

Diagnostic Tests in Allergy to Green Coffee

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Twenty-two coffee roastery workers with work-related symptoms of various degree from the eyes, nose or bronchi were tested with partly purified water-soluble extract from dust of green coffee beans (GCB). Eighteen persons had a positive prick test, eight a positive bronchial provocation test and seven a positive nasal provocation test. Fourteen had a positive methacholine test, indicating unspecific bronchial hyperreactivity. Specific IgE antibodies to GCB extract were found in sera of 11 workers and to castor bean (CB) extract in 16. The workers measured their lung function with an air flow meter, three times a day for 1 week, and the values were lower in the second half of the week for the workers with IgE antibodies to GCB, but not for the others. It is concluded that the case history, prick test, RAST, and simple lung function tests for one or a few weeks are the best tools when investigating occupational allergy. When the allergen is unknown, but the occurrence of an IgE-mediated allergy is suspected, serial lung function measurements and determinations of total serum IgE, in addition to taking a careful case history, are valuable methods with which to start the investigation.

Key words: castor bean; diagnostic test; green coffee bean; occupational allergy.

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CLINICAL ASPECTS

Twenty-two coffee roastery workers with allergic symptoms related to their work were investigated with the aim of finding the most valuable diagnostic test that would reveal sensitization. Allergen-specific tests, namely skin tests, bronchial provocation tests and RAST, and tests independent of the allergen, i.e. determination of total serum IgE levels, methacholine tests and serial lung function measurements, were performed. It is concluded that when occupational IgE-mediated allergy is suspected but the allergen is unknown, taking of the case history, measurements of total serum IgE and serial lung function tests are simple and reliable methods to start with. When the allergen is known, prick tests and RAST tests with a relevant extract should be added.

Workers in the coffee industry may develop occupational allergy to factory dust, the main allergens originating from green coffee beans (GCB) and castor beans (CB) (7, 8, 13, 15). In a previous paper we reported that about 40% of the coffee workers had symptoms at work, and in about half of the symptomatic subjects we found evidences of IgE-mediated sensitization (15). The aim of the present study was to evaluate and compare allergen-specific diagnostic tests such as skin tests, broncho-provoca-

tion tests and radioallergosorbent test (RAST), with tests for bronchial hyperreactivity in the diagnosis of occupational allergy.

MATERIAL AND METHODS

Twenty-two coffee roastery workers with work-related symptoms were investigated. They were three women and 19 men, 23-57 years of age (mean age 34.7 years), who had been employed at the roastery for 2-20 years (mean 8 years).

The most common symptoms were nasal congestion, sneezing and itching in the nose (reported by 20), and cough or wheezing in the chest (reported by 16). Furthermore, three complained of itching in the skin, one of sweating and one of burning in the throat. They had all noticed that dust from parts of the plant where the green coffee was handled played a major part in eliciting symptoms. Some of the workers had very troublesome symptoms when they came into contact with the burlap sacks used for transportation of green coffee beans.

Seven of the 22 workers could be classified as atopics on the basis of their history and of two or more positive prick tests with six common allergens. Fourteen workers were smokers.

The workers were assigned to groups according to the type and severity of their symptoms. Eleven workers had mild symptoms, mainly nasal congestion and sneezing or itching in the

nose and skin. A few were sometimes slightly inclined to cough at work. None had noticed any wheezing in the chest. Five workers had moderate symptoms of rhinitis and sometimes conjunctivitis. They sometimes developed wheezing in the chest at work, and some of them also outside work, especially in cold weather or after physical effort. Six workers had the same symptoms as the former group but more severe. They sometimes needed medicines or had to be off sick. None of the workers was on medicine regularly.

Allergen extract

An allergen extract, 1/10 w/v, was prepared in Coca's solution from dust collected in the department handling GCB. The GCB allergens were partially purified by gel filtration on Sephadex G-50 as described in detail elsewhere

