The minerological analysis of parietal pleura samples in cases with enviromentally exposed to mineral fibers

Çevresel mineral liflerin etkisinde kalan olguların parietal plevra örneklerinin minerolojik analizi

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Summary

Purpose: Inhalation of asbestos fibers results in a variety of neoplastic and nonneoplastic diseases of the respiratory tract. Asbestos related chest disease are endemic in the rural region of Eskisehir in Turkey. It has been demonstrated that the cause of this can be related to exposure to dust generated from a white-soil containing tremolite and/or tremolite-chrysotile mixture.

Materials and methods: We have performed a minerological analysis by electron microscope of the dust contained in samples of tumor in the parietal pleura of cases arising in these rural areas. The results of the examination of the initial 8 cases are presented. Of the 8 cases, 4 had malignant pleural mesothelioma, 2 adenocarcinoma, 1 malignant melanoma, and 1 benign mesothelioma. Lengths and diameters of asbestos fibers were measured from the electron micrographs.

Results: Tremolite, chrysotile and sepiolite fibres were detected in samples of parietal pleura from 2 of the malignant mesothelioma cases, and tremolite only in other 2 cases; tremolite and chrysotile fibres were observed in 1 adenocarcinoma case, and tremolite fibres only in the other; chrysotile fibres only were observed in one malignant melanoma case. No fibres were detected in the sample of the fibrous tumor case.

Conclusion: Mineralogical analysis can give valuable information on the type and intensity of exposure.

Key words: Pleura, asbestos, mineral fiber, analyses, enviromentally occupation

Özet

Amaç: *Asbest liflerinin inhalasyonu solunum sisteminde birçok neoplastik ve neoplastik olmayan hastalık oluşumuna neden olur. Eskişehir yöresinde asbest nedenli akciğer hastalıkları sıktır. Daha önceki çalışmalarda aktoprak örneklerinde tremolite ya da tremolite ve chrysotile lifleri ile kontaminasyon olduğu saptanmıştı.*

Gereç ve yöntem: *Kırsal alanlardan gelen olgularda toz içeren parietal plevranın tümör örneklerinde elektron mikroskop ile minerolojik analizi yapıldı. İlk 8 hastaya ait sonuçlar sunuldu. Toplam 8 hastanın 4'ü malign plevral mezotelyoma, 2'si adenokarsinom, 1'i malign melanom, 1'i fibröz tümör idi. Elektron mikroskopi mikrograflarında asbest liflerinin türleri, çapları ve uzunlukları ölçüldü.*

Bulgular: *Malign plevral mezotelyomalı 4 hastanın 2'sinde tremolite, chrysotile ve sepiolite lifleri, diğer ikisinde yalnızca tremolite lifleri, adenokarsinomlu bir olguda tremolite ve chrysotile lifleri, diğer olguda yalnızca chrysotile lifleri, malign melanomlu olguda chrysotile lifleri saptandı. Plevral fibröz tümörlü olguda lif gözlenmedi.*

Sonuç: *Minerolojik analiz, asbest kontaminaston tipi ve düzeyi konusunda değerli bilgiler verebilir.*

Anahtar sözcükler: *Plevra, asbest, mineral lif, analiz, çevresel kontaminasyon*

Consideration of the human epidemiology of disease arising from exposure to naturally occurring and man-made mineral fibers encompasses the several forms of asbestos (chrysotile, crocidolite, amosite, anthophyllite, tremolite-actinolite), other naturally occurring silicates (talc, sepiolite, erionite, attapulgite, vermicute, and wollastonite), and man-made mineral fibers (glass continuous filament, glass/rock/slag insulation wools, ceramic and other refractory fibers, and glass microfibers). The disease arising from exposures to some of these fibers include benign pleural disease (plaques, diffuse pleural thickening, and calcification), pulmonary fibrosis, lung cancers, mesothelioma of the pleura and peritoneum, and possibly other cancers. These knowledge originated from studies medical studies of occupational exposures, but it has been increasingly realized that environmental exposure also can pose grave dangers (1-4). Such fibers include the categories shown in Table I.

Table I. Fiber categories.

Asbestos	Other silicates	Man-made mineral fibers
AMPHİBOLES	Attapulgite	Continuous filament
Amosite	Erionite	(glass fibers)
Crocidolite	Sepiolite	Insulation wool
Tremolite	Talc	(glass wool, rock wool,
Actinolite	Vermiculite	slag wool)
Anthophyloite	Wollastonite	Refractory fibers
NON-COMMERCIAL		(ceramic)
AMPHIBOLES		Special purpose fibers
Chrysotile		(glass microfibers)

Asbestos is the name given to a group of minerals that is found in the soil known as the “white soil”, especially used as a building material in many rural areas of Turkey for decades. The importance of asbestos comes from the fact that it can cause asbestos and mesothelioma (5).

