

Brewer's asthma due to malt contamination

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We describe a case of a 28 year old brewery worker who developed asthma whilst grinding malt. Lung function measurements demonstrated deterioration and improvement in lung function associated with work and absence from work. Inhalation challenge with ground malt from the brewery was positive but with ground malt from another source was negative suggesting a contaminant of the malt was responsible. Culture of the brewery malt showed heavy contamination with *Aspergillus niger*, but *A. niger* skin test was negative and aspergillus-specific IgG was not detected in the patients serum. Removal of the subject from the grinding room resulted in resolution of symptoms and normal lung function. We discuss the role of *A. niger* as an aetiological agent for occupational asthma with reference to the above case.

Key words: *Aspergillus*; asthma; brewery; malt.

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INTRODUCTION

Aspergillus niger is well known as the black mould often found in damp places and is a ubiquitous fungal spore. Like other *Aspergillus* species it can resist the human lung's defences and not infrequently can be cultured in human sputum.¹ *A. fumigatus* is a more frequent pathogen presumably because it is most prevalent in air, especially in winter when spore counts may reach 60 per m³.¹ *A. niger* on the other hand is found in the air at an average concentration of less than five spores per m³. However, asthma due to *A. niger* has been described in the biotechnology industry where the fungus was used to produce citric acid from fermentation of molasses and spore concentrations were unusually high.² We present a case of occupational asthma due to *A. niger* in a brewery worker where exposure took place whilst grinding malt.

Case history

A 28 year old male was employed as a brewer with a commercial brewery which he joined in 1988. A routine pre-employment screen documented no history of respiratory or asthmatic problems or atopic disease.

He remained well and his sickness absence over the ensuing years was unremarkable. In July 1995, as part of an health screen introduced by the occupational health physician (PMcC), the MRC respiratory questionnaire was administered by interview and peak flow was measured. He gave no history of specific respiratory symptoms; however, his peak flow was noted to be reduced at 276 l/min (47% predicted) and further reduced to 160 l/min (27%) when repeated 4 weeks later. Spirometry was performed which confirmed air-flow obstruction [FEV₁ 2.55 (61% predicted Cotes normal), FVC 4.27 (102%), ratio 60%] and repeat spirometry 1 week later when he attended for examination by the occupational health physician was also obstructive [FEV₁ 2.0 (48%), FVC 4.16 (99.5%), ratio 48%]. At that time he was noted to be well with normal chest examination. He had never smoked cigarettes and had a 5 year old son recently diagnosed as having asthma. He had no allergies, was on no regular medication and had no significant past medical history. At this stage the subject left work for a period of 5 months (June to October 1996) to attend a computer course outside the brewery and he noticed at that time that his chest felt significantly better. The symptoms which improved and which he had regarded as normal consisted of shortness of breath on exertion and mild wheeze. He also had a dry cough with no history of temperature or fever. In retrospect, he commented his chest symptoms got worse after he left work and went home. He returned to work in October for a week and

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again he noticed that his chest symptoms recurred. He was placed on sick leave and referred for assessment at the local chest clinic which he attended 1 month later.

The brewery concerned produces three beers using lager malt, crystal malt and ale malt. These are generically identical, the difference being that the individual malts are roasted for different periods. The roasting takes place in a different site and the different malts arrive in tankers and are piped into the grinding room. In the grinding room, the malt is ground (a particularly dusty process), then mashed and mixed with yeast and boiling water and fermented for two or three days. Copper filings are added to enhance sedimentation of solids in the beer and it is subsequently filtered using filter powder (calcinized diatomaceous earth). Hop powder (in pellet form) is added followed by carbon dioxide and the finished product is then piped to tankers for transport. Apart from the malt grinding, the whole beer producing process is sealed, in particular the addition of the yeast to the beer. During his first one and a half years in the brewery the subject worked in the mill room where the malt was ground. During his subsequent years, he worked in a variety of jobs including brewing process operator, evaporator operation and tank washing, filtration, beer rundown and cold storage and tanker filling and off-loading. At the time of presentation, he was again working in the grinding room and had been for 3 months and was in fact doing double shifts due to a local surge in popularity of one of the brewery products. At that time, five grinds of 5 hours duration took place per week with each grind processing 23 bags of malt each weighing 32 kg. During the grind, he wore a mask (European single use 3M disposable dust/mist respirator, code no. 8810) which was changed at the end of each grind. He did not wear a mask during his initial period in the grind room.

