

ACOUSTIC IMPEDANCE METRY PARAMETERS IN OTOSCLEROSIS AND ADHESIVE OTITIS.

Makhmudova Saodat Kurbonbekovna

Resident 2nd year of the Department of Otorhinolaryngology

Abstract: The article is devoted to the study of otosclerosis, acoustic impedance testing will show a superficial tympanogram (type AS) or a normal tympanogram (type A) because otosclerosis increases the stiffness of the middle ear system, which may decrease conduction, and a stapedial reflex (or absence thereof) may be seen on reflex testing.

Introduction

Acoustic impedance metrology has great potential for diagnosing middle ear pathology. In otosclerosis, as a rule, normal function of the auditory tube is noted and tympanograms of type A and As are determined. At the initial stages of otosclerosis, a decrease in the amplitude of the acoustic reflex is characteristic. Later, with bone fixation of the stapes, contractions of the stapedius muscle, occurring in response to the action of a stimulating sound, are unable to overcome the immobility of the stapes, and the acoustic reflex disappears. According to the results of the study of most authors the acoustic reflex is not recorded in patients with otosclerosis. At the same time, in patients with otosclerosis, at high intensities of a sound stimulus of 110-120 dB, an altered acoustic reflex is sometimes recorded. In this case, a biphasic or inverse-phase reflex is most often noted. Most impedance meters record an inverted acoustic reflection or inverted acoustic effect. This reflex occurs with homolateral sound stimulation, while with contralateral stimulation the acoustic reflex is completely absent. In otosclerosis, inversion of the ipsilateral acoustic reflex occurs in 46-100% of patients with otosclerosis with stimulation at 110 dB with 500, 1000 and 2000 Hz. Detection of an inverted ipsilateral acoustic reflex and a normal tympanogram allow differentiating otosclerosis from other pathologies that lead to fixation of the middle ear ossicular chain. This can be used as a diagnostic test.

Pathophysiology

A positive Spearman correlation was found between the data obtained during tympanometry on the worse hearing ear and the duration of otosclerosis ($r = 0.151\ 887$ at $p = 0.01\ 122$). It was noted that with an increase in the duration of the disease, the compliance of the eardrum and the entire middle ear system decreases. No correlation was found between the tympanogram on the better hearing ear and other audiological signs.

Acoustic reflex assessment. An insilateral acoustic reflex of normal configuration with reduced amplitude on the first, worse hearing ear was noted in 1 patient ($0.36 \pm 0.36\%$), a 26-year-old man with unilateral otosclerosis and a hearing loss duration of 6 years. The reflex in this patient was recorded at a stimulus intensity of 110 dB at frequencies of 0.5 and 2 kHz. In 2 patients ($0.72 \pm 0.52\%$), the ipsilateral acoustic reflex was absent at all frequencies. In $98.92 \pm 0.62\%$ of patients, a decrease in the acoustic impedance of the middle ear was noted in the worse-hearing ear during homolateral sound stimulation with an intensity of 110-115 dB from one to three frequencies in the range of 0.5-2 kHz.

These changes in the resistance of the middle ear were expressed as an inverted ipsilateral acoustic reflex. At a frequency of 4 kHz, the acoustic reflex was absent in all patients. The contralateral acoustic reflex was not reproduced in the worse-hearing ear in any of the patients over the entire frequency range. In the second, better hearing ear, the ipsilateral acoustic reflex of normal configuration was noted in 20 ($7.19 \pm 1.55\%$), the reflex was absent in 10 ($3.6 \pm 1.12\%$) patients with otosclerosis. An inverted ipsilateral reflex was detected in 248 of 278 patients, which amounted to $91.18 \pm 1.7\%$. With counterstimulation from the first ear, a normal acoustic reflex with reduced amplitude was reproduced in 22 patients ($7.91 \pm 1.62\%$) in the second ear at a sound stimulus intensity of 90-110 dB, all with unilateral hearing loss.

