiving injections of quartz dust, the macrophages lie in a silicotic nodule or very close to one. The fat load increases both the number of lipid-containing macrophages and the lipid content of each individual cell.

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