There is little information on the relationship between pleural disease and asbestos fiber type; a study (6) reported there was a greater likelihood of progression of pleural disease among asbestos coment workers exposed to both chrysotile and crocidolite then among those with chrysotile alone. It is now generally accepted that the risk for the development of mesothelioma is increased among those exposed to amphibole asbestos compared to exposure to chrysotile, which has been less frequently associated with mesothelioma (7). Review of mesothelioma data indicates that mesothelioma risk is associated primarily with exposure to crocidolite, amosite, or mixed fibers (8).

In the present study, we analyzed numbers of asbestos bodies and fibers, as well as fiber sizes, in parietal pleura tissue samples obtained from patients.

Material and methods

We obtained parietal pleura samples from 8 patients (4 malignant pleural mesothelioma, 2 adenocarcinoma, 1 malignant melanoma, and 1 benign mesothelioma) at Osmangazi University Medical School Hospital. Routine demographic and exposure data collected for each patient include age, sex, province and data of emigration and occupation. Asbestos exposure information was obtained by direct patients interview and through review of the medical records. The probality of domestic aspestos exposure (use of white-wash) was also recorded. Mesothelioma were confirmed by a panel (Cytokeratin, Leusin-M1, CEA, Mucicarmen and Alcian Blue).

Investigators dissolved a 0.5 g specimen of wet parietal pleura in in 40% potassium hydroxide in a boiling water bath. After the sediment was washed with distilled water three times by centrifugation at 2000 rpm (700 g), investigators dropped a 25 μl sample of diluted suspension onto a collodion-coated grid on a dental plate. Investigators perused the fibers on the grids with a transmission electron microscope at 2.000x magnification (detection limit: 2 μm length, 0.06 μm diameter). We examined all fibers with a scanning electron microscope, which was equipped with an X-ray energy-dispersive spectrometer (in Division of Materials & Minerals, School of Engineering, University of Wales, Cardiff, UK). Investigators compared the spectrum of each samples with standards offered by the Union Internationale Contre le Cancer (9).

Asbestos fibers were classified as commercial amphiboles, specifically amosite, crocidolite, tremolite, anthophyloite and actinolite non-commercial amphiboles, chrysotile.

We were unable to measure the length of fibers if their edges were concealed by other minerals, nor could we measure the diameter of fibers that were severely separated, totally coated, and/or without parallel sides.

We included data for only those fibers for which both length and diameter could be measured.

Results

The patient age ranged from 30 to 66 (median 52.5) yr. All patients had a history of enviromental asbestos exposure. The length of exposure to asbestos ranged 8 from to 66 yr.

Tremolite, chysolite and sepiolite fibres were detected in samples of parietal pleura from 2 of the malignant mesothelioma cases, and tremolite only in other 2 cases; tremolite and chrysotile fibres were observed in 1 adenocarcinoma case, and tremolite fibres only in the other; chrysotile fibres only were observed in one malignant melanoma case (Fig. 1-4). No fibres were detected in the sample of the benign mesothelioma case.

The values of the length to diameter ratio were found to vary between 0.3 and 28 for tremolite type asbestos, and are concentrated between 1-3. These ratios varied between 1 and 14 for chrysotile and are consentrated around 1.

Demographic, pathologic, exposure information and the results of the fiber analyses are summarized in Table II.