Table 1
Clinical data of the 22 workers

Symptom group	Patient No.	Smoker	Coffee			MT	RAST class		IgE Ku/l	AFM index
			Prick test mm	NPT	BPT		coffee	castor		
Mild	1	×	—	—	—	—	0	2	150	4
	2		—	—	—	—	0	0	3	—8
	3	×	2 × 2	—	—	—	0	4	65	8
	4		4 × 4	—	—	+	0	3	21	3
	5	×	3 × 3	—	—	—	0	2	26	—12
	6		—	—	—	+	0	0	42	13
	7		2 × 2	—	—	—	0	0	6.5	1
	8	×	5 × 5	—	—	+	0	4	125	ND
	9		3 × 3	—	—	—	0	2	21	0
	10	×	4 × 4	—	—	—	0	0	180	—12
	11	×	—	—	—	+	0	0	42	5
Moderate	12	×	6 × 6	—	—	+	1	4	52	3
	13	×	4 × 4	—	—	+	2	4	1200	—29
	14	×	6 × 8	+	+	+	3	4	330	25
	15	×	5 × 5	+	+	+	4	4	650	11
	16	×	8 × 9	—	+	+	1	4	150	9
Severe	17		6 × 6	+	+	—	2	0	35	17
	18		5 × 6	+	+	+	4	4	1650	83
	19		6 × 10	+	+	+	4	4	370	26
	20	×	10 × 14	+	+	+	3	4	450	23
	21	×	6 × 6	—	—	+	2	4	75	—1
	22	×	7 × 8	+	+	+	3	4	240	42

(14). Allergen-containing fractions identified by RAST were pooled and used for RAST, skin tests and challenges. An extract of CB was made from a freeze-dried preparation (a gift from R. Panzani, Marseilles) dissolved in Coca's solution 1 µg/ml.

Skin tests

Prick tests were performed with a tuberculin needle as described by Pepys (16). The reactions were measured after 10 min and recorded as the sum of the largest diameter of the wheal and the diameter perpendicular to it ($D + d$). Allergen dilutions used were 1:1,000–1:10, histamine 1 mg/ml. A positive prick test reaction was defined as a reaction of 2 + 2 mm or more. Intracutaneous skin tests were made on the back by injection of 0.1 ml of extract. The reactions were measured after 15 min and expressed as for the prick test. Allergen dilutions used were 1:10,000–1:10, histamine 0.1 mg/ml. A positive intracutaneous test reaction was defined as a reaction as large as or larger than the histamine reaction.

Provocation tests

Nasal provocation tests (NPT) were performed by instilling 0.1 ml of an extract, 1:1000 w/v, in one nostril with a syringe. If no reaction ensued the challenge was repeated at 10-min intervals with 10-fold increments of the extract concentration until a positive reaction occurred or the highest concentration was reached, usually 1:10 w/v. The occurrence of sneezing, nasal blockage and discharge was considered as a positive response.

Bronchial provocation tests (BPT) were performed by inhalation of an extract that was nebulized by a De Vilbiss nebulizer 645 using a compressed air flow (Aersile gamma). One milliliter of the extract was administered at 10-min intervals, starting at a concentration of 1:10,000 and with 10-fold increments until 1:10 w/v was reached or a positive reaction occurred. Before and after every inhalation the lungs were auscultated and the peak expiratory flow rate (PEFR) was measured with a Wright

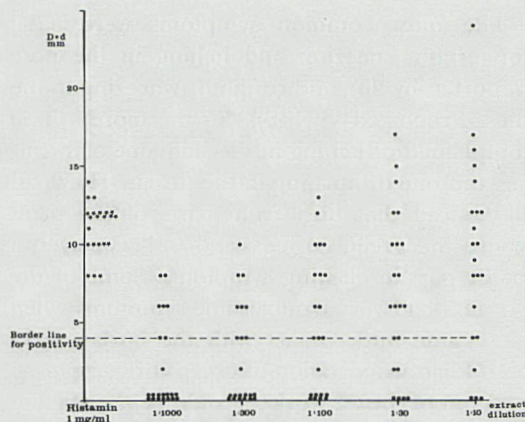


Fig. 1. Prick tests with extract of green coffee beans in 22 coffee roastery workers.

peak flow meter. A decrease in PEFR of 15% or more was considered as evidence of a positive BPT.

The presence of bronchial hyperreactivity was determined by a methacholine test (MT) performed as described by Laitinen (11). Increasing amounts of a 1% solution of methacholine were administered by a De Vilbiss nebulizer. The patient took one inhalation, four inhalations and 16 inhalations with free intervals of 90 sec, and a PEFR measurement was made between each step. A decrease in PEFR by 15% or more was defined as a positive MT.

Serial measurements of lung function

For 1 week the workers themselves measured their variation in lung function with an air flow meter (AFM) three times a day (in the morning, at lunchtime and at bedtime) (5). The best of three values was noted on each occasion. During that week the workers recorded their AFM values and any respiratory symptoms on a diary card.

