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Asthma due to grinding epoxy resin cured with phthallic anhydride

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Summary

A man developed asthma after grinding epoxy resin moulds made from bisphenol-A, with phthallic anhydride as a hardener. He was shown to have a dual asthmatic response after the inhalation of phthallic anhydride fumes. It is postulated that his asthma was caused by the release of phthallic anhydride during the grinding of cured mouldings.

Introduction

Cured epoxy resins are tough and durable. They are used in industry to make adhesives, moulded resins and reinforced plastics. The uncured resin is converted into the final product or 'cured' by the addition of a curing agent or hardener. Molecules of hardener bond with adjacent molecules of resin polymer to form a hard solid plastic. Phthallic anhydride is often used as a curing agent in this process. Asthma caused by hypersensitivity to phthallic anhydride has been described after inhaling fumes given off during mixing resin with hardener and after handling pure phthallic anhydride (Chester *et al.*, 1977; Fawcett, Newman Taylor & Pepys, 1977). However working with cured resin has not been recorded as a cause of asthma.

We describe asthma occurring after grinding cured resin which we believe to be due to release of phthallic anhydride during grinding.

Patient and methods

Case Report

A 48-year-old man first had mild asthma as a schoolboy but became symptom free by the age of 14. He began work in 1961 grinding metals and solid plastics in a workshop in a university engineering department. Plastic moulds were made in another part of the building by mixing resin with phthallic anhydride and then ground by him to make a perfect shape. He usually did this dry and without exhaust ventilation. He began to

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complain of rhinitis and nasal blockage in 1962 and nasal polyps were removed on four occasions between 1962 and 1964. He has used a corticosteroid nasal spray for the past 3 years and his nose is clear.

Asthma returned in 1968 but remitted spontaneously in 1971. It recurred in a more severe form in 1978. Initially he improved on inhaled beclomethasone but be became worse in 1980 and required daily prednisolone to control symptoms.

He noticed that he became very wheezy when he ground plastic moulds made of Araldite but had no reaction after grinding perspex. He was always well on holiday. The Araldite moulds were made from bisphenol-A epoxy resin and phthallic anhydride as a hardener. He has now stopped grinding Araldite and, although he is still in the same building, he seldom wheezes, his symptoms being controlled with reducing doses of inhaled corticosteroid alone.

Investigations

Skin prick tests with house dust mite, cat, dog, rabbit and *Aspergillus fumigatus* extracts gave positive reactions. Serum precipitins against *A. fumigatus* were not present. The chest radiograph was normal. The following inhalation tests were made on consecutive Monday mornings:

(1) inhalation of cured resin dust. The dust was tipped from one tray to another in a closed chamber for 15 min;
(2) inhalation of fumes from heated uncured resin—five breaths;
(3) inhalation of fumes from heated phthallic anhydride flake—one breath; and
(4) inhalation of fumes from heated phthallic anhydride flake—five breaths.

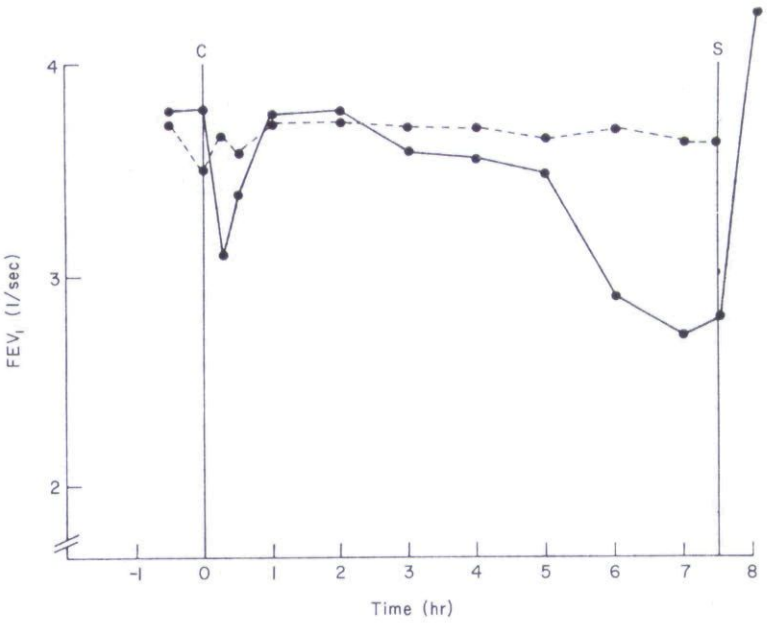


Fig. 1. Inhalation test (C) with five breaths of heated resin (●– – –●) and five breaths of heated phthallic anhydride (●———●). Salbutamol given at end of test (S).

Results

There were no symptoms and no change in FEV_1 or FVC and after Tests 1, 2 and 3. Fifteen minutes after taking five breaths of phthallic anhydride fumes (Test 4) he developed a cough and wheeze and the FEV_1 fell by 20%. He recovered after 1 hr but symptoms recurred after 5 hr and the FEV_1 fell by 25% at 6 hr (Fig. 1). He was then given nebulized salbutamol which produced prompt bronchodilatation. For 4 days afterwards his asthma, which had been in remission, was very much worse, especially at night time when he had difficulty in sleeping.

Discussion

The patient had a dual response after inhaling phthallic anhydride. The immediate and non-immediate reactions occurred after 1 and 5 hr respectively and were followed by recurrent asthma for the next 4 nights. Recurrent late attacks have been described after single exposure to such allergens as western red cedar, grain dust, penicillin and formalin (Newman Taylor *et al.*, 1979). After the tests he realized that his symptoms conformed to the pattern of asthma which he had in 1980 with wheezing soon after starting work, followed by improvement and recurrence in the afternoon.

He had been grinding plastics since 1961 but only had asthma between 1968 and 1971 and between 1978 and 1980. We have been unable to find out whether phthallic anhydride was used as a hardener throughout this time or only at certain periods. It may be that he only became sensitive in 1978 after working with it for 17 years for it is known that sensitization to phthallic anhydride may take up to 20 years (Chester *et al.*, 1977).

Although asthma due to phthallic anhydride is well recognized after exposure during the curing process (Fawcett *et al.*, 1977), asthma after working with cured resin has not been reported. In an epoxy resin system a curing agent reacts with resin to form bonds between adjacent resin molecules to produce a solid. The amounts of resin and hardener are weighed in an attempt to reach equality between the number of reacting curing groups and the number of epoxy groups so that the amount of free unreacted hardener in the plastic is reduced to a minimum. Even so some unreacted curing agent may be trapped within the cured resin and be released during grinding (Bourne, Milner & Alberman, 1959; Dernehl, 1963).

Heat generated at the grinding interface may also lead to disruption of bonds between resin and hardener and release of phthallic anhydride vapour. He did not get asthma from prepared Araldite dust in the laboratory presumably because phthallic anhydride is only released during grinding.

He is not exquisitely sensitive to phthallic anhydride because one breath of vapour failed to produce a reaction. This may be why he is able to continue working in a large workshop, where moulds are still being prepared and ground, without getting asthma. He has symptoms only when he does the grinding himself.

The belief that cured resins are safe is evidently incorrect, and grinding may liberate hardener and cause sensitization.

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