Rhinology, 45, 40-46, 2007

Use of nasal provocation test in the diagnostics of occupational rhinitis

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SUMMARY

Objectives: *The purpose of the study was to evaluate the usefulness and clinical value of the nasal provocation test (NPT) with various allergens and non-IgE-mediated irritants in the diagnostics assessing occupational rhinitis.*

Methods: *A large number nasal provocation data from patients with suspected occupational rhinitis was evaluated retrospectively. The results of nasal provocation tests with different agents, as well as the correlation of nasal scoring to weighed mucus secretion, were analyzed.*

Results: *Altogether 507 NPTs were done in three years in 165 persons. In total, 39% of the allergen provocations (125/318) were positive. The most common positive reactions were against flours, animal epithelia, storage mites and various plants. Wood dusts, mainly through non-IgE-mediated reactions, gave 50% positive results. Positive NPTs to moulds were observed mainly in sensitized patients. Altogether, 10% of the control provocations were positive. The weighting of mucus secretion added sensitivity of NPT.*

Conclusions: *The NPT is an essential standard tool in the diagnostics of allergic occupational rhinitis; however it needs to be evaluated in the context of the medical and work history and knowledge of sensitization. Although expensive and laborious, NPT is safe and easy for the patient. We still need reliable diagnostic tools for non-allergic work-related rhinitis.*

Key words: nasal provocation, allergic rhinitis, allergen, control provocation, sensitization

INTRODUCTION

The main indications for using the nasal provocation test (NPT) are the assessment of allergic symptoms in both occupational rhinitis and immunotherapy. NPT has also been used for the diagnosis of nonallergic occupational rhinitis caused by irritating occupational substances to differentiate individuals with relevant symptomatic sensitization from asymptomatic sensitization [(1)].

Work-related rhinitis is episodic as there is work-related occurrence of sneezing, nasal discharge, and nasal obstruction [(2)]. It may coexist or precede asthma, but may present alone. Work-related rhinitis can be caused by any irritant exposure at work. According to the Act on Occupational Diseases in Finland, occupational rhinitis is defined as work-related rhinitis, caused by physical, chemical or biological factors. In practice the role of the etiological agents, i.e. cause-effect, needs to be proven reliably in order for the patient to be eligible for compensation. Most of the rhinitis cases that are compensated as an occupational disease are therefore allergic rhinitis. Although the classification of occupational rhinitis by Bardana [(3)] includes a heightened sense of olfactory awareness, called annoyance reactions, and irritation rhinitis with neurogenic inflammation, usually they have not been accepted as occupational rhinitis in Finland. Only a few toxic or irritative reactions are reported annually. In addition to skin prick or specific IgE testing, the provocation test is used to prove the causal relationship with the causative agent in occupational rhinitis. In cases of non-IgE-mediated work-related nasal symptoms, the pathogenesis and causal effect is more difficult to assess.

During 2001-2003 about one fifth of the occupational rhinitis (OR) diagnoses and NPTs in Finland were conducted at the Finnish Institute of Occupational Health. Practically all NPTs from Southern Finland (with a population of ca. 1.3 million), and provocations to chemicals and most provocations to moulds from the whole country (population ca. 5.2 million) were done at the institute. As a reference institute also re-evaluation or repetition of some NPTs done by other clinics was done here.

*Received for publication: July 4, 2005; accepted: October 3, 2006

The purpose of this study was to summarize the results of NPTs from the three-year period at our clinic and to evaluate the results of NPT with various IgE- and non-IgE-mediated agents causing OR. We also wanted to critically assess the usefulness of the nasal provocations with various allergens, haptens and non-IgE-mediated irritants. We compared the diagnostic criteria with nasal scoring by Hytönen [4] to the amount of nasal secretion. The nasal secretion has been introduced as a parameter superior to acoustic rhinometry or anterior rhinomanometry in monitoring NPT reaction in a previous report [11]. That study suggested a cumulative amount of 0.1 g nasal secretion as a threshold value for test positivity in a 30 min observation period in a unilateral nasal provocation test.

MATERIALS AND METHODS

Patients

Altogether 1495 outpatient consultations were done at the unit of Otorhinolaryngology in 2001-2003 because of suspected OR. Eleven % (165 patients) of these patients (117 women and 48 men) were examined by a NPT. The average age of these nasal provocation patients was 41 years (range 23-64 years).