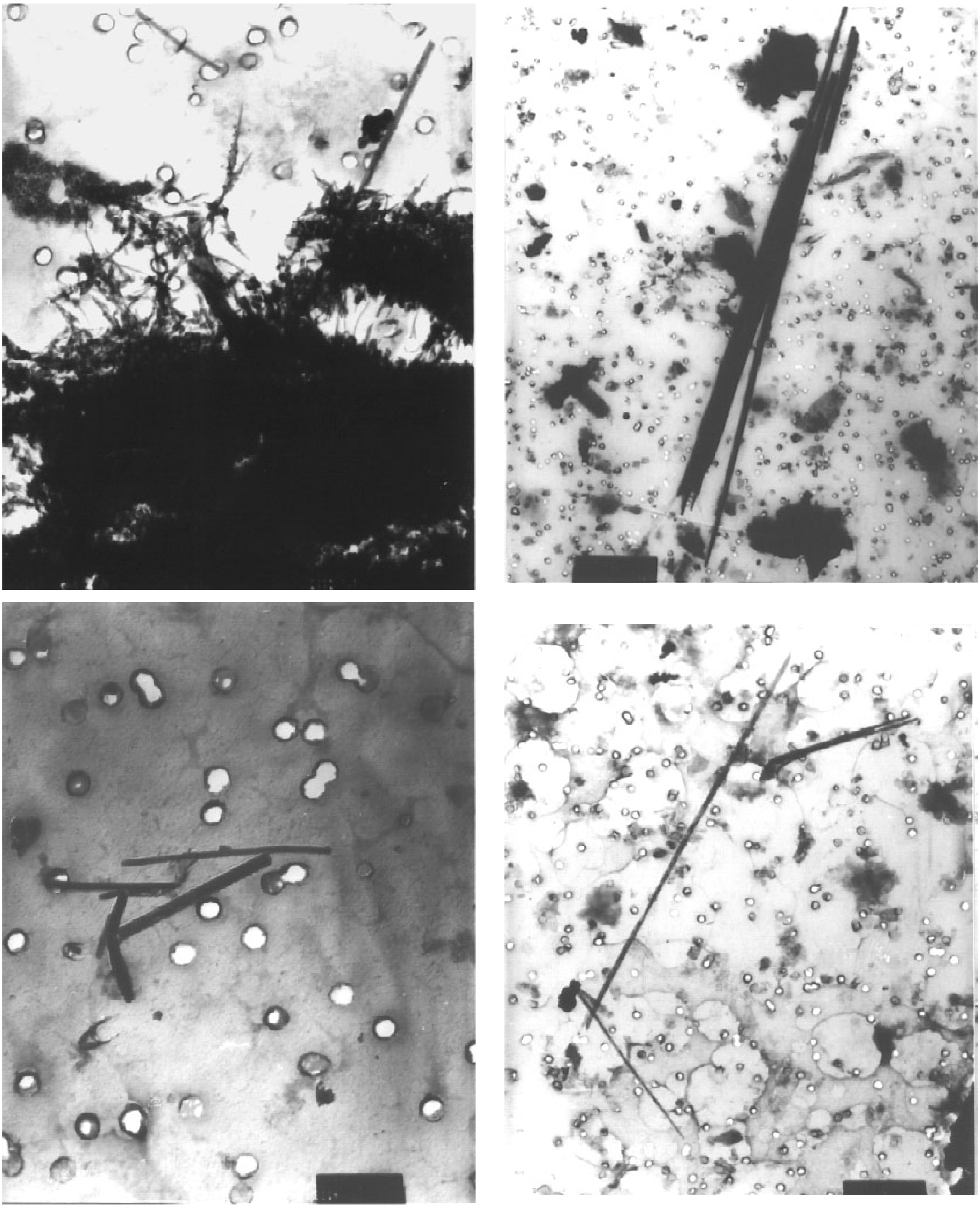
Discussion

Many different mineral fibers exist in the environment. Only a handful, however, are both dangerous to inhale and occur in places where humans can be exposed. Those now identified as problem fibers are the asbestos fibers and the fibrous zeolite called erionite. Experimental studies showed that erionite has 300-800 times more carcinogenic potency than chrysotile, and 100-500 times more such potency than crocidolite when given through intrapleural routes. In intraperitoneal experiments, erionite was 20-40 times more active than crocidolite (10). The physical and chemical characteristics of erionite could explain the higher carcinogenecity compared with that of asbestos. It has hexagonal structure with an internal surface of 200 m^2/g, which is 20 times larger than that of crocidolite asbestos and to have a high catalytic activity (11).

Enviromental problems have been reported in the general population in the southern part of China, and from populations around old mines in South America. Amosite is also nowadays rarely used. Population old mines in South Africa have been environmentally exposed. Tremolite has been mined only to a small extent but is a common contaminant in different ores (talc, zinc, nickel, iron, chrysotile etc) and also occurs in many rocks all over the world. This is the most common enviromental problems, with exposure to general population in areas of Australia, Bulgaria, Corsica, Cyprus and Turkey. A special problem is white-washing of houses with tremolite-containing material, which has been in practice in Greece, New Caledonia and Turkey. Anthophyllite has been mined for examle in Finland and Japan, but today has no industrial use. Endemic plaques are reported from these two countries, but no mesothelioma. Erionite is not a very common mineral but is formed under certain conditions in volcanic areas of the world and is found with other zeolite minerals. It has a very strong tendency to cause mesotheliomas, as seen from some villages in Turkey (12-20) (Table III).

