CHARACTERISTICS OF LUNG-RETAINED COAL DUSTS RELATED TO MORPHOLOGICAL AND CLINICAL FINDINGS

M. DOBREVA • T. Burilkov • K. Kolev

Institute of Hygiene and Occupational Health, Medical Academy, Sofia Bulgaria

The role of the coalrank, quartz and other mineral admixtures in the pathogenicity of coal dusts is still not sufficiently elucidated. The relationships, established for coal sorts in definite coal fields are not always confirmed in others. Some authors give priority to quartz and the other mineral admixtures as determinants of the dust fibrogenicity, but others stress the coalrank itself.[1,3,10,14,15]

In the oldest coal field in Bulgaria—the Pernik one, in which brown coal has been extracted as long ago as since more than 100 years mainly by underground mining, clinical cases of coal dust pneumoconiosis have still not been detected up to now.[2] The field is set up of four strata with clay interlayers between them, situated in clay marl. The micropetrographic coal composition included mainly humanit and vitrinit—about 53–58% and mineral admixtures, mainly clay and quartz—22–43%. Since the last 20–30 years, intensive methods of extraction were introduced, which resulted in comparatively high dust concentration in the air of the mine.

The quartz content in the airborne dust was varied in a wide range, being in the total dust 7%, in average, and in the respirable fraction—4%.[9]

Taking into consideration the comparatively high dust concentrations with significant quartz content in the air of the mine, it becomes difficult to explain the absence of pneumoconiosis cases among the exposed workers.

The purpose of this investigation was to examine the quantity and composition of the lung dust of deceased exposed miners from the above mentioned coal field and to establish possible changes in their lung morphology. So we hoped to make a contribution in the elucidation of the pathogenicity of the dust from this coal field.

MATERIALS AND METHODS

A post mortem study of the morphological lung changes and the lung dust from 23 miners with continuous dust exposure (up to 30 years) in the Pernik coal field, but without clinical and radiographic data for pneumoconiosis while still livinq, was performed. The average life continuance of the investigated cases was from 32 to 79 years, all deaths under the age of 50 being due to labour or other accidents. The lung dust was isolated by the formamide-digestion method after Thomas and Stegemann. A constant weight of dust at 105° and the residue after ashing at 600° was determined.

The free crystalline silica content was determined hy the spectrophotometric micro-method according to Polezhaev[4] and I-R-spectrophotometry,[11] the total silica quantity—by the method of Peregut and Gernet.[12]

For histological evidencing of collagen the method of Holusa was applied.[8]

The integral half-quantitative assessment of dust-related morphological changes and the extent and severity of lung fibrosis, in particular, was performed by the scoring system of Kolev[5] for the following indices: interstitial fibrosis, type and extent of granulatoma, hyalinization in nodules and conglomerative masses, presence and dissemination of aceptic necrosis, etc. According to this system, the maximum score of 24—rarely up to 28, is obtained at the presence of exclusively severe fibrosis, while the scores from 1 to 7 correspond to negligible reactions of the lung parenchyma to the lung dust retained in it, without relevant collagenogenesis.

RESULTS

According to the length of the exposure, the cases under study were divided into four groups: group I—2 cases with exposure up to 10 years, group II—from 10 to 20 years and group III—from 21 to 30 years. In group IV, 4 cases with unknown length of exposure were included. The data obtained in the examination are shown in Table I.

The quantity of the isolated lung dust was varying between 0.8 and 9.1 g. For the cases of the group I it was under one g., for those of group II –2.8 g in average, for group III –3.9 g and for group IV—5.3 g.

The residue after ashing at 600°C for all investigated cases was varying from 34 to 62%, the total silica content—from 11.2 to 40.5, in average 22.6%, whereas the free crystalline silica content—from 2.9 to 10.7%, or 6.1% in average.

The absolute quantity of quartz in lungs for the two cases with comparatively short exposure period (up to 10 years) attained an average of 38.3 mg, or 22.5 mg/100 g dry tissue. For the two groups of longer exposure, significantly greater quartz quantities were found: for the group II—176.8 mg total quantity or, 110.4 mg/100g dry tissue; for group II—261.9 mg and 145.9 mg/100 g dry tissue; and group IV—404.0 mg or 140.1 mg/100 g dry tissue. At calculating the mean quantities in group II for both total lung dust and quartz, one case which was drastically different on the background of the other cases, was excluded.

