

Allergic rhinitis and ear pain in flight

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Background: Ear pain is the most common physiologic incident in hypobaric chamber training in the Japan Air Self-Defense Force, and the incidence of ear pain has been gradually increasing. There has been a concomitant increase in the incidence of allergic rhinitis in Japan. We hypothesized that the increased incidence of ear pain may be due to the increased incidence of eustachian tube dysfunction associated with allergic rhinitis.

Objective: To explore whether there is an association between allergic rhinitis and ear pain experienced in hypobaric chamber training.

Methods: We examined 9 years of training records and noted whether there was a seasonal influence on the occurrence of ear pain in 7,047 trainees. In addition, we studied the prevalence of allergic rhinitis among trainees during a representative training year using a questionnaire method, noting association between allergic rhinitis and the occurrence of ear pain.

Results: Comprehensive review of training records showed 429 (6.1%) of 7,047 trainees complained of ear pain. Ear pain occurred more often in spring than the other 3 seasons. The questionnaire data showed 202 (23.0%) of 878 trainees had allergic rhinitis. Trainees with allergic rhinitis complained of ear pain more often in the spring than trainees without allergic rhinitis.

Conclusions: Active allergic rhinitis is closely associated with the occurrence of ear pain in hypobaric chamber training. A similar phenomenon might occur in an actual flight. Special attention should be paid to not only common cold but also allergic rhinitis in both hypobaric chamber training and actual flights.

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INTRODUCTION

Ear pain is a common physiologic incident in the aviation environment.^{1,2} We have previously reported that ear pain is the most prevalent physiologic incident in hypobaric chamber training in the Japan Air Self-Defense Force (JASDF) and that the frequency of ear pain during JASDF's hypobaric training has been increasing.³ Ear pain due to pressure changes typically occurs when a person is unable to equilibrate middle ear pressure with ambient air pressure through the eustachian tube⁴ due to eustachian tube dysfunction of various causes.

There have been reports of increases in the prevalence of allergic rhinitis in several countries in recent years.^{5–7} A similar trend of increased prevalence of allergic rhinitis has been reported in Japan. Many Japanese people have allergic rhinitis mainly in the spring season, because the main pollen for this allergy in Japan is cedar.^{8–10}

Allergic rhinitis can cause eustachian tube dysfunction.^{11,12} We, therefore, hypothesized that increased prevalence of allergic rhinitis in Japan may be the cause of the observed trend of increasing incidence of ear pain during JASDF hypobaric chamber training during the past decades. In this retrospective observational study, we investigated the association between ear pain and allergic rhinitis during hypobaric chamber training.

METHODS

The JASDF has 6 protocols for hypobaric chamber training: types I, II, and III, high altitude–low opening A, high altitude–low opening B, and rapid decompression,³ with type III training (Fig 1) being the type most often conducted throughout the year. In JASDF hypobaric training, trainees were screened for common cold and/or inability to pass air into the middle ear using a Valsalva maneuver. Presence of either condition resulted in disqualification from training. We con-

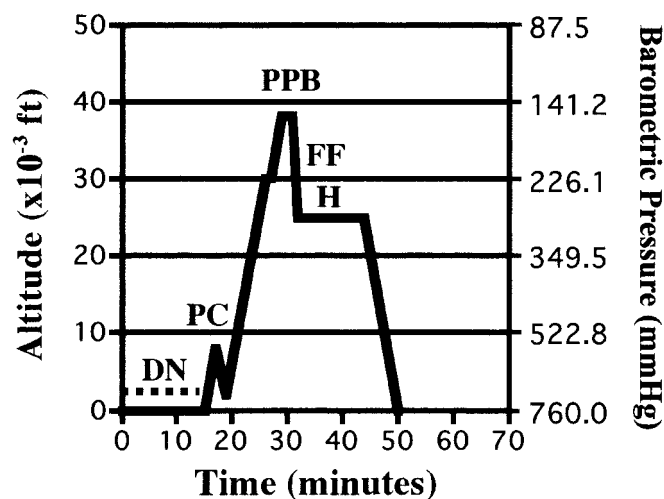


Figure 1. Profile of hypobaric chamber type III training. Ascent and descent rates are 4,000 ft/min except for free fall (FF), which is 12,000 ft/min. DN indicates denitrogenation; PC, precheck flight; PPB, positive pressure breathing; and H, hypoxia challenge.

