Fuller's earth (montmorillonite) pneumoconiosis

A R Gibbs, F D Pooley

Abstract

A fuller's earth worker developed signs of pneumoconiosis. Pathological examination of the lung tissues showed interstitial collections of dust laden macrophages associated with mild fibrosis. Mineralogical analysis showed a high content of montmorillonite. This study shows that a pneumoconiosis can result from prolonged heavy exposure to calcium montmorillonite (fuller's earth) in the absence of quartz. The disease is relatively mild and associated with little clinical disability.

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The term fuller's earth has been used in a general sense for clays or fine grained materials that have adsorptive properties and has included calcium montmorillonite, sodium montmorillonite (bentonite), and attapulgite. Pneumoconiosis associated with exposure to fuller's earth has been described rarely and in these reports the role of quartz has been questioned.¹ Four cases of pneumoconiosis associated with fuller's earth pneumoconiosis with full postmortem examinations have been described and these were all in workers from Redhill, Surrey, England.²⁻⁵ The Redhill deposit of fuller's earth consists of calcium montmorillonite with a very low quartz content, which comprises about 0.8% of the milled product.⁶

We describe the postmortem pathological and mineralogical findings of the lungs from a subject who had developed pneumoconiotic changes after more than 40 years exposure to calcium montmorillonite at Combe Down, Bath, England. He had worked mainly in the drying and bagging section. The purpose of the study was to clarify the respective roles of montmorillonite and quartz in the pathogenesis of the pneumoconiosis.

Case history

The subject, a cigarette smoker, came to post-mortem examination at the age of 73 years. The cause of death was given as acute gastrointestinal haemorrhage from a benign gastric ulcer. For three years before death he had complained of shortness of breath. A chest radiograph taken two years previously had shown bilateral fine reticulonodular shadowing. A few weeks before he died he was admitted to hospital because of severe breath-

lessness. On examination crackles were heard at both lung bases. A chest radiograph at this time showed a slight increase in the reticulonodular opacities and a mass at the left hilum and apex (fig 1). No detailed lung function studies were available. When in hospital he died suddenly.

PATHOLOGY

At postmortem examination the lungs showed numerous soft stellate grey-black dust lesions 4-5 mm in diameter that occupied most of the lung lobules. No lesions of progressive massive fibrosis were seen. There was also severe centrilobular emphysema and a 4 cm diameter tumour arising from the bronchus of the left upper lobe. Microscopic examination of the lungs showed numerous interstitial collections of brownish green dust laden macrophages situated around the respiratory bronchioles together with some free dust (fig 2). These collections extended out from the respiratory bronchioles along the adjacent alveolar septa. Some of these lesions linked up with similar lesions from adjacent lobules. There was a slight degree of fibrosis associated with these dust lesions. Polarisation showed strongly birefringent particles. The tumour was a poorly differentiated adenocarcinoma containing giant cell areas.

Figure 1 A chest radiograph showing a mass in the upper zone of the left lung and bilateral reticulonodular shadowing.

Department of
Histopathology and
Environmental Lung
Disease Research
Group, Llandough
Hospital, Penarth
South Glamorgan
A R Gibbs

School of Engineering,
Division of Materials
and Minerals,
University of Wales,
Cardiff
F D Pooley

Correspondence to:
Dr A Gibbs, Department of
Histopathology, Llandough
Hospital NHS Trust, Penlan
Road, Penarth, South
Glamorgan CF64 2XX.

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Figure 2 Light microscopy of the lungs showing interstitial collections of dust laden macrophages with slight fibrosis.

Figure 3 x Ray diffraction patterns of the dust residue showing montmorillonite.

MINERAL ANALYSIS
Mineral analysis was performed on a pooled sample of wet lung tissue obtained from the apical upper, apical lower, and basal segments of the right lung. The tissue was removed by a digestive technique with potassium hydroxide⁷ to leave a dust residue for examination. The concentration of dust in the lung was calculated from the dust residue as 127.9 mg/g of dried tissue. This dust residue was subjected to mineralogical analysis by both x ray diffrac-

tion and analytical transmission electron microscopic techniques with the following results.

x Ray diffraction patterns of the dust residue showed a poorly crystalline material the pattern of which closely resembled that of several montmorillonite standards, including a sample obtained from Combe Down (fig 3). Examination of the peak intensities and positions in the diffractometer trace confirmed that the dust extracted from the tissue specimen was mainly montmorillonite. No other mineral could be identified. Examination of the extracted dust in the analytical transmission electron microscope showed that the dust particles consisted of aggregates of micro-crystalline plate like material very similar in morphology to montmorillonite reference materials. The table shows chemical analysis of the dust extracted and a montmorillonite standard. From this table it can be seen that the chemistries of the two materials are similar, with the exception of an excess of calcium in the reference standard used. The montmorillonites are well known for their ion exchange properties and ease of substitution of ions such as potassium and sodium for calcium. A preparation of the montmorillonite standard in a solution containing potassium hydroxide that was used to prepare the tissue specimens produced an exchange of potassium for calcium ions in the mineral. The dust extracted from the lung tissue specimen was confirmed as being a montmorillonite mineral. Other minor components relating to general atmospheric dust exposure were detected in the extract, but there was not enough to quantify.

Discussion
The mineralogical findings of the dust obtained from the postmortem examination of the lung tissues indicate that a pneumoconiosis can result from exposure to montmorillonite in the absence of quartz. Fuller's earth from Combe Down consists of calcium montmorillonite and does not contain free silica. The considerable dust load in the lung was mineralogically similar to that of the mining product.

From the previous case reports of post-mortem examinations from the Redhill deposit and the present case the pathological changes of calcium montmorillonite (fuller's earth) pneumoconiosis seem to be characterised macroscopically by grey black stellate nodules and microscopically by centrilobular interstitial collections of brown dust laden macrophages associated with slight fibrosis. These pathological changes are similar to those described in other silicate pneumoconioses such as kaolin, mica, and talc.^{8,9}

The emphysema, lung carcinoma, and benign gastric ulcer were probably caused by cigarette smoking and were unlikely to have been related to the presence of pneumoconiosis.

It seems from the few reliable case reports available that fuller's earth pneumoconiosis is

Results of chemical analysis of the dust residue and montmorillonite standard (not including water of crystallisation)

	MgO	Al ₂ O ₃	SiO ₂	K ₂ O	CaO	TiO ₂	FeO
Dust extracted from tissue specimen	3.6	20.38	61.5	3.8	0.26	2.06	8.38
Montmorillonite standard	3.12	15.87	63.5	1.21	3.28	1.57	11.46

associated with little clinical disability and the radiological changes have been found only after prolonged exposure to dust, usually in excess of three decades.

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