Pathoanatomic Findings

In 14 of the lungs investigated macroscopic and microscopic

Table I

Characteristics of Dusts, Extracted from Coalminers Lungs, Post Mortem

Length of exposure years	Number of cases	Total quantity of dust, g average	Quartz content in dust % average	Quartz content mg/100 g dry tissue from... to	Quartz content mg/100 g dry tissue average	Grade of morphological changes
<10	2	0,85	4,5	20,5- 25,0	22,5	3, 4
from 11 to 20	8	2,8	6,6	28,3-156,1	110,7	3, 5, 5, 4, 5, 5, 4, 6
from 21 to 30	9	4,1	6,2	34,7-314,5	145,9	3, 1, 4, 3, 3, 5, 3, 4
unknown	4	5,3	7,9	80,8-190,7	140,1	5, 5, 5

signs of bronchitis with different severity and cell-proliferation in the interalveolar septa were seen. The nonhomogeneity of the distribution of the changes in both lungs as well as the involvement of the pleura with dust accumulations under it, should be noted. The dust was situated peribronchially, perivascularly and septally, only few dust granuloma being seen. No enlargement and confluence of lymph nodes was observed, in spite of the significant quantity of centrally situated dust, found both in macrophages and extracellularly—in an irregular net of collagen fibers.

According to the accepted scale for integral assessment of the dust-related morphological changes the cases were given estimates from 1 to 5 (with the exception of one i.e., in general the changes were assessed as poor.

Clinical data

While still living, neither of the cases was found to be carrier of dust-related disease. In three of them, after being pensioned off, severe bronchitis with respiratory and cardial insufficiency were established.

The cases under 50 y. died on occupational or other accidents and the rest of the cases—on different nonoccupational diseases, mainly of the cardiovascular sphere.

DISCUSSION

The data obtained in the present study showed great individual differences in the lung dust quantity for miners with approximately the same exposure—a finding, reported also by other authors.

The dust quantity and its ashed content, as well as the quartz content found in the lungs we investigated, was significantly lesser as compared with that found by other authors in the lungs of coal miners with manifested fibrosis changes.[1,6,7,13] This fact could be explained by the lower dust concentrations in the mines of the Pernik coal field, or to the lesser aggressiveness of the dust, leading most probably to a better clearance.

In support of the last explanation comes the fact that the difference in the lung dust quantity, accumulated in the groups of subjects with 10–20 and 20–30 year exposure were comparatively small—a little more than 1g of dust. On the other hand, in 10 of the cases the quartz quantity per 100g dry tissue exceeded that established by Einbrodt and Klosterkötter[6] and confirmed by other authors[5,7] critical level—150 mg, at residence time more than 30 years.

The clinical pathological data showed that the exposure to brown coal dust in the Pernik coal field, regardless of its continuance, did not lead to significant changes of fibrosis nature. The comparatively frequent morphological findings in the bronchial tree have no clinical correlate or are diagnosed as simple, non-obstructive dust-related bronchitis.

The score system we used for assessment of dust-related changes in the lungs allows a semi-quantitative categorization of the findings with good recurrence. The values obtained were between 3 and 5. Nevertheless, this study showed that when used for estimation of the reaction to non-fibrogenic dusts it is necessary for indices concerning the condition of the bronchial three to be added. The lung changes in the cases we studied differ and are more favourable than the described in literature "simple pneumoconiosis" in coal miners in FRG, Great Britain, France and USA. On the other hand, the dust quantity does not exceed that, corresponding to the 0 criterion in the coal fields mentioned above.[5,6,13 etc.] That's why, our hypothesis that the dust from the Pernik coal field is less harmful as compared with similar sorts of coal dust from other coal fields should be confirmed by further experiments.

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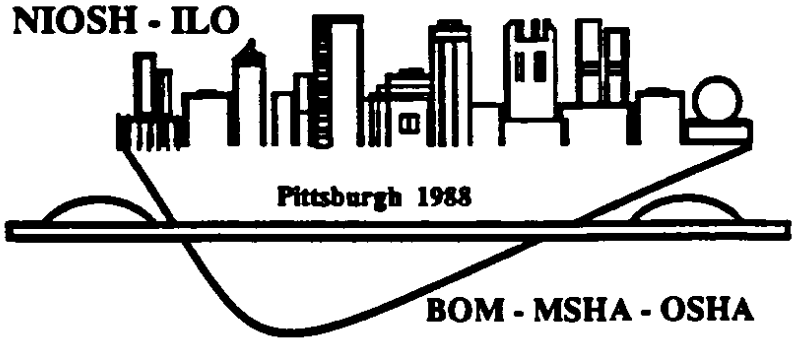
Proceedings of the VIIth International Pneumoconioses Conference *Part*
Transactions de la VIIe Conférence Internationale sur les Pneumoconioses *Tome*
Transaciones de la VIIa Conferencia Internacional sobre las Neumoconiosis *Parte*

II



Pittsburgh, Pennsylvania, USA—August 23–26, 1988
Pittsburgh, Pennsylvanie, Etats-Unis—23–26 aout 1988
Pittsburgh, Pennsylvania EE. UU—23–26 de agosto de 1988

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November 1990

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DHHS (NIOSH) Publication No. 90-108 Part II