Recurrent Otic Barotrauma in a Student Naval Aviator

Wayne T. Murphy, MD, LT, MC, USN

For military pilots, pharmacologic options to treat allergic rhinitis—and associated conditions, such as eustachian tube dysfunction—are limited. This case illustrates an alternative strategy that may succeed when available medications fail.

Eustachian tube dysfunction (ETD) can be a significant problem for individuals who frequently deal with changing atmospheric pressures—such as military flight personnel. The eustachian tubes play a key role in equalizing middle ear pressures, and the lack of proper pressure equalization can cause various problems. While ear pain and pressure are the most common and benign of these problems, greater pressure differentials can have more serious consequences, such as tympanic membrane rupture, ossicular disruption, or perilymphatic fistula. The most significant of these complications may cause severe vertigo and permanent hearing loss.

ETD has a variety of possible etiologies, including allergic disorders. Such allergic disorders have increased in prevalence over the past two decades, becoming a significant problem for millions of people.[1] While the widely accepted first-line treatment for allergic rhinitis is pharmacologic therapy, not all individuals achieve the desired result from such therapy. Moreover, potential adverse effects of some of the most effective pharmacotherapies for allergies preclude their use in certain populations, such as military pilots. And, for such individuals, successful resolution of allergic symptoms can mean the difference between being permitted to fly and being grounded permanently.

When medication fails to resolve allergic symptoms, allergy immunotherapy is an alternative option whose efficacy and safety is supported by placebo-controlled trials. In fact, unlike pharmacotherapy, immunotherapy has the potential to alter the course of allergic disease through its immunomodulatory effects, thus improving the patient's quality of life and possibly decreasing the need for chronic medication use.

This article describes the case of a military flight student who experienced recurrent otic barotraumas resulting from allergic ETD. This case demonstrates the limitations of pharmacologic therapy for such patients, and the important role allergy immunotherapy can play.

INITIAL EXAM

A 27-year-old, active duty, male, student naval aviator presented to his flight surgeon upon check-in for primary flight training. He reported a long history of perennial nasal stuffiness and rhinorrhea for which he had never sought treatment. He felt fine otherwise and did not have any fever, chills, sinus pain, cough, sore throat, dizziness, vertigo, or hearing loss.

Review of his medical records revealed bilateral ear pain during his initial hypobaric chamber flight earlier that month. At that time, he had been evaluated by a physician who documented a normal physical examination and normal tympanograms bilaterally.

Upon further questioning, the patient reported ear symptoms during commercial airline flights. Specifically, he experienced ear pain and difficulty clearing his ears with the Valsalva maneuver, the manual introduction of air into the middle ear spaces accomplished by exhaling against closed lips and a pinched nose. He had no significant past medical history and took no prescription or over-the-counter medications.

Physical examination revealed edema of the nasal mucosa and turbinates bilaterally, with clear nasal discharge. No nasal polyps were seen. Both tympanic membranes appeared normal, but when he was asked to perform the Valsalva maneuver, no movement of his tympanic membranes was observed in either ear.

TREATMENT COURSE

The flight surgeon counseled the patient at length on the proper Valsalva

LT Murphy is the senior naval flight surgeon for Training Airwing 4 at Naval Air Station Corpus Christi and the department head for flight medicine at Naval Hospital Corpus Christi, both in Corpus Christi, TX.

maneuver technique and prescribed oral loratadine and fluticasone nasal spray for presumed allergic rhinitis. A Waters view of his sinuses revealed no pathology. The patient was grounded per U.S. Naval Aerospace Medical Institute (NAMI) guidelines and instructed to follow up with the flight surgeon prior to his first flight.

On follow-up, he reported subjective improvement of his nasal congestion and rhinorrhea as well as his ability to clear his ears with the Valsalva maneuver. On examination, the flight surgeon observed tympanic membrane movement bilaterally during the Valsalva maneuver, although it was difficult to discern and more pronounced on the left side. Tympanometry demonstrated normal Type A curves in both ears. The patient was cleared for his first flight and instructed to follow up immediately if he developed symptoms while flying.

He returned two weeks later reporting bilateral ear pain during and after flights. His symptoms were particularly bad during descents, and his ear pain had continued for several hours following his last flight. Physical examination at this visit was normal and revealed no retraction, serous or hemorrhagic exudate, or rupture of either tympanic membrane. These findings were limited, however, by the fact that the patient had waited several days after his flight to return to the clinic. Once again, Valsalva maneuver was difficult to discern and movement was more pronounced on the left side. A computed tomography (CT) scan of the sinuses yielded normal results except for a mucous retention cyst dependently located in the left maxillary sinus, which was determined not to be a factor in the patient's ETD.

