Metsovo Lung Outside Metsovo*
Endemic Pleural Calcifications in the Ophiolite Belts of Greece

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Endemic PCs and high incidence of malignant mesothelioma from household use of asbestos have been reported in Metsovo in northwestern Greece ("Metsovo lung"). In the present study, we present similar findings in six more areas of Greece. Like Metsovo, all these areas are located within ophiolite belts. Like Metsovo, material similar to "Metsovo whitewash" has been used for various domestic uses. Asbestos fibers (chrysotile, antigorite and tremolite) were found in three of the six areas. Also, in two, MPM has been diagnosed. These findings suggest that "Metsovo lung" occurs in several areas of Greece and has similar etiology and epidemiology. (Chest 1991; 99:1155-61)

It has been previously reported that inhabitants of Metsovo in northwestern Greece have a high incidence of PCs2 (Fig 1). Subsequently, it was found that in the same area MPM was unusually frequent.3 Both were attributed to household use of asbestos, more specifically a whitewash that was a form of ophiolite ("Metsovo whitewash").4 The condition was named "Metsovo lung" from the name of the village where the calcifications were first noticed. It seems, however, that "Metsovo lung" is not confined to that area. Since 1985, we noticed sporadic cases of PCs in inhabitants of Distarto, also in northwestern Greece, and in Trikala and Karditsa, in central Greece.5,6 This observation led to a systematic epidemiologic survey that is presented in this report.

**GEOLOGIC AND MINERALOGIC BACKGROUND**

The areas where we observed endemic PCs are located within or near ophiolite complexes belonging to the Hellenic-Dinaric ophiolite belts (Fig 2). The ophiolites of Greece as well as Yugoslavia and Albania outcrop as two belts. The west belt can be traced south as far as the island of Evoia. The east belt forms part of the Axios (Vardar) zone in Macedonia and also part of the Circum Rhodope belt in Thrace. There also are some other isolated occurrences of serpentines within the crystalline massifs of the Rhodope Moun-

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**MATERIALS AND METHODS**

**History of the Study**

The study was initiated with two inhabitants of Distarto (Fig 2, area 2) who were admitted to the University Hospital of Ioannina for unrelated causes but were noticed to have extensive calcifications in the chest roentgenogram, just like those of individuals from Metsovo. This observation led to a field study in Distarto (population, 400). As part of the study, 101 inhabitants had a complete medical history taken and a physical examination as well as a miniature chest roentgenogram.

Soon after, local physicians reported to us that chest roentgenograms with "Metsovo lung" had been observed in villages of central

**Figure 1.** Chest roentgenogram of individual from Metsovo showing extensive pleural calcifications.
Greece. After this, a systematic survey was undertaken using the archives of the HTRI, where roentgenograms from all areas of Greece, some dating back to 50 years ago, can be found.

Roentgenograms, or reports of roentgenograms, with PCs were identified. The inhabitants of the areas where the roentgenograms with PCs originated were then asked for the use of local soil for whitewashing or any other uses that could lead to the presence of asbestos fiber even in the remote past. When such a material was identified, it was examined mineralogically at the Department of Geology, section of Mineralogy and Petrology of the University of Athens.

Identification Procedure of the Examined Specimens

The x-ray diffractometer patterns of the examined specimens were carried out by using CuKa radiation of a Philips PW 1140/00 unit. Transverses were made at 40 kV and 30 mA with Ni filter at 1°/min and a time constant of 1 s. A divergent slit of 1°, a receiving slit of 0.2° and a scatter slit of 1° were used. On the basis of x-ray diffractometry, the identification procedure of the calculated d values was carried out by using the powder data file cards of the ASTM.

The identified asbestos minerals, tremolite, antigorite and chrysotile, and the other minerals found in the examined specimens are mentioned later on in the text.

RESULTS

Including Metsovo, seven areas of endemic PCs were identified (Fig 2). It is interesting to note that there is no asbestos mining or other official form of exploitation in any of these areas.

