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Pulmonary Ferruginous Bodies in City Dwellers

A Study of Their Central Fiber

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Chrysotile, which comprises more than 90% of the asbestos used in this country, has a characteristic electron diffraction pattern because of its unique, hollow, tubular, crystalline structure, as seen under the electron microscope.

On the basis of the electron diffraction pattern, chrysotile was decisively excluded as a constituent of the cores of all 28 ferruginous bodies isolated from lungs of urban dwellers not occupationally exposed to asbestos.

This exclusion is considered highly significant because if the ferruginous bodies in the above city dwellers had been caused by the inhalation of asbestos dusts, then some of the cores should logically be composed of chrysotile.

It has recently been suggested that the prevalence of ferruginous ("asbestos") bodies in the lungs of city dwellers not occupationally exposed to asbestos was largely dependent upon the method and diligence employed in searching for the ferruginous bodies.[1]

The reported prevalence of the positive cases was represented to range from 30% to 70% of the hospital deaths investigated; whereas, by digesting some of the lung tissue, a 97% prevalence of lungs positive for ferruginous bodies was found among randomly selected autopsied hospital patients in Pittsburgh.[1]

Ferruginous bodies, which are indistinguishable from those produced by asbestos dust, were recently demonstrated in lungs of hamsters injected intratracheally with

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fibrous dusts other than those of asbestos.[2] In view of this demonstration, it would seem proper to ask whether the "asbestos" bodies found in city dwellers have been evoked by the inhalation of asbestos dust or the inhalation of fibrous dust of other compositions.[3]

Based on the assumption that there is a substantial contamination of urban air by asbestos dust, it has been suggested that the source of such dust is from the brake lining of automobiles, the weathering of asbestos cement products (shingles and tiles), as well as from insulation used in the building construction industry.[4] Inasmuch as 90% or more of the asbestos used in the United States is chrysotile,[5] and since very little of other types of asbestos is used in the above-named products, the major component of the asbestos dust that is assumed to contaminate urban air would logically be chrysotile. Since there are no grounds for believing that asbestos bodies develop with greater difficulty around chrysotile fibers than around the fibers of other types of asbestos that may be inhaled, it would be reasonable to expect the vast majority of ferruginous bodies in the lungs of nonoccupationally exposed city people to have a central core of chrysotile—if the ferruginous bodies are indeed asbestos bodies.

Inasmuch as chrysotile fibers appear to be hollow in the electron microscope,[6] these may sometimes be identified by inspection. Furthermore, because of its hollow structure, chrysotile has a unique and readily identifiable diffraction pattern.[7] Because chrysotile lends itself so readily to positive identification by electron microscopy, we undertook a study of the central cores of ferruginous bodies derived from lungs of people of Pittsburgh not occupationally exposed to asbestos. We are here reporting the results of our study.

Methods and Materials

Ferruginous bodies isolated from the lungs of 28 people[1] were placed upon electron microscope grids by means of a micromanipulator. In the electron microscope, it became necessary to find a suitable fiber area on the ferruginous body that was free of electron-opaque encrustation (possibly ferritin) which would have interfered with the study of the core. Work with "standard" samples of chrysotile, amosite, and crocidolite showed that useful diffraction patterns could be obtained from fiber areas as small as 500 × 500 Angstrom, and as large as 5,000 × 5,000 A. All bodies examined had fiber areas suitable for such study. The bodies had to be manipulated in such a way as to yield their characteristic electron diffraction patterns, so that measurements of interplanar crystal lattice spacings could be made. Typical "layer line" diffraction patterns are obtained if the fiber axis is perpendicular to the electron beam. Ferruginous bodies isolated from the lungs of hamsters killed 12 months after an intratracheal injection of 25 mg of brake-drum dust (iron-free) were similarly placed upon electron microscope grids, and electron diffraction patterns were obtained of the central filaments.

Results

None of the cores of the 28 ferruginous bodies showed the hollow, tubular structure characteristic of chrysotile. Measurements of the diffraction patterns obtained (to an accuracy of ± 1%) on each of the cores of these bodies from human lungs showed that none of the fibers examined were identifiable as one of the three forms of asbestos cited above. In particular, chrysotile could be excluded as being involved in the formation of the ferruginous bodies. On the other hand, the central filament of the ferruginous bodies isolated from hamster lungs injected with brake-drum dust yielded electron diffraction patterns characteristic of chrysotile.

Comment

Although we have failed to identify the fibers that caused the population of ferruginous bodies in people not occupationally exposed to asbestos, we have decisively excluded chrysotile. This exclusion is highly significant in view of the fact that if asbestos dust were the contaminant in urban air responsible for the formation of these bodies, chrysotile would be the most prominent constituent of the cores and should be identifiable in some of the ferruginous bodies recovered from the lungs of these people, particularly since we have demonstrated that the cores of ferruginous bodies resulting from intratracheal injections of brake-drum dust were composed of chrysotile.

From the fact that the central fibers of the ferruginous bodies examined demonstrate an electron diffraction pattern, it must be concluded that the fiber is crystalline, but identification must await further electron diffraction information and possibly electron microprobe measurements. Its crystalline diffraction pattern effectively rules out fibrous glass, glass wool, and other vitreous materials in this sample which have been shown experimentally to be capable of producing ferruginous bodies.[8]

A recent analysis, utilizing an electron microscope, of the central fiber of asbestos bodies removed from lungs of people who had worked in a Flushing (Netherlands) shipyard, led to the conclusion that these cores were composed of amphibole asbestos.[9] This might have been expected since crocidolite and amosite have long been the predominant types of asbestos used in the shipbuilding industry. However, the relevance, if any, of this finding to the ferruginous bodies found in the lungs of urban dwellers, not occupationally exposed to asbestos, would appear to be doubtful.

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Michael D. Utidjian, MD, Department of Epidemiology, University of Pittsburgh Graduate School of Public Health, isolated the ferruginous bodies and transferred them to electron microscope grids.

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