ISSN: 2582-4686 SJIF 2021-3.261,SJIF 2022-2.889,
2024-6.875 ResearchBib IF: 8.848 / 2024

THE MULTIDISCIPLINARY JOURNAL OF SCIENCE AND TECHNOLOGY

VOLUME-4, ISSUE-3

SOME CONSIDERATIONS ON FUNCTIONAL ANATOMY OF THE INNER EAR AND CHANGES IN THE AUDITORY ORGANS

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Abstract. This article discusses the functional anatomy of the inner ear, age-related changes and structure of auditory organs and balance. It provides information on the anatomical features of the auditory field of the ear, the functional functions of the organ parts, internal features and pathological changes based on examples and analysis.

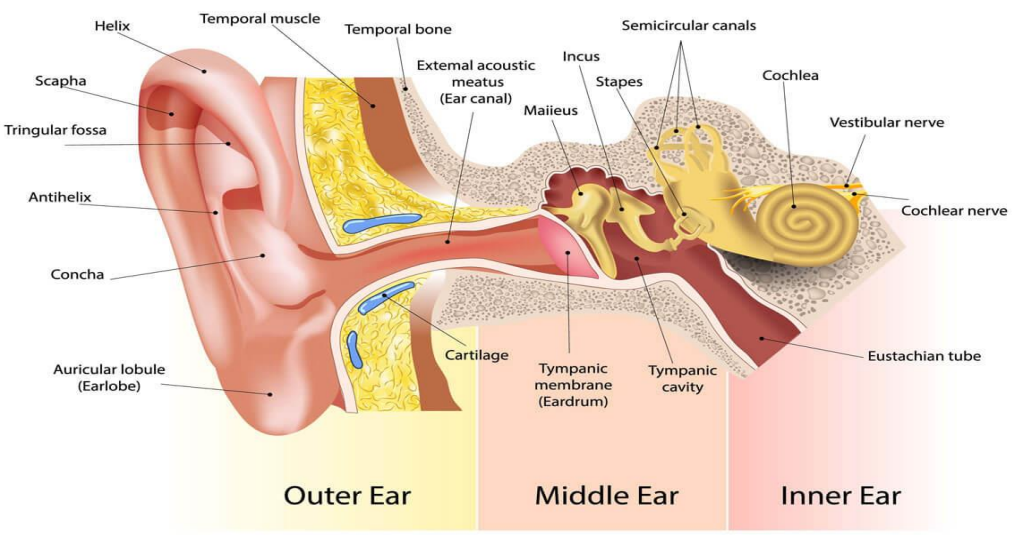
Key words: sound vibrations, inner ear, impulse, vestibule, malleus, stapes, semicircular canals.

INTRODUCTION

The main functions are auditory and vestibular. The auditory analyzer allows you to perceive sound vibrations and ensures the transmission of nerve impulses to the auditory nerve centers, where recognition of the received information occurs. The vestibular analyzer implements sensory, somatic and other reactions. The inner ear contains the cochlea, which contains receptor cells responsible for receiving sound waves. The organ was named cochlea due to its spiral structure. The cochlea converts sound waves into electrical signals, which are then transmitted to the brain to process and perceive sound.

The human ear is a complex organ that helps maintain communication with the outside world and gives a person information about his location and movement in space. It consists of three sections: external, middle and internal. The unique structure of the auditory organ ensures: reception, transmission of sound and conversion of vibration energy into a nerve impulse.

Sounds surround a person from birth. There are 3 sections of the hearing organ:



• *external ear;*

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• *middle ear;*

• *inner ear.*

The outer ear is the visible part of the organ. It is represented by the auricle and the external auditory canal. The concha is a funnel-shaped cartilage covered with skin. On its surface there are various formations: pits, curls, hills. They help improve sound quality, make it louder and direct it into the ear canal.