He was grounded and referred to an otolaryngologist. His workup included a CT of the skull and temporal bones, which revealed no abnormalities. The otolaryngologist recommended adding an antihistamine nasal spray and long-acting pseudoephedrine to his regimen. Unfortunately, because the adverse effect profiles of these two drugs preclude their use in naval aviation personnel, this treatment was not a viable option. As a last resort, the otolaryngologist recommended tympanostomy tubes to prevent further in-flight otic barotrauma. This option was considered but ultimately rejected due to its potential for complications.

Instead, the patient was referred to an allergist for allergy testing and optimal treatment of his presumed allergic ETD. Allergy testing with intradermal injections and scratch test confirmed an immunoglobulin (Ig) E–mediated hypersensitivity reaction to multiple allergens. The patient began an accelerated schedule of allergy immunotherapy shots, which he tolerated well without any adverse effects. After five weeks of treatment, he reached a maintenance dose and reported tremendous improvement in his subjective symptoms and with his Valsalva maneuver.

On repeat examination one week later, the patient was able to move air into his middle ear spaces using the Valsalva maneuver. Subsequently, he successfully completed a test flight to 10,000 ft in a U.S. Navy T-34C Turbo Mentor trainer aircraft without symptoms. NAMI granted a waiver to allow him to return to flying, and he went on to complete primary flight training without further incident.

ABOUT THE CONDITION

Otic barotraumas result when middle ear pressures are unable to equilibrate easily with ambient environmental pressures. Normally, the body achieves this pressure equalization through the eustachian tubes. As outside pressures change, actions such as yawning or swallowing cause the soft palate to tense and the eustachian tubes to open, permitting pressure equalization. If needed, a more forceful, manual introduction of air into the middle ear space may be accomplished through the Valsalva maneuver. This technique is taught to all military pilots early in their training.

Ear pain or pressure, with an inability to perform the Valsalva maneuver, is the most commonly reported consequence of poor pressure equalization. But more serious effects—such as mucosal capillary rupture, serous fluid exudate, and tympanic membrane rupture—also can occur. Temporary hearing impairment may result from poor compliance of a taut tympanic membrane. If the pressure differential is great enough, ossicular disruption and persistent hearing loss are possible, as well as rupture of the membranes separating the middle and inner ear. This rupture, known as a perilymphatic fistula, can result in both vertigo and sensorineural hearing loss. Tinnitus also may result from otic barotrauma—but typically resolves once the ear heals.

Common etiologies of ETD include eustachian tube obstruction from upper respiratory infection, acute otitis media, sinusitis, adenoid hypertophy, space occupying lesions (such as tumors or polyps), and anatomic abnormalities.[2,3] Mucosal edema associated with allergies also has emerged as an important contributing factor, with at least one study suggesting a direct link between allergies and in-flight otic barotrauma.[4–8] The case presented here provides further evidence of this link.

The treatment challenge

The mainstay of treatment for allergic rhinitis consists of intranasal steroids and oral antihistamines. Other phar-

Continued on page 14

Continued from page 12

macologic options include intranasal antihistamines, oral decongestants, leukotriene inhibitors, anticholinergics, and mast cell stabilizers.

Treatment of naval flight status personnel, however, is limited by potential adverse effects that are incompatible with piloting an aircraft.[9] In this case, the patient continued to have pain and difficulty clearing his ears in flight despite maximal use of intranasal steroids and oral, nonsedating antihistamines—the preferred first-line treatment for naval aviation personnel.[9] Pressure equalizing tubes were considered, but the risks of infection and other complications associated with this long-term treatment made it undesirable.

