Case reports

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Pneumoconiosis and systemic sclerosis following 10 years of exposure to polyvinyl chloride dust

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Abstract

The case history is presented of a 58 year old man who was exposed to thermoplastic dusts, mainly polyvinyl chloride (PVC), for 10 years. Radiography and high resolution computed tomographic scans of the lungs suggested both pneumoconiotic and scleroderma-like lesions. Trans-bronchial biopsy revealed foreign body granulomas with macrophages laden with birefringent inclusions which ultrastructurally resembled PVC dust. Biopsy samples of thickened skin showed histological evidence of extensive fibrosis. During follow up Raynaud's phenomenon and oesophageal involvement developed. The antinuclear antibody titre was 1:640, and the Scl-70 subset was positive. It is concluded that exposure to PVC dust may cause pneumoconiosis and secondary systemic sclerosis.

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Keywords: pneumoconiosis, systemic sclerosis, polyvinyl chloride, occupational diseases.

Pneumoconiosis induced by exposure to polyvinyl chloride (PVC) was first documented by Szende *et al*¹ who described foreign body granulomas in a 31 year old man. Arnaud *et al*² reported identical histological findings and demonstrated ultrastructurally that the particles accumulated within macrophages were PVC powder. Studies of work forces exposed to PVC dust have demonstrated an increased prevalence of pneumoconiotic chest radiographic abnormalities.^{3,4} However, for these studies lung tissue was not microscopically assessed. Cordasco *et al*⁵ reported digital angitis resembling Raynaud's phenomenon in a patient with PVC-associated lung disease. Ward *et al*,⁶ when investigating a PVC plant, documented an increased prevalence of antinuclear antibodies. An increased incidence of systemic sclerosis has been noted in pneumoconiosis among coal workers.⁷ However, we are unaware of any report of coexisting pneumoconiosis and systemic sclerosis due to exposure to PVC.

Case report

A 58 year old man was admitted with a six month history of exertional dyspnoea and fatigue. He had smoked five cigarettes a day for 30 years. Over the preceding 10 years he had worked in a plastic reutilisation plant, operating a plastic mill. He had to feed and clean this poorly ventilated plastic mill up to five times a day, either by hand or with the use of pressurised air. Given the repeated milling of PVC material, dust particles in the micrometre range were dispersed in the air, especially during cleaning. Altogether this resulted in approximately two hours per day exposure to PVC dust either by inhalation or dermally. On clinical inspection skin thickening of the forearms, hands, and fingers was observed. During follow up progression of skin thickening to the trunk and face was noted and microstomia developed. Flexion contractures of the fingers were present and the patient became unable to close his fist. Additionally, periungual telangiectasia appeared.

The chest radiograph showed a nodular pattern in the upper zones. High resolution computed tomographic (HRCT) scanning showed a pattern of nodules with increased density and predominance in the upper lobes (fig 1) and thickened intralobular septal lines ("parenchymal bands"), subpleural cysts and traction bronchiectasis in the lower lobes. A second HRCT scan 12 months later showed progression of the scleroderma-like lesions. Lung function recorded over the same time interval

Figure 1 High resolution CT scan from upper lung showing bilateral nodular opacities.

Figure 2 (A) Lung biopsy specimen showing foreign body granuloma with birefringent inclusion bodies. Stain: haematoxylin and eosin, original magnification $\times 200$ reduced to 83% in origination. (B) Electron micrograph of pulmonary macrophage with intracytoplasmic inclusions (arrow) resembling polyvinyl chloride dust. Original magnification $\times 4000$ reduced to 83% in origination.

also indicated deterioration of restrictive impairment. Total lung capacity at the first visit was 5.65 l (98% pred) but 12 months later was only 4.27 l (75% pred). Measurements of forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) showed only mild obstruction (FEV_1 1.72 l (54% pred), FVC 2.35 l (59% pred)), and FEV_1/FVC 73%. Bronchoscopic examination revealed narrowed bronchial segments due to submucosal thickening. Histological evaluation of haematoxylin and eosin stained transbronchial biopsy specimens demonstrated foreign body granulomas and fibrotic changes in the alveolar walls. Within granulomas macrophages containing birefringent and other inclusions were found (fig 2A). The Sudan IV stain demonstrated positive deposits within some of these granulomas as previously reported for PVC exposure.⁸ Electron microscopic examination revealed in-

clusions within macrophages, as noted for PVC-associated pneumoconiosis (fig 2B).²

Skin biopsy specimens were taken from the forearm and fingers and extensive fibrotic changes were described. During follow up acral oscillography and thermography indicated Raynaud's phenomenon. Oesophageal dysmotility was documented with manometry. In the serum the antinuclear antibody (ANA) titre was 1:640, with a positive subset for Scl-70. All other ANA subsets, including SS-A, SS-B, Jo-1, nuclear RNP, and anticentromere antibody, were negative.