Area 1: Metsovo, Northwestern Greece

Since our initial report we have examined almost 1,000 chest roentgenograms from the Metsovo area (population, 4,500). The incidence of PCs has remained practically unchanged (46 percent) but two more villages have been added to the original four. As previously mentioned, the whitewash used extensively in these villages contained tremolite. This was confirmed with the methodology of the present study.

Area 2: Distrato, Northwestern Greece

Plural calcifications were observed in 24 of 101 examined inhabitants of Distrato, all older than 50 years. The incidence was comparable to that of Metsovo in those over 70 years old (65 vs 71 percent). Younger individuals from Distrato had, however, much lower incidence of PCs (18.5 vs 48 percent in those 50 to 59 years old). The reason for this difference became obvious when the source of the fiber was identified. It was a material similar to the "Metsovo whitewash" used for similar purposes. The difference was that in Distrato the use of this whitewash was abruptly discontinued when the village was burned down during World War II, while in Metsovo it was still in use in the 1960s and 1970s. Minerologic examination of the "Distrato whitewash" revealed chrysotile and tremolite fibers.

Figure 2. Map of Greece showing the Hellenic-Dinaric ophiolite belts (dark areas) and the areas where endemic PCs were found. 1, Metsovo; 2, Distrato; 3, Megarchi/Trikala; 4, Mousaki/Karditsa; 5, Evia; 6, Pella; 7, Serres. Abbreviations: YU, Yugoslavia; AL, Albania; BUL, Bulgaria; TR, Turkey.
Areas 3 and 4: Megarchi/Trikala and Mousaki/Karditsa, Thessaly, Central Greece

The initial observation of PCs in inhabitants of these areas is attributed to Dr. D. Pazarakis, a roentgenologist from Trikala who was collecting such roentgenograms for years. From his collection and the archives of the HTRI, which had examined 148,280 inhabitants of the area in 1975, we identified 198 individuals with PCs, similar to those found in the people of Metsovo, scattered in 50 villages. In most of these villages, local soil was used for various domestic purposes. Its minerologic analysis revealed quartz, asbestite and other nonfibrous minerals but no asbestos.

Area 5: Evoia, Central Greece

Roentgenologic screening by the HTRI in the island of Evoia (population, 190,000), first in the 1970s and again in 1988, with roughly 6,000 inhabitants examined, revealed two types of PCs. The first was unilateral calcified pleurisy reminiscent of old hemotherax or tuberculous pleurisy. The 118 individuals with this type of calcification were scattered in 40 villages all over the island. The second type was bilateral PCs just like those found in inhabitants of Metsovo. The 35 individuals with these PCs were clustered in nine villages of southern Evoia around the village Tsakaioi (population, 105), where 13 of 37 individuals examined had PCs.

There was extensive exploitation of local soil in Tsakaioi, between 1936 and 1940; the soil was exported to Italy for talc production. Samples of this soil were examined and were found to contain antigorite, but soil and stones from inside the village contained large amounts of antigorite and tremolite.

Area 6: Pella, Macedonia, Northern Greece

During a roentgenologic screening of the HTRI in 1973 in the area of Pella (population, 132,000), with roughly 20,000 inhabitants examined, again two types of PCs were identified. In 75 inhabitants of 16 villages, the PCs were similar to those found in people of Metsovo. In 62 more individuals scattered in 44 villages of the same area, unilateral calcified pleurisy was noted.

Our epidemiologic survey revealed that inhabitants of Pella used local soil for several uses, including insulation of boilers of family distilleries. Its use was discontinued before 1950. Minerologic examination of the soil revealed chrysotile fibers.

Area 7: Serres, Macedonia, Northern Greece

Roentgenologic screening of the HTRI, in 1986, identified “Metsovo lung” in 72 inhabitants of six villages of Serres. Here again, local soil was used mainly for whitewashing until 1950. Minerologic examination of this soil, however, did not reveal asbestos fibers. It showed the presence of only tale and chlorite.

