

Case report

Deer ked–induced occupational allergic rhinoconjunctivitis

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Background: Deer keds (elk fly) have not previously been described as a cause of respiratory or conjunctival sensitization.

Objective: To report a case of IgE-mediated allergic rhinoconjunctivitis from occupational exposure to deer ked.

Methods: Skin prick testing (SPT) was performed with pollens, animal danders, mites, molds, and deer ked. The serum deer ked–specific IgE level was examined in ImmunoSpot and radioallergosorbent test assays, and deer ked IgE-binding fractions and their specificities were examined in immunoblot and immunoblot inhibition assays. Nasal provocation testing (NPT) and conjunctival provocation testing (CPT) were performed to detect the association between deer ked sensitization and rhinoconjunctival symptoms. Both SPT and NPT were performed with deer ked whole-body extract, whereas CPT was performed with deer ked wing.

Results: The results of SPT, NPT, and CPT were positive for deer ked. In laboratory tests, serum deer ked–specific IgE antibodies were demonstrated in radioallergosorbent test and ImmunoSpot assays. In immunoblot, IgE-binding bands were demonstrated at 17, 33, 70, and 85 kDa, which were clearly inhibited with deer ked extract but not with the control extract.

Conclusions: Occupational IgE-mediated rhinoconjunctival allergy to deer ked was confirmed in this patient.

Ann Allergy Asthma Immunol. 2005;94:604–608.

INTRODUCTION

Deer ked or elk fly (*Lipoptena cervi*) belongs to the louse flies (Hippoboscidae), and its main host in Finland is the elk (*Alces alces*). The deer ked is a dark brown insect, with a head and body length of approximately 5 mm. The exoskeleton of the insect is tough and covered with dark hairs (Fig 1). In recent years, deer keds have become common in the forests of eastern and southern Finland. Their abundance is associated with an increase in the elk population. Winged adult deer keds fly to seek out their hosts in late summer and early autumn. After locating an elk, deer keds will burrow through the fur, lose their wings, and take a blood meal. Deer keds can also attack humans, and because they are flat, they can easily burrow their way under the clothes and into the hair. The bite is barely noticeable, but it may be followed by immediate wheals and persistent pruritic papules.¹

Respiratory sensitization to insect allergens, in most cases work-related sensitization, has been reported for many insect orders, including cockroaches, flour moths, butterflies, and various flies, such as common houseflies, caddish flies, sewer flies, laboratory fruit flies, champignon flies, and sheep blow-flies.^{2–10} However, deer ked has not been previously described



Figure 1. The deer ked has a thin sucker and stout legs with sharp claw (Photo: Soili Jääntti).

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Received for publication June 14, 2004.

Accepted for publication in revised form November 22, 2004.

as a cause of respiratory or conjunctival allergy. We report an occupational deer ked–related allergic rhinoconjunctivitis in a research assistant who had been repeatedly heavily exposed to these insects.

CASE REPORT

A 42-year-old man had been working for 12 years as a research assistant in a geological institute. His previous history was negative for atopic diseases and exceptional insect bite reactions. The job included fieldwork in forests, where during the previous 2 years there had been local mass infestations of deer keds from late August to early October. All insect repellents had proved ineffective; therefore, the patient was forced to wear protective clothing and a cap equipped with an insect net. Nevertheless, deer keds occasionally bit him on the neck or scalp. During these 2 years, after experiencing deer ked bites, the patient began to have skin reactions that consisted of immediate wheals that appeared within 15 to 20 minutes and pruritic papules that lasted for several months. During his work in the forests, he began to experience acute rhinoconjunctivitis episodes that consisted of sneezing, profuse rhinorrhea, redness and itching of eyes, and lacrimation. At other times he had no symptoms. The patient connected his rhinoconjunctival symptoms with exposure to deer ked attacks, even in those cases when he had succeeded in avoiding the bites. At least once the patient had also experienced unilateral conjunctivitis without nasal symptoms when he had handled a glass jar that contained deer keds. During that occasion, he had been nowhere near a forest.