At his initial assessment at the chest clinic, the above history was confirmed and on clinical examination he was noted to be well and his chest was clinically clear to auscultation. His spirometry demonstrated an FEV₁ 3.74 (89%), FVC 5.06 (99%). The history and improved spirometry away from work was suggestive of some occupational sensitization. It was felt the malt was most likely as it was powderized on site and was a dusty process. Other agents — notably the yeast — were considered as possibilities; however, the mixing of the yeast and the malt was a sealed process and less likely to generate airborne dust.

Investigation

Full blood count, biochemical screening and ESR were normal. Total IgE was normal (55 KU/l, [normal > 7 y < 120 KU/l]) and specific IgE measured by radio-allergosorbent test (RAST) to cat epithelium, dog epithelium, house dust mite, mixed grass pollens and malt were negative. Arrangements were made to perform 2 hourly peak flows for one week while the patient

was still away from work and on his return to work in the grinding room for the subsequent week (Figure 1). After return to work his symptoms returned associated with reduction of peak flows throughout the day with marked diurnal variation.

The negative RAST to malt suggested that the reaction may have been due to some other agent inhaled with the malt and bacteriological analysis of the malt was performed. Direct examination demonstrated fungal spores and subsequent quantitative culture demonstrated *Aspergillus niger* with 8×10^4 colony forming units/g of ground malt. Analysis of the subjects' serum was performed to look for *Aspergillus*-specific IgG against *A. Fumigatus*, *A. niger*, *A. nidulans*, *A. terreus*, *A. clavatus* and *A. versicolour*. Gel diffusion was positive for *A. nidulans*, however subsequent ELISA was negative for *Aspergillus*-specific IgG. Skin prick testing for *A. niger* using both somatic antigen and *A. niger* culture filtrate was negative.

In view of the fact that there was no immunologic evidence of sensitization to either malt or *A. niger*, an inhalation challenge was performed (Figure 2). Initial challenge was performed with ground malt from the brewery which consisted of the subject slowly emptying a small amount of ground malt from one container

Figure 1. (1a) peak flow recordings performed every 2 h away (continuous line) and at (broken line) work (malt grinding). (1b) daily maximum, minimum and median peak flow recordings performed every 2 h away and at work (malt grinding).

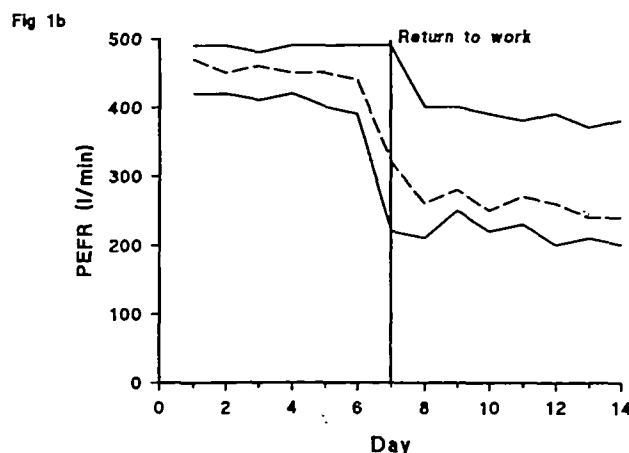
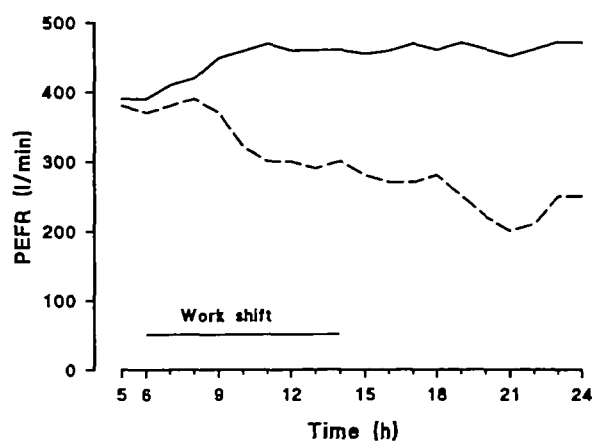
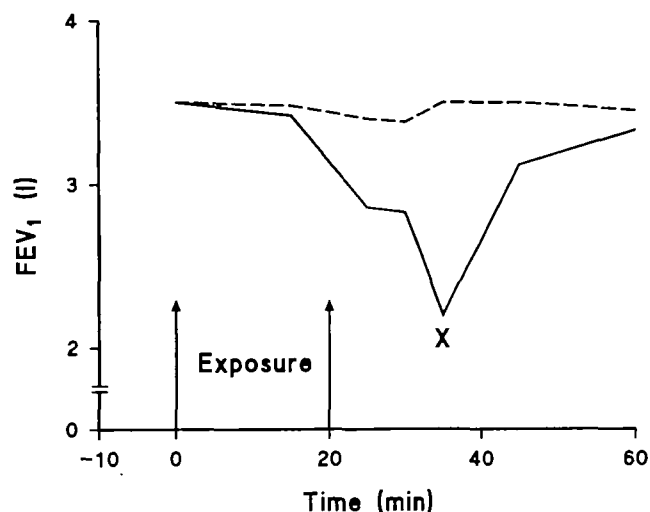