The symptoms suggestive of occupational allergic rhinitis were episodic, work-related occurrence of nasal obstruction, rhinorrhea, sneezing, itching of the nose and/or postnasal drainage [5]. In addition, sensitization against work-related allergen(s) was generally found, supporting the suspicion of occupational disease. The inclusion criteria for performing the nasal provocation were: 1) obvious exposure to a known occupational allergen, or mould damage found in the workplace, 2) symptoms referring to work-related allergic rhinitis, 3) no other obvious cause for the rhinitis and 4) no contraindications for the nasal provocation test [6].

Skin prick specific serum IgE tests

The suspected occupational aeroallergens were tested by a skin prick test (SPT), specific serum IgE test, or both. SPTs and specific serum IgE tests were performed according to the published guidelines [7,8]. Sensitization to common inhalant aeroallergens (later called general atopic propensity) were tested to the following agents (ALK- Abelló): birch, alder, meadow fescue, timothy, mugwort and dandelion pollens, horse, dog, cat and cow epithelia, *Dermatophagoides pteronyssimus, Alternaria alternata, Cladosporium herbarum* and latex. SPT was considered positive if it was at least half of histamine wheal and ≥ 3 mm (with *T. putrescentiae* ≥ 4.5 mm) [9]. The SPTs were carried out according to the information obtained on the allergen exposure at the workplace. The specific serum IgE was measured if dermographism or other skin problems hampered SPT evaluation, if the SPT result was borderline positive, or the SPT result was different from the medical history. Commercial specific IgE measurements (Pharmacia Unicap system, Uppsala, Sweden) were used, if available. The mould allergens used in the SPTs were the following (ALK-Abelló): *Acremonium kilience, Aspergillus fumigatus, Aspergillus versicolor, Botrytis cinerea, Chetomium globosum, Cladosporium cladosporioides, Fusarium culmorum, Geotrichum candidum, Mucor racemosus, Penicillium brevicompactum, Penicillium expansum, Phoma herbarum* and *Rhodotorula rubra*. The exposure to moulds was evaluated by employers or property owners by various methods and levels of accuracy. In some of the cases samples of building material and even air samples had been analyzed for moulds and spores, while in others only visual inspection of moisture damage or mould growth had been carried out. In many cases, however, the exposure data were suggestive only and difficult to interpret.

NPT test

Before the NPT time, the patients were acclimatized to room temperature for at least for 20 min. The tests were done in single-blinded manner (the patient was blinded as to whether the test agent was an allergen or a placebo, until all the tests were done). The placebo test was done first, mostly on a different day, but in a few cases 4 hours before the allergen challenge. Each allergen was tested on a different day. Liquid allergens were applied on the topical surface of the inferior conchae, usually by applying an 0.1 ml allergen-saturated small piece of neurosurgical cotton disk (Cameco, Sweden) or, to avoid any irritation, by dropping 0.1 ml of allergen solution from a syringe with a metal suction head [4,6]. The dry provocation agents were bilaterally delivered by applying a small amount of allergen powder on the topical surface of both inferior conchae with the head of a nasal elevator. The degree of rhinorrhea and nasal blockage was evaluated before, and 15 and 30 min after the provocation. Changes in the rhinorrhea and blockage from both nostrils were scored from 0 (dry mucosa or mucosa lining only the bony conchae) to 3 points (dripping mucus or swelling of the mucosa obstructing nasal cavity) [9]. The NPT was regarded as positive if the total sum of the score points changed ≥ 4 from both nostrils within 30 min. General contraindications for the NPT were followed, including the absence of seasonal allergy, airway infection, and nasal traumas 1 month before the NPT [6]. Severe nasal polyposis and sinusitis were treated with surgery and / antibiotics at minimum a month before the provocation time. Antihistamines and nasal sprays were left off a week before the provocation, and oral steroid doses were ≤ 10 mg prednisolone. An exception to general rules for the NPT was that the NPTs were generally conducted as planned, even if the placebo test was positive. By doing so, we often noted that the patient did not react to the suspected allergen, or, on the other hand, if the reaction to the allergen was several-fold stronger than towards the diluent, the tests could be finished as planned. This reduced the time and expenses. If the results turned out to be unclear, tests were repeated. Acoustic rhinometry measurements were performed before and after the provocation in all cases, but the values measured were considered to be mainly supportive to the diagnosis [4]. Nasal secretion was also measured or judged

in most cases (84%), to test the parameter in the diagnosis of OR. The nasal secretion dripping out of the nose was collected in 30 min time to a pre-weighted plastic mug and in the end of the follow-up period the secretion from anterior to nasal skin-mucosa junction was suctioned in the anterior rhinoscopy to a pre-weighted suction tip (Mediplast aural suction tip, 2 mm) with a collector, if needed. The total nasal secretion was weighted with EK-200G compact balance (accuracy ± 0,002g, A&D instruments, Japan). In cases which the amount of secretion was scored normal (1) or dry (0), with no change of scoring points from rhinorrhea, the amount of secretion were valued in this analysis as zero.