METHODS

Skin Tests

To prepare materials for skin prick testing (SPT) and nasal provocation testing (NPT), live deer keds were collected in the forest into a glass jar. The tests were performed with deer ked whole-body extracts that were prepared by crushing and mixing live deer keds with physiologic saline. The extracts were filtered through a Millex-GV filter (pore size, 0.22 μ m; Millipore Co, Billerica, MA). SPT with the deer ked extract was started at a concentration of 1.50 mg/mL, and if the results were positive, SPT was continued at concentrations of 1.0 and 0.5 mg/mL. Furthermore, SPT was also made with 13 common environmental airborne allergens and 7 microbes (ALK-Abelló A/S, Hørsholm, Denmark), as well as latex (Alyostal, Stallergenes SA, Antony Cedex, France). SPT was performed and the results interpreted according to the recommendations of the European Academy of Allergology and Clinical Immunology.¹¹ Histamine hydrochloride (10 mg/mL) and allergen diluent were used as positive and negative controls, respectively. A wheal diameter of at least 3 mm and half of the histamine control was considered a positive response when there was no reaction with the negative control. The common allergens used in the SPT were pollen from birch, alder, 3 grasses (timothy, meadow grass, and meadow fescue), mugwort and dandelion, 4 animal danders (horse,

cow, dog, and cat), 2 house dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*), and latex. The microbe SPT was performed with *Aspergillus fumigatus*, *Cladosporium herbarum*, *Chaetomium globosum*, *Geotrichum candidum*, *Mucor racemosus*, *Penicillium brevicompactum*, and *Penicillium expansum*.

In Vitro Tests

In addition to serum total IgE, laboratory tests included ImmunoSpot and radioallergosorbent test (RAST) assays, which were used to demonstrate serum specific IgE antibodies to deer ked.³ In the ImmunoSpot assay, IgE antibodies were also evaluated to mold skin test extracts: *Alternaria alternata*, *A fumigatus*, *C herbarum*, and *P expansum* (ALK-Abelló A/S). IgE-binding fractions of deer ked extract and the specificity of the binding were evaluated in immunoblot and immunoblot inhibition studies as previously described.¹² In immunoblotting, deer ked proteins separated in nonreduced sodium dodecyl sulfate–polyacrylamide gel electrophoresis were probed with the patient's serum (1:2 vol/vol). In immunoblot inhibition, the patient's serum was preincubated with deer ked extract and as a control with a mold (*P expansum*) skin test extract (ALK-Abelló A/S). Autoradiography with iodine 125–labeled antihuman IgE antibody was used for detection.

Nasal Provocation Test

In the single-blinded NPT, one nasal cavity was at first challenged with physiologic saline (the negative control). A volume of 0.05 mL of this fluid was sprayed with a 1-mL syringe filled with air and equipped with a thin needle toward the inferior and middle turbinate of one nasal cavity while the patient was holding his breath. Nasal reactions were monitored during the following 15 minutes. NPT with the deer ked extract (0.35 mg/mL wt/vol) was then performed in the other nasal cavity. The supernatant of this fluid was sprayed into the nose as described previously, and nasal reactions were monitored and recorded at 15-minute intervals for 60 minutes. The interpretation of the challenge test was based on (1) rhinoscopy findings (hypersecretion and mucosal edema) and symptoms (obstruction and nasal itching and sneezing), (2) minimum cross-sectional area changes in acoustic rhinometry, and (3) resistance changes in rhinomanometry. The test result was considered positive if hypersecretion (weighed) and at least 1 of the other objective findings or symptoms were recorded.¹³

Conjunctival Provocation Test

Conjunctival provocation testing (CPT) was performed by touching the lateral conjunctiva with the wing of a deer ked for 5 seconds. Touching with a piece of cotton wool served as a negative control. A positive response in CPT consists of itching, tearing, and conjunctival hyperemia and redness, accompanied sometimes by conjunctival edema.¹⁴

Furthermore, SPT, NPT, and CPT were also performed in 6 female control subjects, aged 32 to 57 years (mean age, 47 years). They all were working in health services. Among

them, there were 3 atopic persons and 3 persons, one of them atopic, who had sometimes experienced deer ked bites but had not experienced any symptoms related to the bites.