Role of allergy immunotherapy

Another treatment option available for some forms of allergic disease is allergy immunotherapy. This therapy involves the subcutaneous administration of allergens in sequentially increasing doses until a maintenance dose is reached. The most common protocol recommends weekly or biweekly dosing for approximately six months, followed by a monthly maintenance dose for several years.[1,10] In certain cases, however, accelerated schedules may be used to achieve quicker results.[11,12]

Controlled trials have demonstrated the efficacy of immunotherapy in treating allergic rhinitis, allergic asthma, and stinging insect allergies.[13–15] In these studies, immunotherapy consistently decreased allergy symptom scores to a greater degree than pharmacologic treatment, while also reducing the need for allergy medication.[13,15] Additional research suggests that this therapy may retard the transition from allergic rhinitis to asthma and prevent the development of new allergies.[16,17] In many patients, treatment benefits have continued indefinitely, even after injections are discontinued—although the endpoint of this benefit is unclear.[18–20] While there appear to be no studies that specifically address immunotherapy's utility in treating allergic ETD, it was effective in the case of this patient and allowed him to successfully complete his flight training.

Despite the success of immunotherapy, its mechanism has not been fully elucidated. Studies thus far have linked the beneficial effects of immunotherapy to down-regulation of Th2 lymphocyte-mediated responses and up-regulation of Th1 lymphocyte-mediated responses. Ultimately, these processes lead to a decrease in mast cell, IgE, eosinophil, and basophil inflammatory responses in the setting of an allergen exposure.[21]

While allergy immunotherapy is well tolerated by the vast majority of patients, it is associated with a risk of severe systemic reactions, including anaphylaxis. Local swelling and pruritis occur commonly at the injection site. More serious reactions, such as hypotension and respiratory symptoms, have been estimated to occur at a rate of one per one million injections.[22] Death following immunotherapy injection occurs at a rate of approximately one per 2.5 million injections, with an average of 3.4 deaths per year.[23]

Poor candidates for allergy immunotherapy include patients without evidence of IgE-mediated, type I, immediate hypersensitivity by positive skin testing or elevated allergen-specific serum IgE levels[1,10]; those taking beta-blockers; and those who are less likely to survive systemic allergic reactions because of comorbid medical conditions. Examples of such conditions include chronic lung disease, coronary artery disease, and uncontrolled hypertension.[1,10] Initiation of immunotherapy should be avoided in pregnant women—although continuation of therapy during pregnancy may be safe in certain cases.

Allergen immunotherapy is considerably more costly and time consuming than conventional allergy treatment because it requires allergy testing and must be administered regularly by a trained health care provider—sometimes, for many years. At least one study, however, has demonstrated that immunotherapy is more cost-effective than medication use alone for long-term treatment of allergic rhinitis and asthma.[24]

IN SUMMARY

This case demonstrates that allergies can contribute significantly to ETD, even resulting in otic barotrauma. As such, an allergic etiology should be investigated in any patient who presents with ETD, particularly with chronic symptoms. The case also illustrates the potential utility of allergy immunotherapy as a safe and effective alternative treatment for allergic ETD, especially when pharmacotherapy fails or is limited by unacceptable adverse effects. In this case, immunotherapy was used successfully to return a student naval aviator with persistent allergic ETD to flight training. While immunotherapy currently is too time consuming and expensive to replace pharmacotherapy as a first-line treatment, it appears to be an excellent alternative. Serious consideration should be given to the use of this therapy in appropriately selected patients.

Author disclosures

The author reports no actual or potential conflict of interest with regard to this article.

Disclaimer

The opinions expressed herein are those of the author and do not neces-

Continued on page 17

Contined from page 14

sarily reflect those of Federal Practitioner, *Quadrant HealthCom Inc., the U.S. government, or any of its agencies. This article may discuss unlabeled or investigational use of certain drugs. Please review complete prescribing information for specific drugs or drug combinations—including indications, contraindications, warnings, and adverse effects—before administering pharmacologic therapy to patients.*