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ducted a detailed historical review of the frequency of ear pain from 1990 to 1998 in 7,047 JASDF type III hypobaric trainees. We segregated the data into 4 distinct seasons and noted seasonal patterns. In addition, we administered a questionnaire to a representative year (1998) group of 878 trainees to ascertain presence of allergic rhinitis. We then compared the rate of ear pain from trainees with allergic rhinitis with the rate of ear pain from trainees without allergic rhinitis.

Definition of Seasons

The climatic pattern of Japan shows 4 distinct seasons during the following periods: spring (March to May), summer (June to August), autumn (September to November), and winter (December to February).

Definition of Ear Pain

The JASDF hypobaric trainees are instructed to report ear pain as soon as experienced, before training, to avoid serious damage. It is possible for a trainee to report more than 1 episode of ear pain during ascent or descent experienced in hypobaric training. We counted 1 occurrence of ear pain when a trainee complained of ear pain spontaneously during hypobaric chamber training.

Definition of Allergic Rhinitis

Allergic rhinitis was diagnosed when a trainee had 1 or more of the following symptoms seasonally or perennially for the past several years: watery rhinorrhea, sneezing, nasal obstruction or congestion, and eye and/or nose itching.

Statistical Analysis

Ear pain incidences segregated by season, from 1990 to 1998, are expressed as means $\pm$ SDs. A seasonal influence on the occurrence of ear pain was analyzed by comparing the occurrence rate among the 4 seasons by the Kruskal-Wallis rank test. If this rank test was statistically significant, each season was then further subjected to the Wilcoxon rank sum test with Bonferroni adjustment. Comparison of prevalence of ear pain between trainees with allergic rhinitis and those without allergic rhinitis during the spring season was performed with the Fisher exact test. $P < .05$ was considered statistically significant. All statistical analyses were performed using Dr. SPSS (version 8.0.1, SPSS Inc, Chicago, IL).

RESULTS

A total of 429 (6.1%) of 7,047 trainees complained of ear pain, totaling 625 times (1.5 times per affected person) in type III hypobaric chamber training during 1990 through 1998. Ear pain occurred more often in spring than the other 3 seasons (7.9% in spring, 5.1% in summer, 5.9% in autumn, and 5.4% in winter) (Fig 2). There was seasonal statistical significance except between spring and autumn.

Our questionnaire survey conducted during a representative year (1998) showed 202 (23.0%) of 878 trainees had allergic rhinitis. Most allergic rhinitis (71.3%) was identified in spring (Fig 3), with autumn being a distant second (4.5%). Cedar pollen is heaviest in Japan during spring.

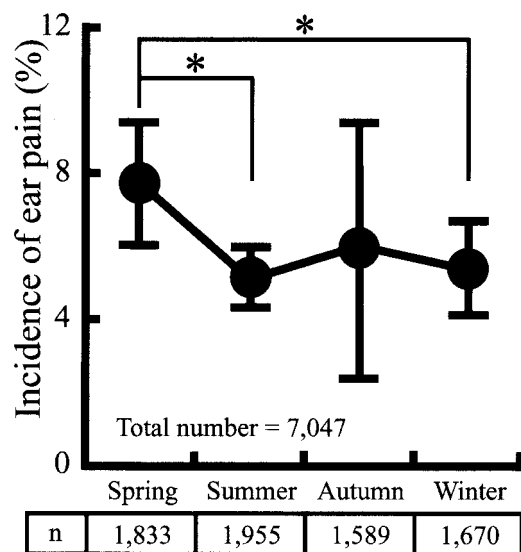


Figure 2. Seasonal changes of ear pain in type III training. Trainees complained of ear pain more often in spring than in summer and winter. Values are mean $\pm$ SD of 9 years from 1990 to 1998. The sample sizes (n) are the number of trainees. * $P < .05$.

Trainees with allergic rhinitis had ear pain more often than trainees without allergic rhinitis only in spring (Fig 4). Further statistical analysis focused on the spring showed that trainees with active rhinitis in spring complained of ear pain more often than trainees without active allergic rhinitis in spring (8 [13.3%] of 60 vs 10 [5.5%] of 181, $P = .049$) (Table 1). Three trainees did not have symptoms of allergic rhinitis during spring, and they were transferred to the group of trainees without active allergic rhinitis during spring. These data might indicate that allergic rhinitis, particularly in the active state, is closely related to eustachian tube dysfunction (ie, ear pain).

