

A Novel Case of Mealworm-Induced Occupational Rhinitis in a School Teacher

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ABSTRACT

A 47-year-old African American female elementary schoolteacher presented with itchy, watery eyes, rhinorrhea, postnasal drainage, and nasal congestion complicated by recurrent epistaxis for 2 months. She had similar symptoms the previous year from September to May but was symptom free during the summer. Her symptoms began within 1 hour after entering the classroom and improved in the evening at home, on weekends, and vacation. She denied symptoms around dust, freshly cut grass, or pets and had no prior history of underlying allergic rhinitis and asthma. She had a 20-pack-a-year smoking history but quit 1½ years ago. A detailed history of her classroom environment revealed the presence of mealworms that were used to teach the children about life cycles. Physical exam revealed swollen, erythematous nasal turbinates but was otherwise unremarkable. Prick skin testing was positive for oak tree, grasses, feathers, and cockroaches. Mealworm whole body extracts were prepared using standard methodology. Titration intracutaneous skin testing revealed a positive reaction at a 1:1000 concentration associated with a large delayed reaction 8 hours later that persisted for 24 hours. Specific nasal provocation using acoustic rhinometry revealed a dose response change in nasal volume (48% decrease at 1:100; 53% decrease at 1:50) and cross-sectional area (32% decrease at 1:100; 48% decrease at 1:50) in response to mealworm challenge compared with a saline control. Removal of the mealworms from the classroom resulted in complete relief of her symptoms. This is the first reported case of mealworm-induced rhinitis in a schoolteacher.

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Because mealworm demonstrations are now part of the standard curriculum in public school elementary classrooms in Ohio, it is important that school administrators recognize the sensitizing nature of these insects and their potential for causing allergic rhinitis and asthma in the workplace. (Allergy and Asthma Proc 23:41–44, 2002)

Various non-Hymenoptera insect species have been reported previously to cause skin sensitization and asthma in atopic individuals.^{1–5} Occupational asthma induced by beetles was first reported in a museum curator who was exposed to larvae used to digest flesh from zoological specimens.⁶ In 1967, Stevenson and Matthews reported a case of occupational asthma in a fish bait handler associated with exposure to larvae from the bee moth *Galleria mellonella*.⁷ This case was confirmed by specific bronchoprovocation. An immunoglobulin E (IgE)-mediated mechanism was confirmed by a positive prick test to a bee moth extract and a positive Prausnitz-Kustner reaction.⁷ *Tenibrio molitor* (Tm) beetles thrive in temperate climates and are found in areas where cereal is stored such as farms and in the cupboards of homes.⁸ Mealworms are the larvae of the Tm beetle and have been used commonly as live fish bait by fish anglers.⁸ They also are used as food for birds and reptiles.⁹ Previous studies have shown that inhaled particulates derived from the exoskeletons of Tm larvae are potent sensitizers and can induce IgE-mediated occupational asthma in fish handlers.¹⁰ A variety of allergic disorders including asthma, rhinoconjunctivitis, and urticaria have been reported after prolonged mealworm exposure in fishermen, grain handlers, and pet shop workers.^{8–11}

We report a novel case of occupational rhinitis in an elementary schoolteacher after prolonged exposure to mealworms in her classroom.

CASE REPORT

A 47-year-old African American female elementary schoolteacher presented with itchy, watery eyes, rhinorrhea, postnasal drainage, and nasal congestion complicated by recurrent epistaxis for 2 months. She had similar symptoms the previous year from September to May but was symptom free during the summer. Her symptoms began within 1 hour after entering the classroom and improved in the evening at home, on weekends, and vacation. She denied symptoms around dust, freshly cut grass, or pets and had no prior history of underlying allergic rhinitis and asthma. She had a 20-pack-a-year smoking history but quit 1½ years ago and was otherwise healthy. A detailed history of her classroom environment revealed the presence of mealworms that were used to teach the children about life cycles. Physical exam revealed swollen, erythematous nasal turbinates but was otherwise unremarkable. Prick skin testing to common seasonal and perennial allergens revealed cutaneous sensitization to oak tree, grasses, feathers, and cockroaches.

MATERIALS AND METHODS

Preparation of Mealworm Extract

Standard methodology was used to prepare a mealworm extract for cutaneous testing.⁸ A mixture of Tm exoskeletons and excreta was extracted in phosphate-buffered saline to make a concentrated solution of 1:20 wt/vol. Serial 10-fold dilutions were prepared for testing. All skin test reagents were Millipore filtered prior to use.