Immunological assays

Serum IgE levels were measured by Phadebas IgE PRIST (Pharmacia Diagnostics AB, Uppsala) according to the recommendation of the manufacturer (10). IgE antibodies were deter-

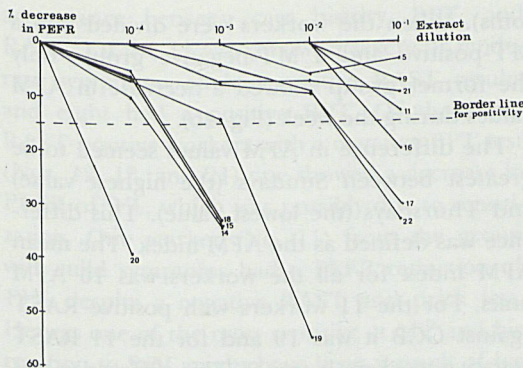


Fig. 2. Bronchial provocation tests with extract of green coffee beans in coffee roastery workers.

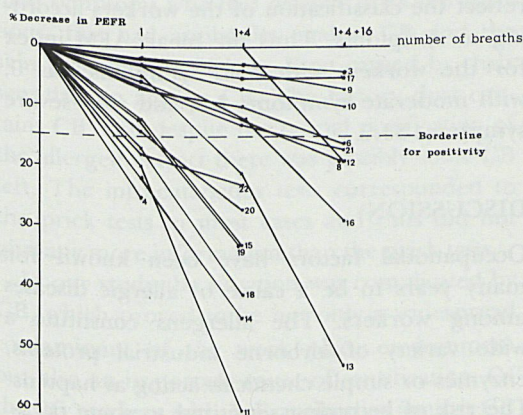


Fig. 3. Methacholine tests in coffee workers.

mined by RAST (19), using an immunosorbent-purified ^{125}I -labelled anti-IgE with D52 specificity (1). GCB or CB allergen extract was coupled to CNBr-activated filter paper discs as described (9). The results were expressed in PRU (Phadebas RAST units), using the Phadebas RAST reference, and classed as follows: 0 for no detectable IgE antibodies and 1–4 for increasing concentrations.

Statistical methods. The Wilcoxon rank sum test was used for comparison of two groups and the chi-square test for comparison of two proportions.

RESULTS

The grouping of the workers according to their history and some of the clinical data is summarized in Table 1. Eighteen workers had positive prick test reactions to GCB (Fig. 1) and 17 had positive intracutaneous reactions. BPTs were positive in eight persons (Fig. 2) two of whom had late asthmatic reactions (workers 17 and 18). In seven persons the NPTs were positive. Fourteen workers had positive MTs (Fig. 3) and 10 of them were smokers. Seven workers (5 smokers) showed positive reactions to both BPT and MT.

The grouping of the workers correlated well with the RAST results and skin tests. RAST against GCB was positive in all persons with severe or moderate symptoms and negative in those with mild symptoms. RAST against CB, on the other hand, was positive in 16 persons, six of whom had mild symptoms. The prick tests were positive in all workers with moderate or severe symptoms; there were also some positive tests, but weaker, in the workers with mild symptoms. The intracutaneous skin tests were also positive in all workers with moderate or severe symptoms. In the workers with mild symptoms six had positive intracutaneous reactions, but only with the highest allergen concentration.

The IgE levels were significantly higher in the two groups with moderate or severe symptoms than in the one with mild, the geometrical mean values being 402 and 66 kU/l respectively, and thus correlated to the grouping ($P < 0.01$).

The results of the test of bronchial reactivity, MT, was also related to the clinical grouping. Thus MT was positive in 10 of 11 workers with more pronounced symptom and in four of the 11 with mild ($P < 0.01$).

Many workers reported on their diary cards that their symptoms worsened towards the end of the week. This general tendency was in accordance with the AFM values, which were lower in the second half of the week (Fig. 4a). The most pronounced decrease in AFM values was found among the workers who were RAST positive to GCB (moderate or severe symp-