The allergens used in the NPTs were water-based commercial agents if such were available at the time. For mould provocations, three water-based agents were available: *Aspergillus fumigatus, Cladosporium cladosporioides* and *Acremonium kilience* (from ALK-Abelló, used at 1:100 w/v). The *Aspergillus fumigatus* was changed to Allergopharma product 10000 BU/ml in the end of 2003, with 4 provocations. Three storage mite species (ALK-Abelló) were available for the NPTs: *Acarus siro* (1:1000 w/v), *Lepidoglyphus destructor* and *Tyrophagus putrescentiae* (10 BU/ml). Cow allergen (ALK-Abelló) was used as 1:100 w/v (after 6/03 Allergopharma as 5000 BU/ml). From 2003 on also water-based mouse allergen 5000 BU/ml (Allergopharma) was available and used, before that time SPT agents (ALK-Abelló) containing glycerol and phenol were used. The pig allergen concentration was 1:10 w/v (Allergopharma) and the horse epithelia extract was diluted to 10% (in PBS, pH 7.4). Flowers and plants were tested by crude fresh plant extracts, which were diluted to a maximum concentration of 20% w/v in PBS. Dry pure spices were extracted to 10% w/v in PBS. Lower concentrations were applied first if considered necessary from the patient history or previous SPT result. Flours and pure wood dusts obtained from the workplaces of the patients were used as such for the provocations. In the wood dust provocations most often pine and spruce, but also birch, alder, oak, obeche, beech, mahogany, teak, and padouk were tested. Plywood dust was used in one provocation. α-Amylase was used at a concentration of 100 µg/ml. In a few cases when water-based test agents were not available, SPT agents containing glycerol and phenol were used (*Penicillium expansum, Rhodotorula glutinis, Aspergillus versicolor*, mouse, rat, cotton and linen, (ALK-Abelló)).

Placebo test agents were matched to the diluent and allergen, and they were: NaCl, PBS, aqua, lactose, wood dust (to which the patient was not exposed) and SPT (Soluprick®) control agent.

RESULTS

The NPT was positive in 63% of the occupational allergen provocations (Table 1), whereas in 10% (19/193) placebo gave a positive nasal provocation reaction. Forty-seven % (78/165) of the patients were diagnosed as having occupational rhinitis. On average, three NPTs were performed to each patient, i.e. mainly one control and two allergen provocations.

High-molecular-weight allergens caused most positive reactions in our patients. The flours (68% positive, Table 2) and indoor plants and flowers (73%, Table 4) were most likely positive in the provocation test, followed by animal allergens (37%, Table 3). The patients with positive nasal provocation test usually were sensitized to these macromolecular allergens showing positive SPT or specific IgE.

The amounts of nasal secretion in NPTs that were scored positive varied between 0.1 and 11.3 g (111/117 ≥ 0.2 g). NPTs with flours produced the highest volumes of secretion. A few patient showed > 0.2 g of baseline nasal secretion already before any provocations (two cases with the other having Samter's triad and another with thick mucous rhinorrhea). Such cases were not regarded as occupational rhinitis together with patients having nearly similar reactions with allergen as with placebo provocations.

In all but one provocation secretion < 0.2 g (302/303) was regarded as no occupational rhinitis, so the measured secretion matched well with scoring. This one NPT case with *Aspergillus fumigatus* was assessed as a positive occupational rhinitis based on scoring criteria (and positive history of symptoms) with secretion of 0.13 g in our material.

In the scoring, (were points 0-3 for both rhinorrhea and nasal blockage were given for both nostrils and calculated together) all positive reactions had ≥ 4 points for rhinorrhea, but not for the nasal blockage. The ≥ 4 points means watery rhinorrhea dripping out of the nose and this finding matches well to the weighted amount of discharge. Nasal discharge is a good and reliable indicator in the diagnostics compared to the nasal blockage.

