Malignant Mesothelioma in a Patient with Anthophyllite Asbestos Fibres in the Lungs

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The amphibole asbestos, anthophyllite, is associated with asbestos-related disease in humans, along with mesothelioma in animal models. In humans, however, there are only three cases of histologically proven malignant mesothelioma of the pleura associated with anthophyllite that have been documented in the English-language literature. A fourth case is presented in a man who lived in South Africa and had anthophyllite in his lung. Anthophyllite was never commercially mined in South Africa. Using scanning electron microscopy, his lung fibre burden was calculated to be 358 000 fibres and 31 000 asbestos bodies per gram of dry weight of lung tissue. The mean aspect ratio of the anthophyllite fibres in the lung was 41.2 (SD = 28.8). No other types of asbestos were detected in the lung. His exposure was almost certainly occupational. He worked in the plastic manufacturing industry and was exposed to talc and asbestos blankets that were used to insulate machinery.

Keywords: anthophyllite; asbestos; lung fibre burden; mesothelioma; plastic; South Africa

INTRODUCTION

Anthophyllite is an amphibole asbestos and is regulated in terms of the South African asbestos regulations of 2001 (South Africa, 2001). Anthophyllite was never commercially mined in South Africa. It was mined in Finland (350 000 tons total production) (Rom et al., 2001; Kottek and Kilpatrick, 2002), Australia (510 tons) (Kottek and Kilpatrick, 2002), and in a few other countries, including Japan (Hiraoka et al., 1998) and the Eastern States of the USA (Van Goosen, 2006). It was used in the manufacture of construction and insulation materials. Anthophyllite has been shown to be a contaminant of other minerals, such as chrysotile asbestos (Tossavainen et al., 2001) and talc (Rohl, 1974; Rohl and Langer, 1974; Rohl et al., 1976; Gamble et al., 1979; Paoletti et al., 1984). Other amphiboles, crocidolite, amosite and tremolite, have been shown to cause malignant mesothelioma of the pleura of the lung (Srebro and Roggli, 1994; Roggli et al., 2002; Nolan, 2006). There is little in the literature concerning the association of anthophyllite and mesothelioma, although other adverse health effects, such as pleural plaques (Hillerdal, 1984; Hillerdal et al., 1984; Murai et al., 1997; Hiraoka et al., 1998) and asbestosis (Noro, 1968; Meurman et al., 1974) have been described.

Anthophyllite has been shown to induce mesothelioma in experimental animals (Wagner et al., 1973; Wagner et al., 1974; Pylev, 1980). However, histologically confirmed cases of malignant pleural mesothelioma in humans attributable to anthophyllite alone are rare. In a study of lung tissue from 19 mesothelioma patients in Finland, anthophyllite was present in 13 (68%) of the lung samples (Tuomi et al., 1989). The study was inconclusive in attributing the mesothelioma to anthophyllite as other asbestos fibres, such as crocidolite, were also present.

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Three cases of histologically verified malignant mesothelioma of the pleura and one of the peritoneum were reported in a cohort of 999 Finnish anthophyllite miners (Karjalainen et al., 1994). A case report in 2001 described a pleural mesothelioma in a man who lived and went to school close to an asbestos manufacturing plant that used anthophyllite (Rom et al., 2001).

Because of the paucity of reports of pleural malignant mesothelioma associated with anthophyllite in the literature, a case in a worker exposed to anthophyllite is presented. How he was exposed to anthophyllite was not initially apparent. It is the first report of mesothelioma associated with anthophyllite in South Africa.

CASE DESCRIPTION

The patient was born in 1931 in Berzence, a small rural village in Hungary. He worked as a tailor and a musician before fleeing from Hungary in 1956. He arrived in South Africa in 1957 and began working in 1958. From 1958 to 1972, he worked in South African factories that manufactured plastic goods. He mixed plastics, designed processes and products, and repaired and maintained machinery. From 1961 to 1965, his tasks involved the mixing of chemicals for plastic manufacture and the covering of imported machines with asbestos blankets. This work took place in a shed that was described by his daughter as dirty and filled with fumes. In 1972, he left the plastics industry and ran a production line, coating electrodes with gold and platinum, at an electrical company for 9 years until retirement. His hobbies were gardening and music.

In his 40s, he was treated for a period of 3–4 years for pulmonary tuberculosis. He was also treated for asthma. He was a chain smoker but stopped smoking on medical advice. He presented with sharp chest pain in 2002 and was on oxygen until his death in 2005. Following a computerized tomography scan, a mesothelioma was diagnosed.

He took morphine for pain and was confined to bed during his last year of life. He also developed diabetes mellitus and was treated with insulin. He died at the age of 73 from a malignant pleural mesothelioma. The clinical diagnosis was confirmed at post-mortem examination. The left pleura was markedly thickened, by tumour, up to 6 cm. Histologically, the tumour comprised pleomorphic epithelial-type cells with nests and pseudoglandular structures. The tumour cells stained positive for calretinin, a marker for mesothelial cells. Staining was negative for carcinoembryonic antigen, a marker for adenocarcinoma.

Tumour tissue obtained at post-mortem examination was processed and examined using transmission electron microscopy (TEM). The preservation of the tissue was poor, but tumour cells with numerous, long, and branching microvilli with a length to width ratio >10:1 were identified. The long microvilli are a diagnostic feature of mesothelioma cells and TEM is considered to be the gold standard in diagnosing mesothelial cell differentiation (Lloreta-Trull, 2006).