DISCUSSION

The eustachian tube ventilates between the middle ear cavity and the nasopharynx and equalizes the pressure within the middle ear cavity with that of the atmosphere. This mechanism is important in situations where ambient pressure changes, such as during flight or hypobaric chamber training. The pressure gradient between the middle ear and the atmosphere is spontaneously resolved during ascent.⁴ During descent, flutter-valve action of the eustachian tube prevents spontaneous equilibration.⁴ A person, therefore, needs to swallow or do a Valsalva maneuver to induce air pressure equalization during descent. Ear pain occurs when a eustachian tube does not ventilate the middle ear on descent and an abnormal pressure gradient is created. Eustachian tube dysfunction, therefore, induces people to have ear pain during descent in hypobaric chamber training.

We have reported that ear pain was the most prevalent incident in hypobaric chamber training in JASDF, accounting

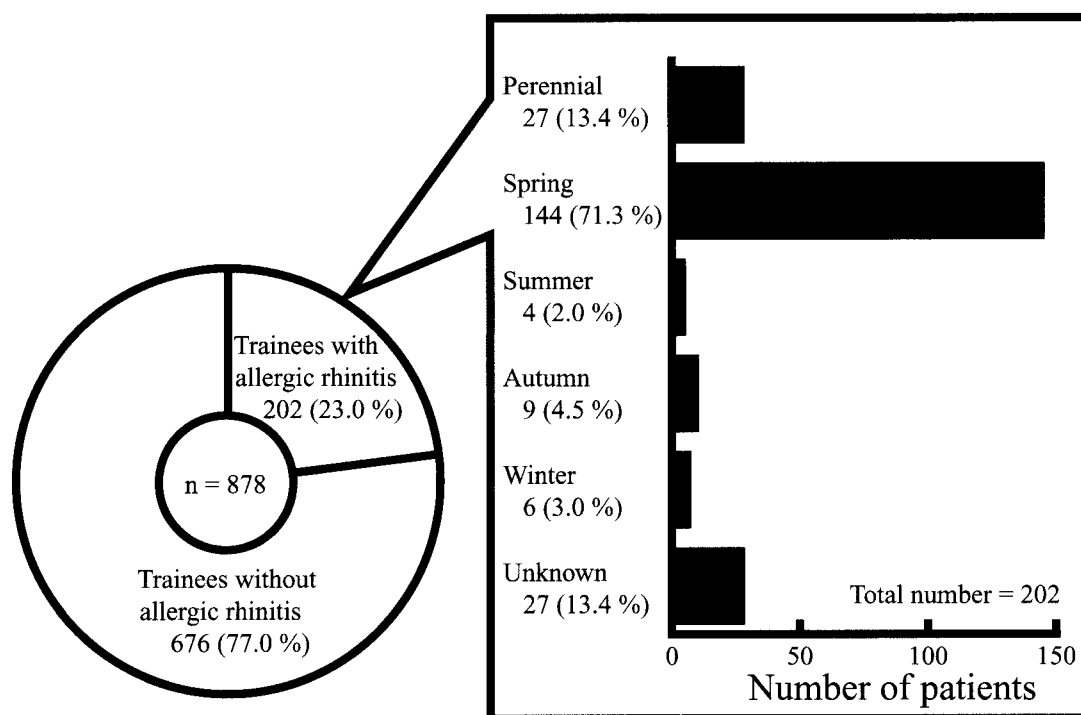


Figure 3. Seasonal distribution of allergic rhinitis of trainees. Approximately a quarter of trainees had allergic rhinitis, and most of them had it in spring.

for 76% of the total incidents.³ In addition, ear pain has been increasing gradually, from 3.6% to 4.6% before 1991 to 5.4% to 7.2% after 1991, whereas frequency of all other physiologic incidents have been stable throughout the period.³ As mentioned previously, ear pain tends to occur in a trainee with eustachian tube dysfunction. Our data indicate that JASDF hypobaric trainees are increasingly presenting with eustachian tube dysfunction. On the other hand, the marked increase in prevalence of allergic rhinitis is reported in Japan during recent years^{8,10} as in other countries.⁵⁻⁷ Previous studies indicate that allergic rhinitis induces eustachian tube obstruction.^{11,12} We, therefore, hypothesized that the increase of ear pain, that is, the increase of a trainee with eustachian tube dysfunction, was due to an increase of allergic rhinitis.