Wood dusts gave positive provocation test results (50 %), although the specific skin prick tests seldom turned out to be positive. Only one case of allergy with positive SPT to obeche was found among the wood exposures. Another patient reacted to pine and spruce dusts in SPT, but the reaction was repeatable only with pine. Atopic propensity was found in 67 % of patients suspected of having nasal symptoms from wood dusts, (Tables 2-4), but 90% of the patients found to react positively to wood dusts were atopic.

Table 1. Nasal provocation tests (NPT) performed in 1/2001- 12/2003.

Nasal provocation test type	**Number of NPTs / All the NPTs**		**Number of positive NPT / all the NPTs**	
Allergen provocations	318/507	63 %	125/318	39 %
Control provocations	189/507	37 %	19/189	10 %

Table 2. Results of nasal provocation to flours.

Allergen	Proportion of positive skin prick test (SPT)		Proportion of specific IgE > 0.35 kU		Proportion of positive provocations		Proportion of nasal secretion ≥ 0.2 g		General atopic propensity according to SPT	
	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N
Wheat	61	(23/38)	59	(20/34)	63	(24/38)	92	(35/38)	59	(20/34)
Rye	65	(13/20)	69	(11/16)	65	(13/20)	67	(12/18)	47	(8/17)
Oat	86	(6/7)	57	(4/7)	71	(5/7)	83	(5/6)	57	(4/7)
Barley	67	(4/6)	60	(3/5)	100	(6/6)	100	(6/6)	67	(4/6)
Soybean	0	(0/0)	0	(0/1)	100	(1/1)	100	(1/1)	0	(0/1)
Total	65	(46/71)	62	(39/63)	68	(49/72)	71	(47/66)	55	(36/66)

* Allergen provocations were repeated if the control provocation was positive and occupational rhinitis diagnosis was not done in one case

Table 3. Description of provocations with animal-derived allergens.

Allergen	Proportion of positive skin prick test (SPT)		Proportion of specific IgE > 0.35 kU		Proportion of positive provocations		Proportion of nasal secretion ≥ 0.2 g		General atopic propensity according to SPT	
	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N
Storage mites	80	(16/20)*	68	(13/19)	39	(9/23)	41	(9/22)	87	(20/23)
Cow	82	(9/11)*	91	(10/11)	25	(3/12)	27	(3/11)	83	(10/11)
Pig	100	(1/1)	0	(0/1)	0	(0/1)	0	(0/1)	0	(0/1)
Mouse	100	(3/3)	33	(1/3)	67	(2/3)	67	(2/3)	50	(1/2)
Rat	100	(1/1)	100	(1/1)	100	(1/1)	100	(1/1)	0	(0/0)
Horse	100	(1/1)	0	(0/0)	100	(1/1)	100	(1/1)	100	(1/1)
Egg (white and yolk)	50	(1/2)	0	(0/0)	0	(0/2)	0	(0/2)	100	(2/2)
Total	82	(32/39)	71	(25/35)	37	(16/43)	39	(16/41)	69	(24/37)

* Dermographism hampered the evaluation of some test results

Table 4. Description of nasal provocation tests to miscellaneous agents.

Allergen	Proportion of positive skin prick test (SPT)		Proportion of specific IgE > 0.35 kU		Proportion of positive provocations		Proportion of nasal secretion ≥ 0.2 g		General atopic propensity according to SPT	
	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N
Flowers and indoor plants	78	(7/9)	33	(1/3)	73	(8/11)*	60	(3/5)	64	(7/11)
Spices	40	(4/10)	25	(2/8)	30	(3/10)*	13	(1/8)	100	(10/10)
Vegetables	50	(1/2)	0	(0/0)	0	(0/2)	0	(0/2)	100	(2/2)
Cotton, wool and linen	66	(2/3)	100	(1/1)	67	(3/3)	67	(2/3)	67	(2/3)
α-Amylase	100	(1/1)	0	(0/1)	100	(1/1)	100	(1/1)	100	(1/1)
Wood dusts	9	(3/32)	0	(0/1)	50	(22/44)*	48	(19/40)	67	(12/19)
Chromium 6+	0	(0/2)	0	(0/0)	0	(0/3)	0	(0/3)	100	(2/2)
Ammonium persulphate	0	(0/2)	0	(0/0)		0 (0/2)	0	(0/2)	100	(2/2)

* Several nasal provocations were done to the same patients

Moulds were positive in 18% of the nasal provocations. *Cladosporium cladosporioides* was positive in 26%, and *Aspergillus fumigatus* in 16% of the provocations, but *Acremonium kilience* in only 8%. Specific sensitization to moulds was found infrequently in these patients, but their general atopic propensity was 34% (Table 5).