Figure 2. Inhalation challenge with malt plus *Aspergillus niger* (continuous line) and malt alone (broken line) performed on separate days. Inhaled β_2 -agonist was given at time X due to subject discomfort preventing follow-up for late reaction.



to another in an enclosed chamber. The subject was clear that this generated less airborne malt than in the workplace. Placebo challenge took place with ground malt provided from a different source which was pasteurized and spray cleaned, a process which removes all bacteriological contaminants including fungi. Culture of this malt showed no fungal growth. A placebo challenge with lactose powder was also performed to further exclude the possibility of a non-specific irritant reaction. No fall in FEV₁ was detected after lactose exposure.

Follow-up

The subject returned to work having been given duties which would not involve any exposure to ground malt. After 2 months' return to work he has remained well with occasional wheeze on exertion. Peak flow monitoring at work has demonstrated no evidence of airflow obstruction and spirometry at last review was FEV₁ 3.7 l (88%) FVC 4.7 l (92%).

DISCUSSION

Asthma has been described in brewery workers due to inhalation of chloramine,³ however, this is the first recorded case of asthma in a brewer due to malt grinding. There was evidence of deterioration and improvement in lung function associated with returning and leaving work respectively both in terms of peak flow monitoring and spirometry. The subject gave a clear history of symptoms directly associated with malt grinding thus implicating the malt or some component of the malt as the causative agent of his asthma. Further, this subject was the only exposed worker to demonstrate airflow obstruction whilst in contact with ground malt in the workplace which was strongly

against a non-specific irritant reaction.

The inhalation challenge demonstrated a significant fall in FEV₁ after exposure to ground malt powder contaminated with *A. niger* but not with malt alone. This is strong evidence that *A. niger* is the causative agent and it has been previously reported as causing occupational asthma.² The concentration in the implicated factory was recorded as 4.9×10^2 colony forming units/m³.⁴ Thus, the *A. niger* levels are compatible with sensitization. Sensitization to *A. niger* is not excluded by a negative skin test and lack of specific IgG. In the original description of asthma due to *A. niger* only nine of the 18 subjects diagnosed as having occupational asthma showed a positive skin test to *A. niger*.² An attempt to implicate another antigen in the factory proved inconclusive and this group concluded these subjects were sensitized to *A. niger* but lacked circulating specific IgE or that sensitization took place via a non-IgE mediated mechanism. The above study also demonstrated that RAST testing using a commercial *A. niger* preparation produced fewer positive results than with a preparation made from the *A. niger* culture fluid used in the factory. This suggests qualitative differences between different fungal extracts and is a further reason why immunologic testing in this subject could be negative. This qualitative difference has been documented before and is hardly surprising as fungal extracts are complex mixtures of different proteins containing many different antigens. Considerable antigenic variation has been documented with 10 different strains of *A. fumigatus*⁵ and subjects may respond differently to the various antigenic components in a given extract.⁵ It again demonstrates the danger in excluding a specific agent as the cause of occupational asthma on the basis of skin and serological testing alone.

This case also demonstrates problems with the use of questionnaires alone to assess respiratory symptoms. This subject denied any symptoms when questioned initially and it was only when he was removed from work that he retrospectively recorded an improvement in his chest. If further exposure had occurred, this subject may have become progressively more symptomatic and responded positively to a questionnaire. It supports the use of lung function measurements as part of an occupational surveillance programme and would suggest that in situations when any airborne dust is generated in the workplace surveillance should be routine and include lung function measurements.

A further study followed-up the workers in the biotechnology factory and concluded *A. niger* was a relatively weak antigen.⁵ During a period of no control, a low prevalence of asthma and sensitization occurred and with simple hygiene precautions (the aerosolizing process was enclosed, exhaust ventilation supplied and respirators used when access to the area necessary), no new sensitizations took place and three subjects lost their skin sensitivity to *A. niger*. No new cases of occupational asthma or work related symptoms were identified. Of note, in the original description, the

index case had worked at the factory for 10 years before presentation and our subject had been in the brewery with variable exposure for 8 years. This suggests a marked temporal delay between initial exposure to *A. niger* and presentation. In the current work environment, we would recommend that the workforce be informed about the risks and which symptoms to look out for. The malt grinding process should eventually be enclosed and measures employed (such as face masks) to avoid exposure in the grinding room.

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