

CHANGES IN THE ORGANS OF WHITE RATS DUE TO AN INTRAPERITONEAL INJECTION OF QUARTZ DUST

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The literature does not contain much research studying the effect of dust containing different concentrations of silicon dioxide injected into the peritoneal cavity of experimental animals [3, 4].

Therefore, we decided to study the changes which occur in the internal organs of white rats due to an intraperitoneal injection of quartz dust.

EXPERIMENTAL METHODS

The experiments were done on 8 white rats, which were injected once intraperitoneally with 100 mg of quartz dust containing 98.6% free silicon dioxide. Eighty-nine per cent of the dust we used consisted of particles 1 micron or smaller in size, the remainder, of particles 2 microns or smaller. All the animals received the dust injection without visible discomfort, and their condition was completely satisfactory throughout the experiment. Four of the rats were killed after 68 days, and the other four were killed 5 months after the dust injection.

EXPERIMENTAL RESULTS

In the peritoneal cavity of the rats killed 68 days after the dust injection, we observed many, round, dense grayish formations varying in size from those scarcely visible to the naked eye to those the size of a small pea, which were distributed on the parietal peritoneum, in the epiploon, the mesentery, and the intestinal serous membrane. When the largest formations were opened, the injected dust was found in their central portions.

In the rats which had been killed 5 months after the dust injection, the number of the formations described above in the peritoneum was much greater — they studded the peritoneum, the mesentery and the epiploon.

The nodular structure of these formations in all the animals was established by microscopic examination. They seemed identical to the silicotic nodes which form in the lungs of animals after an intratracheal injection of quartz dust. Histologically, they were round, millary or larger, nodules (Fig. 1), sometimes too large to fit the field of vision in a small microscope magnification. They were rarely situated apart from each other; most of them were in conglomerations, distributed between the individual intestinal loops, causing the loops to coalesce with each other or with the peritoneal wall. The cellular composition of the nodules and nodes was analogous to that observed in the lungs after an intratracheal quartz dust injection: histiocytes, cells of the epithelial type, and lymphocytes — the lymphocytes were usually distributed over the surface of the nodules. Many silicon dioxide particles were observed in the histiocytes and in the epithelial-type cells. Silvering the 68 day sections according to Foot showed that the framework of nodules consisted of a thick net of concentrically arranged, collagenous fibers; the number of fibers gradually decreased towards the center of the nodules.

The central portion of many of the nodules stained yellow with picric acid, and did not have a definite morphological structure — only loose dust and cell detritus were found in it, there were no fibers or cells. Newly-formed, thin-walled, blood capillaries could be seen on the surface of the nodules.

In the animals killed 5 months after the quartz dust injection, the number of collagenous fibers on the nodular surfaces was much greater — many were discovered in the central portions also, but the node itself remained structureless and contained only dust. When the sections were silvered, a thick, developed net of argentophilic fibers was discovered in the nodules.

At the same time, we observed hyperplastic retroperitoneal, para-aortal, and portal lymph nodes in the animals. When the lymph nodes were examined histologically, dilatation of the lymph sinuses with an increased number of dust-containing reticuloendothelial cells and the presence of nodular formations consisting of reticuloendothelial, proliferative cells were observed. The reaction in the above lymph nodes to the intraperitoneal injection of quartz dust was so strongly expressed that only separate islands of lymphoid tissue remained in them, while the main mass of the node was represented by multiplying reticuloendothelial cells, containing dust particles in their cytoplasm (Fig. 2).

The lymph nodes of the rats which had been killed after 5 months showed delicate collagenous fibers in the marginal sinuses.

In the liver of rats killed 68 days after the dust injection, there were many foci of submiliary size (Fig. 3) consisting of reticuloendothelial elements distributed in the periportal tissue, between the hepatic cords, with a developed net of argentophilic and collagenous fibers. We also observed that the nuclei of the hepatic cells were of different sizes.

In the spleen, both 68 days and 5 months after the injection, a different number of miliary foci was found, consisting of reticuloendothelial elements and primarily distributed in the center of the follicles. In the pulp, there was a large quantity of dark brown pigment which did not give a positive reaction to iron (quartz dust) and also a pigment which did give a positive reaction to iron (hemosiderin).

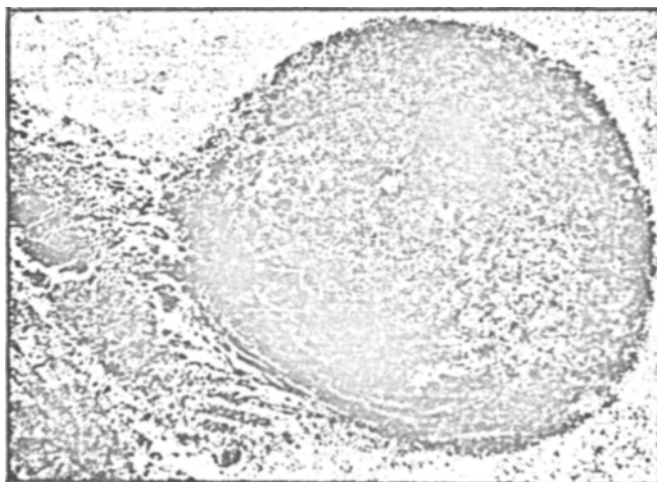


Fig. 1. Silicotic nodule on the parietal peritoneum of a rat killed 68 days after an intraperitoneal injection of 100 mg of quartz dust. Ocular 5, objective 10.