In our material general atopic propensity to 14 common environmental agents was found in 47% (77/164) patients successfully tested in our institute. Comparison to the general atopic propensity 34% in Finnish adults with 11 aeroallergens [10] shows selection of our patients by elevated atopic propensity.

Altogether, 189 placebo or control provocations were conducted (Table 1). According to their irritative characteristics, the control test agents were grouped into: 1) water-based and non-irritating (NaCl 0.9%, phosphate buffer, aqua), 2) lactose, 3) SPT control agent and 4) miscellaneous control agents. The placebo test agents gave a different number of positive results: group 1 had 9% (11/114) positive reactions, group 2 had 8% (5/62), group 3 had 14% (1/7) and group 4 had 33% (2/6) positive reactions. Amount of secretion in the placebo reactions (163 tests) was between 0 to 2.11 g (in the group 1 between 0-1.72 g, in the group 2 between 0 - 1.74 g, in the group 3 between 0-0.92 and in the group 4 between 0-2.11g). Twelve %

Table 5. Description of 125 nasal provocations to moulds.

Allergen	Proportion of positive skin prick test (SPT)		Proportion of specific IgE > 0.35 kU		Proportion of positive provocations		Proportion of nasal secretion ≥ 0.2 g		General atopic propensity according to SPT	
	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N	%	N_{pos}/N
Aspergillus fumigatus	14	(8/58)*	9	(3/35)	16	(10/62)**	14	(6/43)	33	(19/57)
Cladosporium cladosporioides	6	(2/31)*	13	(2/16)	26	(9/34)**	21	(5/24)	36	(12/33)
Acremonium kilience	5	(2/24)*	0	(0/11)	8	(2/25)	10	(2/21)	30	(7/23)
Penicillium expansum	100	(1/1)	0	(0/1)	100	(1/1)	100	(1/1)	100	(1/1)
Aspergillus versicolor	100	(1/1)	0	(0/0)	0	(0/1)	100	(1/1)	100	(1/1)
Rhodotorula glutinis	0	(0/1)	100	(1/1)	0	(0/2)**	0	(0/1)	0	(0/2)
Total	12	(14/116)	9	(6/64)	18	(22/125)	16	(15/91)	34	(38/113)

* Dermographism hampered the evaluation of some test results

** Allergen provocations were repeated if the control provocation was positive and occupational rhinitis diagnosis was not done in all cases.

(19/16) of placebo reactions gave 0.2 g or more secretion. No generalized allergy reactions occurred in the provocation tests.

DISCUSSION

Our study summarizes one of the largest NPT data for the diagnosis of OR in the literature with detailed evaluation of control provocations. Our main purpose was to evaluate the usefulness and restrictions of NPT in the diagnostics of OR. We also wanted to compare the diagnostic criteria of nasal scoring and the amount of secretion found in our material in the NPTs.

We derived the nasal secretion parameter to bilateral NPT from a previous report [11]. The report by Pirilä and Nuutinen suggested cumulative nasal secretion 0.1 g as a threshold value for a test positivity in unilateral nasal provocation in 30 min observation period. As we use bilateral nasal provocation, we multiplied the criteria by two to 0.2 g for a bilateral provocation. When comparing nasal scoring (with secretion and nasal obstruction), we found high similarity of results with scoring criteria positivity and the weighted secretion ≥ 0.2 g. Based on this study we showed that weighing of mucus secretion is useful and gives more detailed information from the reactions compared to the scoring alone.

We re-evaluated the nasal reactions initially regarded as “no occupational rhinitis” although they had ≥ 0.2 g secretion. They appeared to be positive placebo reactions in the patients who reacted similarly both to the allergen and the control agent. Among these cases there were some patients suffering from nasal polyposis. As one could expect, dry wood dusts caused unspecific irritation. The skin prick test agents containing glycerol and phenol seemed to cause some unspecific irritation reactions. We find that available allergen extracts used should be water-based provocation agents, as glycerol-based SPT test agents are prone to false positive results in these NPTs, as has been already previously stated [12].