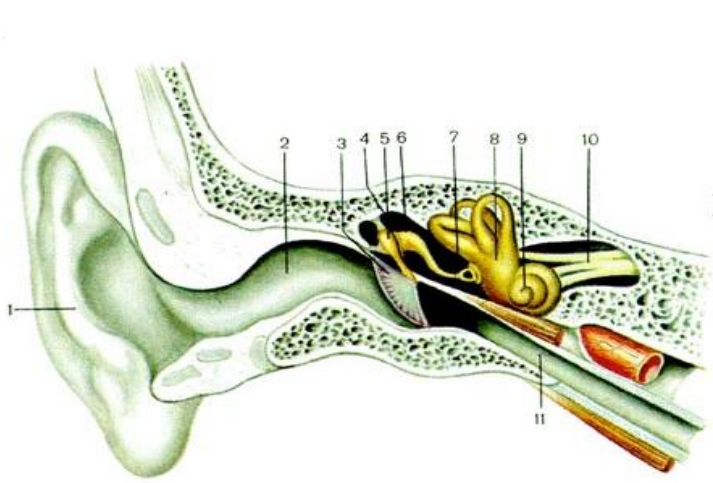
Material and methods

The fibers of the ear muscles are attached to the concha. In the process of evolution, man has lost the ability to "move his ears" in order to more accurately localize sounds; these muscles work in rare "lucky" people. The skin of the shell has sebaceous and sweat glands.

The external auditory canal is a winding canal, the length of which is slightly more than 2 cm, and the diameter is up to 0.7 cm. In it, the sound signal continues to be amplified and transmitted to the middle ear. The passage is lined with skin containing sebaceous and sulfur glands. Earwax is a yellowish substance that provides hydration to the canal and protection against infectious agents. When accumulated and compacted, it forms plugs that disrupt the movement of the eardrum. This can lead to conductive hearing loss.

Describing the structure of the auditory organ, anatomists indicate that the outer part of the canal has cartilaginous walls, and the part in contact with the middle ear has bone walls. The structures of the middle and inner ear are located in the body of the temporal bone. The eardrum is a thin membrane covered on the outside with skin and on the inside with mucous membrane. In young children, it has an opening that exposes the middle ear to the outside environment and is more vulnerable to infection and it closes by 3 years.

The middle ear is a cavity whose volume is slightly more than 1 cubic centimeter. It



contains three small auditory ossicles, which are connected to each other in a chain:

malleus – (malleus) attached to the eardrum,

anvil (incus)

stirrup (stapes) - inserted into the oval opening of the inner ear.

These ossicles are connected in series with each other and transmit vibrations from the eardrum to the inner ear.

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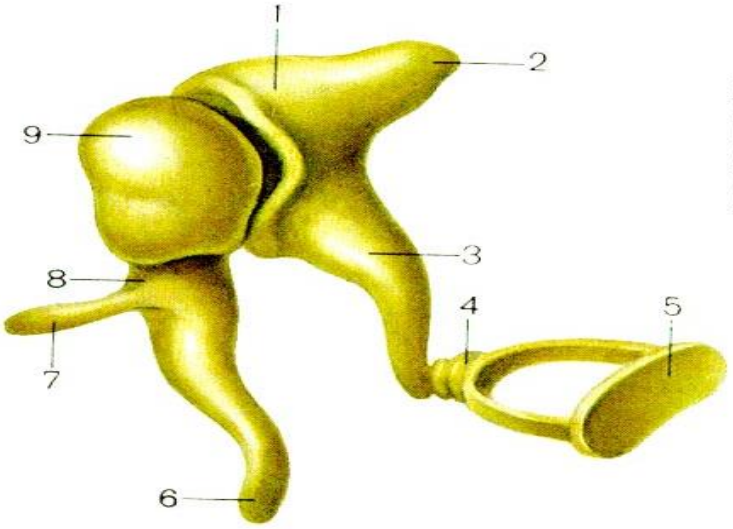

1 – corpus incudis;
2 – crus breve incudis;
3 – crus longum incudis;
4 – caput stapedius;
5 – basis stapedius;
6 – manubrium mallei;
7 – processus anterior mallei;
8 – collum mallei;
9 – caput mallei.

They are named so because of their resemblance to everyday objects. The stapes connects to the window of the vestibule. The middle ear is also connected to the nasopharynx via the Eustachian tube.