Discussion

Only a small number of PVC-induced pneumoconioses so far reported have been histologically described. All demonstrated a granulomatous reaction with macrophages containing inert material. These observations of PVC-induced pneumoconiosis in humans are corroborated by animal studies. Frongia *et al*⁹ reported the same granulomatous lesions in animals kept in the packing area of a PVC plant. In epidemiological studies on PVC exposure radiographic evidence of pneumoconiotic lesions has been reported. Lilis *et al*⁸ examined 985 workers in three PVC production plants with different industrial hygiene standards and reported a 4.3%, 19.4%, and 22.7% prevalence of abnormal chest radiographs. Soutar *et al*⁴ reported a 6.1% incidence of small rounded opacities in 818 workers exposed to PVC dust.

Following exposure to PVC localised scleroderma-like lesions are reported and a "vinyl chloride disease" has been described.⁵ However, to our knowledge PVC-induced systemic sclerosis with a positive Scl-70 subset has never been reported. Our patient had a skin biopsy specimen compatible with systemic sclerosis, and the transbronchial biopsy specimen showed thickening of the alveolar walls. HRCT revealed pneumoconiotic lungs and scleroderma-like lesions. An association has been reported between systemic sclerosis and silica-induced pneumoconiosis,⁹ and between silica-associated scleroderma and Scl-70 autoantibodies.¹⁰ One of the hypotheses to explain environmentally-induced scleroderma is the presence of non-digestible particles within macrophages. These activated macrophages might stimulate fibroblasts in the lungs, and possibly the skin, to produce excess collagen by releasing growth factors. Non-digestible particles within macrophages have been found in all cases of PVC-associated pneumoconiosis, including our own. In summary, whilst it is possible that this patient had two separate and unconnected diseases, the simultaneous development of systemic sclerosis and pneumoconiosis leads us to conclude that both diseases occurred as a result of exposure to PVC.

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Occupational asthma caused by dry metabisulphite

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Abstract

A case is described of occupational asthma in a worker with no previous history of asthma who sprinkled dried metabisulphite powder onto potatoes and developed work-related symptoms. Occupational asthma was confirmed by specific inhalation challenges.

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Keywords: asthma, occupational diseases, bronchial provocation test, bronchial hyperreactivity.

Sensitivity to oral metabisulphite is well known to occur in asthmatic subjects.^{1,2} Asthma and occupational asthma due to inhaled metabisulphite appears never to have been described.

Case report

A 27 year old man who had been working for 3-4 weeks for an agricultural producer developed respiratory symptoms. He was responsible for cleaning potatoes with water and sprinkling them with dried metabisulphite sodium powder. His symptoms included swelling, itching, redness and running of the eyes, nasal congestion and sneezing, with nausea and shortness of breath as soon as he was exposed to metabisulphite. He was asymptomatic in the evenings and at weekends. He paid three visits to an emergency department where a diagnosis of work-related toxic or allergic reaction was suspected. He was assessed six months after being away from work. He reported no nasal respiratory symptoms. Personal and familial atopic history was negative. He had never smoked. Chest auscultation and radiography were normal. Skin prick tests with 15 common

inhalants as well as with diluted metabisulphite (0.1 mg/ml, 1 mg/ml, and 10 mg/ml) were negative. Although baseline forced expiratory volume in one second (FEV₁) was reduced (3.4 l with a predicted value³ of 4.7 l or 72%), the FEV₁/FVC ratio (3.4/4.4, 77%) was normal. The provocative concentration of methacholine causing a fall of 20% in FEV₁ (PC₂₀)⁴ was >128 mg/ml – in other words, showing no significant bronchial hyperresponsiveness.⁵

Specific inhalation challenges were performed by exposing the subject to metabisulphite in powder form at 10% and 1% (respectively 10 g or 1 g of metabisulphite powder mixed with 90 g and 99 g of lactose powder) on two occasions separated by a two month interval, using previously described methods.^{6,7} Control exposure to lactose for 30 minutes did not cause significant changes in FEV₁ in the minutes or hours after exposure. As shown in the figure, on each exposure to dry metabisulphite maximum falls in FEV₁ of 35% and 52% were elicited 10 and 60 minutes after exposure periods of 35 seconds and four minutes. There were no late reactions and PC₂₀ was >128 mg/ml seven hours after exposure ended. Exposing a control normal subject (PC₂₀ >128 mg/ml) to metabisulphite 10% for a total period of 30 minutes did not cause any significant change (<10%) in FEV₁ in the fol-

Results of specific inhalation challenges with lactose and metabisulphite. BDT=inhaled β_2 adrenergic agent.

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