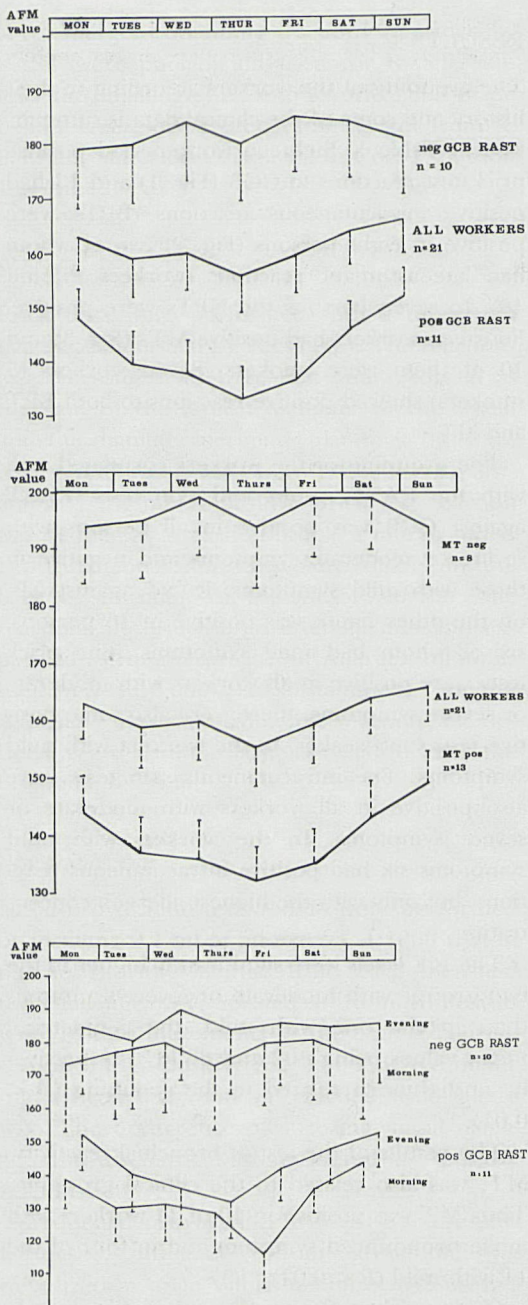


Fig. 4. Air flow meter values in coffee workers during 1 week. The values in Figs. a and b are mean values $\pm$ SEM of three measurements a day (morning, middle of the day and evening). The best of three values is used on each measure occasion. a) All workers with positive and negative RAST against GCB. b) Workers with positive and negative methacholine tests. c) Mean morning and evening values in workers with positive and negative RAST against GCB.

toms). When the workers were divided into a MT-positive and a MT-negative group, only the former group showed a decrease in AFM values during the week (Fig. 4b).

The difference in AFM values seemed to be greatest between Sundays (the highest value) and Thursdays (the lowest value). This difference was defined as the AFM index. The mean AFM index for all the workers was 10 AFM units. For the 11 workers with positive RAST against GCB it was 19 and for the 11 RAST negative workers it was 0. This difference was statistically significant, $P < 0.05$. The mean AFM indices for the five workers most sensitive at BPT and MT were 34 and 32 AFM units respectively. The AFM index also seemed to reflect the classification of the workers according to symptoms. Thus the mean AFM index for the workers with mild symptoms was 0, with moderate symptoms 3.8, and with severe symptoms 31.7.

DISCUSSION

Occupational factors have been known for many years to be a cause of allergic diseases among workers. The allergens constitute a wide variety of airborne industrial proteins, enzymes or simple chemicals acting as haptens. The risk of becoming sensitized to some occupational allergen does not seem to have decreased during the last century. Many processes in which organic dust is handled have been centralized to factories, and the workers have become exposed to greater amounts of dust. New substances are constantly being introduced. Since preventive measures can restrict the extent of occupational allergies to a considerable degree it is of great importance to detect the harmful agent as early as possible. Workers in a coffee roastery may develop occupational allergy of the IgE-mediated type against components in the factory dust. The workers are exposed to the allergens only at work, and a coffee plant offers a good opportunity to study the question of which investigation methods are most valuable in finding the cause of a suspected occupational allergy.

Regarding the allergy to GCB, there was good

accordance between case history, BPT, and RAST. Of the 11 workers with severe or moderate symptoms, all had positive RAST results and eight had a positive BPT. Of the three RAST-positive workers with a negative BPT test (Nos. 12, 13, and 21) one showed a decrease in PEFR of 9%, which was possibly due to sensitization. One worker (No. 11) from the group with mild symptoms had a PEFR reduction of 13% despite a negative RAST and prick test. He was one of the most sensitive at MT and his reaction to BPT might have been a result of his hyperreactivity.