The inner ear is the most bizarre formation of the human auditory organ. It consists of:

• *vestibule (vestibulum);*

• *snails;*

• *semicircular canals.*

The organ of auditory includes only the cochlea. It contains lymphatic fluid and stretches fibers (the main membrane). Each of the fibers is like a small string and "responds" (resonates) to a sound of a certain frequency. There are about 25 thousand of these fibers. On the wall of the cochlear canal there is a receptor field, which consists of nerve (hair) cells - the organ of Corti. The death of hair cells can lead to sensorineural hearing loss.

The human ear is responsible not only for the perception and further transmission of sound information. The inner ear is the organ of hauditoryand balance. This is a complex formation in which a wave of mechanical vibrations, like sea surf, spreads through the lymphatic fluid and sways the processes of nerve cells, forming an electrical impulse. This signal carries information about the volume, duration, and pitch of sound to the brain.

Another part of the inner ear is the organ of balance (vestibular apparatus). It consists of: the vestibule, the three semicircular canals located in it, the utricle and the sac. The vestibule is a round-shaped cavity with a diameter of about 5 mm. It is located between the canals and the cochlea. The canals are mutually perpendicular and at the junction with the vestibule they have expansions - ampoules. The channels are filled with endolymphatic fluid.

The utricle and saccule are fields of nerve cells that perceive various irritations. A change in body position is registered by the receptors of the uterus and causes a reflex reaction of the muscles, helping a person maintain balance. The vibration is picked up by the ends of the sac. The vestibulocochlear nerve runs from the organ to the brain.

Results and discussion

When talking about the functions of the auditory organ, physiologists describe them in accordance with their anatomical structures. So, each department has its own specific tasks:

• catches sounds and sends them further (outer ear);

• transmits sound waves (outer and middle ear);

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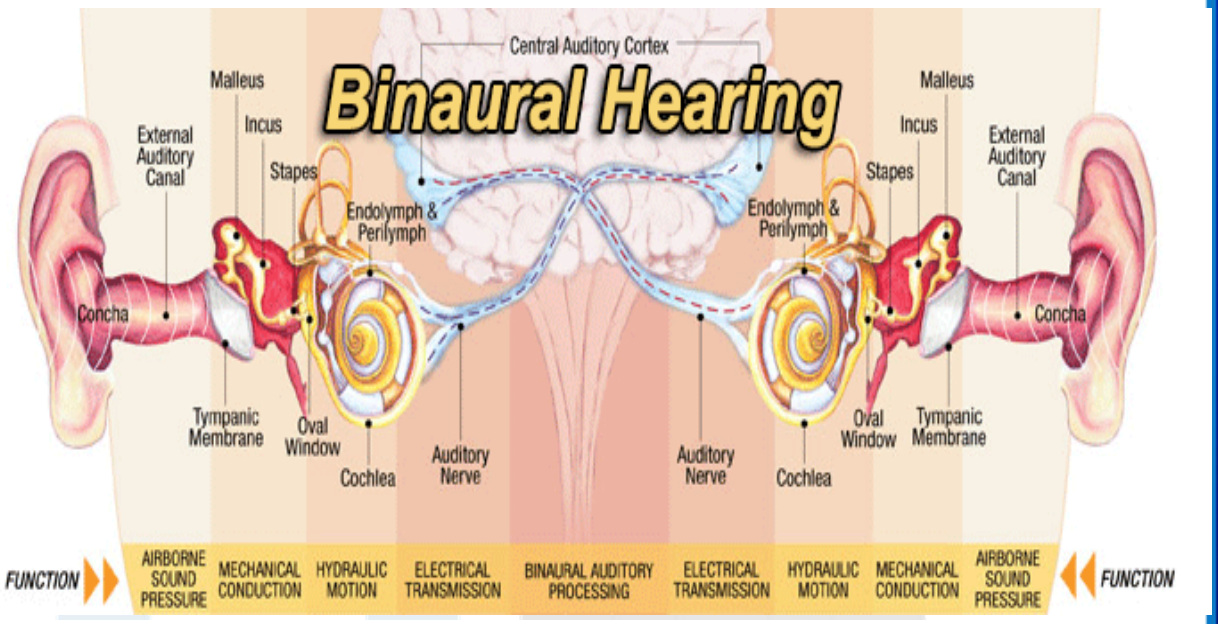
• protects against infections, loud sounds, damage to internal parts (outer ear, eardrum);

• transforms sound energy into electrical energy (inner ear).