With unilateral hearing loss with normal hearing in the second ear, the following picture was obtained in 22 of 278 patients. In the first, worse hearing ear, an inverted ipsilateral reflex was determined in all patients. On the better hearing ear, the normal acoustic reflex was noted in 19 patients, which amounted to $6.83 \pm 1.51\%$ of the total number of patients in this group, inverted - in 2 patients ($0.72 \pm 0.51\%$), and in 1 patient the ipsilateral reflex was completely absent. When comparing according to Wilcoxon, differences in the acoustic reflex between the better and worse hearing

ears were significant, $p = 0.000\ 037$. A positive correlation was found according to Spearman between the change in the acoustic reflex with the worse hearing ear and the age of patients ($r = 0.1178$, $p = 0.04972$).

Adhesive otitis media is a chronic inflammatory process in the middle ear, leading to the formation of adhesions and connective tissue strands that cause obstruction of the auditory tube and mobility of the auditory ossicles. Adhesive otitis media is manifested by the appearance of noise in the ear and hearing loss that worsens over time. Mandatory diagnostic tests for suspected adhesive otitis media include an examination by an ENT specialist, otoscopy, audiometry, a study of the patency of the auditory tube, and impedancemetry. Treatment for adhesive otitis media includes the introduction of proteolytic enzymes, lidase, hydrocortisone, and physiotherapy. If they are ineffective, surgical treatment (tympanotomy, tympanoplasty) and hearing aids are indicated.

The middle ear includes the auditory tube and the tympanic cavity, which contains the auditory ossicles (stapes, malleus, and incus). The tympanic cavity is separated from the auditory tube by the eardrum, which transmits sound vibrations to the auditory ossicles. Then, through the ossicles, the vibrations go to the structures of the inner ear, which are responsible for sound perception and the transmission of sound signals along the auditory nerve to the corresponding part of the brain.

Hearing loss in adhesive otitis media is associated with a decrease in the mobility of the auditory ossicles and eardrum, leading to a disruption of the sound conduction mechanism from the eardrum to the cochlea of the inner ear. However, over time, long-term adhesive otitis media can lead to a disruption of sound perception as a result of a decrease in the sensitivity of hair cells to endolymph vibrations and a decrease in the impulses emanating from them to the brain.

The most common cause of adhesive otitis media is the preceding exudative or catarrhal non-perforative otitis, chronic tubootitis. The development of adhesive otitis media after these diseases can be provoked by irrational antibiotic therapy.

As a result of the resolution of the inflammatory process and the resorption of the exudate accumulated in the tympanic cavity, fibrin threads remain in it and connective tissue adhesions and cicatricial cords are formed. The latter intertwine the auditory ossicles and are attached to the eardrum, blocking the mobility of these structures, which is necessary for normal sound conduction. At the same time, adhesions and cords of adhesive otitis media can also form in the auditory tube, which leads to a violation of its patency.

In clinical otolaryngology, there are often cases when adhesive otitis media occurs without preceding acute or chronic otitis. In such cases, the cause of its development are various pathological processes that impede the patency of the auditory tube and prevent normal ventilation of the tympanic cavity. These include: acute diseases of the upper respiratory tract (ARI, pharyngitis, tracheitis, laryngitis), chronic tonsillitis, adenoids, chronic inflammatory processes of the paranasal sinuses and nasal cavity (sinusitis, sinusitis, rhinitis), hypertrophic changes in the inferior turbinates, tumors of the pharynx and nasal cavity, curvature of the nasal septum. The main complaints that a patient with adhesive otitis media presents are a gradual deterioration in hearing and the presence of noise in the ear. When questioning the anamnesis of such patients, it is possible to reveal previously noted acute or chronic otitis. Hearing examination in adhesive otitis media determines the conductive nature of hearing loss - hearing loss due to impaired sound conduction. The clinical symptoms of adhesive otitis media are few and similar to those of other ear diseases. Therefore, to diagnose the cause of the detected hearing changes, it is necessary to carry out a number of diagnostic measures and exclude other pathological processes that lead to conductive hearing loss (cerumen plugs, traumatic damage to the structures of the middle ear, tubootitis, otosclerosis, etc.).