NPT is an expensive and time-consuming method for examining occupational rhinitis. It is nevertheless also safe and well-tolerated by the patients, and no serious adverse reactions have occurred in our provocation series. Half of our patients tested were diagnosed as having specific occupational rhinitis. The other half of the patients, however, did not react in the NPT, or reacted also in the placebo test. These patients had symptoms indicating unspecific nasal hyperreactivity also in their medical history and most of them were regarded to have idiopathic rhinitis or upper airway irritation.

The NPTs with all the various allergens were positive in total of 36% of the tests, while 10% of the placebo tests were positive. According to our clinical experience, the application of allergen with disks does not significantly irritate in the nose, in contrast to some previous criticism [13]. Moist paper disks do not cause clear physiological nasal responses in tests of baseline monitoring of nasal challenges [14]. Also later published guidelines for nasal provocations recommend that disks can be used to deliver allergens [15]. The relatively high number of positive NPT control reactions in our material more likely relates to the patient's general atopic propensity with a hyperreactivity of nasal mucosa. Most of these patients have been at their workplaces on the day before the challenge test, and they had been without allergy medication, because of the SPTs made at the same visit. This may have increased the number of positive control test reactions.

Flours, especially wheat, were the main allergens causing OR in our material. The sensitization verified by SPTs seems to predict nasal reactions well with these common allergens. These patients usually had worked in small bakeries with exposures to relatively high flour dust levels. A few allergy reactions to spices were also noted in the sensitized bakers.

Cow dander is a common allergen in Finland [16], but we had only a few cattle farmers in our mostly urban material. During the time of this evaluation, the allergen extract also changed, and some of the negative tests turned to be positive later on, in retesting, after comparison of the main allergen content in the two different extracts. Storage mites are other common allergens among farmers. The increased awareness of storage mites

is possibly reflected in the increased number of diagnosed allergies towards them since the 1980's [16]. The sensitization measured by either SPT or RAST was not good in predicting a positive NPT result to mites in our material.

Reports of symptoms at workplaces with moisture problems have been increasing in the 1990's [17]. Moulds have become an often suspected cause of respiratory symptoms, which is reflected in the increased number of such patients. The mould allergy diagnostics using nasal provocation has been problematic for a number of reasons. We had only three commercial non-standardized test agents available for NPT, whereas the fungal growths at workplaces are mostly mixed. It was assumed that these test agents represent a part of the exposure at the workplace. Most of our patients did not display IgE towards moulds with the tested extracts, and also the NPTs performed were mostly negative. The results of these NPT results support the conclusion of a previous report, i.e., that the clinical importance of moulds as allergens is low [18] in Finland, even in our selected patient material. The standardization and availability of many allergen extracts in occupational diagnosis, e.g. the mould extracts [19], is still scanty and that should be regarded when interpreting the provocation results. It seems that the majority of the nasal symptoms of employees in moisture-damaged buildings are caused by mechanisms other than immediate IgE-mediated allergy, as has been suggested previously [20]. Accordingly, since 2003-2004 we have adopted a protocol to perform mould provocations only to patients with positive IgE towards moulds that are available as water-based test agents.

Wood dusts gave lot of positive NPT even without IgE-sensitization. The possible specific inhalant allergens in Finnish wood dusts have not been characterized thus far [21] or don't exist. Atopic propensity was found in 90% of the patients reacting positively to dry wood dusts in our material. Concomitant sensitization to ubiquitous aero-allergens has also previously been found to be more common among persons with airway diseases from wood dusts compared to the general population [22]. Unspecific mucosal hypersensitivity and mechanical and perhaps some hydroscopic irritation of the nasal mucosa are the likely causes to most of the rhinitis symptoms of these patients in NPT.

The NPT is a valuable tool when there is uncertainty whether the patient's exposure should be discontinued or the patient should change his or her job. Occupational rhinitis may cause inability to work in the present job or obligate the employer to reduce the exposure at the workplace. The nasal provocation is useful in proving the occupational origin of the rhinitis when the allergens are well characterized. However, in non-allergic rhinitis, knowledge of the reactions of the nasal mucosa is unknown, and specific relatedness to work is therefore more difficult to prove. There is a great need to develop the diagnostic tools to demonstrate also the non-IgE-mediated work-related rhinitis.

ACKNOWLEDGEMENTS

We thank Suvi-Päivikki Salo for collecting the patient material for the evaluation and Terttu Kaustia for language revision.

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