The prick tests also correlated to the case history, with stronger reactions in workers with more symptoms. Of the seven workers with mild symptoms who had positive prick test reactions, five had antibodies against CB and the skin reactions could have been caused by their sensitization against CB. The factory dust contains CB, and despite the partial purification of the allergen extract there was possibly some CB left. The intracutaneous tests corresponded to the prick tests in most cases and thus did not give any more information than the prick tests.

In our study the situation was complicated by CB, which proved to be not only a widespread contaminant of the work place environment but also an important cause of sensitization. Of the 16 workers with IgE antibodies against CB (Nos. 1, 3, 4, 5, 8, and 9) six had negative RAST, negative BPTs, and small or negative prick tests to GCB. They all had only mild symptoms. These findings support the previous observation that workers in the coffee roastery industry are sensitized to at least two groups of allergens, namely GCB and CB. GCB is the major source of the dust and seems also to be responsible for most of the symptoms, in contrast to CB which is a potent allergen but occurs in smaller amounts. More workers were RAST positive to CB than GCB. One explanation to this might be that CB initiates the sensitization process and thus facilitates the latter sensitization to GCB.

Intracutaneous tests and BPTs are time-consuming, more troublesome for the patient, and not entirely without risk. A combination of the case history, RAST and prick tests seems to be

the easiest and most appropriate approach when looking for the occurrence of IgE-mediated sensitization at a place of work. A relevant allergen extract is required, however. When the allergen is unknown, measurement of IgE levels seems to be of great value in identifying unclear symptoms as being due to atopic allergy. Among the coffee workers the serum IgE levels correlated well with the symptom grouping.

Another test for evaluation of respiratory symptoms at work which, like the IgE level, is independent of access to the relevant allergen, is measurement of lung function during the week or of the difference between a lung function value obtained after some days of rest and one after some days of work. However, the results are influenced by a number of factors and may not be so valuable in individual subjects. This has also been reported by Burge, in a study of workers with occupational asthma, who points out that detailed measurement of lung function on a single occasion is a poor method of diagnosing occupational asthma, while longitudinal measurements even of simple parameters are valuable in revealing occupational asthma in a group of subjects (2).

Smoking affects the bronchial mucosa and is often associated with an increased reactivity (6). Among the coffee roastery workers, 10 of 14 with a positive MT were smokers. Allergic symptoms are also often associated with bronchial hyperreactivity (12). A higher frequency of positive MTs was found among the coffee workers with IgE antibodies against GCB than among the other workers. The former group also showed a greater difference between the AFM values on Sundays and Thursdays, measured as AFM index. The decrease in AFM during the week, especially in the most reactive workers, is in accordance with the workers' reports of more symptoms towards the end of the week. It is likely that the effect of allergic inflammation does not clear up during the night and thus is enhanced every day. However, the weekend allows a partial recovery, which explains the almost normal AFM values seen on Mondays.

The degree of bronchial obstruction normally

has a diurnal rhythm, with greatest obstruction in the morning (18). The daily allergen exposure of the coffee workers did not alter that pattern, as seen in Fig. 4c. The AFM values were lower in the mornings than in the evenings both for workers and for those without specific IgE antibodies against GCB. These findings indicate that measurements of lung function before and after a workshift on the same day would not have revealed the sensitized workers. This is in contrast to the result of Zuskin et al. (20), who found that coffee workers had lower postshift than preshift maximal expiratory flow. Our findings also indicate that the allergic reaction is going on in the airways, not only for some hours after exposure, but throughout the following 24 h. Immediate and late allergic reactions are superimposed on each other. Cockcroft et al. (3, 4) observed that an unspecified bronchial reactivity is associated with the allergic reaction, especially with the late one. Similar observations were made by Lam et al. (12) in patients with occupational asthma due to red cedar, who developed increased reactivity to methacholine 24 h after allergen challenge. Platt-Mills et al. (17) have demonstrated a reduction of reactivity during prolonged allergen avoidance. Thus, symptoms of unspecific hyperreactivity, such as cough and wheezing in cold weather or as a result of physical effort outside work, may be the first indication of occupational allergy.

Tests of bronchial reactivity, such as MT, are safe and useful procedures in the initial assessment of patients suspected to have occupational asthma. Our findings also suggest that measurement of the AFM index is a simple and reliable way to determine the individual variability of bronchial reactivity at work.

From the results of our investigation we can recommend the combination of taking the case history, measurements of serum IgE levels, and longitudinal lung function tests when an IgE-mediated sensitization at a work place is suspected but when the allergen is unknown. Depending on the result obtained, it can then be decided whether to proceed with more elaborate and expensive investigations or not.

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