RESULTS

The results of SPT with the deer ked extract were positive at all tested concentrations, and the weakest extract (0.50 mg/mL) resulted in a 4-mm positive wheal. The results of SPT with standard allergens were positive only for *C herbarum* (3-mm wheal) and *P expansum* (4-mm wheal). Histamine hydrochloride evoked a 6-mm wheal, whereas allergen diluent gave no wheal.

The serum total IgE level was elevated (132 kU/L; reference range, 0–87 kU/L). Deer ked-specific IgE antibodies were demonstrated in RAST and ImmunoSpot assays. In the RAST assay, we noted a 5% binding from the patient's serum compared with 1% binding from the nonatopic control serum. Also the ImmunoSpot assay demonstrated a distinct IgE binding to deer ked extract but only a faint binding to mold extracts (Fig 2). In immunoblotting studies, IgE-binding bands were demonstrated in deer ked extract at approximately 17, 33, 70, and 85 kDa, which were completely inhibited with the deer ked extract but not with the control mold extract (Fig 3).

NPT with the control fluid caused neither subjective symptoms nor objective signs in the challenged nasal cavity.

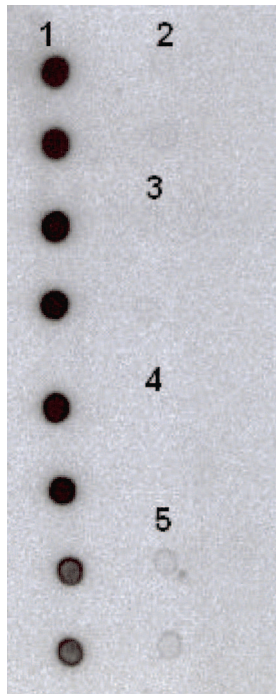


Figure 2. IgE binding to deer ked and molds in ImmunoSpot. Lane 1, deer ked extract (1:10 wt/vol) and three 2-fold dilutions in duplicates; 2, *Alternaria alternata*; 3, *Aspergillus fumigatus*; 4, *Cladosporium herbarum*; and 5, *Penicillium expansum*.

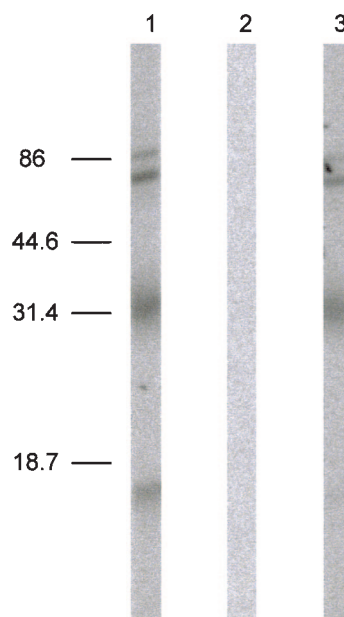


Figure 3. IgE binding from the patient's serum to deer ked proteins in immunoblotting after nonreduced sodium dodecyl sulfate–polyacrylamide gel electrophoresis (lane 1). The binding was totally inhibited by preincubation of the serum with deer ked extract but not with the mold skin test extract (*Penicillium expansum*). Molecular weight markers in kilodaltons appear on the left.

Subsequently, when deer ked fluid was sprayed into the other nasal cavity, the patient began immediately to sneeze. Within a couple of minutes, he reported watery rhinorrhea and ipsilateral nasal obstruction. In rhinoscopy, there was profuse clear secretion and mucosal swelling on that side. Both rhinoscopic and rhinometric criteria for positive NPT results¹³ were clearly fulfilled, rhinorrhea being the most prominent response. In CPT, an ocular response with itching, tearing, and redness of the conjunctiva developed in a few minutes. The results of SPT, NPT, and CPT were negative in all of the controls.