After 68 days, according to the dust deposit and to the development of granulation tissue on the serous membrane of the small intestine, the villi on the mucous membrane of the small intestine were observed to decrease in number and size and to be sclerosed. The mucous membrane situated directly above the granulation tissue portions lost almost all its villi. After 5 months, the changes of the mucous membrane were characterized by more marked focal areas of atrophy.

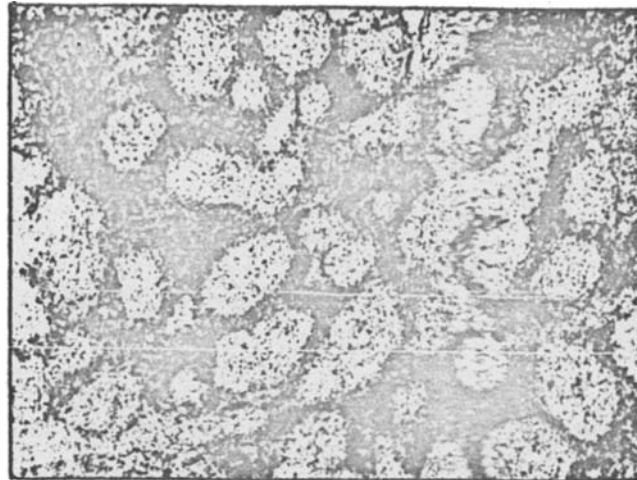


Fig. 2. Retroperitoneal lymph node of a rat killed 68 days after an intraperitoneal injection of 100 mg of quartz dust. Small focal nodular proliferation of the reticuloendothelial elements. Ocular 7, objective 10.

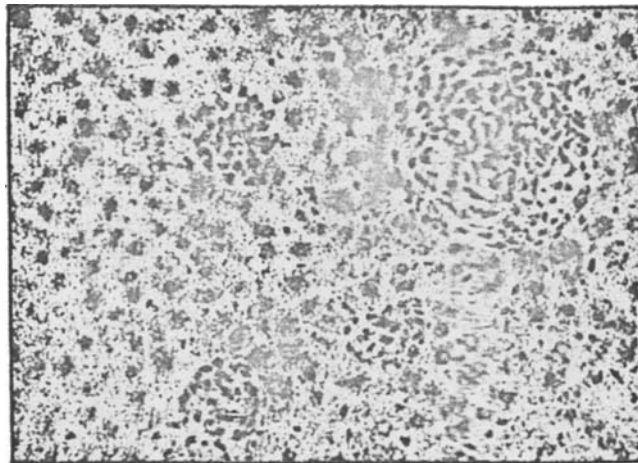


Fig. 3. Submiliary and miliary foci from the proliferating reticuloendothelial cells in the liver of a rat killed 5 months after an intraperitoneal injection of 100 mg of quartz dust. Ocular 7, objective 40.

Single foci of small, round cell and histiocyte infiltration were found between the convoluted tubules in the kidneys.

In the lungs, we found histiocyte multiplication in the interalveolar septi, which led to a considerable thickening of the septi, and lymphoid infiltration was noted around the small vessels and bronchi. The peribronchial lymph nodes were slightly hyperplastic, and a small accumulation of large cells with foamy protoplasm was found in them. There were no typical silicotic nodes in the lungs and regional lymph nodes in the animals of this series.

There were no changes in the other organs examined.

The studies which have been done show that typical silicotic nodes usually form according to the place at which the animal is injected with quartz dust. If the dust is injected intratracheally, the nodes will appear in the lungs and the regional (bifurcated) lymph nodes; if the dust is injected into the peritoneal cavity, the nodes will appear in the epiploon, along the serous membrane of the peritoneal cavity and in the regional lymph nodes. When the nodes appearing in the lungs and those appearing in the peritoneal cavity are structurally compared, it is evident that their cellular composition is identical and that they originate from the same cellular elements, which belong to the reticuloendothelial system (N. N. Anichkov).

The changes in the liver and spleen, i. e., the small foci forming from multiplying cells of the reticuloendothelial type, with the subsequent formation of argentophilic and collagenous fibers in these foci, belong to this category of changes. In the lungs, however, we observed no nodular formations to develop.

These studies also show that the intraperitoneal method of dust injection can be used as an index to test the silicogenic action of different sorts of dust.

SUMMARY

Intraperitoneal injection of 100 mg of quartz dust to white rats led to the appearance of typical silicotic nodes in the peritoneum, epiploon, mesentery and intestinal serous membrane. Simultaneously in the regional lymph nodes there developed focal and diffuse reticuloendothelial elements and later there also appeared collagenous fibers. In the liver and spleen there were small foci of developing reticuloendothelial elements with the appearance of the argentophilic and collagenous fibers. In the intestinal tissue of the kidneys, infiltrates developed and atrophy appeared in the mucous membrane of the intestine. No typical silicotic nodes developed in the lungs, but an infiltrative and proliferative process was observed.

LITERATURE CITED

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