The auditory functions are evolutionarily closely related to danger notification and communication in the community. In order to maintain your ability to hear for a long time, you must follow simple rules for preventing hearing loss.



Human auditory organs are paired. What does this mean? A person can listen with both the right and left ear at the same time. Binaural hearing gives more information about the sound and amplifies it under certain conditions.If the source of mechanical vibrations is at the same distance from the right and left ears, the signal volume increases by 50%. This means that in case of unilateral impairment, compensation with the help of a hearing aid of even low power significantly improves the quality of life.

Perceiving with two ears is better for determining the localization of sound. Binaural hearing gives:

• *feeling of surround sound;*

• *idea of the location of the source.*

This helps you avoid danger (such as an approaching car) and isolate useful sounds from all the background noise when talking to one person in a noisy room. If you experience any hearing problems, you must urgently undergo a hearing test using professional equipment. If you seek help in time, you have a chance to fully restore your hearing.

Special possibilities are associated with adaptation of the auditory organ and the cortical part of the analyzer in case of injury, simultaneous exposure to several sound waves, and the ability to “complete” a conversation based on existing experience.

The development of the temporal areas of the cerebral cortex occurs gradually in response to signals from the outside. The physiology of the auditory organ is such that if the cortical part of the analyzer is damaged, the surrounding neurons can take on the “responsibilities” of the dead cells. This phenomenon is called neuroplasticity. Its supply is especially large in children at an early age, which indicates the importance of auditory stimulation for brain and auditory development. The auditory pathways are a collection of nerve fibers responsible for transmitting nerve impulses from the cochlea to the auditory centers, which are located in the temporal lobes

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of the brain. This is where complex sounds, such as speech, are processed and analyzed. The speed of transmission of the auditory signal from the outer ear to the centers of the brain is approximately 10 milliseconds.

The ear sequentially converts sounds into mechanical vibrations of the eardrum and auditory ossicles, then into vibrations of the fluid in the cochlea, and finally into electrical impulses, which are transmitted along the pathways of the central auditory system to the temporal lobes of the brain for recognition and processing.

Receiving nerve impulses, the brain not only converts them into sound, but also receives additional information that is important for us. This is how we distinguish the pitch and volume of a sound and the time interval between the moments when the sound is captured by the right and left ear, which allows us to determine the direction in which the sound comes. At the same time, the brain analyzes not only the information received from each ear separately, but also combines it into a single sensation. In addition, our brain stores so-called “templates” of familiar sounds, which helps the brain quickly distinguish them from unfamiliar ones. With hearing loss, the brain receives distorted information, sounds become quieter and this leads to errors in their interpretation. The same problems can occur as a result of aging, head injuries and neurological diseases. This proves only one thing: for good hearing, the work of not only the hearing organ, but also the brain is important.

Adults do not have this ability, but communication experience allows them to replenish information that is lost during a conversation - for example, during a poor telephone connection or conversation in noise. This is achieved due to the increased work of neurons in the temporal regions and leads to rapid fatigue.

Conclusion

How does the ear react to very loud sounds? It has been proven that after exposure to such signals, a person develops a temporary decrease in hearing sensitivity. This is the so-called post-stimulus fatigue. Full recovery requires up to 16 hours. Such a mechanism should protect the hearing organ from damage, but people who listen to loud music for a long time involuntarily “turn it up loud” and harm their health.

Phantom sounds are another phenomenon that describes the functioning of the hearing organ. Sometimes a person “hears” low sounds, although in reality there are none. The peculiarity of vibrations of the cochlear membrane leads to the “appearance” of low-frequency sounds, while there is no signal source. Such vibrations, especially loud ones, have the interesting ability to mask high-frequency sounds until they disappear completely.

The hearing organs are complex and fragile formations. Attentive attention to their condition will help maintain health and prevent the development of a number of serious diseases.

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