Skin Testing

Initially, prick skin testing to undiluted mealworm extract was performed followed by titration intracutaneous skin testing using 0.02 mL of mealworm extract at concentrations of 1:100,000, 1:10,000, 1:1000, and 1:100. Similar testing was conducted on two subjects without prior exposure to mealworms to exclude the possibility of an irritant response.

Nasal Provocation Using Acoustic Rhinometry

Acoustic rhinometry is a noninvasive technique that can be performed rapidly and reproducibly.^{12,13} Acoustic rhinometry measures sound waves that are transmitted into the anterior nares to map the anatomy of the nasal cavity. Results are recorded as changes in minimal cross-sectional areas and nasal volumes.^{12,13} Previous studies have shown that this technique correlates well with other methods that measure nasal patency. Acoustic rhinometry has been studied in a variety of settings over the past several years including nasal provocation in response to specific allergens.^{14,15}

The subject was instructed to withhold all medications 72 hours before the testing day. Acoustic rhinometry was performed at baseline to record right- and left-sided resistance, volume, and minimal cross-sectional area of each nasal

passage. The right nasal passage had the largest nasal volume and lowest minimal cross-sectional area (14.55 and 4.70 cm³, respectively). Therefore, the right nasal passage was selected as the challenge side whereas the left nasal passage served as a naive control side. Challenges were performed at 10-minute intervals using the right nasal passage only. Acoustic rhinometry was performed on each nasal passage before each challenge. Initially, 0.02 mL of saline was instilled beneath the right inferior turbinate. This was followed by graded challenges using 0.02 mL of 1:1000, 1:100, and 1:50 concentrations of mealworm extract. Acoustic rhinometry also was performed 30 minutes after the last challenge. The patient was brought back on a different day for acoustic rhinometry performed at baseline and after saline challenge to verify that changes in nasal resistance and volume after the graded mealworm challenges were not caused by the initial saline challenge. Acoustic rhinometry was performed every 10 minutes for 30 minutes on both nasal passages.

RESULTS

Prick skin testing to undiluted mealworm extract was negative. Titration intracutaneous skin testing revealed a positive reaction to the mealworm extract at a concentration of 1:1000 (6-mm wheal and 12-mm flare). This was associated with a large delayed (8-mm wheal and 12-mm flare) reaction after 8 hours that persisted for 24 hours.

Specific nasal provocation with mealworm extract using acoustic rhinometry revealed a dose-response change in cross-sectional area and nasal volume. Cross-sectional area decreased by 32% after challenge with a 1:100 concentration of mealworm extract and by 48% after challenge with a 1:50 concentration of mealworm extract compared with saline control (Fig. 1). Nasal volume decreased by 48% after challenge with a 1:100 concentration and by 53% after challenge with a 1:50 concentration of mealworm extract compared with saline control. Subsequent removal of the mealworms from the classroom resulted in complete relief of her symptoms.

DISCUSSION

MMealworms have been a well-documented cause of occupational asthma, rhinitis, and urticaria among live fish bait handlers.⁸⁻¹¹ This case is novel in that it illustrates the importance of obtaining a thorough workplace history in assessing patients with chronic rhinitis symptoms. Failure to elicit information regarding this patient's occupation would have entirely misdirected her evaluation and management. This case also emphasizes the need for clinicians to appreciate the importance of rhinitis in the workplace because it frequently precedes the development of occupational asthma.¹⁶

Case detection of this type requires a fundamental knowledge of the many causes of occupational asthma. Causes of