Discussion

The results of our study suggest that “Metsovo lung” occurs outside Metsovo, in various areas of Greece, and also that its etiology and epidemiology in Metsovo and in most of the new areas outside Metsovo are similar.7

Some questions from our initial reports are answered in the present study while others still remain open. One question was8 whether PCs have any ethnic preference, since they were observed initially only among “Vlachi,” an ethnic subgroup of Greeks which constitutes the vast majority of the population of Metsovo. In the present study, however, PCs have been noted in both Vlachi and non-Vlachi in most of the new areas. Also we were eventually able to find PCs in two non-Vlachi inhabitants of Metsovo. Thus, as we suggested previously,9 incidence of PCs is a result of life-style rather than an ethnic preference.

Pleural calcifications are not the only sequelae of asbestos exposure in these new areas. Just as in Metsovo, MPM also is found in some of them. Two cases from Distarto have been diagnosed in Ioannina University Hospital since 1984, while three from Pella have been reported by Sichletides et al.8

One question has remained open from our previous reports, while others have risen from the present study. The first is the lack of PCs in all established cases of mesothelioma as well as from two cases of other types of malignancy in Metsovites. Even with chest CT, we could not detect PCs in those patients; however, we were able to demonstrate such calcifications by CT in all Metsovites age 50 or older who had roentgenograms that showed no PCs.9 Rabinowitz et al10 also have noted that “calcified plaques were infrequently encountered in mesothelioma” while Grant et al11 found PCs in 7 of 14 consecutive patients with MPM. In our first report4 we speculated on the possibility of different responses to asbestos in different individuals. This has been strengthened by a preliminary observation obtained from bronchoalveolar lavage. In a limited number of individuals, on whom we performed this procedure as part of an ongoing study, we have noticed that those with PCs on the chest roentgenograms have a high percentage of lymphocytes; those without PCs have a moderate elevation; and those with malignancy (and no PCs) have a quite low percentage and absolute number (Dr. Y. A. Dalavanga, unpublished data).

The first question that has risen from the present study is whether both types of PCs (unilateral calcific pleurisy and bilateral scattered pleural plaques) observed in the areas of Pella and Evoia are asbestos-
related, and if so, what causes the appearance of either one. Previous hemotherax or tuberculous pleurisy has not been ruled out, but the frequency of the unilateral calcifications is so much higher than in other areas of Greece that this explanation is unlikely. The fact that the two types of PCs occur in different villages leads us to believe that they are related to different degrees of exposure. This hypothesis presently is being investigated. The second question is the etiology of the PCs in the areas where we were unable to detect fiber. The most likely possibility is that we have not identified the correct material. The fact that erionite, which is not asbestos, has caused similar PCs and mesothelioma in Turkey,\textsuperscript{12} leaves some room for speculation that the minerals present in the material that we have found may indeed cause PCs. It is of interest that no cases of MPM have been reported in these areas.

There are, of course, more questions. It is not at all certain, eg, that the map of endemic PCs of Greece is complete. Already, we have scattered cases from Kilkis (northern Greece) and Tinos (an Aegean island). In the latter, examined soil was found to contain antigorite and serpentine. This study, however, shows with certainty that there are many areas of "Metsovo lung" in Greece. It is added to several previous studies mainly from Turkey,\textsuperscript{12,13} and several countries of eastern Europe\textsuperscript{14,15} demonstrating a very similar problem. All of these studies together suggest that there is a large area in eastern Europe and Turkey with endemic sequelae of environmental asbestos exposure. Prerequisites for these sequelae are the location of a village inside a serpentine zone and the household use of local soil containing asbestos.

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Detailed maps of the areas where endemic PCs are found as well as plates showing the composition of the whitewash and other materials from the different areas described in the text are available from the authors upon request.

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