DISCUSSION

A few previous reports exist of occupational respiratory or conjunctival insect allergy, where sensitization has been a consequence of occupational exposure to large numbers of insects and inhalation of their emanations.^{2–10} In those previous cases, the exposure has taken place indoors (eg, inside a barn or a laboratory), whereas the patient described herein became exposed and sensitized to deer keds when working outdoors.

When our patient was working in the forests, he was attacked by hundreds of deer keds. Although he usually succeeded in avoiding most bites by wearing protective equipment, he experienced rhinoconjunctivitis, which in his case was the most severe deer ked-related problem. Occa-

sionally, eye symptoms could be related to hand-to-eye contact, but often the rhinoconjunctivitis occurred also in the absence of bites or other direct contacts. It is probable that exposure to small inhalable airborne particles was the main cause of the rhinoconjunctival symptoms rather than actual bites or direct contacts with deer keds.

Our patient's skin reactions to deer ked bites consisted of immediate wheals and pruritic papules that persisted for several months. Dual skin reactions have previously been described following mosquito bites.^{15,16} The delayed skin reactions due to mosquito bites, which involve IgE, IgG1, and IgG4 responses and lymphocyte proliferation,¹⁷ however, do not endure as long as those noted following deer ked bites. Rantanen et al¹ suggested that the pathogenesis of deer ked bite reactions involves IgE-, complement-, and cell-mediated immune mechanisms and furthermore that the sensitizing antigens are probably derived from the salivary secretion, as is the case for many other hematophagous insects.

This study demonstrated an IgE-mediated rhinoconjunctival allergy to deer ked. SPT and NPT were performed with deer ked whole-body extracts, because commercial deer ked extracts are not available. Many previous studies of insect allergies have concluded that whole-body extracts contain clinically relevant allergens.²⁻⁹ Furthermore, immunoblot analyses have revealed that the whole-body extract contains antigens that are not present in the insect's saliva.¹⁸ When allergy tests are performed with whole-body extract, it is not possible to analyze which of the body components (wings, dust, exoskeleton, secretions, excreta) are the major sources of the allergens. We could demonstrate at least 4 IgE-binding fractions at 17, 33, 70, and 85 kDa in nonreduced deer ked extract. The nature of the allergens is not known, but 34- to 38-kDa tropomyosins have been shown to be pan-allergens among invertebrates.¹⁹ In the current study, the allergenicity of deer ked wing was demonstrated with a positive result in CPT.

NPT and CPT are straightforward and reliable in vivo tests that link SPT and in vitro test results to clinical symptoms. These tests are routinely used in Finland, because work-related sensitization (positive SPT or RAST results) alone, even in a symptomatic individual, is not legally sufficient for a diagnosis of occupational allergic rhinoconjunctivitis. The placebo-controlled and single-blinded tests are reliable if there is no reactivity to control fluid. In this patient, the placebo test results were clearly negative.

When an occupational respiratory disease is diagnosed, there is a legal requirement that there should be a reduction in the workplace exposure. This may be achieved by different measures that improve the working environment and conditions. Sometimes the only possibility is retraining of the worker for a new job. In the case described herein, the employee has been prohibited from working in the forests during the insect season.

To our knowledge, this case is the first report of deer ked-induced IgE-mediated occupational allergic rhinoconjunctivitis. On the basis of this study, it cannot be concluded

whether sensitization to deer ked was originally a consequence of inhalation exposure, bites, or both.

A good correlation among the clinical symptoms, exposure, and results of the allergy testing favor the hypothesis that deer keds may emanate allergenic substances that act as outdoor aeroallergens at least in cases of massive exposures. Deer ked bites were not necessary to induce symptoms of rhinoconjunctivitis in our patient. This finding is in concordance with earlier reports²⁻¹⁰ on the mechanisms of insect-related respiratory allergy.

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