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CASE REPORT

Malignant Mesothelioma From Neighborhood Exposure to Anthophyllite Asbestos

William N. Rom, MD, MPH,[1]* Samuel P. Hammar, MD,[2] Valerie Rusch, MD,[3] Ron Dodson, PhD,[4] and Shepard Hoffman[5]

Background *Anthophyllite asbestos has been reported to cause asbestosis, lung cancer, mesothelioma, and pleural plaques in occupationally exposed workers. Anthophyllite has also been associated with pleural plaques in Finland and Japan among those who live near mines and mills and have neighborhood or environmental exposure.*
Methods *We evaluated a 38-year-old patient with pleural mesothelioma who lived, attended school, and delivered newspapers near a manufacturing facility that used exclusively anthophyllite asbestos fiber from ages 8–17 years. He had no work exposure to asbestos.*
Results *The pleural mesothelioma was an epithelial type with tubulopapillary structures and was treated with an extrapleural pneumonectomy followed by radiation therapy. The malignant cells were positive by immunohistochemistry for cytokeratin but negative for carcinoembryonic antigen, S100, B72.3, and leu M1 antigen. Anthophyllite fibers were > 5 μm in length in lung tissue compared to 3 μm from a general population study.*
Conclusions *Anthophyllite asbestos has been associated with neighborhood environmental exposure and pleural plaques; we now report a neighborhood exposure and pleural mesothelioma.* Am. J. Ind. Med. 40:211–214, 2001. *© 2001 Wiley-Liss, Inc.*

KEY WORDS: ***mesothelioma; anthophyllite; asbestos***

INTRODUCTION

Amphibole asbestos has a 2–4 times greater risk for malignant mesothelioma as the serpentine variety, chrysotile [Smith and Wright, 1996]. Crocidolite asbestos has been shown to cause mesothelioma in crocidolite miners and millers, gas mask workers, and factory workers exposed in pipe mills or filter manufacture [Wagner et al., 1960; McDonald and McDonald, 1978; Acheson et al., 1982; Hughes et al., 1987; Talcott et al., 1989]. Neighborhood exposure was described in the first case series report by Wagner et al. [Wagner et al, 1960]. Newhouse and Thompson expanded on neighborhood asbestos exposure in a study of mesothelioma cases and controls in London in 1965 [Newhouse and Thompson, 1965]. Amosite-induced malignant mesothelioma has been described in workers and four household contacts at the Union Asbestos and Rubber Company in Paterson, New Jersey, exposed in the 1940s and 1950s [Anderson et al., 1976, 1979]. From a commercial perspective, 95% of asbestos products are made of chrysotile while the remainder of the commercial applications of the world's production is of the amosite or crocidolite forms of asbestos [Wagner, 1972].

In many reviews anthophyllite is considered a noncommercial asbestiform fiber [Rom, 1998]. However, there

[1]Division of Pulmonary and Critical Care Medicine, NYU School of Medicine, Bellevue, NY
[2]Diagnostic Specialties Laboratory, Bremerton, WA
[3]Department of Surgery, Memorial Sloan Kettering Medical Center, New York, NY
[4]Department of Cell Biology, The University of Texas Health Center at Tyler, Tyler, TX
[5]301 N. Charles Street, Baltimore, MD
Contract grant Sponsor: NIH; Contract grant number: M01 RR00096.
*Correspondence to: William N. Rom, Division of Pulmonary and Critical Care Medicine, NYU School of Medicine, 550 First Avenue, Bellevue 7N24, New York, NY 10016.
E-mail: william.rom@med.nyu.edu

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were some very limited commercial uses of anthophyllite asbestos which was exclusively mined in Finland and Japan. Finland produced 350,000 tons of anthophyllite from 1918 to 1975 and 230,000 tons were exported [Huuskonen et al., 1980]. In 1960, Kiviluoto reported bilateral pleural plaques in persons with environmental exposure to the Finnish asbestos mines; he had collected 800 cases [Kiviluoto, 1960]. In persons over 65 years of age, the pleural calcifications were observed in approximately 30%. Anthophyllite asbestos was mined and milled in Matsubase, Japan, and 9.5% of the inhabitants over 20 years of age in this town had pleural plaques [Hiraoka et al., 1998]. Meurman et al., [1994] have reported elevated levels of lung cancer among the Finnish anthophyllite miners whereas Karjalainen et al., [1994] have noted the occurrence of mesotheliomas among the same cohort. Limited data exists about anthophyllite-induced disease in the U.S. We evaluated a patient with malignant mesothelioma who had neighborhood exposure to anthophyllite asbestos used exclusively at a U.S. manufacturing facility.

CASE REPORT

Born in 1956, the patient lived 3/4 mile from an asbestos product manufacturing plant. He attended grades 1–6 at an elementary school 1/4 mile from the asbestos factory. He played in a field between the school and the plant. He delivered newspapers as a school boy throughout the neighborhood surrounding the plant. In 1974, he left for college but continued to spend his summers at home. Following college he was hired as a physician's assistant out of state and had no further asbestos exposure. The asbestos plant manufactured various tanks and piping systems. It imported 4.5 million pounds of Finnish anthophyllite asbestos from December 1964 to January 1972. This period overlapped the patient's age of 8–16 years when he resided, played, attended school, and delivered newspapers near the plant. The patient recalled the white dust released from the plant, and its presence on the ground and in the foliage around the plant. An industrial hygiene plant tour in 1978 observed very poor housekeeping practices, and noted that an air blower on the roof was scattering asbestos fibers into the atmosphere.