Tissue from the upper, middle and lower zones of the uninvolved lung was pooled and digested using potassium hydroxide. The digested material was then ashed in a furnace at 400°C and the residue was mixed with 50 ml of distilled water and passed through a 0.2 μm polycarbonate filter. After drying, the filter was coated with gold and examined in a Jeol JSM 5600 scanning electron microscope equipped with Thermo Noran energy dispersive X-ray spectroscopy capabilities. Only fibres >5 μm in length and <3 μm in width, with an aspect ratio >3:1 were counted. At a magnification of 2000 times, 200 fields were examined and 19 fibres were counted (Fig. 1).

The lung fibre burden was determined to be 358 000 asbestos fibres and 31 000 asbestos bodies per gram of dry weight of lung tissue (Fig. 2). In our laboratory, a fibre count of >125 000 and an asbestos body count >10 000 per gram dry weight of lung tissue indicates significant exposure to asbestos. A limitation of this study is that the TEM technique of selected area diffraction, to determine the crystalline nature of asbestos and discriminate between anthophyllite and talc, was not available to us. However, the energy dispersive spectroscopy showed all of the asbestos fibres to be anthophyllite, with spectral peaks for silicon, magnesium and iron in ratios comparable with (World Health Organization) standard samples of anthophyllite (Fig. 3). The method we have used is accepted by some authors for analyzing anthophyllite in the lungs (Tuomi, 1992; Roggli et al., 2002).

The mean length of the fibres was 36.4 μm (SD = 23.8; range: 11.9–67.9 μm), the mean diameter was 0.94 μm (SD = 0.26; range: 0.6–1.5 μm), and the mean aspect ratio was 41.2 (SD = 28.8). In addition to the anthophyllite fibres, numerous non-asbestiform particles containing silica and or calcium were noted.

DISCUSSION

There has been only one documented case of a South African worker having anthophyllite fibres.
in the lung and in that report, there was an equivalent amount of crocidolite fibres present (Nolan, 2006). In this case, the exposure to anthophyllite was most likely to have been occupational. In our laboratory, reference values for an asbestos fibre burden in the lung have been derived from an autopsy service which has examined lungs from miners of various commodities, including asbestos. The figure of 358 000 fibres $>$5 $\mu m$ long and 31 000 asbestos bodies (Fig. 2) per gram of dry weight of lung tissue is indicative of significant or occupational exposure. Compared to South African chrysotile asbestos workers, the lung fibre burden in this case is low. However, the figures do compare with the amount of tremolite, a contaminant of chrysotile, found in the lungs of chrysotile asbestos workers (Rees et al., 2001). The asbestos fibre counts appear low compared with scanning electron microscopy counts.

Fig. 1. Scanning electron micrograph of an anthophyllite fibre from the lung.

Fig. 2. Anthophyllite asbestos body from the lung.
of fibres from lungs of mesothelioma patients in Finland (Tuomi et al., 1989; Tuomi, 1992) but we only count fibres >5 μm. Only half of the anthophyllite fibres counted from the lungs in Finland were >5 μm and for other types of asbestos fibres, <25% were >5 μm (Tuomi, 1992). While laboratories agree with the overall ranking of results of lung fibre burdens and are consistent in the application of their own methods, it is unwise to attempt to draw conclusions by comparing data from different laboratories (Gylseth et al., 1985).

Our patient died 46 years after commencing work in the South African plastics industry where he worked for 14 years. The plastics industry uses talc which is blended with plastic to improve its strength and surface qualities. Talc is known to be contaminated with fibrous minerals, including anthophyllite asbestos fibres (Rohl, 1974; Rohl and Langer, 1974; Rohl et al., 1976; Gamble et al., 1979; Paolletti et al., 1984). Although anthophyllite was not mined commercially in South Africa, it may contaminate imported talc which is used by many industries manufacturing, among other things, plastic, paint, paper, rubber, ceramics, leather, pharmaceuticals and cosmetics. Alternatively, the blankets used to cover and insulate imported machines may have been manufactured using anthophyllite. Unfortunately, we have no details concerning the asbestos blankets.

Reports of malignant mesothelioma of the pleura associated with exposure to anthophyllite asbestos fibres alone are rare. It has been suggested that the carcinogenic properties of asbestos are related to the size of the fibres (Stanton et al., 1981). Anthophyllite fibres are shorter and have larger diameters than crocidolite and amosite fibres. In an analysis of the fibre burden in the lungs of residents of a Japanese town where pleural plaques are endemic, the mean length and diameter of anthophyllite fibres in the lungs were reported as 25.1 and 0.84 μm, respectively. The mean aspect ratio was 38.7 which is larger than the mean of 18.0 reported for anthophyllite fibres in the lungs of mesothelioma patients from Finland (Tuomi, 1992) but smaller than that of 81.8 for amosite (Murai et al., 1997). The mean aspect ratio of the anthophyllite fibres in the lung of our patient was 41.2. With a mean length of 36.4 μm and a diameter of 0.94 μm, these fibres are asbestiform and not cleavage fragments (Gamble and Gibbs, 2008).

CONCLUSIONS AND RECOMMENDATIONS

Cases of malignant mesothelioma of the pleura attributable to exposure to anthophyllite are rare. In our case, the most likely exposure is occupational, due either to the use of talc in the plastics industry or to the exposure to fibres from asbestos blankets used to insulate imported machines in the same industry. Talc is used in many manufacturing processes and good hygiene practices should be employed to prevent exposure to talc dust which has been shown to cause talc pneumoconiosis (Berner et al., 1981; Gibbs et al., 1992). In addition, it is a potential source of amphibole asbestos fibres and has been
associated with cases of mesothelioma (Ng, 1984; Hull et al., 2002).

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REFERENCES