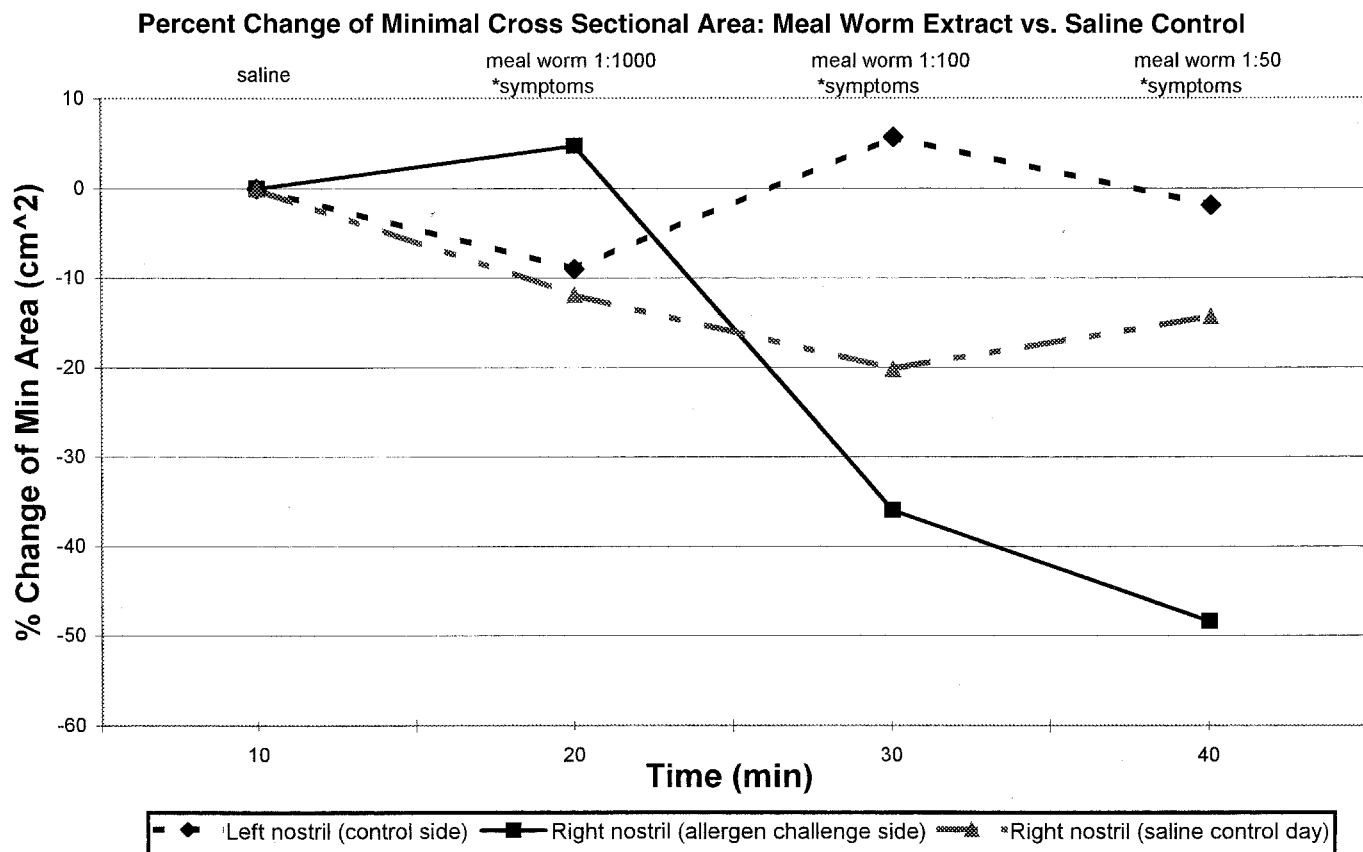


Figure 1. Percent change of minimal cross-sectional area (cm^2) in response to saline and mealworm allergen. Challenges were conducted on separate days. The right nasal passage was selected as the challenge side on both days because it had the greatest nasal volume and the least nasal resistance. The left nostril was used as the control side.

occupational asthma can be categorized as being caused by high molecular weight antigens (plant or animal proteins), low molecular weight agents (isocyanates or acid anhydrides), or irritant induced (toxic exposure to an irritant gas or fume). Occupational disease secondary to plant or animal proteins is much easier to evaluate and diagnose in that there is a classic exposure period followed by a latency interval during which time the individual becomes sensitized. Reexposure to the antigen in question after sensitization results in clinical symptoms. Confirmation of the diagnosis can be established by skin testing and/or *in vitro* assays to the suspected agent in most cases. In this case, after it was ascertained that the patient was exposed to mealworms in the classroom, we were able to prepare a whole-body mealworm extract for skin testing to confirm sensitization. To exclude an irritant response, similar testing was required in nonatopic, nonexposed controls.

Acoustic rhinometry is a noninvasive tool that can further help to confirm cases of occupational rhinitis. Nasal provocation can be more problematic because of continuous fluctuations in nasal resistance caused by natural physiological responses such as circadian rhythm. On each challenge day, we chose the nasal passage that elicited the largest

nasal volume or cross-sectional area. In this manner, post-challenge changes in nasal volume and cross-sectional area would be most apparent compared with the control nasal passage side. To assess whether changes in nasal volume and cross-sectional area were antigen specific, the subject was challenged to saline on a separate day under the same conditions. In this case, acoustic rhinometry proved to be a very simple method of confirming end organ sensitization to a specific antigen.

In conclusion, we present an index case of mealworm-induced occupational rhinitis in a schoolteacher. Her exposure history was confirmed by skin testing and acoustic rhinometry to the inciting agent, indicating skin sensitization and end organ hyperresponsiveness, respectively. Finally, her clinical symptoms completely resolved after the mealworms were removed from her classroom. This case should serve as a reminder to allergists that a probing clinical history can turn a seemingly mundane case into a fascinating experience.

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