In 1994, he presented with left sided chest pain and shortness of breath of 1 week duration. He had a left pleural effusion with a thick tumor peel along the left mediastinum on a CT scan of the chest. A thoracentesis was done and cytological preparations of the pleural fluid showed highly atypical mesothelial cells. At thoracoscopy, there was diffuse irregular white nodularity of the visceral and parietal pleura including the left hemidiaphragm. A biopsy showed diffuse malignant mesothelioma which was an epithelial type with tubulopapillary structures. He was a lifelong non-smoker. He had an extrapleural pneumonectomy with mediastinal lymph node dissection and diaphragmatic resection with Gore-tex reconstruction performed. This was followed by radiation therapy to the left hemithorax at a dose of 5000 cGy at Memorial Sloan Kettering Cancer Center in November 1994. The malignant cells were positively immunostained for cytokeratin, epithelial membrane antigen, and alcian blue but did not stain for carcinoembryonic antigen, S100 protein, B72.3, Ber EP4, or leuM1 antigen.

DISCUSSION

This 38-year-old man presented with an epithelial-type diffuse malignant pleural mesothelioma with a neighborhood exposure up to age 18 years to anthophyllite asbestos. Analytical Transmission Electron Microscopy, which combined selected-area electron diffraction and X-ray dispersive analysis were used in analyzing digested lung tissue and tissue from a thoracic lymph node. Anthophyllite asbestos was found in digested material from both the lung tissue and the lymph node with the anthophyllite fibers being >5 μm in length. This contrasts with the average length of anthophyllite fibers from a general population study which was found to be 2.97 μm [Dodson et al., 1999, 2000]. The asbestos manufacturing plant used anthophyllite fibers exclusively from 1964 to 1972.

Anthophyllite was practically the only amphibole used in Finland. Until 1988 Finland had imported 175,000 tons of chrysotile and less than 5000 tons of crocidolite and amosite. Asbestosis has been reported in Finland equally from three occupations: quarry and mill workers, asbestos product factories, and construction insulators [Huuskonen et al., 1980]. Approximately 10 diffuse malignant mesotheliomas (DMM) per 10^6 persons or 50 per year are reported from Finland, and the rate has tripled since the 1970s [Huuskonen et al., 1988]. Most of these patients (80%) have occupational or environmental exposure to asbestos; their lung fiber counts range from 0.5 to 370×10^6 fibers/g of dry lung tissue. Most of the scanning/transmission electron microscopy analyses show mixed fibers in lung tissue. The Finnish Institute of Occupational Medicine in 1990 reported two mesothelioma patients with only anthophyllite in lung tissue, and six subjects with anthophyllite and chrysotile fibers [Hernberg et al., 1990].

Noro described two cases of anthophyllite-induced asbestosis from an asbestos factory in 1945 (Noro, 1995). In 1947 Wegelius [Wegelius, 1947] reported radiographic findings from 126 Finnish asbestosis cases among 476 workers at Finska Mineral AB. This company included the mine at Paakkila and a finished products factory at Helsingfors. Ahlman and colleagues reported that anthophyllite miners/millers had the following rates of asbestosis: one-third of 286 workers with 6 years or more and 47% with 24 years or more [Ahlman et al., 1973]. Noro stated that the pleural calcifications in rural Finns near the anthophyllite districts probably came from contamination of soil or air [Noro, 1968]. Meurman and colleagues reported excess mortality due to lung cancer and asbestosis in 1092 Finnish asbestos workers [Meurman et al., 1974]. The relative risk of lung cancer for high-exposed was 3.3 and low to moderate exposed was 1.4.

Wagner and colleagues reported two studies where anthophyllite asbestos was given to rats [Wagner et al., 1974, Wagner et al., 1973]. Anthophyllite inhalation produced greater asbestosis scores at 6, 12, and 24 months than crocidolite or chrysotile [Wagner et al., 1974]. It produced similar numbers of lung tumors and two mesotheliomas compared to four each for chrysotile and crocidolite. In another experiment where anthophyllite was injected into the pleural cavity, 8 of 32 rats developed mesothelioma [Wagner et al., 1974].

Tuomi and colleagues have analyzed lung tissue of 29 mesothelioma patients in Finland [Tuomi et al., 1989; Tuomi, 1992]. Fiber concentrations with transmission electron microscopy were three times more than previously reported with scanning electron microscopy. Anthophyllite asbestos was the most prevalent fiber type in eight patients and was found in samples of 13 other patients. The median length of anthophyllite was 5 μm and median width 0.35 μm, and 50% were >5 μm in length. Antilla and colleagues found anthophyllite fibers in 30 of 33 lung cancer patients (90%), and crocidolite/amosite in 18 patients (55%) (Antilla et al., 1990]. Anthophyllite was the major fiber type (>50% of all fibers) in 20 patients, and crocidolite/amosite in two patients (6%).

Krajaleinen and colleagues reported four cases of DMM among Finnish anthophyllite miners in 1994 [Krajaleinen et al., 1994]. There were three pleural DMM and one peritoneal DMM in 503 deaths of a cohort of 1000 miners followed to 1991. Exposures ranged from 13–31 years in anthophyllite mining and milling. All four had asbestosis and a latency ranging from 39–58 years. Three had fiber analysis of lung tissue finding 270–1,100 million fibers/g of dry lung and all fibers were anthophyllite. The fibers were long (>5 μm) but wide (0.35 μm) similar to previous reports whereas crocidolite was thinner (0.1 μm width). Eighty-five cases of DMM were reported to the Finnish Cancer Registry from 1953 to 1969 with 45% having probable or possible asbestos exposure [Huuskonen and Tossavainen 1992]. In summary, anthophyllite asbestos has been shown to produce all types of asbestos-related diseases in humans and animal models, and we now add neighborhood exposure to anthophyllite as a likely cause of diffuse pleural malignant mesothelioma.

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