Table II. Demographic, pathologic, occupational type and mineral fiber type.

bk	Age (yr)	Sex	Tumor type	Occupation	Fiber Type	Exposure duration (yr)
1	59	M	Malignant mesothelioma	Enviromental	Tremolite Chrysotile Sepiolite	12
2	55	M	Malignant mesothelioma	Enviromental	Tremolite	55
3	37	F	Malignant mesothelioma	Enviromental	Tremolite	14
4	60	F	Malignant mesothelioma	Enviromental	Tremolite Chrysotile Sepiolite	60
5	50	F	Adenocarcinoma	Enviromental	Tremolite Chrysotile	48
6	66	M	Adenocarcinoma	Enviromental	Chrysotile	66
7	30	M	Malignant melanoma	Enviromental	Chrysotile	8
8	36	F	Fibrous tumor of the pleura	Enviromental	No fiber	36



Figures 1-4. Electron micrographs of tremolite (Fig 1,2) sepiolite and tremolite (Fig 3), chrysotile (Fig 4) fibers detected in the parietal pleura.

Table III. Environmental problems with mineral fibres.

Tremolite
General population: Corsica, Cyprus
Farmers: Austria, Bulgaria, Turkey
White-washing houses: Greece, New Caledonia, Turkey
Amosite
Population around mine: South Africa
Crocidolite
General population: Rep. of China
Population around mine: South Africa
Anthopyllite
Population around mine: Finland, Japan
Erionite
Villages: Turkey
Actinolite
Villages: Turkey

Asbestos related chest disease are endemic in the rural region of Eskisehir in Turkey (21). Asbestos- and erionite-related chest diseases are showed in Table IV (22). It has been demonstrated that the cause of this can be related to exposure to dust generated from a soil containing tremolite and/or tremolite-chrysotile mixture (23).

Human lung tissue analyses have demonstrated that the risk for mesothelioma is related to the conceration of long (> 8 μm) amphibole fibres. Animal experiments using intracavitary injections of asbestos confirmed that the most carcinogenic fibers were those measuring ≥8 μm in length and < 0.25 μm in diameter (length/diameter ratio more than 3) (24,25). In sharp contrast with these data is the fact that all previous mineralogic studies have shown that short chrysotile fibers are the most common type of asbestos present in the parietal pleura (26-30). We were also observed similar findings in our study. Amphiboles fibers meeting Stanton's dimensional criteria for carcinogenicity are uncommon or absent (24).

The proportion of long pleural fibers has been variable in previous reports. Le Bouffant (27) reported that 7% of amosite fibers and 5% of chrysotile fibers in the parietal pleura were 5 μm or longer. Bautin and coworkers (26) stated that 24% of amphibole fibers and 14% of chrysotile fibers in the parietal pleura exceeded 4 μm. Dodson and associates (29) found that 10% of amphibole fibers and 3.1% of chrysotile fibers were longer than 5 μm. In a mineralogical study by Dogan and Emri in the region of Central Anatolia, fibrous mineral dusts were measured both in outdoor and indoor surroundings indicating exposure to these minerals since birth. It was mentioned that any mechanical manipulation of asbestos rocks rapidly produces many long, thin fibers/fibrils since for the most part asbestos fibrils are easily separable. Mineralogical findings included tremolite, chrysotile, antophyllite, and antegorite minerals with the fiber lengths ranging from 2 to 200 μm, and diameter ranging from 0.2 to 20 μm. The indoor fiber dose was measured as 0.054 to 0.1 fiber/ml and 2.9 to 7 fiber/ml (31).

In our the study, tremolite, chrysolite and sepiolite fibres were detected in samples of parietal pleura from 2 of the malignant mesothelioma cases, and tremolite only in other 2 cases; tremolite and chrysotile fibres were observed in 1 adenocarcinoma case, and tremolite fibres only in the other; chrysotile fibres only were observed in one malignant melanoma case. The values of the length to diameter ratio were found to vary between 0.3 and 28 for tremolite type asbestos, and are concentrated between 1-3. These ratios varied between 1 and 14 for chrysotile and are consentrated around 1.

In conclusion, mineralogical analysis gives valuable information on the type and intensity of exposure, especially in patients with both enviromental and occupational exposure. Perhaps these differences in fiber size are related to the strength of the carcinogenicity to the pleura.

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