ACOUSTIC PERCEPTION OF HIGH-PITCH TONES BY PATIENTS WITH BRONCHIAL ASTHMA

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A regular and marked increase of hearing acuity at frequencies of 12, 16, and 20 kHz, by both air and bone conduction, is found in patients with bronchial asthma.

KEY WORDS: sensitization; allergy; bronchial asthma; hearing acuity.

Sensitization of the body to various antigens may be accompanied by changes in indices of physiological reactivity. An important index of this type is the acuity of hearing. The writers' previous experiments on animals [3] showed that at the height of sensitization of rabbits with horse serum their sensitivity to acoustic stimuli is increased, as shown by recordings of microphonic potentials from their inner ear. Information indicating that the upper limit of perceptible frequencies is shifted in patients with bronchial asthma is of great interest in this connection [6]. This fact may be considered in connection with other information in the literature to the effect that the sensitivity of patients with bronchial asthma to certain physical agents is increased [5, 7]. In the light of all these facts it was decided to study hearing acuity, i.e., to determine the thresholds of audibility of tones at the higher end of the audible range of frequencies, in patients with bronchial asthma.

EXPERIMENTAL METHOD

Tests were carried out on 30 patients with infectious-allergic asthma. They included 11 subjects aged 21-40 years and 12 aged 41-60 years. According to the classification of Ado and Bulatov [1] the asthma in 11 patients was mild, in 10 it was moderately severe, and in 9 it was severe. On investigation of the hearing of all the patients by traditional audiometry, i.e., over a range of frequencies from 0.1 to 8 kHz, normal thresholds for their age were found in 23 cases. In seven patients hearing was disturbed as a result of previous ear diseases. These seven patients were excluded from subsequent analysis.

In the remaining 23 patients hearing acuity was measured by air and bone conduction at frequencies of 12, 16, and 20 kHz by means of a specially developed method [4]. Since hearing acuity for high pitch tones is largely dependent on the subject's age, a group of 80 otologically normal subjects aged from 21 to 60 years was first investigated. The results of the investigation of hearing acuity of the patients were then compared with the age norms for both air and bone conduction. The tests of both air and bone conduction were carried out with the aid of a specially designed lead zirconate-titanate ceramic telephone and calibrated against the "Artificial Mastoid" wide-range instrument [2].

The vital capacity of the lungs and the forced vital capacity for 1 sec were determined for all patients, Tiffeneau's index was calculated, and pneumotachometry carried out. On this basis the functional state of the bronchi could be determined. The number of eosinophils also was counted in the patients' sputum and blood, their bacterial flora was investigated, and allergic skin tests were carried out with infectious and noninfectious allergens, depending on the history and the clinical manifestations of the disease.

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EXPERIMENTAL RESULTS

Measurement of the auditory thresholds at high frequencies revealed a marked increase in hearing acuity in the patients with bronchial asthma compared with healthy subjects of the corresponding age. In particular, in patients of the age group from 21 to 40 years the hearing acuity was increased during air conduction at a frequency of 12 kHz on the average by 7 dB and at 16 kHz by 12 dB. In patients of the age group from 41 to 60 years this increase in hearing acuity was 12 and 11 dB respectively ($P < 0.001$ compared with the control). The study of hearing acuity at a frequency of 20 kHz in these patients by air conduction did not give reliable results, for most of the subjects tested could not perceive this frequency sufficiently clearly.

Hearing acuity was increased even more in the patients with bronchial asthma at high frequencies when tested by bone conduction. Under these conditions the increase averaged 8 dB for patients of the first age group at frequencies of 12 and 16 kHz and 5 dB at a frequency of 20 kHz. The increase in hearing acuity for the patients of the second age group compared with the healthy subjects by bone conduction averaged 10 dB at a frequency of 12 kHz, 11 dB at 16 kHz, and 5 dB at 20 kHz ($P < 0.001$ in both groups). It will be noted that hearing acuity by air conduction did not go beyond a frequency of 16 kHz (frequencies of 20 kHz were perceived by only individual subjects in the age group from 21 to 40 years and could not be heard by any subject with normal hearing in the age group from 41 to 60 years). Meanwhile, by bone conduction the hearing acuity of all subjects could be assessed at frequencies not only of 12 and 16 kHz, but also at a frequency of 20 kHz.

It can thus be concluded that hearing acuity for tones at the upper end of the range of audible frequencies is increased in patients with bronchial asthma. On the one hand, this is in agreement with the shift of the upper limit of audible frequencies discovered by Mason [7] in patients with bronchial asthma, and on the other hand, it develops and provides a concrete clinical basis for the phenomenon of increased amplitude of the variable electrical potentials of the inner ear observed under the influence of sensitization by foreign protein discovered by the writers previously in experiments on animals [3]. The increase in hearing acuity for high-pitched tones observed in patients with bronchial asthma is also connected, it must be assumed, with sensitization. Whatever the case, in the overwhelming majority of patients there was a marked increase in the number of eosinophils in the blood and in the bronchial secretions. Skin tests indicated increased sensitivity of some of the patients to staphylococci, and in others to house dust or drugs. Meanwhile, comparison of the degree of increase of hearing acuity with the severity of the disease, its duration, and the indices of bronchial function revealed no direct correlation.

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