REFERENCES

1. Stokes JR, Casale TB. Allergy immunotherapy for primary care physicians. *Am J Med*. 2006;119(10):820–823.
2. DeHart RL, Davis JR. *Fundamentals of Aerospace Medicine*. 3rd ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2002.
3. Seibert JW, Danner CJ. Eustachian tube function and the middle ear. *Otolaryngol Clin North Am*. 2006;39(6):1221–1235.
4. Skoner DP, Doyle WJ, Chamovitz AH, Fireman P. Eustachian tube obstruction after intranasal challenge with house dust mite. *Arch Otolaryngol Head Neck Surg*. 1986;112(8):840–842.
5. Ohrui N, Takeuchi A, Tong A, Iwata M, Nakamura A, Ohashi K. Allergic rhinitis and ear pain in flight. *Ann Allergy Asthma Immunol*. 2005;95(4):350–353.
6. Derebery MJ, Berliner KI. Allergic eustachian tube dysfunction: Diagnosis and treatment. *Am J Otol*. 1997;18(2):160–165.
7. Lazo-Sáenz JG, Galván-Aguilera AA, Martínez-Ordaz VA, Velasco-Rodríguez VM, Nieves-Rentería A, Rincón-Castañeda C. Eustachian tube dysfunction in allergic rhinitis. *Otolaryngol Head Neck Surg*. 2005;132(4):626–629.
8. Sente M, Sente R, Puleva K, Mileki NK. Allergic rhinitis as a possible cause of eustachian tube dysfunction [in Croatian]. *Med Pregl*. 2001;54(3–4):166–171.
9. ENT section. In: Metzger J, Maur E, eds. *U.S. Navy Aeromedical Reference and Waiver Guide*. Pensacola, FL: Naval Aerospace Medical Institute; March 13, 2007 (last update). http://www.nomi.med.navy.mil/NAMI/WaiverGuideTopics/pdfs/Waiver%20Guide%20-%20ENT.pdf. Accessed December 28, 2007.
10. Huggins JL, Looney RJ. Allergen immunotherapy. *Am Fam Physician*. 2004;70(4):689–696.
11. Cox L. Accelerated immunotherapy schedules: Review of efficacy and safety. *Ann Allergy Asthma Immunol*. 2006;97(2):126–137.
12. Smits W, Inglefield JT, Letz K, Lee R, Craig TJ. Improved immunotherapy with a rapid allergen vaccination schedule: A study of 137 patients. *Ear Nose Throat J*. 2003;82(11):881–887.
13. Ross RN, Nelson HS, Finegold I. Effectiveness of specific immunotherapy in the treatment of allergic rhinitis: An analysis of randomized, prospective, single- or double-blind, placebo-controlled studies. *Clin Ther*. 2000;22(3):342–350.
14. Golden DBK, Kagey-Sobotka A, Norman PS, Hamilton RG, Lichtenstein LM. Outcomes of allergy to insect stings in children, with and without venom immunotherapy. *N Engl J Med*. 2004;351(7):668–674.
15. Ross RN, Nelson HS, Finegold I. Effectiveness of specific immunotherapy in the treatment of asthma: A meta-analysis of prospective, randomized, double-blind, placebo-controlled studies. *Clin Ther*. 2000;22(3):329–341.
16. Möller C, Dreborg S, Ferdousi HA, et al. Pollen immunotherapy reduces the development of asthma in children with seasonal rhinoconjunctivitis (the PAT-Study). *J Allergy Clin Immunol*. 2002;109(2):251–256.
17. Finegold I. Is immunotherapy effective in allergic disease? *Curr Opin Allergy Clin Immunol*. 2002;2(6):537–540.
18. Grammer LC, Shaughnessy MA, Suszko IM, Shaughnessy JJ, Patterson R. Persistence of efficacy after a brief course of polymerized ragweed allergen: A controlled study. *J Allergy Clin Immunol*. 1984;73(4):484–489.
19. Des Roches A, Paradis L, Knani J, et al. Immunotherapy with a standardized *Dermatophagoides pteronyssinus* extract. V. Duration of the efficacy of immunotherapy after its cessation. *Allergy*. 1996;51(6);430–433.
20. Mosbech H, Osterballe O. Does the effect of immunotherapy last after termination of treatment? Follow-up study in patients with grass pollen rhinitis. *Allergy*. 1988;43(7):523–529.
21. Norman PS. Immunotherapy: 1999–2004. *J Allergy Clin Immunol*. 2004;113(6):1013–1023.
22. Amin HS, Liss GM, Bernstein DI. Evaluation of near-fatal reactions to allergen immunotherapy injections. *J Allergy Clin Immunol*. 2006;117(1):169–175.
23. Bernstein DI, Wanner M, Borish L, Liss GM; and Immunotherapy Committee, American Academy of Allergy, Asthma and Immunology. Twelve-year survey of fatal reactions to allergen injections and skin testing: 1990–2001. *J Allergy Clin Immunol*. 2004;113(6):1129–1136.
24. Ariano R, Berto P, Tracci D, Incorvaia C, Frati F. Pharmacoeconomics of allergen immunotherapy compared with symptomatic drug treatment in patients with allergic rhinitis and asthma. *Allergy Asthma Proc*. 2006;27(2):159–163.