Our study revealed that many more trainees complained of ear pain in the spring than in the other seasons. Approximately a quarter of trainees have symptoms of allergic rhinitis, and three quarters of those have it in the spring. Many Japanese people have allergic rhinitis brought on by the spring cedar pollen release.^{9,10} Trainees with allergic rhinitis complained of ear pain more often than those without allergic rhinitis only in the spring. Furthermore, our study confirmed that ear pain was significantly more common among trainees with symptomatic allergic rhinitis during the spring season. Active allergic rhinitis and ear pain might be closely and causally related. We believe that active allergic rhinitis induces eustachian tube dysfunction as previously reported^{11,12} and causes the JASDF hypobaric trainees to experience and

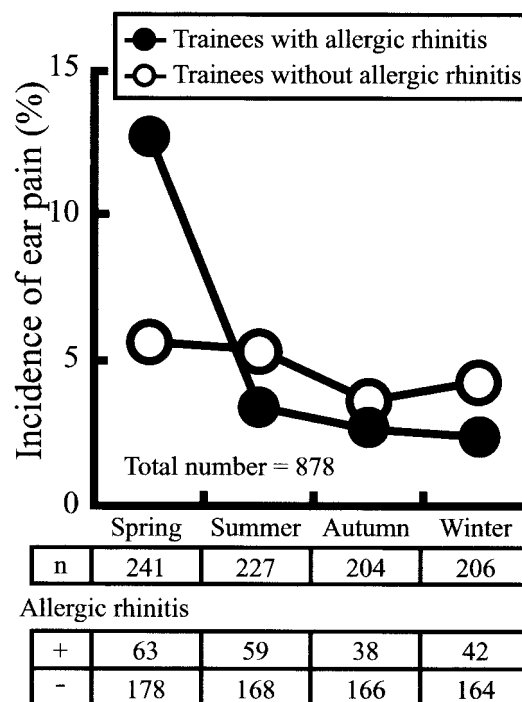


Figure 4. The effect of allergic rhinitis on the occurrence of ear pain. More trainees with allergic rhinitis had ear pain compared with those without allergic rhinitis only in spring. The sample sizes (n) are the number of trainees. Plus sign indicates presence of allergic rhinitis; minus sign, absence of allergic rhinitis.

Table 1. Relationship Between Ear Pain and Active Allergic Rhinitis During Spring*

	Incidence of ear pain		Total No. of trainees
	Yes	No	
Trainees with active allergic rhinitis during spring	8	52	60
Trainees without active allergic rhinitis during spring	10	171	181
Total No. of trainees	18	223	241

* Ear pain occurred more often in trainees with active allergic rhinitis than in those without active allergic rhinitis during spring ($P = .049$, Fisher exact test).

report ear pain during hypobaric chamber training. Active allergic rhinitis predisposes a trainee to have ear pain as common cold does. A US Navy study¹³ did not find an association between allergic rhinitis and barotraumas. As the author of the US Navy study discussed, this lack of association might be because the data were analyzed without excluding asymptomatic allergic cases. Our Fisher exact test also failed to detect significance in our study when subjects who reported allergic rhinitis of some sort but were asymptomatic in the spring were included.

This study clearly showed an association between active allergic rhinitis and ear pain during altitude-induced pressure changes. Allergic rhinitis predisposes people to barotraumas in pressure-changing environments such as flight and hypobaric chamber training. This is a recognized occupational hazard for all flight crews. This phenomenon may also affect aircraft passengers, although most civilian aircraft offer partially pressurized cabins, as evidenced by passengers flying with a cold who sometimes complain of ear pain in flight.

In conclusion, this study demonstrates that active allergic rhinitis is closely associated with occurrence of ear pain in hypobaric chamber training. Because allergies appear to become more common in the future, ear pain will continue to be the leading physiologic incident in hypobaric chamber training. Health care specialists need to recognize this trend that allergies increase and ear pain caused by eustachian tube dysfunction becomes more prevalent in the flying environment.

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