Diagnostic examination for adhesive otitis media includes a visual examination by an otolaryngologist and a number of special studies: determining the patency of the Eustachian tube, otoscopy, microotoscopy, audiometry, impedancemetry, endoscopic catheterization of the auditory tube. Audiometry. Audiometry reveals hearing loss of varying severity up to complete deafness in patients with adhesive otitis media. Politzer blowing. To determine the patency of the auditory tube, a test blowing is performed. In adhesive otitis media, it usually provides a weak improvement in hearing or has no effect at all. However, this does not always clearly indicate impaired patency. Otoscopy. The most important point in the diagnosis of adhesive otitis media is the identification of a characteristic otoscopic picture of the disease. Otoscopy (simple and with magnification) determines the retraction of the eardrum, its opacity and the presence of cicatricial changes, in some cases causing deformation of the membrane. In the cavity of the auditory tube, strands and adhesions are visualized, sometimes completely obliterating its lumen.

Acoustic impedancemetry. Allows you to assess the mobility of the eardrum and auditory ossicles. It consists of thickening and rarefaction of the air in the auditory tube, as a result of which the eardrum is drawn in and straightened. With adhesive otitis media, the movements of the membrane are limited or completely absent, acoustic muscle reflexes are not evoked.

Discussion.

Correlation dependencies indicate that with increasing age of patients and duration of the disease, the frequency of occurrence of the inverted acoustic reflex in the worse hearing ear increases. In the better hearing ear, a relationship is noted between the increase in audiological signs of otosclerosis, especially the thresholds of air conduction and the bone-air interval, with the tendency of the ipsilateral acoustic reflex to inversion. In addition, the correlation of the acoustic reflex with the manifestation of the Carhart tooth and a change in the differential threshold indicates a combination of these signs in the symptoms of otosclerosis with the presence of an inverted ipsilateral acoustic reflex. The diagnosis of otosclerosis was confirmed in 273 patients during surgical treatment.

Conclusion. Most patients with otosclerosis ($99.28 \pm 0.51\%$ in the worse hearing ear and 100% in the better hearing ear) had type A and type A3 tympanograms, indicating good ventilation function of the auditory tube. The tympanogram was predominantly type A, indicating sufficient mobility of the tympanic membrane. Correlation analysis showed a decrease in the compliance of the tympanic membrane with an increase in the duration of the disease.

In $98.92 \pm 0.62\%$ of patients with otosclerosis in the worse hearing ear and $91.18 \pm 1.7\%$ in the second ear, an inverted ipsilateral acoustic reflex was detected. This response was obtained for one or three frequencies in the range of 0.5-2 kHz at a sound stimulus intensity of 110-115 dB. Correlation analysis of the dependence of the acoustic reflex on other data showed that with increasing age of patients and duration of the disease, the frequency of occurrence of the inverted acoustic reflex in the worse hearing ear increases. In the better hearing ear, a relationship is noted between the increase in audiological signs of otosclerosis, especially the thresholds of air conduction and the bone-air interval, with the tendency of the ipsilateral acoustic reflex to inversion. In addition, the correlation of the acoustic reflex with the manifestation of the Carhart tooth and a change in the differential threshold indicates a combination of these signs in the symptomatology with the inversion of the ipsilateral acoustic reflex in otosclerosis.

Conclusions

1. In impedance examination of patients with otosclerosis, characteristic changes are tympanograms of type A. With an increase in the duration of the

disease, the compliance of the middle ear system decreases, which leads to the appearance of type A\$ tympanograms.

2. A characteristic sign of otosclerosis is the inversion of the ipsilateral acoustic reflex, which occurs in $98.92 \pm 0.62\%$ of patients in the worse hearing ear and $91.18 \pm 1.7\%$ in the second ear.

3. With increasing age of patients and duration of the disease, the frequency of occurrence of the inverted acoustic reflex in the worse hearing ear increases.

Tinnitus usually tends to increase as hearing loss progresses, and is much more difficult for patients to bear than with other forms of hearing loss. In some cases, tinnitus deprives patients of sleep and appetite and sometimes leads to despair, close to suicide. Subjective tinnitus is most often low-pitched and resembles the sound of falling water, wind, surf, rustling leaves, the hum of wires, and may resemble buzzing, hissing, or clicking. The noise is mostly constant, but may increase under the influence of alcohol, mental stress, fatigue, during a runny nose, after physical work, or sports activities.

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